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City of Oxnard

Public Works Integrated Master Plan

WASTEWATER

PROJECT MEMORANDUM 3.1
BACKGROUND SUMMARY

REVISED FINAL DRAFT
September 2017

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PREFACE

The analysis and evaluations contained in these Project Memorandum (PM) are based on data and information available at the time of the original date of publication, December 2015. After development of the December 2015 Final Draft PMs, the City continued to move forward on two concurrent aspects: 1) advancing the facilities planning for the water, wastewater, recycled water, and stormwater facilities; and 2) developing Updated Cost of Service (COS) Studies (Carollo, 2017) for the wastewater/collection system and the water/distribution system. The updated 2017 COS studies contain the most recent near-term Capital Improvement Projects (CIP). **The complete updated CIP based on the near-term and long-term projects is contained in the Brief History and Overview of the City of Oxnard Public Works Department's Integrated Planning Efforts: May 2014 – August 2017 section.**

At the time of this Revised PWIMP, minor edits were also incorporated into the PMs. Minor edits included items such as table title changes and updating reports that were completed after the December 2015 original publication date.

City of Oxnard

Public Works Integrated Master Plan

WASTEWATER

PROJECT MEMORANDUM 3.1
BACKGROUND SUMMARY

TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

BACKGROUND SUMMARY

1.0 INTRODUCTION

The City of Oxnard (City) owns and operates the Oxnard Wastewater Treatment Plant (OWTP) and the associated wastewater collection system. The City provides wastewater treatment to Oxnard and several surrounding communities. The City is permitted to discharge treated wastewater to the Pacific Ocean and in addition, a portion of the treated wastewater is used as recycled water after further treatment through the City's Advanced Water Purification Facility (AWPF).

This Project Memorandum (PM) will provide an overview of the existing OWTP and collection system, as well as summarize past OWTP planning reports, regulatory requirements and climate change issues the system will be facing.

1.1 PMs Used for Reference

Other Project Memoranda (PMs) that expand on the wastewater system needs/recommended projects include:

- PM 3.2 - Wastewater System - Flow and Load Projections.
- PM 3.3 - Wastewater System - Infrastructure Modeling and Alternatives.
- PM 3.4 - Wastewater System - Treatment Plant Performance and Capacity.
- PM 3.5 - Wastewater System - Condition Assessment.
- PM 3.6 - Wastewater System - Seismic Assessment.
- PM 3.7 - Wastewater System - Treatment Alternatives.
- PM 3.8 - Wastewater System - Arc Flash Assessment.
- PM 3.9 - Wastewater System - Cathodic Protection Assessment.
- PM 3.10 - Wastewater System - SCADA Assessment.
- PM 3.11 - Wastewater System - Biosolids Management.

1.2 Other Reports Used for Reference

In developing the wastewater background summary of this Public Works Integrated Master Plan (PWIMP), information from other reports were incorporated to ensure a well-rounded and holistic look at the wastewater system. The following reports are used in this PWIMP analysis:

- Oxnard Wastewater Treatment Facilities Plan, November 1985 (John S. Murk Engineers, 1985).

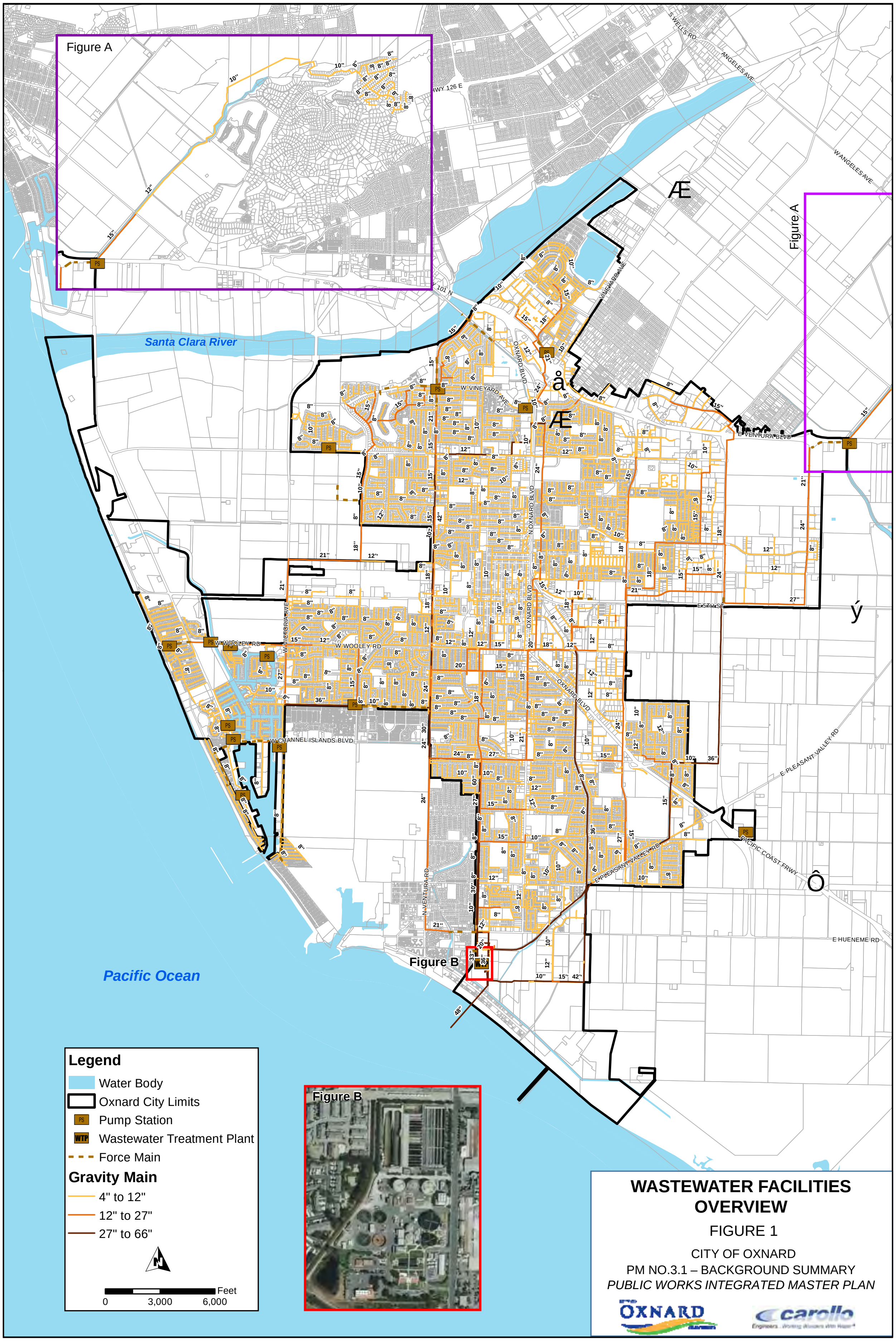
- Oxnard Wastewater Treatment Plant National Pollutant Discharge Elimination System (NPDES) Permit, Order No. R4-2013-0094, NPDES No. CA0054097. (NPDES Permit, 2013).
- Oxnard Wastewater Treatment Plant Operations and Maintenance Manual Volume 1-6, April 1980 (Brown and Caldwell, 1980).
- Oxnard Wastewater Treatment Plant Operations and Maintenance Manual Phase 1 Expansion Volumes 1-4, September 1991 (Camp Dresser McKee Inc., 1991).
- Oxnard Waste Discharge Requirements, Order No. R4-2008-0083 as amended by Order No. R4-2011-0079, File No. 64-104 and File No. 08-070, CI- 9456, (WDR, 2008).
- Cayan, D., P. Bromirski, K. Hayhoe, M. Tyree, M. Dettinger, and R. Flick (2006) Projecting Future Sea Level. A Report From: California Climate Change Center. CEC-500-2005-202-SF, (Cayan *et al.*, 2006).
- Walsh, J.E., *et al.* (2005) Cryosphere and Hydrology. In Arctic Climate Impact Assessment (ACIA): Scientific Report. pp. 184-242. Cambridge University Press, (Walsh, 2005).
- Mike Healey, Projections of Sea Level Rise for the Delta, Memorandum to Blue Ribbon Task Force, CALFED Independent Science Board, September 6, 2007. http://www.deltavision.ca.gov/BlueRibbonTaskForce/April2008/Item2_Attachment1.pdf, (Healy, 2007).

2.0 EXISTING WASTEWATER SYSTEM

The wastewater system provides collection, treatment, and disposal of wastewater for most of Oxnard and areas with institutional agreements with the City, which include the City of Port Hueneme, the Port Hueneme Water Agency, the Naval Base Ventura County facilities at Port Hueneme and Point Mugu, Ventura Regional Sanitation District, Crestview Mutual Water Company, Santa Clara Wastewater Company, Nyeland Acres, and Las Posas Estates. Figure 1 and Figure 2 show an overview of the wastewater collection and treatment system.

2.1 Overview

In 1955, the City of Oxnard constructed a wastewater treatment facility with an average dry weather flow (ADWF) capacity of 5 million gallons per day (mgd) that collected wastewater from throughout the City. The facility included raw sewage pumping, influent screening, primary sedimentation, an activated sludge secondary treatment process, effluent disinfection, and anaerobic digestion. Digested sludge was dewatered using on-site drying beds. Final effluent was transported through a 30-inch diameter cast iron outfall and discharged approximately 700 feet offshore.



WASTEWATER FACILITIES OVERVIEW

FIGURE 1

CITY OF OXNARD

PM NO.3.1 – BACKGROUND SUMMARY

PUBLIC WORKS INTEGRATED MASTER PLAN

OXNARD

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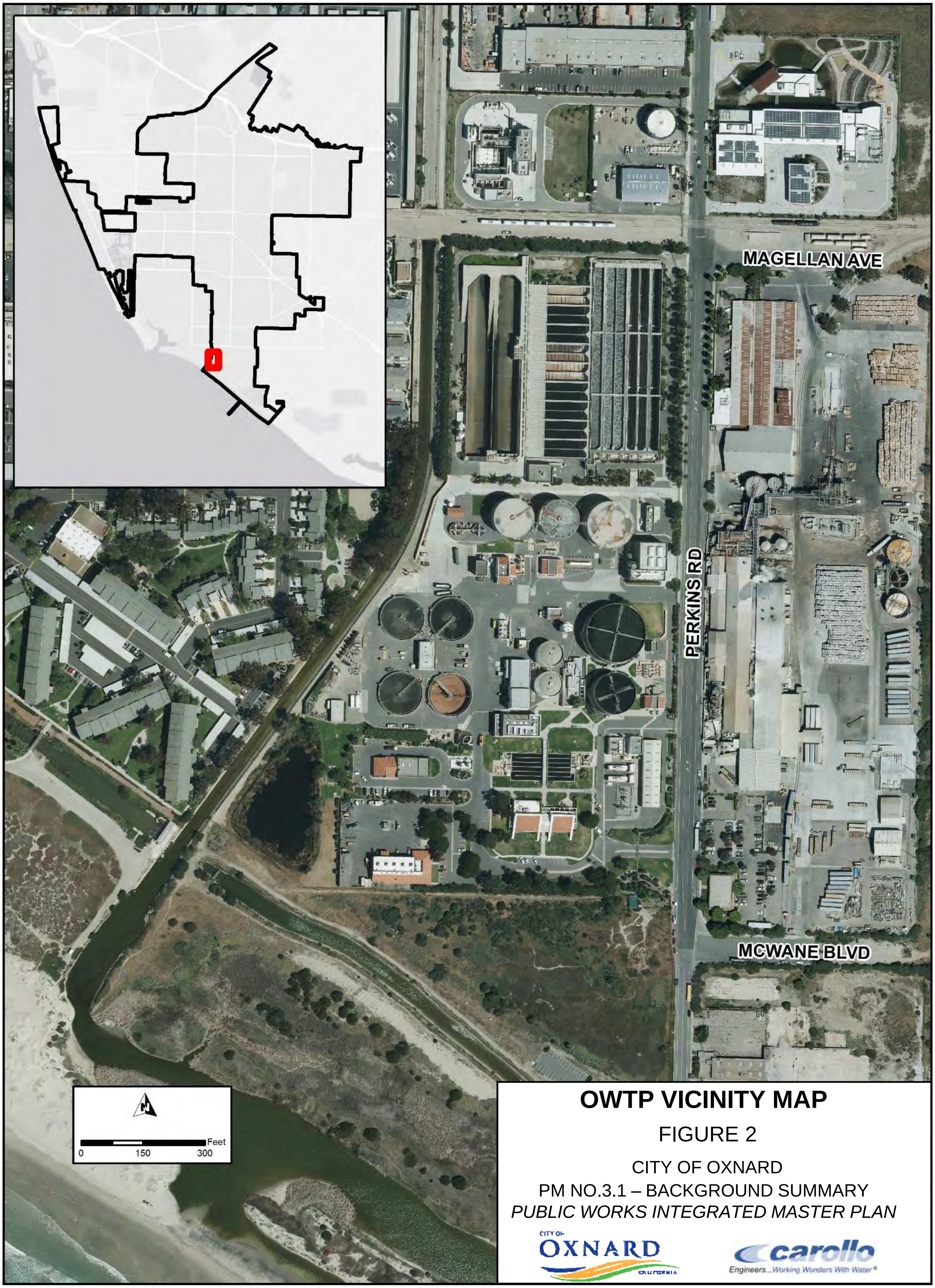


OWTP VICINITY MAP

FIGURE 2

CITY OF OXNARD

PM NO.3.1 – BACKGROUND SUMMARY

PUBLIC WORKS INTEGRATED MASTER PLAN

In 1964, the ADWF capacity was increased to 11 mgd by abandoning the existing activated sludge system and converting the existing aeration tank to a pre-aeration tank and the existing secondary clarifier to a second primary clarifier. This project also included a final effluent pumping station and a 48-inch diameter land outfall segment that tied into the existing 30-inch diameter outfall. In addition, a 4,816 foot long 48-inch diameter extension and a 384-foot long 48-inch diameter multiport diffuser, with 17 6-inch diameter ports, was added to extend the existing outfall.

A 1971 project expanded the ADWF capacity further to 25 mgd by adding a parallel advanced primary treatment train with flotation clarifiers. The existing anaerobic digesters were converted to a skimmings (scum) storage tank and primary sludge storage tank, respectively. A new solids handling building was constructed with vacuum filters for sludge dewatering and a multiple-hearth furnace for sludge incineration.

A 1975 project was designed to comply with the Ocean Plan enacted by the State Water Resources Control Board in the early 1970s. The primary clarifiers from the 1961 project were incorporated into two biofilters (trickling filters) to provide additional carbonaceous BOD (cBOD) removal and two of the flotation clarifiers from the 1971 project were converted to treat the trickling filter effluent. These secondary treatment facilities increased the overall cBOD and TSS removal to 92 percent. The multiple-hearth furnace was abandoned and two new anaerobic digesters were constructed for sludge stabilization upstream of the existing vacuum filters. Dewatered sludge was hauled to landfill. Additional facilities constructed in this project included a biofilter feed pumping station, chlorine contact tank, and digester gas-driven engine generators. The existing skimmings (scum) storage tank and primary sludge storage tank were converted to gravity thickeners.

The existing outfall diffuser was modified to provide the higher initial dilution required by the Ocean Plan. Inserts were added to the existing ports to reduce the diameter to 3 inches and an additional 106 3-inch diameter ports were drilled in the existing diffuser and the last 616 feet of the existing outfall. These modification increased the multiport diffuser length to 1,000 feet. Because a portion of the 1971 primary treatment facilities were incorporated into the new secondary treatment facilities, the ADWF capacity decreased to 22.6 mgd.

The ADWF capacity was increased to 31.7 mgd in a 1990 project that added an activated sludge treatment system downstream of the existing biofilters. Secondary effluent equalization (5 MG of storage) was added immediately downstream of the secondary clarifiers to limit the peak flow through the outfall to 50 mgd at the projected peak wet weather flow rate of 75.4 mgd. The aeration basins, rectangular secondary clarifiers, and secondary effluent equalization basins were constructed in a single structure at the north end of the OWTP site. Provisions were made for three future secondary clarifiers. This project also included modification of the existing flotation clarifiers to gravity primary settling tanks, modifications to the existing interstage pumping station to lift the trickling filter effluent to the new aeration tanks, two dissolved air flotation thickeners (DAFTs) to handle the new waste activated sludge (WAS) stream, a new anaerobic digester, a new belt filter press dewatering facility to replace the existing vacuum filters, modifications to the headworks, a new standby influent pumping system, new gaseous chlorine and sulfur dioxide storage and delivery facilities, and a new pump station for the Eastern Trunk line.

A new headworks structure, located north of the existing OWTP site, was constructed in a 2003 project. As part of this project the Eastern Trunk line was rerouted to the new headworks facility and the existing Eastern Trunk pump station located at the OWTP was decommissioned. The northeast interceptor and southeast interceptor flow by gravity into the new headworks structure, which included climber-type mechanical bar screens, aerated grit tanks, and a raw sewage pumping station. Raw screenings are washed and compacted and raw grit is washed and dewatered in an adjacent screenings and grit handling building. Solids handling recycles (gravity thickener overflow, DAFT overflow, and belt filter press filtrate) and other OWTP recycle streams are routed via the southeast interceptor to the new headworks structure. The preliminary treatment and raw sewage pumping facilities were designed for a maximum flow rate of 77.4 mgd.

In 2009, an advanced water purification facility (AWPF) was constructed to further treat undisinfected OWTP secondary effluent using membrane filtration (MF), reverse osmosis (RO), and ultraviolet/advanced oxidation (UV/AOX) process that provides disinfection and reduces micropollutant concentrations. The recycled water from the AWPF effluent is currently permitted for landscape irrigation, turfgrass irrigation, food crop irrigation, industrial or commercial cooling tower makeup, industrial boiler feed, and recreational impoundments. Planned future uses of AWPF recycled water include aquifer recharge for indirect potable reuse and as a barrier for seawater intrusion.

As of 2015, the City's OWTP is permitted to process up to 31.7 mgd of ADWF. The OWTP collection system includes roughly 384 miles of piping to convey waste from both within city limits and from the surrounding area. The OWTP is designed to remove conventional pollutants including biochemical oxygen demand (BOD_5), total suspended solids (TSS), and other pollutants regulated in the NPDES permit. Most of the treated effluent is discharged to the Pacific Ocean through the existing outfall. Stabilized and dewatered solids residuals are hauled to landfill.

2.2 Collection System

2.2.1 Description

The City's existing sanitary sewer collection system is comprised of roughly 384 miles of gravity collection system pipe from 4-inches in diameter up to 60-inches in diameter. As is typical for a community this size, most of the sewers are 8-inches in diameter (67 percent). Table 1 summarizes the pipe size distribution for the gravity sewers.

Table 2 summarizes the gravity sewer pipe by material. As shown in Table 2, the majority of the sewers are made of vitrified clay pipe (VCP) (70 percent) and Polyvinyl Chloride (PVC) (22 percent).

Table 1 Gravity Sewer Pipe Size Distribution
Public Works Integrated Master Plan
City of Oxnard

Pipe Diameter, in.	Length, ft	Length, miles	Percent of Total, %
4	1,953	0.4	0.1%
6	21,795	4.1	1.1%
8	1,367,230	258.9	67.4%
10	167,265	31.7	8.3%
12	100,282	19.0	4.9%
14	90	0.0	0.0%
15	91,076	17.2	4.5%
16	8,671	1.6	0.4%
18	42,563	8.1	2.1%
20	2,807	0.5	0.1%
21	34,966	6.6	1.7%
24	37,074	7.0	1.8%
27	29,918	5.7	1.5%
30	8,052	1.5	0.4%
33	6,112	1.2	0.3%
36	52,610	10.0	2.6%
42	26,699	5.1	1.3%
48	6,926	1.3	0.3%
60	15,417	2.9	0.8%
Unknown	6,660	1.3	0.3%
Total	**2,028,166**	**384.1**	**100.0%**

Notes
(1) Source: City GIS Database, June 2014.
(2) Table only accounts for active pipes. Inactive or abandoned pipes are excluded.
(3) Table only accounts for pipes owned by the City of Oxnard. Privately owned pipes or pipes owned by the County of Ventura are excluded.

Table 2	Gravity Sewer Pipe Material Public Works Integrated Master Plan City of Oxnard	
Material	**Length, ft**	**Percent of Total, %**
Asbestos Cement Pipe (ACP)	15,618	0.8%
Cast Iron (CIP)	1,275	0.1%
Centrifugally Cast, Glass-Fiber-Reinforced, Polymer Mortar (CCFRPM)	22,447	1.1%
Ductile Iron (DIP)	320	0.0%
Fiberglass Reinforced Pipe (FRP)	15,757	0.8%
High Density Poly Ethylene (HDPE)	64,559	3.2%
Polymer Resin Concrete (PRC)	3,816	0.2%
Polyvinyl Chloride (PVC)	453,325	22.4%
Reinforced Concrete Pipe (RCP)	14,641	0.7%
Vitrified Clay Pipe (VCP)	1,420,147	70.0%
Unknown	16,260	0.8%
Total	**2,028,166**	**100.0%**

Notes
(1) Source: City GIS Database, June 2014.
(2) Table only accounts for active pipes. Inactive or abandoned pipes are excluded.
(3) Table only accounts for pipes owned by the City of Oxnard. Privately owned pipes or pipes owned by the County of Ventura are excluded.

The City currently operates and maintains 15 lift stations throughout the City. All of the lift stations utilize a submersible pump configuration except for the Patterson & Hemlock Wastewater Lift Station which has a wet well configuration. All of the pump stations have a duty and a standby pump. Table 3 summarizes the wastewater lift stations in the service area.

Table 4 summarizes the lift station force main pipe size distribution. The force mains associated with the wastewater lift stations are composed of approximately 4.7 miles of pressurized pipe from 4-inches in diameter up to 20-inches in diameter. The majority of the pipes are 6-inches and 10-inches in diameter (67 percent).

Table 5 summarizes the age of the wastewater gravity and pressure force mains. Installation dates for the gravity mains were not readily available. Approximately 89 percent of the gravity mains do not have installation dates available in the GIS database, but all force mains had installation dates. Force main pipe ages ranged from 6 to 46 years old.

Table 3 Wastewater Lift Stations Public Works Integrated Master Plan City of Oxnard							
Lift Station No.	**Name**	**Type**	**Year Built**	**No. of Pumps**	**Rated Pump Capacity (gpm)**	**Rated TDH (ft)**	**Pump Op Strategy**
1	Cabezone	Submersible	1971	2	315	27	Duty/Standby
2	Harbor	Submersible	1970	2	200	55	Duty/Standby
4	Madalay & Wooley	Submersible	1986	2	600	46	Duty/Standby
6	Canal	Submersible	1986	2	1,000	40	Duty/Standby
7	Viewpoint	Submersible	2003	2	300	25	Duty/Standby
8	Seabridge	Submersible	2006	2	600	33	Duty/Standby
9	Oxnard High School	Submersible	2003	2	300	25	Duty/Standby
15	Cascade	Submersible	1970	2	300	30	Duty/Standby
20	Beardsley	Submersible	1965	2	1,100	15	Duty/Standby
23	Wagon Wheel	Submersible	1991	2	1,500	36	Duty/Standby
24	Handyman	Submersible	1971	2	500	24	Duty/Standby
27	Launch Ramp	Submersible	1977	2	230	18	Duty/Standby
28	Riverpark	Submersible	2006	2	1,395	32	Duty/Standby
29	Patterson & Hemlock	Wet Well	2004	2	5,400	80	Duty/Standby
			2004	2	3,700	37	Duty/Standby
30	Colony	Submersible	1984	2	450	66	Duty/Standby

Note:
(1) Source: City of Oxnard, October 2014

Table 4 Lift Station Force Main Pipe Size Distribution Public Works Integrated Master Plan City of Oxnard			
Pipe Diameter, in.	**Length, ft**	**Length, miles**	**Percent of Total, %**
4	245	0.05	1.0%
6	7,519	1.42	30.5%
8	264	0.05	1.1%
10	9,097	1.72	36.9%
12	3,952	0.75	16.0%
20	3,560	0.67	14.5%
Total	**24,637**	**4.67**	**100.0%**

Note:
(1) Source: City of Oxnard, October 2014

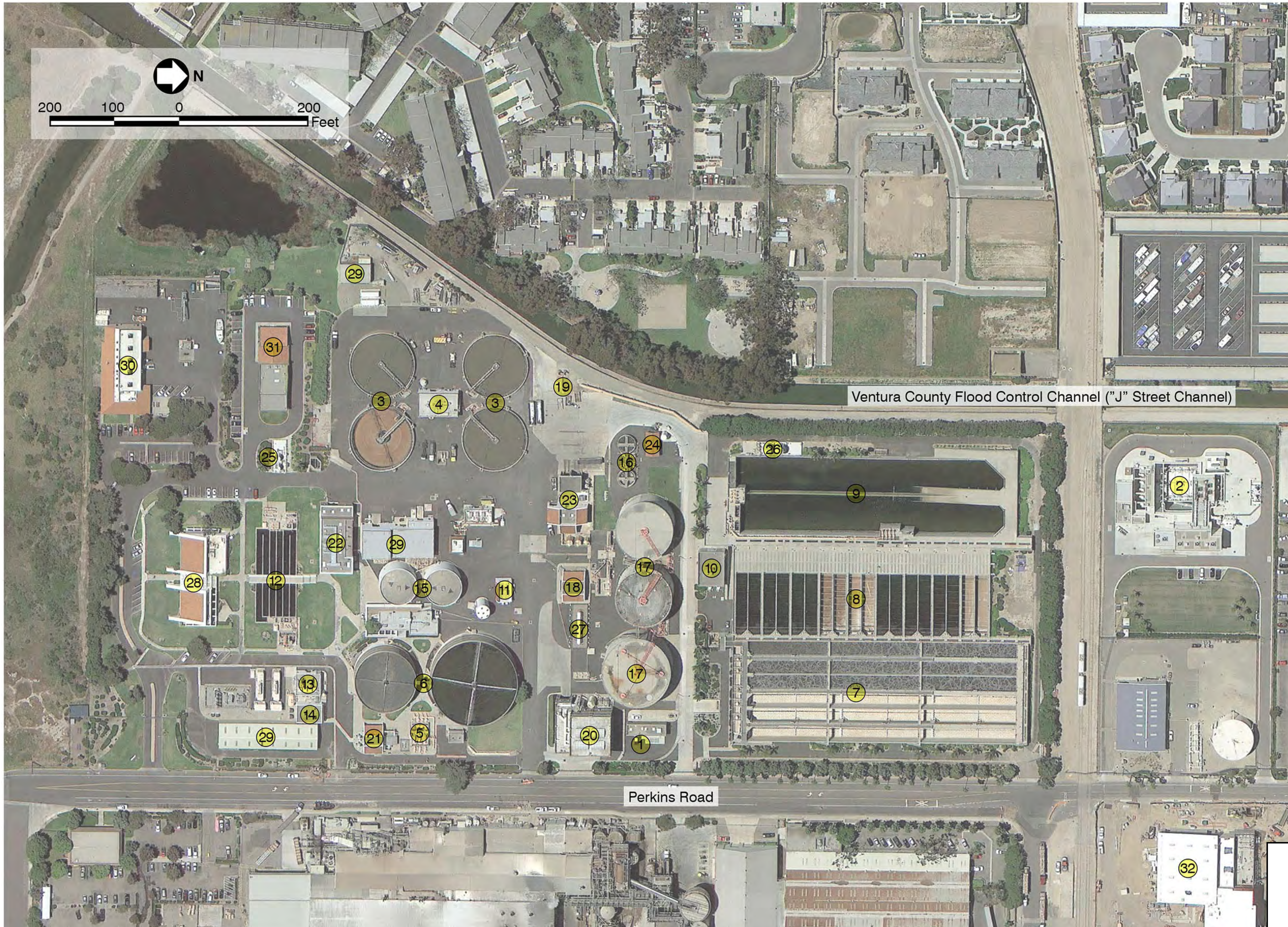
Table 5	Wastewater Mains Age Distribution Public Works Integrated Master Plan City of Oxnard				
Installation Year	**Estimated Age (at least), years**	**Length, feet**		**Percent of Total, %**	
		Force Main(4)	**Gravity Main(1,2,3)**	**Force Main(4)**	**Gravity Main(1,2,3)**
1960-1969	46	7,096	53,993	28.8%	2.7%
1970-1979	36	4,422	0	18.0%	0.0%
1980-1989	26	5,383	3,834	21.9%	0.2%
1990-1999	16	1,078	1,611	4.4%	0.1%
2000-2009	6	6,658	158,939	27.0%	7.8%
2010	5	0	5,630	0.0%	0.3%
2011	4	0	300	0.0%	0.0%
2012	3	0	2,534	0.0%	0.1%
2013	2	0	2,034	0.0%	0.1%
Unknown	--	0	1,799,291	0.0%	88.7%
Total		**24,637**	**2,028,166**	**100.0%**	**100.0%**

Notes
(1) Source: City GIS Database, June 2014.
(2) Table only accounts for active pipes. Inactive or abandoned pipes are excluded.
(3) Table only accounts for pipes owned by the City of Oxnard. Privately owned pipes or pipes owned by the County of Ventura are excluded.
(4) Source: City of Oxnard, October 2014.

2.3 Wastewater Treatment Plant

2.3.1 Description of Existing Treatment Facilities

The OWTP has a permitted capacity of 31.7 mgd and treats wastewater for discharge to the City's existing ocean outfall. An overall site plan and process flow schematic are provided in Figure 3 and Figure 4, respectively. Table 6 summarizes basic design criteria for the OWTP. Appendix A includes a detailed summary of the unit process sizing, original design criteria, and major equipment that was collected from operation and maintenance manuals.



LEGEND

1. Eastern Trunk Pump Station
2. Headworks
3. Primary Sedimentation Tanks
4. Primary Sedimentation Building
5. Interstage Pump Station
6. Biofilters
7. Activated Sludge Tanks
8. Secondary Sedimentation Tanks
9. Flow Equalization Basins
10. North Area Electrical Building
11. Blower Building
12. Chlorine Contact Tanks
13. Effluent Pumping Station
14. Effluent Electrical Building
15. Gravity Thickeners
16. DAF Thickeners
17. Anaerobic Digesters
18. Digester Control Building
19. Waste Gas Burner
20. Solids Processing Building
21. Main Electrical Building
22. Generator Building
23. Chemical Handling Facilities
24. Polymer Building
25. Dechlorination Storage
26. Chlorination Storage Area
27. Propane Storage Tank
28. Administration Building
29. Storage Buildings (3)
30. Maintenance Building
31. Collection System Maintenance Building
32. Advanced Water Purification Facility

OWTP SITE PLAN

FIGURE 3

CITY OF OXNARD

PM NO. 3.1 – BACKGROUND SUMMARY

PUBLIC WORKS INTEGRATED MASTER PLAN

CITY OF OXNARD CALIFORNIA

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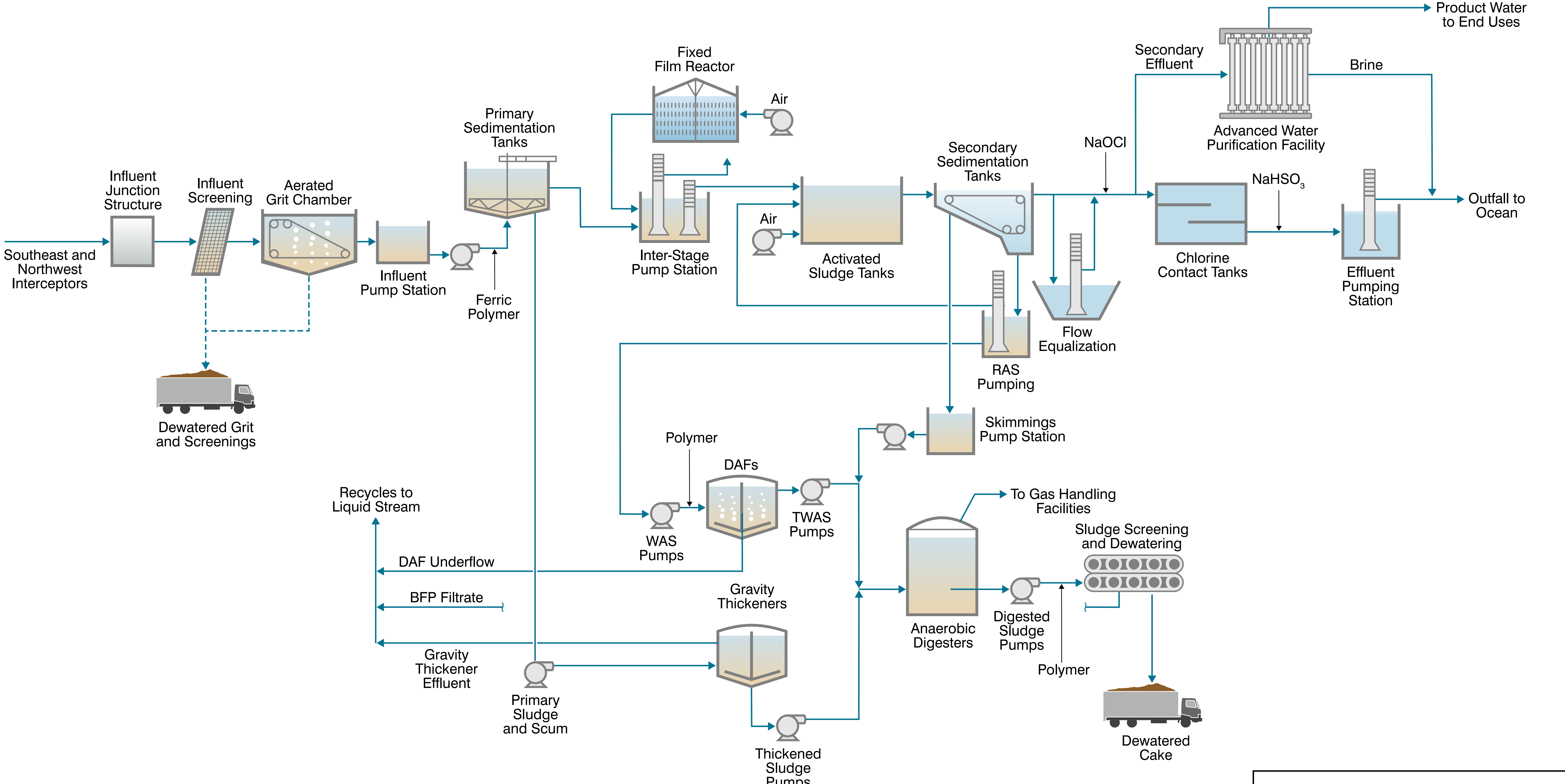


OWTP PROCESS SCHEMATIC

FIGURE 4

CITY OF OXNARD

PM NO. 3.1 – BACKGROUND SUMMARY

PUBLIC WORKS INTEGRATED MASTER PLAN

ox0715f21-9587(PM3-1 FIG4).ai

Table 6	OWTP Design Criteria Public Works Integrated Master Plan City of Oxnard		
Criteria	**Main Equipment**	**Ancillary Equipment**	**Year Installed**
Preliminary Treatment			
Bar Screens	4 mechanical screens (1/4-inch openings) 2 manual screens (1/2-inch opening)	Screenings Conveyor/Compactor	2008
Aerated Grit	2 chambers, each with 4 hoppers	Grit pumps/separator	2008
Influent Pumps	6 – 18,000 gpm 450-hp pumps		2008
Primary Treatment			
Sedimentation	4 circular 105-foot diameter basins	Sludge scrapers, transfer pumps, scum ejector, optional polymer	4 basins – 1972
Interstage Pumping Station	3 variable-speed vertical mixed-flow pumps 2,800 – 21,500 gpm each 8 – 21 ft TDH 250 HP each		1975
Secondary Treatment			
Biofiltration	2 – one 140-foot dia., and one 100-foot dia. filters	Feed and recirculation pumps, ventilation system	2 filters – 1975
Activated Sludge	2 tanks, each with 3 passes, 3 step-feed channels per pass. Fine air diffusers fixed on floor.	6 - single-stage blowers, return activated sludge pumps	1990
Sedimentation	18 rectangular sedimentation basins	Waste activated sludge pumps	1990
Flow Equalization	1 - 5-MG storage tank with 2 sections	Pump station and recirculation tubes	1990
3W Pumping Station	3 vertical turbine pumps 1,880 gpm each 185 ft TDH 125 HP each	Strainer	1988

Table 6	OWTP Design Criteria Public Works Integrated Master Plan City of Oxnard		
Criteria	**Main Equipment**	**Ancillary Equipment**	**Year Installed**
Disinfection			
Chlorination/ Dechlorination	6 pass contact tank	Hypochlorite and bisulfite feed systems	6 passes – 1980
Effluent Pump Station	1 variable-speed mixed-flow pump 17,400 gpm @ 900 rpm 30 ft TDH 4 variable-speed engine driven mixed-flow pumps 12,000 gpm each @ 1,200 rpm 146 ft TDH		1975 Prior to 1975
Solids Handling			
Gravity Thickening (for primary solids)	2 - 59-foot diameter thickeners	Polymer and ferric chloride system for thickening, thickened sludge pump station	2 GT – 1980
Dissolved Air Flotation (for secondary solids thickening)	2 - 25-foot diameter thickeners	Polymer system for thickening	2 units - 1990
Anaerobic Digestion	3 digesters, 2 at 90-foot diameter and 1 at 110-foot diameter	Heat exchanger, mixer, recirculation pumps, fixed cover, gas collection system, digested sludge pumping	90-foot dia.– 1980 110-foot dia. – 1990
Belt Filter Press (Dewatering)	4 - 2.2-m units	Polymer system for sludge conditioning	4 BFPs – 1990
Cogeneration	3 - 500-kW generators	Waste heat recovery system	1980

Note:
(1) Source: OWTP, Operation and Maintenance Manuals, and comments from Mark Moise.

2.3.1.1 Preliminary Treatment and Influent Pump Station

Preliminary treatment (or “Headworks”) consists of an inlet junction structure, bar screens, screenings conveyance, grit removal, and grit conveyance. The influent junction box collects flow from the Southeast Interceptor Sewer and the Northwest Interceptor Sewer as well as tank drainage and return flows from the OWTP. From there flow is routed to a total of six influent screen channels. Four of the screen channels have mechanical bar screens while the remaining two are equipped with manual bar screens. From there, flow is routed to one of two grit chambers to remove grit and other heavy material that is hauled to an offsite landfill for disposal.

Finally, flow is gravity fed to the influent pump station wet well. The influent pump station includes six dry pit submersible pumps. During normal operations three of the six pumps are on duty.

2.3.1.2 Primary Treatment

Raw wastewater from the headworks flows to four primary sedimentation basins for primary treatment. Each sedimentation basin is 105 feet (ft) in diameter and has a designated sludge collector, sludge pump, and surface scum removal mechanism. The primary treatment process includes facilities for adding ferric chloride and polymer to enhance sedimentation. Ferric chloride destabilizes the suspended particles in the primary influent wastewater to promote flocculation. The addition of polymer after floc formation produces a much larger floc, enhancing the settling of suspended solids in the primary clarifiers.

2.3.1.3 Secondary Treatment

The secondary treatment system uses a fixed-film secondary treatment process followed by an air-activated sludge process that removes organic material (biochemical oxygen demand, [BOD]) from primary effluent. The City's discharge permit for the facility does not currently require nitrogen or phosphorus removal.

The secondary treatment system is comprised of biotowers, activated sludge tanks (ASTs), and secondary sedimentation basins (SSTs). First, the primary effluent flows to an interstage pump station where it is pumped by four circulation pumps over the two existing biotowers. These biotowers were constructed in 1975. The larger biotower is 140 feet in diameter while the smaller biotower is 100 feet in diameter. Flow is then pumped by three interstage feed pumps to the ASTs.

The OWTP has two ASTs that can be operated in a step-feed configuration. Additionally, each AST has three channels that can be run in series or in parallel. Each pass has fixed fine bubble diffusers fed by five single-stage centrifugal blowers. Each of the three channels in the ASTs is 450 ft long with a surface water depth of 17 feet.

The South Pipe Gallery at the south end of the aeration passes house the aeration blower equipment. Five centrifugal blowers supply air to the aeration basins to provide oxygen for the activated sludge microorganisms and mixing of the mixed liquor. Air drawn into the blowers is compressed, and then discharged through dedicated headers to the fine bubble diffusers.

Flow exiting the ASTs is collected in an effluent channel that flows to the SST inlet channel. This SST inlet channel runs along all eighteen rectangular SSTs to distribute flow. Each

SST has plastic flight and chain sludge collectors that send sludge to a centralized return activated sludge (RAS) pump station consisting of a wet well and four mixed flow pumps. Secondary effluent leaving the SSTs flows in the secondary effluent channel that runs along all eighteen SSTs. This secondary effluent then flows by gravity to the Chlorine Contact Tank (CCT) and/or to the Advanced Water Purification Facility (AWPF) lift pump station wet well.

When flow exiting the SSTs is greater than 50 mgd, a portion of the flow is diverted and flows by gravity to two equalization basins (EQ Basin). Each EQ Basin is 2.5 million gallons. When peak flows subside, secondary effluent stored in the EQ basins is pumped by three vertical mixed flow pumps out of the basins to the CCTs.

2.3.1.4 Effluent Disinfection

Secondary effluent leaving the SSTs and/or EQ Basin flows by gravity or is pumped through a 48-inch secondary effluent line that discharges to the inlet of the CCT adjacent to the Administration Building. The OWTP has two three-pass CCTs. Each pass is 145 feet long.

Chlorination using sodium hypochlorite and dechlorination using sodium bisulfite are the final liquid treatment processes at the OWTP. Their primary function is to disinfect the effluent before it is discharged to the ocean. Disinfection with sodium hypochlorite solution inactivates pathogens by oxidation during a “contact time.” Chlorine contact tanks are provided to slow the flow and allow time for disinfection to occur. Chlorine residual in the plant effluent is toxic to aquatic organisms so it must be completely removed by adding sodium bisulfite solution. The reaction between the chlorine residual and sodium bisulfite is essentially immediate.

Sodium hypochlorite is added at the secondary clarifier effluent channel located in the north area process tankage along the southern end of the EQ basins. Sodium bisulfite is added to the chlorinated effluent at the CCT discharge end prior to final ocean disposal.

Secondary uses for sodium hypochlorite in the plant include odor control at the influent manholes and at the secondary effluent feed tie-in to the AWPF.

2.3.1.5 Effluent Pump Station and Outfall

The effluent pump station and outfall dispose treated wastewater to the ocean. The system includes in-plant conveyance piping, a pump station with two engine driven pumps, two electric motor (VFD) pumps, one additional motor driven pump ("big red"), and an outfall. The two engine driven pumps and two VFD pumps are located at the effluent pump station, while the one motor driven pump is located at the effluent end of the CCT. Typically, the motor driven pump is used during low flow conditions while the engine driven pumps are only used for peak flows.

The OWTP has a 6,800-foot outfall that was constructed around 1963 and modified in 1978. It discharges OWTP effluent into the Pacific Ocean through multi-port diffusers offshore of Ormond Beach. It has a permitted capacity of 50 mgd.

2.3.1.6 Solids Handling

The solids handling facilities at the OWTP consist of two gravity thickeners for primary sludge thickening, two dissolved air flotation thickeners (DAFTs) for waste activated sludge (WAS) thickening, three anaerobic digesters, and four belt filter presses (BFPs) for dewatering.

Primary sludge and scum is pumped from the primary clarifiers to the gravity thickeners. The sludge feed is combined at the thickener feed junction box and discharged to the thickener influent well where it is evenly distributed to prevent short circuiting. Polymer is added to this sludge stream. The purpose of the gravity thickeners is to reduce the liquid content in the primary sludge sent to the digesters.

WAS and scum from the secondary clarifiers are pumped from the RAS/WAS pump stations to the DAFTs. Polymer is added to this sludge stream. The DAFTs separate the solids from the liquid in the WAS flow by using fine air bubbles to float the sludge particles to the surface, where it is then scraped off. Volume reduction from WAS thickening benefits the sludge digestion and dewatering processes by reducing the volume of sludge to be processed, quantity of chemicals required for sludge conditioning, and amount of heat required for digestion. The thickened solids are combined with the thickened primary sludge and pumped to the digesters for digestion.

The main purpose of anaerobic digestion is to biologically decompose organic material in primary and secondary scum and sludge to a stable form in compliance with regulatory requirements for final disposal. Anaerobic digestion also reduces the amount of solids to dewater, reduces the volume of sludge cake that is hauled to the landfill, reduces pathogens in the sludge and produces digester gas that is high in methane and useful for fueling other equipment.

The solids dewatering facility consists of the belt filter press (BFP) process in the Solids Processing Building east of the digesters. The BFP system is designed to concentrate the anaerobically digested sludge from a solids content of less than 3 percent to a range of 18 to 20 percent. Polymer is mixed with digested sludge upstream of the BFPs to promote flocculation and solids capture so that the solids will concentrate into cake form. BFP sludge cake is conveyed to hauling trucks for transport to an offsite landfill.

3.0 REGULATIONS

3.1 Current Wastewater Regulations

3.1.1 Collection System

Wastewater collection systems are governed by the California State Water Resources Control Board (SWRCB) which adopted statewide general waste discharge requirements (WDRs) for sanitary sewer collection systems in 2006. All systems with greater than one mile of pipeline must apply for coverage under the WDR.

The WDRs require all collection systems to monitor for sanitary sewer overflows and require all collection systems to implement a sewer system management plan (SSMP). This SSMP is essentially an asset management plan that takes into account future capacity and operation and maintenance needs. There are eleven mandatory elements to the SSMP and these elements include an operation and maintenance program, design and performance provisions, emergency response plan, system evaluation and capacity assurance plan, monitoring, and program audits.

The operation and maintenance program requirements include the implementation of a rehabilitation and replacement plan to prioritize system deficiencies and plan actions to address these deficiencies. The design and performance provisions include the creation of design and construction standards for installing new sewer system components and for repairing existing elements. These standards include the need for inspection and for providing systems that resist infiltration and inflow. Another component of the SSMP, the system evaluation and capacity assurance plan, is essentially the creation of a capital improvement plan that will provide sufficient capacity for both peak dry and wet weather flows. Such a plan must include an evaluation, design criteria, capacity enhancement measures, and a schedule. Oftentimes sewer system modeling is an integral component of this planning effort.

3.1.2 Treatment Plant

Wastewater discharges are governed by both federal and state requirements. The primary laws regulating water quality are the Clean Water Act (CWA) and the California Water Code. Under the CWA, the Environmental Protection Agency (EPA) or a delegated State agency regulates the discharge of pollutants into waterways through the issuance of National Pollutant Discharge Elimination Systems (NPDES) permits. NPDES permits set limits on the amount of pollutants that can be discharged into the waters of the United States. The California Water Code and the Porter-Cologne Act, a provision of the Water Code, require the State to adopt water quality policies, plans, and objectives for the protection of the State's waters. The State Water Resources Control Board (SWRCB) and the nine Regional Water Quality Control Boards (RWQCBs) meet this requirement by establishing water quality criteria in regional Basin Plans, the Inland Surface Waters, Enclosed Bays and Estuaries Plan, the Thermal Plan, and the Ocean Plan. The SWRCB and the RWQCBs also have regulatory authority along with the California Division of Drinking Water (DDW) over projects using recycled water. Table 7 provides more detail on the responsibilities and authority of the SWRCB, RWQCB, and the DDW.

Table 7 Responsibilities and Authorities of Water Boards and State Department of Public Health
Public Works Integrated Master Plan
City of Oxnard

Department/Board	Responsibility
RWQCB	Protects surface and groundwater resources. Issues permits that implement DDW recommendations.
SWRCB	Establishes general policies governing the permitting of recycled water projects.(1) Exercises general oversight over recycled water projects, including review of RWQCB permitting practices.
DDW	Protects public health and drinking water supplies. Develops uniform water recycling criteria appropriate to particular uses of water.

Note:
(1) Consistent with its role of protecting water quality and sustaining water supplies.

The OWTP is located in the Los Angeles Region, and therefore the Los Angeles RWQCB (LARWQCB) has authority to issue permits for wastewater discharge and recycled water use. The OWTP currently discharges to the Pacific Ocean under existing NPDES permit (CA0054097) which was adopted by the LARWQCB on July 26, 2013 (WW-16). The City also operates an AWPF under its Groundwater Enhancement and Treatment (GREAT) Program, to produce non-potable water for reuse. The GREAT Program operates under a separate Water Recycling Requirement (WRR) and Waste Discharge Requirements (WDRs) Order No. R4-2008-0083 (WW-17), as amended by Order No. R4-2011-0079. The reuse of the reclaimed water is regulated under separate WDR and WRRs; Order No. R4-2008-0083 as amended by Order No. R4-2011-0079, File No. 64-104 and File No. 08-070, CI- 9456.

OWTP's existing 2013 NPDES permit establishes discharge limits for conventional constituents, nutrients, metals, and organics. These limits are established to be protective of aquatic life and other beneficial uses of the receiving water. Table 8 provides a list of conventional constituents and metals along with their permit limit. The full OWTP NPDES permit can be found in Appendix B.

In addition to the discharge limits on the constituents, nutrients, and metals provided above, there are also receiving water limitations (including monitoring) that must be met and performance goals, which are not enforceable standards. These additional limitations are listed in the NPDES permit.

3.2 Future Wastewater Regulations

There are several upcoming regulatory developments and overall trends that must be considered in the master planning process for wastewater systems in Oxnard.

3.2.1 New Water Quality Standards

Water quality standards may be updated in the future, possibly resulting in requirements that are more stringent. Effluent limits for toxics included in Oxnard's discharge permit have historically been based on water quality standards outlined in the California Ocean Plan.

Diazinon is an example of a constituent with objectives that have been adopted or are under development by EPA, yet have not been included in any of the previously listed documents. Aquatic life ambient water quality criteria for diazinon (an organophosphate pesticide) are 6.7 ug/L for acute toxicity and 1.4 ug/L for chronic toxicity in saltwater.

In some instances, the RWQCB will use EPA criteria that have not yet been incorporated into the California Toxics Rule (CTR) based on Best Professional Judgment (BPJ).

New or updated water quality criteria for other parameters such as Alachlor and Atrazine are in the process of being developed. High levels of brominated compounds (e.g., polybrominated diphenylethers [PBDEs]) are also of concern in California. In 2003, two of the three types of PBDEs were banned in the state of California. PBDEs are being monitored within the 303 (d) framework.

Table 8 OWTP NPDES Permit Limits
Public Works Integrated Master Plan
City of Oxnard

Constituent	Units	Effluent Limitations[1] Average Monthly	Average Weekly	Maximum Daily	Instantaneous Minimum	Instantaneous Maximum
BOD_5	mg/L	30	45	--	--	--
	lbs/day	7,960	11,900	--	--	--
TSS	mg/L	30	45	--	--	--
	lbs/day	7,960	11,900	--	--	--
pH	standard units	--	--	--	6.0	9.0
Oil and Grease	mg/L	25	40	--	--	75
	lbs/day	6,630	10,600	--	--	19,900
Settleable Solids	ml/L	1.0	1.5	--	--	3.0
Turbidity	NTU	75	100	--	--	225
Chronic Toxicity	TUc	--	--	99	--	--
Gross alpha	PCi/L	--	--	15	--	--
Gross beta	PCi/L	--	--	50	--	--
Combined Radium-226 & Radium-228	PCi/L	--	--	5.0	--	--
Tritium	PCi/L	--	--	20,000	--	--
Strontium-90	PCi/L	--	--	8.0	--	--
Uranium	PCi/L	--	--	20	--	--
Benzidine[2]	ug/L	0.0068	--	--	--	--
	lbs/day	0.0018	--	--	--	--
Heptachlor epoxide[2]	ug/L	0.002	--	--	--	--
	lbs/day	0.00053	--	--	--	--
PCBs[2]	ug/L	0.0019	--	--	--	--
	lbs/day	0.0005	--	--	--	--
TCDD Equivalents[2]	ug/L	0.00000039	--	--	--	--
	lbs/day	0.0000001	--	--	--	--

Notes:
(1) From the 2013 NPDES Permit No. CA0054097.
(2) The result of the reasonable potential analysis is inconclusive. Therefore, limitations are carried over from Order No. R4-2007-0029, as amended by Order No. R4-2010-0048, to avoid backsliding.

3.2.2 Lower Detection Limits

As analytical techniques for detection of toxic compounds improve, and detection limits drop; additional parameters may be found to have reasonable potential to exceed California ocean plan objectives, and effluent limits may be added to the OWTP NPDES permit.

3.2.3 Dioxin

Dioxin is a combustion by-product that is present in collections systems due to air deposition and subsequent runoff to the system. Water quality objectives for dioxin congeners are very low and therefore, difficult to meet. It is possible that a Water Quality Based Effluent Limit (WQBEL) may be added to future OWTP permits. Consequently, measures to minimize dioxins should be considered over the master planning horizon.

3.2.4 Emerging Microconstituents

OWTP's NPDES 2013 permit includes special provisions to develop a work plan to investigate Constituents of Emerging Concern (CECs) in the OWTP effluent. Upon approval of the work plan by the LARWQCB executive officer, OWTP will be required to implement the plan. A list of CECs required to be investigated are included in the permit, and monitoring will be performed every 2 years. A subset of CECs that are under investigation can be classified as Endocrine Disruptors, discussed below.

Endocrine Disruptors: In 1996, Congress passed new legislation in the Food Quality Protection Act and Safe Drinking Water Act Amendments requiring EPA to "determine whether certain substances may have an effect in humans that is similar to an effect produced by a naturally occurring estrogen or other such endocrine effect." In response, the EPA developed the Endocrine Disruptor Screening and Testing Advisory Committee (EDSTAC). The EDSTAC's ongoing Endocrine Disruptor Screening program (EDSP) has a goal to review more than 87,000 chemicals for endocrine-disrupting potential – both individually and when combined with other chemicals (to determine synergistic or additive effects) – in a two-tiered approach. The EPA also expanded the EDSP to include male hormones (androgens) and the thyroid system, and to include effects on fish and wildlife.

Through Tier 1, EPA hopes to identify chemicals that have the potential to interact with the endocrine system. Through Tier 2, EPA will determine the endocrine-related effects caused by each chemical and obtain information about effects at various doses.

Endocrine disruptor screening is currently in progress. The EPA has developed the EDSP Comprehensive Management Plan that provides guidance for agency personnel and outlines the critical activities that are planned for the EDSP over the next 5 years.

In the meantime, while EPA continues to screen compounds, other agencies are requiring monitoring to identify exposure routes of EDCs. For example, DDW *Title 22, Chapter 3:*

Recycling Criteria includes monitoring requirements for known endocrine disruptors and pharmaceuticals in recycled water recharged to groundwater for informational purposes.

The possibility of new regulations governing the discharge of endocrine disruptor compounds must be considered within a typical 10- to 20-year planning horizon for new wastewater facilities. In fact, many of the ‘suspect’ compounds also appear in the EPA National Toxics Rule, and in state regulations governing discharges of toxic substances. Therefore, additional source control measures and/or treatment to reduce many of these compounds in the environment will probably be implemented sooner than regulations related specifically to endocrine disruptors. Therefore, it is clear that endocrine disrupting chemicals will have real impacts on the planning and design of wastewater facilities in the coming years.

3.3 Receiving Water Quality Issues

The 2012 California Ocean Plan provides Table 3 (formerly Table C), which stipulates the background receiving water quality used in the determination of reasonable potential and in permit calculations. In other words, since Ocean water quality is uniform, default values specified in the Ocean Plan are used for background receiving water concentrations. The 2012 California Ocean Plan is available here: http://www.waterboards.ca.gov/water_issues/programs/ocean/docs/cop2012.pdf.

The Ocean Plan includes a statistical approach for determining if a pollutant has reasonable potential to exceed WQOs. This methodology is based on the EPA’s *Technical Support Document for Water Quality-based Effluent Limits.*

The procedure used to calculate limitations from the Ocean Plan is:

$$C_e = C_o + D_m (C_o - C_s)$$

Where:

C_e = The effluent concentration limit.
C_o = Water Quality Objective.
C_s = Background seawater concentration (from Table 3).
D_m = Minimum probable initial dilution (defined conservatively).

The Ocean Plan does not apply further adjustments to the result calculated by the equation above.

3.4 Air Quality Regulations

Several agencies at the federal, state, and local level have jurisdiction pertaining to air pollution and odor control at wastewater treatment plants. At the federal level, the major agencies are the EPA and the Occupational Safety and Health Administration (OSHA). At the state level, the applicable agencies are the California Air Resources Board (CARB) and Cal-OSHA. At the local level, it is the Ventura County Air Pollution Control District (District).

These agencies establish ambient air quality criteria and levels of treatment necessary to protect the public health and environment both off-site and on-site of a potential source. The RWQCB also includes general nuisance (odor) provisions in NPDES permits and WDRs. These agencies also have the responsibility to permit new facilities for construction and operation and to establish new source pollutant levels and treatment requirements.

The EPA establishes standards (termed National Ambient Air Quality Standards or NAAQS) under the authority of the Federal Clean Air Act (CAA) that identify safe levels of certain pollutants in the atmosphere to prevent adverse impacts to human health and to crops, forests, and materials. Standards were established for carbon monoxide, ozone, fine particulate matter (PM), nitrogen oxide, and lead. EPA also sets National Emissions Standards for Hazardous Air Pollutants (NESHAPs) for major sources of hazardous air pollutants. Existing major sources are subject to the federal CAA requirements to implement maximum achievable control technology (MACT) only if a process is modified to emit toxic air contaminants above the “major” threshold (10 tons/year of a single HAP or 25 tons/year of a combination of HAPs).

CARB is the lead agency for air pollution control in California, coordinating and overseeing state and local air pollution control programs and implementing the California Clean Air Act. CARB has also developed state air quality standards that are generally more stringent than federal standards.

The District has the primary responsibility for the control of air pollution from sources other than motor vehicles and consumer products. The District issues and renews air quality permits for any air polluting equipment such as diesel generators and compressors that are 50 horsepower (hp) and over. Air quality permits are required by State and Federal laws as part of doing business in Ventura County. Additionally, the District also issues permits for modification of the existing permitted equipment and for the installation of abatement equipment used to control emissions, such as activated carbon odor control units.

Types of new permits include the “Authority to Construct” and “Permit to Operate.” A facility must file an application for an Authority to Construct before construction begins. District permit staff will evaluate the project before an Authority to Construct is issued to ensure that the project plans are reviewed and the project complies with District rules and regulations.

After an Authority to Construct has been issued and construction is complete, but before the facility begins operation, operators are required to obtain a Permit to Operate. A temporary Permit to Operate may be issued so that emissions testing or a District inspection may be conducted while the new or modified facility is operating. Upon determining that the facility is complying with all applicable District rules, District staff issues a Permit to Operate with enforceable permit conditions to ensure continuing rule compliance. Permits must be renewed annually.

See Appendix C for OWTP's existing Air Quality Permit. The OWTP currently holds permits from the District for the following sources:

- Two effluent pump natural gas engines.
- Three electrical generator waste gas engines.
- Two waste gas burners.
- One odor reduction tower.
- One odor control system (headworks).
- One odor reduction station (solids processing building).
- Six standby diesel engines for electricity generators.
- One emergency standby diesel engine for air compressor.

The District also regulates the emission of certain odorous substances, such as Sulfur Dioxide and Hydrogen Sulfide. Table 9 summarizes these concentration levels.

Table 9 Hydrogen Sulfide and Sulfur Dioxide Ground Level Concentrations - Emission Limits
Public Works Integrated Master Plan
City of Oxnard

Substance	Limit Ground Level Concentration (ppm)	Duration
Hydrogen Sulfide(1)	0.06 or	Averaged over 3 consecutive minutes
	0.03	Averaged over 60 consecutive minutes
Sulfur Dioxide(1)	0.25 or	Averaged over 60 consecutive minutes
	0.04	Averaged over 24 hour period

Notes:
(1) Source: Ventura County Air Pollution Control District Regulation 4, Rule 54, (July 1994).
(2) http://www.vcapcd.org/Rulebook/Reg4/RULE%2054.pdf.

Improvements and changes to wastewater process and discharge location may require revised air quality permits. However, requirements of the air quality permitting process should not have an impact as large as other regulatory requirements such as water quality regulations on capital improvement planning decisions.

3.4.1 Greenhouse Gas Emissions

3.4.1.1 State and Federal Mandatory Reporting

The Air Resources Board (ARB) adopted the Global Warming Solutions Act (also referred to as Assembly Bill 32, AB 32) in September 2006. This Act was the first regulatory program in the U.S. to require public and private agencies statewide to reduce GHG emissions. The GHGs regulated under AB 32 are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated gases. Currently, the Act does not affect wastewater treatment process emissions, but it does cover onsite general stationary combustion sources and electricity generating units. An agency must report their annual (calendar year) emissions if it emits over 10,000 metric tons of CO_2 equivalent (CO_2e) emissions from its stationary combustion units and they have an aggregate maximum rated heat input capacity of 16 million Btu per hour or greater.

In addition, the EPA's Mandatory GHG Reporting Rule (Reporting Rule) was adopted October 30, 2009. The Reporting Rule explicitly states that centralized domestic wastewater treatment systems are not required to report emissions; however, any stationary combustion of fossil or non-fossil fuels taking place at a wastewater treatment facility may be considered a "large" source of GHGs if they emit a total of 25,000 metric tons or more of CO_2e emissions per year.

The City's 2012 onsite stationary combustion of natural gas and biogas resulted in approximately 4,800 metric tons of CO_2e emissions including biogenic CO_2 (i.e., CO_2 from biogas combustion). This is well below each of the reporting thresholds.

3.4.1.2 California Cap-and-Trade Program

In addition to mandatory reporting of GHGs, the ARB adopted a GHG cap-and-trade program that became effective in January 2012. This program states that agencies emitting 25,000 metric tons or more of fossil fuel-based (i.e., natural gas and diesel) CO_2e emissions per year beginning in 2011 or any subsequent year will be capped and required to reduce their emissions over time.

As previously mentioned, the City's 2012 onsite stationary combustion of natural gas and biogas resulted in approximately 4,800 metric tons of CO_2e emissions. This is well below the reporting threshold, which is based on combustion of fossil fuels only.

3.4.2 Regulatory Development

Emissions limitations throughout the state have become more stringent over the last decade. This is especially true within the District, which is a designated non-attainment zone for ozone and particulate matter under the California ambient air quality standards and a designated non-attainment zone under the Ozone National Ambient Air Quality Standard. There is one recent amendment to the District's air quality regulations that may affect the OWTP in the near future. Rule 54 on sulfur compounds was amended in January 2014 to limit sulfur dioxide emissions to 75 parts per billion (ppb) at or beyond the property line. While existing sources do not need to take any action to demonstrate compliance, all sources must meet the combustion emission limit on a dry basis using a revised calculation to account for percent oxygen content.

Additionally, there is a draft amendment to Rule 74.15.1 regarding boilers, steam generators, and process heaters. This rule would limit NOx emissions for new or replacement units rated greater than 2 million BTU/hr and less than 5 million BTU/hr. These new limits would be based on similar standards adopted by the San Joaquin Valley in their Rule 4307.

When new projects are being considered, it is important to include consideration of the District regulations; not so much because they will drive a project, but to make sure that appropriate equipment is selected that complies with the regulation that are in place. The District is becoming more proactive in addressing stationary sources at wastewater treatment plants. They should be consulted during the design or selection of processes or equipment that falls under their jurisdiction.

3.5 Regulatory Considerations for Biosolids Management

Solids generated at a wastewater treatment facility include screenings, grit, primary or raw sludge (PS), and secondary or waste activated sludge (WAS). The PS and WAS are typically described as solids prior to stabilization. Sludge generated by a wastewater treatment facility is defined as biosolids once beneficial use criteria, as determined by compliance with Section 503 of Chapter 40 of the Code of Federal Regulations (40 CFR 503), have been achieved through stabilization processes. Stabilization processes are described as those that help reduce pathogens and reduce vector attraction.

Currently, the OWTP disposes of its screenings, grit, and dewatered anaerobically digested solids (or biosolids) by hauling all of it to a nearby landfill. However, the PWIMP will consider alternatives to landfilling biosolids in order to make the best use of the energy and nutrient content. This section provides a summary of existing and potential future regulations that need to be considered as part of the PWIMP's analysis of solids treatment and disposal or use options.

3.5.1 Existing Federal Regulations

As mentioned above, the EPA regulates biosolids use under 40 CFR 503. The 40 CFR 503 regulations address land application, surface disposal, and incineration of biosolids. The 40 CFR 503 regulations are self-implementing and include monitoring, certification, and reporting requirements. Agencies are required to send an annual report to the EPA summarizing and certifying their compliance with the rule.

The 40 CFR 503 regulations establish metal concentration limitations, pathogen density reduction requirements, vector attraction reduction requirements, and site management practices for land application of biosolids. Land application refers to the beneficial use of biosolids for their nutrient and organic matter content. Biosolids land application rates cannot exceed the agronomic rate of the vegetation that will be grown. The metal concentration limitations are based on a risk assessment prepared by EPA. The pathogen density and vector attraction reduction requirements are based on past successful experience. Biosolids are classified as either "Class B" or "Class A" with respect to pathogen density. Class B biosolids have significantly reduced pathogen densities (as compared to raw sludge), but require application site management to ensure protection of public health and the environment. Class A biosolids have further reduced pathogen densities and do not require application site management to ensure protection of public health and the environment. Biosolids that meet the pollutant concentration, Class A pathogen, and vector attraction reduction requirements in 40 CFR 503 are typically called "Exceptional Quality Biosolids", and can be sold or given away in bulk or bags without additional regulation by EPA.

The 40 CFR 503 regulations also establish requirements for surface disposal and incineration of biosolids. Surface disposal includes monofills, surface impoundments, lagoons used for final disposal as opposed to treatment, waste piles, dedicated disposal sites, and dedicated beneficial use sites. Incineration refers to combustion of sewage sludge or biosolids at high temperatures in an enclosed device. The 40 CFR 503 regulations establish metals concentration limits, total hydrocarbon emission limits, and management practices. The use or disposal of non-hazardous incinerator ash is not covered by 40 CFR 503; other Federal regulations (40 CFR 257 and 40 CFR 258) cover these practices.

3.5.2 Existing State Regulations

In California, state regulation of biosolids land application is more stringent than Federal regulation. The SWRCB has adopted General WDRs for the Discharge of Biosolids to Land for use as a Soil Amendment in Agricultural, Silvicultural, Horticultural, and Land Reclamation Activities (Biosolids General Order). The Biosolids General Order can be used by RWQCBs for streamlined permitting of biosolids land application sites. The adoption of the Biosolids General Order has led to increased consistency between WDRs, however, the RWQCBs can adopt site-specific WDRs if conditions warrant.

The Biosolids General Order applies to Class B land application sites and sites where Class A Exceptional Quality biosolids will be applied at rates greater than 10 dry tons per acre per year to a field that is larger than 20 acres in size. The Biosolids General Order goes beyond the requirements of 40 CFR 503 by requiring additional biosolids testing, soil testing, groundwater sampling, and wind and dryness limitations. The SWRCB and the RWQCBs generally recognize that highly treated Class A, Exceptional Quality biosolids products such as heat dried pellets or properly prepared composts are commercial products and their use is not regulated. The California Department of Food and Agriculture (CDFA) regulates nutrient guarantees of fertilizer materials and agricultural minerals. CDFA licensing is required for all producers of fertilizing materials and agricultural minerals.

Biosolids reuse and disposal in landfills falls under the jurisdiction of the California Department of Resources Recycling and Recovery (CalRecycle). In addition to regulating the co-disposal of biosolids in landfills and use of biosolids for Alternative Daily Cover (ADC), CalRecycle also regulates biosolids composting facilities. ADC is considered different from co-disposal because it utilizes the biosolids (mixed with other materials, such as green waste) as a daily cover for the solid waste placed in the landfill, reducing the need to use the soil for that purpose. ADC is considered to be a beneficial use. ADC use is limited to 25 percent of the total landfill cover requirements.

3.5.3 Potential Future Regulations

Use or disposal of biosolids is becoming progressively difficult in California. Land application of biosolids is being restricted by many California counties, and fewer landfills are accepting biosolids.

Numerous counties in California have developed or are currently developing ordinances for biosolids land application. Figure 5 summarizes the current status of County ordinances that affect land application of biosolids.

In 2013, California passed Assembly Bill (AB) 341, which requires 75 percent reduction of solid waste sent to landfills by 2020 (it is expected that 90 percent reduction of solid waste sent to landfills will be required by 2025). Approximately 30 percent of the solid waste stream sent to landfills is organic and CalRecycle is working on a plan to eliminate organics from landfills in support of the Air Resources Board (ARB) AB 32 Scoping Plan’s target to reduce greenhouse gas emissions to 1990 levels by 2020. While the AB 32 Scoping Plan does not explicitly state that organic waste streams are or will be prohibited from use as ADC, it does state that it is exploring opportunities to phase out landfilling organic material, developing legislation as early as 2016. In addition, AB 1594 was passed in September 2014 requiring that green waste no longer qualify for diversion credit when used as ADC at a landfill. This bill may indirectly affect an agency’s biosolids use or disposal program when it is fully implemented January 1, 2020. Agencies that mix green waste with biosolids for use as ADC at landfills currently receive diversion credit under AB 939, but will no longer be able to due to AB 1594. While neither of these bills directly prohibit or limit biosolids sent to landfills, solids management options will likely be impacted by these regulations.

To comply with possible future restrictions, the planning process will need to consider alternative biosolids use and/or disposal scenarios that are cost effective.

STATUS OF BIOSOLIDS LAND APPLICATION ORDINANCES BY COUNTY

FIGURE 5

CITY OF OXNARD

PM NO. 3.1 – BACKGROUND SUMMARY

PUBLIC WORKS INTEGRATED MASTER PLAN

ox0715f22-9587(PM3-1 FIG5).ai

4.0 CLIMATE CHANGE

4.1 Climate Change: Sea Level Rise

Sea level is the elevation of the ocean relative to a reference elevation. Along the coast, sea level is usually measured relative to the adjacent land and is called relative sea level. For practical purposes, sea level is an average or mean elevation recorded over a time period long enough to exclude the effects of waves (usually longer than 1 minute). Tide gage data is often presented as 1-hour averages, but mean sea level (MSL), in the context of global climate change and MSL rise, is usually presented as monthly or annual averages.

Consequences of global warming include increased melting of land ice (specifically in Greenland and Antarctica) and thermal expansion of the marine mixed layer of the ocean, both of which contribute to sea level rise. Independent of climate change, vertical land movements also contribute to relative sea level change and astronomical tides can cause changes in water level along the California coast of about 3 meters (10 feet) (Cayan *et al.*, 2006). Since the processes contributing to sea level changes all have significant spatial variability, it has been suggested that there will be considerable geographic variability in changes in the rate of relative sea level rise (Walsh, 2005).

In the Intergovernmental Panel on Climate Change's (IPCC) Fourth Assessment Report (AR4) published in 2007, the range in projected rise in MSL is 0.18 to 0.59 meters (7 to 23 inches) by the year 2100 relative to 1990 levels. However, these projections are based on physical models that do not reproduce the current rate at which the polar ice caps are melting. Since these projections were released, there have been major advances in the science of sea level rise. The Independent Science Board (ISB) peer-reviewed studies now estimate a rise in MSL of between 0.51 to 1.40 meters (20 to 55 inches) by 2100, and it is recommended that 1.40 meters (55 inches) be used for climate change adaptation planning. The IPCC conservative estimates should be viewed as minima for planning purposes (Healy, 2007).

Per Executive Order S-13-08 by the Governor of the State of California, Department of Water Resources, California Energy Commission, California's Coastal Management Agencies, and the Ocean Protection Council, requested that the National Academy of Sciences (NAS) create an independent panel to complete the first California Sea Level Rise Assessment Report. A prepublication of *Sea Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future* was released in 2012. The report projected a range in MSL rise specific to California of nearly the same as that by the ISB – 0.50 to 1.40 meters (19.8 to 55 inches) – taking into account issues such as coastal erosion rates, tidal impacts, El Niño and La Niña events, storm surge, and land subsidence rates.

Future rates of sea level rise are likely to accelerate. Figure 6 shows the monthly mean higher-high water (MHHW) level relative to the North American Vertical Datum (NAVD) at one tide gauge located nearest to the OWTP from 1933 to 2012. The range of sea level rise projections determined by the IPCC, FEMA, SB, and NAS to the year 2100 is shown in this figure. Figure 7 shows the OWTP site with blue shading representing areas that are vulnerable to the projected sea level rise by year 2100. Some uncertainty exists, due to uncertainty about the emissions of greenhouse gases, population growth rates, government policies to address emissions, and the actual dynamics of the oceans and ice sheets. A detailed discussion of which facilities at the OWTP are at risk and the proposed risk mitigation measures for each facility is provided in PM 3.7.1.

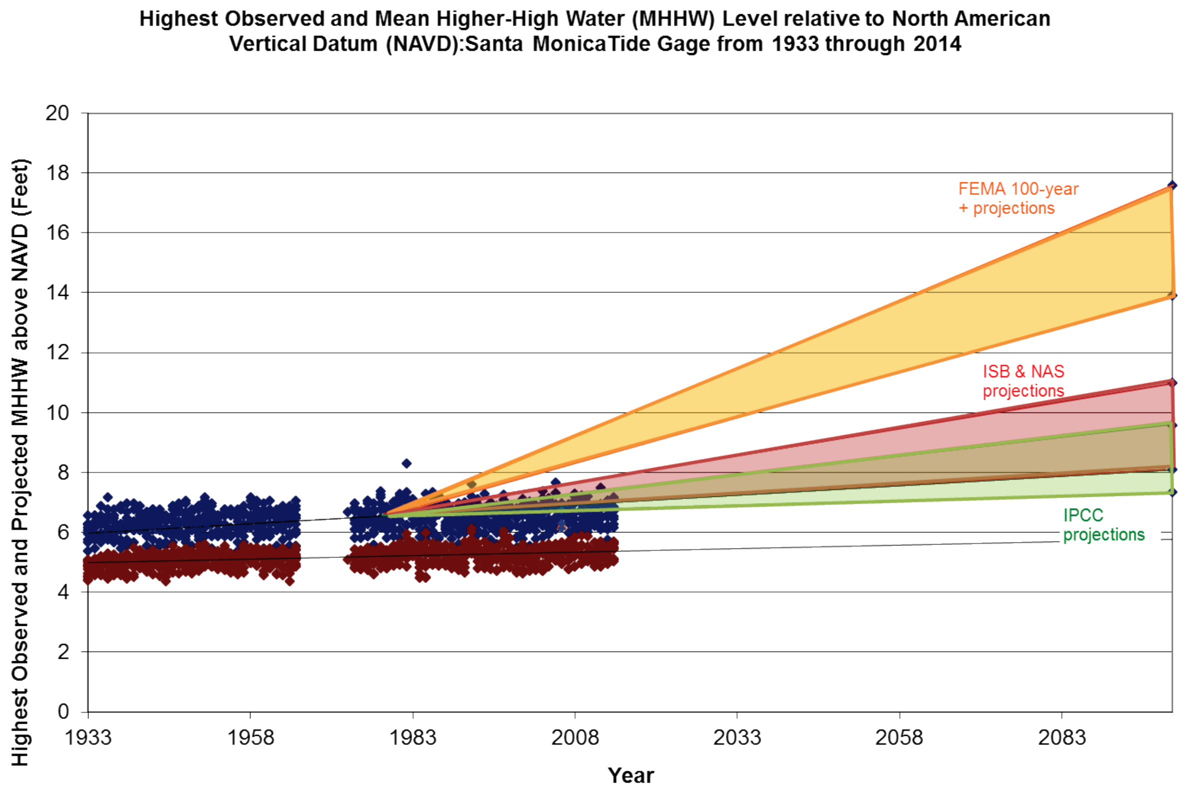
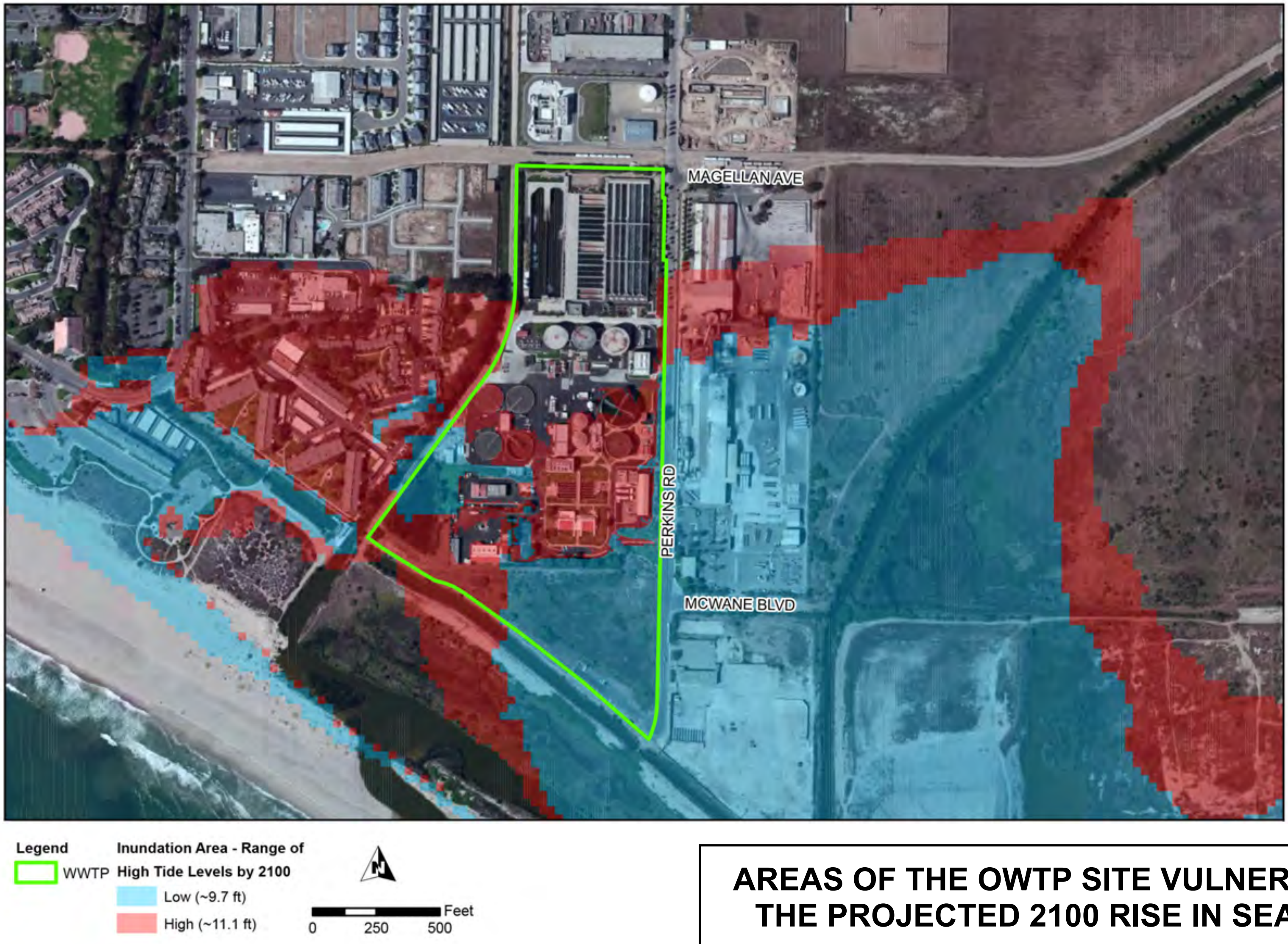


Figure 6 Projected Sea Level Rise



AREAS OF THE OWTP SITE VULNERABLE TO THE PROJECTED 2100 RISE IN SEA LEVEL

FIGURE 7

CITY OF OXNARD

PM NO. 3.1 – BACKGROUND SUMMARY

PUBLIC WORKS INTEGRATED MASTER PLAN

CITY OF OXNARD CALIFORNIA

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APPENDIX A – OWTP DETAILED DESIGN CRITERIA

OXNARD WASTEWATER TREATMENT PLANT
DESIGN CRITERIA

Item	Value
Headworks	
Influent Screens	
Type	Continuous Belt Screen (Duperon)
Number	4
Clear Opening, in	0.25
Capacity, each, mgd	38.7
Type	Manual Bar Screen
Number	2
Clear Opening, in	0.5
Capacity, each, mgd	77.4
Screening Conveyors	
Type	Belt
Number	2
Width, ft	2
Screenings Compactor	
Number	2
Capacity, cf/hr	35
Grit Basins	
Type	Aerated Grit
Number of Basins	2
Length per Basin, ft	45
Width per Basin, ft	20
SWD, ft	11
Grit Pumps	
Type	Recessed Impeller
Number	8
Capacity, gpm	250
TDH, ft	100
Nameplate hp	40
Grit Separators/Classifiers	
Number	3
Capacity, gpm	500
Channel Air Blowers	
Type	Centrifugal
Number	4
Capacity, cfm	2@540@7.5 psig, 2@340@8.2 psig
Influent Pump Station	
Pump Type	Dry-pit centrifugal
Number	6
Capacity, gpm	18,000
TDH, ft	70
Nameplate hp	450
Drive Type	2@constant speed and 4@VFDs
Odor Control at Headworks	
Type	3-stage absorption system scrubber
Capacity, cfm	25,000
Primary Sedimentation Basins	
Type	Circular, center feed
Number	4
Diameter, ft	105
Surface Area, each, sf	8,655
Total Surface Area (all in service), sf	34,619
Primary Sludge Pumps	
Type	Recessed Impeller
Number	4
Capacity, gpm	440
TDH, ft	50
Nameplate hp	25
Drive Type	Constant speed

OXNARD WASTEWATER TREATMENT PLANT
DESIGN CRITERIA

Item	Value
Scum Pumping	
Type	Ejectors
Number	4
Primary Clarifier Chemical Addition	
Type	Ferric Chloride
Number of Pumps	2
Capacity, gph	9 to 90
Type	Polymer (Stranco Polyblend)
Number of Pumps	2
Capacity, gpm	10
Biofilters	
Media Type	PVC
Number	4
Diameter, ft	1@100' and 1@140'
Media Depth	26
Specific Surface Area, sf/cf	27
Total Media Volume, kcf	604
Ventilation Fans	
Number	4 per Biofilter
Capacity, cfm	15,000 cfm@1" WC and 7,500 cfm@1" \
Nameplate hp	10 and 3
Biofilter Circulation Pumps	
Type	Mixed flow vertical
Number	4
Capacity, mgd	16.7
TDH, ft	46
Nameplate hp	200
Drive Type	Constant speed
Interstage Feed Pumps	
Type	Mixed flow vertical
Number	3
Capacity, mgd	28.9
TDH, ft	30
Nameplate hp	250
Drive Type	VFDs
Activated Sludge Tanks	
Type	3-pass
Number	2
Pass Dimensions	
Length, ft	450
Width, ft	22
SWD, ft	17
Volume per Pass, MG	1.26
Volume per Tank, MG	3.78
Total Activated Sludge Tank Volume, MG	7.55
Diffusers	
Type	7-inch ceramic domes
Number per Tank	6,660
Total Number of Diffusers	13,320
Number of Blanks per Tank	5,940
Total Number of Blanks	11,880
Process Aeration Blowers	
Type	Single-Stage Compressor
Number	5
Capacity, acfm	3,475 to 6,950
Design psig	9.8
Nameplate hp	350
Channel Aeration Blowers	
Type	Positive Displacement
Number	1
Capacity, acfm	1674
Design psig	6.0
Nameplate hp	

OXNARD WASTEWATER TREATMENT PLANT
DESIGN CRITERIA

Item	Value
Secondary Sedimentation Basins	
Type	Rectangular
Number	18
Length, ft	150
Width, ft	22
Depth, ft	9.9
Surface Area, each, sf	3,300
Total Surface Area (all in service), sf	59,400
RAS Pumps	
Type	Mixed flow
Number	4
Capacity, gpm	6,700
TDH, ft	53
Nameplate hp	100
Drive Type	VFDs
WAS Pumps	
Type	Horizontal End Suction
Number	3
Capacity, gpm	480
TDH, ft	79
Nameplate hp	20
Drive Type	VFDs
Skimmings Pump Station	
Type	Recessed Impeller
Number	2
Capacity, gpm	425 / 480
TDH, ft	28 / 66
Nameplate hp	40
Drive Type	2-Speed
Flow Equalization Basins	
Number	1
Volume, MG	5
FEB Pumps	
Type	Vertical Mixed Flow
Number	3
Capacity, gpm	8600
TDH, ft	12.5
Nameplate hp	75
Drive Type	VFDs
Chlorine Contact Tanks	
Number of Tanks	Two 3-pass tanks
Dimensions each pass	3-pass
Length, ft	145
Width, ft	10
SWD, ft	10
Volume, each pass, MG	0.11
Volume, each tank, MG	0.33
Total Volume, MG	0.65
Effluent Pump Station	
Type	mixed flow electric
Number	1
Capacity, mgd	25
TDH, ft	30
Nameplate hp	200
Drive Type	VFD
Type	mixed flow engine driven
Number	4
Capacity, mgd	17.3
TDH, ft	146
Nameplate hp	500
Drive Type	VFD

OXNARD WASTEWATER TREATMENT PLANT
DESIGN CRITERIA

Item	Value
Ocean Outfall	
Length, ft	5,100
Type and Diameter	48-inch RCP
Length, ft	1,700
Type and Diameter	30-inch CIP
Diffuser Length, ft	1,016
Number of Diffusers	85
Diffusers	2-inch ports @ 12' OC, each side
Total No. of Diffusers	170
Design Dilution ratio	
Winter	155
Summer	105
Design Capacity, mgd	50
Gravity Thickeners	
Type	Circular, center feed
Number	2
Diameter, ft	59
SWD, ft	15
Surface Area, each, sf	2,733
Total Surface Area (all in service), sf	5,465
Supply Fans	
Number	1
Capacity, cfm	21,680 @ 1/10" WC
Nameplate hp	2
Foul Air/Exhaust Fans	
Number	1
Capacity	24,000 @ 4.5" WC
Nameplate hp	40
Thickened Primary Sludge Pumps	
Number	3
Capacity, gpm	200
TDH, ft	138
Nameplate hp	15
Drive Type	Constant speed
Scum Feed Pump	
Number	1
Capacity, gpm	50
TDH, ft	138
Nameplate hp	5
Drive Type	Constant speed
DAF Thickeners	
Type	Circular, center feed
Number	2
Diameter, ft	25
SWD, ft	7.5
Surface Area, each, sf	491
Total Surface Area (all in service), sf	981
Pressurization Pump	
Number per DAF	1
Capacity	300@174' and 600@160'
Nameplate hp	40
Air Compressor	
Number	1
Capacity	7.1 cfm@ 125 psig
Nameplate hp	2
TWAS Pumps	
Number	2
Capacity, gpm	62
TDH, psig	55
Nameplate hp	3
Drive Type	VFD

OXNARD WASTEWATER TREATMENT PLANT
DESIGN CRITERIA

Item	Value
Thickener Polymer Feed System	
Bulk Polymer Storage Tank	10' Diameter, 13.5' High
Bulk Polymer Transfer Pump	
Number	2
Capacity, gpm	0.35
TDH, psig	10
Nameplate hp	0.5
Mix Tank	4' Diameter, 5.5' High
Mixer	
Number	1
Type	Vertical
Nameplate hp	1
Solution Feed Pumps	
Number	3
Capacity, gpm	5
TDH, psig	10
Nameplate hp	1
Anaerobic Digesters	
Number	2
Diameter, ft	90
SWD, ft	33.5
Volume, ea, MG	1.6
Number	1
Diameter, ft	110
SWD, ft	33.5
Volume, ea, MG	2.4
Total Volume, MG	5.6
Mixing System	
Type	Gas Mixing
Number of Blowers	3
Blower Capacity	1,050 cfm@22.1 psig
Blower Nameplate hp	100
Number of Blowers	2
Blower Capacity	350@10 psig
Blower Nameplate hp	40
Number of Blowers	2
Blower Capacity	1,600@10 psig
Blower Nameplate hp	150
Sludge Circulation Pumps	
Number	3
Capacity, gpm	650
TDH, ft	70
Nameplate hp	50
Hot Water Circulation Pumps	
Number	3
Capacity, gpm	275
TDH, ft	35
Nameplate hp	5
Digested Sludge Screens	
Number	2
Type	In-Line Rotary Screen
Nameplate hp	1
Digested Sludge Pumps	
Number	3
Capacity, gpm	250
TDH, psig	20
Nameplate hp	10
Drive Type	VFD
Dewatering System Feed Pumps	
Number	4
Capacity, gpm	130
TDH, ft	60
Nameplate hp	7.5
Drive Type	VFD

OXNARD WASTEWATER TREATMENT PLANT
DESIGN CRITERIA

Item	Value
Dewatering Units	
Number	4
Type	Belt Filter Press
Belt Size, m	2.2
Belt Drive Motor Nameplate hp	3
Hydraulic Unit Pump Motor Nameplate h	1.5
Washwater Booster Pum	
Capacity, gpm	120
TDH, psig	100
Namplate hp	10
Conveyors	
Number	4
Type	Belt
Belt Width, ft	2
Nameplate hp	3
Dewatering Polymer Feed System	
Bulk Polymer Storage Tank	12' Diameter, 18' High
Manufacturer	Polyblen Stranco
Number	4
Feed Capacity, gph	4-40@35 psi
Mixer motor nameplate hp	1/3
Solution Metering Pumps	
Number	4
Capacity, gpm	5
TDH, psig	50
Nameplate hp	1/8
Odor Control Facilities	
Splids Processing Building Foul Air	
Gravity Thickening Foul Air	
Scum Handling Area Foul Air	

APPENDIX B – OWTP NPDES PERMIT

CALIFORNIA
Water Boards

EDMUND G. BROWN JR.
GOVERNOR

MATTHEW RODRIQUEZ
SECRETARY FOR
ENVIRONMENTAL PROTECTION

Los Angeles Regional Water Quality Control Board

June 11, 2013

Ms. Karen R. Burnham
Interim City Manager
City of Oxnard Municipal Corporation
300 West Third Street
Oxnard, CA 93030

Dear Ms. Burnham:

ADOPTED WASTE DISCHARGE REQUIREMENTS (WDRs) AND NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT – CITY OF OXNARD MUNICIPAL CORPORATION, OXNARD WASTEWATER TREATMENT PLANT (NPDES NO. CA0054097, CI NO. 2022)

Our letter dated May 17, 2013, transmitted the revised tentative waste discharge requirements for renewal of your permit to discharge wastes under the NPDES.

Pursuant to Division 7 of the California Water Code, this Regional Water Board at a public hearing held on June 6, 2013, reviewed the revised tentative requirements, considered all the factors in the case, and adopted Order No. R4-2013-0094. Order No. R4-2013-0094 serves as your NPDES permit and expires on July 26, 2018. Section 13376 of the California Water Code requires that an application and Report of Waste Discharge for a new permit must be filed at least 180 days before the expiration date. A copy of the adopted order and attachments are enclosed.

The complete adopted Order and attachments will be sent only to the Discharger. However, these documents are available on the Regional Water Board's website for your review. The Regional Water Board's web address is www.waterboards.ca.gov/losangeles/.

If you have any questions, please contact Raul Medina at (213) 620-2160 or the undersigned at (213) 576-6664.

Sincerely,

Brandi Outwin-Beals, P.E., Chief
Municipal Permitting Unit (NPDES)

Enclosures
cc: See Mailing List

Mailing List

Environmental Protection Agency, Region 9, Permits Branch (WTR-5)
NOAA, National Marine Fisheries Service
Department of Interior, U.S. Fish and Wildlife Service
Jennifer Fordyce, State Water Resources Control Board, Office of Chief Counsel
Department of Fish and Game, Region 5
California State Parks and Recreation
State Coastal Conservancy
Ventura County Planning Commission
Ventura County Department of Environmental Health
Ventura County Department of Public Health
Ventura County Department of Public Works, Flood Control and Drainage
Ventura Regional Sanitation District
Ventura Coast Keeper
Heal the Bay
Environment Now
Los Angeles Waterkeeper
Natural Resources Defense Council
Southern California Coastal Water Research Project

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD

LOS ANGELES REGION

320 W. 4th Street, Suite 200, Los Angeles, California 90013
(213) 576-6600 • Fax (213) 576-6640
http://www.waterboards.ca.gov/losangeles/

ORDER NO. R4-2013-0094
NPDES NO. CA0054097

WASTE DISCHARGE REQUIREMENTS FOR THE CITY OF OXNARD, OXNARD WASTEWATER TREATMENT PLANT DISCHARGE TO THE PACIFIC OCEAN VIA OUTFALL 001

The following Discharger is subject to waste discharge requirements as set forth in this Order:

Table 1. Discharger Information

Discharger	City of Oxnard Municipal Corporation (Discharger)
Name of Facility	Oxnard Wastewater Treatment Plant (Oxnard WWTP or Facility) and its associated wastewater collection system and outfalls
Facility Address	6001 South Perkins Road
	Oxnard, CA 93033-9047
	Ventura County

Table 2. Discharge Location

Discharge Point	Effluent Description	Discharge Point Latitude	Discharge Point Longitude	Receiving Water
001	Secondary treated wastewater plus brine waste	34°, 07', 24" N	119°,11', 26" W	Pacific Ocean

Table 3. Administrative Information

This Order was adopted by the Regional Water Quality Control Board on:	June 6, 2013
This Order shall become effective on:	July 26, 2013
This Order shall expire on:	July 26, 2018
The Discharger shall file a Report of Waste Discharge as an application for renewal of waste discharge requirements in accordance with Title 23, Division 3, Chapter 9 of the California Code of Regulations, and an application for reissuance of a National Pollutant Discharge Elimination System permit in accordance with Title 40, Section 122.21(d) of the Code of Federal regulations no later than:	180 days prior to the Order expiration date
The U.S. Environmental Protection Agency (USEPA) and the Regional Water Quality Control Board have classified this discharge as follows:	Major

I, Samuel Unger, Executive Officer, do hereby certify that this Order with all attachments is a full, true, and correct copy of the Order adopted by the California Regional Water Quality Control Board, Los Angeles Region, on **June 6, 2013**.

Samuel Unger

Samuel Unger, P.E., Executive Officer

Table of Contents

List of Tables

List of Attachments

I. FINDINGS

The California Regional Water Quality Control Board, Los Angeles Region (Regional Water Board), finds:

A. Legal Authorities. This Order is issued pursuant to section 402 of the federal Clean Water Act (CWA) and implementing regulations adopted by the United States Environmental Protection Agency (USEPA) and chapter 5.5, division 7 of the California Water Code (CWC) (commencing with section 13370). It shall serve as a National Pollutant Discharges Elimination System (NPDES) permit for point source discharges from this facility to surface waters. This Order also serves as Waste Discharge Requirements (WDRs) pursuant to article 4, chapter 4, division 7 of the CWC (commencing with section 13260).

B. Background and Rationale for Requirements. The Regional Water Board developed the requirements in this Order based on information submitted as part of the application, through monitoring and reporting programs, and other available information. The Fact Sheet (Attachment F), which contains background information and rationale for the requirements in this Order, is hereby incorporated into and constitutes Findings for this Order. Attachments A through E, G, I, J and K are also incorporated into this Order.

C. Notification of Interested Parties. The Regional Water Board has notified the Discharger and interested agencies and persons of its intent to prescribe WDRs for the discharge and has provided them with an opportunity to submit their written comments and recommendations. Details of notification are provided in the Fact Sheet of this Order.

D. Consideration of Public Comment. The Regional Water Board, in a public meeting, heard and considered all comments pertaining to the discharge. Details of the Public Hearing are provided in the Fact Sheet of this Order.

THEREFORE, IT IS HEREBY ORDERED, that this Order supercedes Order No. R4-2008-0029 as amended by Order No. R4-2010-0048 except for enforcement purposes, and, in order to meet the provisions contained in division 7 of the CWC (commencing with section 13000) and regulations adopted thereunder, and the provisions of the federal CWA and regulations and guidelines adopted thereunder, the Discharger shall comply with the requirements in this Order.

II. DISCHARGE PROHIBITIONS

A. Ocean Plan Discharge Prohibition

1. Discharge of any radiological, chemical or biological warfare agent or high-level radioactive waste into the ocean is prohibited.

2. Waste shall not be discharged to designated Areas of Special Biological Significance.

3. Pipeline discharge of sludge to the ocean is prohibited by federal law; the discharge of municipal and industrial waste sludge directly to the ocean, or into waste stream that discharges to the ocean is prohibited by the Ocean Plan. Discharge of sludge digester supernatant directly to the ocean, or to a waste stream that discharges to the ocean without further treatment, is prohibited.

   It is the policy of the State Water Resources Control Board (State Water Board) that the treatment, use and disposal of sewage sludge shall be carried out in the manner found to have the least adverse impact on the total natural and human environment. Therefore, if federal law is amended to permit such discharge, which could affect California water, the State Water Board may consider requests for exceptions to this section under chapter III.I of the Ocean Plan, provided further that an Environmental Impact Report on the proposed project shows clearly that any available alternative disposal method will have a greater adverse environmental impact than the proposed project.

4. The by-passing of untreated wastes containing concentrations of pollutants in excess of those of Table A or Table B of the Ocean Plan to the ocean is prohibited.

B. The bypassing of untreated or partially treated wastes to the ocean is prohibited except as allowed in Standard Provision I.G. of Attachment D.

C. Wastes discharged from Discharge Point 001 shall be limited to secondary treated and brine waste produced at the Advanced Water Purification Facility (AWPF) of the City of Oxnard's Groundwater Enhancement and Treatment Program (GREAT Program) – Phase I Project. Discharge of wastewater at a location different from Discharge Point 001 in this Order is prohibited.

III. EFFLUENT LIMITATIONS, PERFORMANCE GOALS, AND DISCHARGE SPECIFICATIONS

A. Effluent Limitations and Performance Goals – Discharge Point 001

1. Final Effluent Limitations and Performance Goals – Discharge Point 001

a. Before, during, and after start-up of the City of Oxnard's GREAT Program – Phase I Project, the Discharger shall maintain compliance with the following effluent limitations at Discharge Point 001, with compliance measured at the interim monitoring location EFF-001A (subject to III.A.1.b. immediately below) as described in the attached Monitoring and Reporting Program (MRP; Attachment E).

The mass emission rates collected from EFF-001A shall be calculated as the actual concentration in the secondary-treated effluent plus brine waste effluent multiplied by the actual flow in the secondary-treated effluent plus brine waste and a conversion factor.

b. The City of Oxnard is currently constructing a permanent sampling facility to incorporate a sampling location that enables complete mixing of the secondary-treated effluent and the brine waste from the AWPF. This sampling facility is expected to be completed by December 2013. This sampling point is referred to as monitoring location EFF-001B. Once this permanent sampling facility becomes operable, the interim monitoring location EFF-001A shall be automatically superseded by monitoring location EFF-001B, which will become the final effluent point of compliance.

c. The performance goals for Discharge Point 001 are also given below. The listed performance goals are not enforceable effluent limitations or standards. However, the Discharger shall maintain, if not improve, its treatment efficiency. The Executive Officer may modify any of the performance goals if the Discharger requests and has demonstrated that the change is warranted. Any exceedance of the performance goals shall trigger an investigation into the cause of the exceedance. If the exceedance persists in three successive monitoring periods, the Discharger shall submit a written report within 90 days to the Regional Water Board on the nature of the exceedance, the results of the investigation as to the cause of the exceedance, and the corrective actions taken or proposed corrective measures with timetable for implementation, if necessary.

Table 4. Effluent Limitations

Parameter	Units	Effluent Limitations[1]					Performance Goals
		Average Monthly	Average Weekly	Maximum Daily	Instantaneous Minimum	Instantaneous Maximum	Average Monthly
Major Wastewater Constituents							

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1 The mass emission rates are based on the plant design flow rate of 31.7 mgd, and are calculated as follows: Flow (mgd) x Concentration (mg/L) x 8.34 (conversion factor) = lbs/day, or Flow (mgd) x Concentration (µg/L) x 0.00834 (conversion factor) = lbs/day. During wet-weather storm events in which the flow exceeds the design capacity, the mass discharge rate limitations shall not apply, and concentration limitations will provide the only applicable effluent limitations.

Parameter	Units	Effluent Limitations[1]					Performance Goals
		Average Monthly	Average Weekly	Maximum Daily	Instan-taneous Minimum	Instan-taneous Maximum	Average Monthly
Biochemical Oxygen Demand (BOD) 5-day @ 20°C	mg/L	30	45	--	--	--	--
	lbs/day	7,960	11,900	--	--	--	--
Total Suspended Solids (TSS)	mg/L	30	45	--	--	--	--
	lbs/day	7,960	11,900	--	--	--	--
pH	standard units	--	--	--	6.0	9.0	--
Oil and Grease	mg/L	25	40	--	--	75	--
	lbs/day	6,630	10,600	--	--	19,900	--
Settleable Solids	ml/L	1.0	1.5	--	--	3.0	--
Turbidity	NTU	75	100	--	--	225	--
Marine Aquatic Life Toxicants							
Arsenic[2]	μg/L	--	--	--	--	--	2.0
	lbs/day	--	--	--	--	--	0.5
Cadmium[2]	μg/L	--	--	--	--	--	1.0
	lbs/day	--	--	--	--	--	0.26
Chromium (VI)[2]	μg/L	--	--	--	--	--	8.0
	lbs/day	--	--	--	--	--	2.1
Copper[2]	μg/L	--	--	--	--	--	30
	lbs/day	--	--	--	--	--	7.9
Lead[2]	μg/L	--	--	--	--	--	23
	lbs/day	--	--	--	--	--	6.1
Mercury[2]	μg/L	--	--	--	--	--	0.3
	lbs/day	--	--	--	--	--	0.08
Nickel[2]	μg/L	--	--	--	--	--	8.0
	lbs/day	--	--	--	--	--	2.1
Selenium[2]	μg/L	--	--	--	--	--	4.7
	lbs/day	--	--	--	--	--	1.2
Silver[2]	μg/L	--	--	--	--	--	1.9
	lbs/day	--	--	--	--	--	0.5
Zinc[2]	μg/L	--	--	--	--	--	36
	lbs/day	--	--	--	--	--	9.5
Cyanide	μg/L	--	--	--	--	--	25
	lbs/day	--	--	--	--	--	6.6
Chlorine Residual	mg/L	--	--	--	--	--	0.13
	lbs/day	--	--	--	--	--	0.03
Ammonia as N	mg/L	--	--	--	--	--	32
	lbs/day	--	--	--	--	--	8.5
Phenolic compounds	μg/L	--	--	--	--	--	5.0

[2] Represents total recoverable metals value.

Parameter	Units	Effluent Limitations[1]					Performance Goals
		Average Monthly	Average Weekly	Maximum Daily	Instan-taneous Minimum	Instan-taneous Maximum	Average Monthly
(non-chlorinated)	lbs/day	--	--	--	--	--	1.3
Phenolic compounds (chlorinated)	µg/L	--	--	--	--	--	0.42
	lbs/day	--	--	--	--	--	0.11
Endosulfan	µg/L	--	--	--	--	--	0.05
	lbs/day	--	--	--	--	--	0.013
HCH	µg/L	--	--	--	--	--	0.1
	lbs/day	--	--	--	--	--	0.026
Endrin	µg/L	--	--	--	--	--	0.05
	lbs/day	--	--	--	--	--	0.013
Chronic toxicity	TUc	--	--	99	--	--	--
Radioactivity							
Gross alpha	PCi/L	--	--	15	--	--	--
Gross beta	PCi/L	--	--	50	--	--	--
Combined Radium-226 & Radium-228	PCi/L	--	--	5.0	--	--	--
Tritium	PCi/L	--	--	20,000	--	--	--
Strontium-90	PCi/L	--	--	8.0	--	--	--
Uranium	PCi/L	--	--	20	--	--	--
Human Health Toxicants – Non Carcinogens							
Acrolein	µg/L	--	--	--	--	--	10
	lbs/day	--	--	--	--	--	2.6
Antimony	µg/L	--	--	--	--	--	2.5
	lbs/day	--	--	--	--	--	0.66
Bis(2-chloroethoxy) methane	µg/L	--	--	--	--	--	25
	lbs/day	--	--	--	--	--	6.6
Bis(2-chloroisopropyl) ether	µg/L	--	--	--	--	--	10
	lbs/day	--	--	--	--	--	2.6
Chlorobenzene	µg/L	--	--	--	--	--	2.5
	lbs/day	--	--	--	--	--	0.66
Chromium (III)	µg/L	--	--	--	--	--	8.0
	lbs/day	--	--	--	--	--	2.1
Di-n-butyl-phthalate	µg/L	--	--	--	--	--	0.19
	lbs/day	--	--	--	--	--	0.05
Dichlorobenzenes	µg/L	--	--	--	--	--	2.5
	lbs/day	--	--	--	--	--	0.66
Diethyl phthalate	µg/L	--	--	--	--	--	10
	lbs/day	--	--	--	--	--	2.6
Dimethyl phthalate	µg/L	--	--	--	--	--	10
	lbs/day	--	--	--	--	--	2.6

Parameter	Units	Effluent Limitations[1]					Performance Goals
		Average Monthly	Average Weekly	Maximum Daily	Instan-taneous Minimum	Instan-taneous Maximum	Average Monthly
2-Methyl-4,6-dinitrophenol	µg/L	--	--	--	--	--	25
	lbs/day	--	--	--	--	--	6.6
2,4-Dinitrophenol	µg/L	--	--	--	--	--	25
	lbs/day	--	--	--	--	--	6.6
Ethyl benzene	µg/L	--	--	--	--	--	2.5
	lbs/day	--	--	--	--	--	0.66
Fluoranthene	µg/L	--	--	--	--	--	0.039
	lbs/day	--	--	--	--	--	0.01
Hexachlorocyclopentadiene	µg/L	--	--	--	--	--	25
	lbs/day	--	--	--	--	--	6.6
Nitrobenzene	µg/L	--	--	--	--	--	5
	lbs/day	--	--	--	--	--	1.3
Thallium	µg/L	--	--	--	--	--	5
	lbs/day	--	--	--	--	--	1.3
Toluene	µg/L	--	--	--	--	--	2.5
	lbs/day	--	--	--	--	--	0.66
Tributyltin	µg/L	--	--	--	--	--	0.0263
	lbs/day	--	--	--	--	--	0.007
1,1,1-Trichloroethane	µg/L	--	--	--	--	--	2.5
	lbs/day	--	--	--	--	--	0.66
Human Health Toxicants – Carcinogens							
Acrylonitrile	µg/L	--	--	--	--	--	10
	lbs/day	--	--	--	--	--	2.6
Aldrin	µg/L	--	--	--	--	--	0.025
	lbs/day	--	--	--	--	--	0.0066
Benzene	µg/L	--	--	--	--	--	2.5
	lbs/day	--	--	--	--	--	0.66
Benzidine[3]	µg/L	0.0068	--	--	--	--	--
	lbs/day	0.0018	--	--	--	--	--
Beryllium	µg/L	--	--	--	--	--	2.5
	lbs/day	--	--	--	--	--	0.66
Bis(2-chloroethyl) ether	µg/L	--	--	--	--	--	5.0
	lbs/day	--	--	--	--	--	1.3
Bis(2-ethylhexyl) phthalate	µg/L	--	--	--	--	--	50
	lbs/day	--	--	--	--	--	13.2
Carbon tetrachloride	µg/L	--	--	--	--	--	2.5
	lbs/day	--	--	--	--	--	0.66
Chlordane	µg/L	--	--	--	--	--	0.5

3 The result of reasonable potential analysis (RPA) is inconclusive. Therefore, limitations are carried over from Order No. R4-2007-0029, as amended by Order No. R4-2010-0048, to avoid backsliding.

Parameter	Units	Effluent Limitations[1]					Performance Goals
		Average Monthly	Average Weekly	Maximum Daily	Instan-taneous Minimum	Instan-taneous Maximum	Average Monthly
	lbs/day	--	--	--	--	--	0.13
Chlorodibromomethane	µg/L	--	--	--	--	--	0.61
	lbs/day	--	--	--	--	--	0.16
Chloroform	µg/L	--	--	--	--	--	1.2
	lbs/day	--	--	--	--	--	0.32
DDT	µg/L	--	--	--	--	--	0.25
	lbs/day	--	--	--	--	--	0.066
1,4-Dichlorobenzene	µg/L	--	--	--	--	--	0.041
	lbs/day	--	--	--	--	--	0.011
3,3'-Dichlorobenzidine	µg/L	--	--	--	--	--	25
	lbs/day	--	--	--	--	--	6.6
1,2-Dichloroethane	µg/L	--	--	--	--	--	2.5
	lbs/day	--	--	--	--	--	0.66
1,1-Dichloroethylene	µg/L	--	--	--	--	--	2.5
	lbs/day	--	--	--	--	--	0.66
Bromodichloromethane	µg/L	--	--	--	--	--	2.5
	lbs/day	--	--	--	--	--	0.66
Dichloromethane	µg/L	--	--	--	--	--	2.5
	lbs/day	--	--	--	--	--	0.66
1,3-Dichloropropene	µg/L	--	--	--	--	--	2.5
	lbs/day	--	--	--	--	--	0.66
Dieldrin	µg/L	--	--	--	--	--	0.05
	lbs/day	--	--	--	--	--	0.013
2,4-Dinitrotoluene	µg/L	--	--	--	--	--	25
	lbs/day	--	--	--	--	--	6.6
1,2-Diphenylhydrazine	µg/L	--	--	--	--	--	5
	lbs/day	--	--	--	--	--	1.3
Halomethanes	µg/L	--	--	--	--	--	4.4
	lbs/day	--	--	--	--	--	1.2
Human Health Toxicants –Carcinogens							
Heptachlor	µg/L	--	--	--	--	--	0.05
	lbs/day	--	--	--	--	--	0.013
Heptachlor epoxide[3]	µg/L	0.002	--	--	--	--	--
	lbs/day	0.00053	--	--	--	--	--
Hexachlorobenzene	µg/L	--	--	--	--	--	5
	lbs/day	--	--	--	--	--	1.3
Hexachlorobutadiene	µg/L	--	--	--	--	--	5
	lbs/day	--	--	--	--	--	1.3
Hexachloroethane	µg/L	--	--	--	--	--	5
	lbs/day	--	--	--	--	--	1.3

Parameter	Units	Effluent Limitations[1]					Performance Goals
		Average Monthly	Average Weekly	Maximum Daily	Instantaneous Minimum	Instantaneous Maximum	Average Monthly
Isophorone	µg/L	--	--	--	--	--	5
	lbs/day	--	--	--	--	--	1.3
N-Nitrosodimethylamine	µg/L	--	--	--	--	--	25
	lbs/day	--	--	--	--	--	6.6
N-Nitrosodi-N-propylamine	µg/L	--	--	--	--	--	25
	lbs/day	--	--	--	--	--	6.6
N-Nitrosodiphenylamine	µg/L	--	--	--	--	--	5
	lbs/day	--	--	--	--	--	1.3
PAHs	µg/L	--	--	--	--	--	0.097
	lbs/day	--	--	--	--	--	0.026
PCBs[3]	µg/L	0.0019	--	--	--	--	--
	lbs/day	0.0005	--	--	--	--	--
TCDD equivalents[3]	µg/L	0.00000039	--	--	--	--	--
	lbs/day	0.0000001	--	--	--	--	--
1,1,2,2-Tetrachloroethane	µg/L	--	--	--	--	--	2.5
	lbs/day	--	--	--	--	--	0.66
Tetrachloroethylene	µg/L	--	--	--	--	--	2.5
	lbs/day	--	--	--	--	--	0.66
Toxaphene	µg/L	--	--	--	--	--	2.5
	lbs/day	--	--	--	--	--	0.66
Trichloroethylene	µg/L	--	--	--	--	--	2.5
	lbs/day	--	--	--	--	--	0.66
1,1,2-Trichloroethane	µg/L	--	--	--	--	--	2.5
	lbs/day	--	--	--	--	--	0.66
2,4,6-Trichlorophenol	µg/L	--	--	--	--	--	0.35
	lbs/day	--	--	--	--	--	0.09
Vinyl chloride	µg/L	--	--	--	--	--	2.5
	lbs/day	--	--	--	--	--	0.66

d. **Percent Removal:** The average monthly percent removal of BOD 5-day 20°C and TSS shall not be less than 85 percent.

e. The temperature of wastes discharged shall not exceed 100°F, which takes into account the very large dilution credit based upon Best Professional Judgment (BPJ).

f. Waste discharged to the ocean must be essentially free of:

i. Material that is floatable or will become floatable upon discharge;

ii. Settleable material or substances that may form sediments, which will degrade benthic communities or other aquatic life;

iii. Substances that will accumulate to toxic levels in marine waters, sediments or biota;

iv. Substances that significantly decrease the natural light to benthic communities and other marine life; and,

v. Materials that result in aesthetically undesirable discoloration of the ocean surface.

g. Waste effluents from the Facility shall be discharged in a manner which provides sufficient initial dilution to minimize the concentrations of substances not removed in the treatment.

h. The locations of waste discharge from the Facility shall assure that:

i. Pathogenic organism and viruses are not present in areas where shellfish are harvested for human consumption or in areas used for swimming or other body-contact sports.

ii. Natural water quality conditions are not altered in areas designated as being areas of special biological significance or areas that existing marine laboratories use as a source of seawater.

iii. Maximum protection is provided to the marine environment.

iv. Waste that contains pathogenic organisms or viruses should be discharged a sufficient distance from shellfishing and water-contact sports areas to maintain applicable bacterial standards without disinfection. Where conditions are such that an adequate distance cannot be attained, reliable disinfection in conjunction with a reasonable separation of the discharge point from the area of use must be provided. Disinfection procedures that do not increase effluent toxicity and that constitute the least environmental and human hazard should be used.

B. Reclamation Specifications

The reuse of the reclaimed water is regulated under a separate WDRs and Water Recycling Requirements (WRRs) for the City of Oxnard GREAT Program – Phase 1 Project, Order No. R4-2008-0083, as amended by Order No. R4-2011-0079, File No. 64-104 and File No. 08-070, CI-9456.

IV. RECEIVING WATER LIMITATIONS

A. Surface Water Limitation

Receiving water limitations are based on water quality objectives contained in the Water Quality Control Plan for the Los Angeles Region (Basin Plan) and are a required part of this Order. The discharge shall not cause the following at Ormond Beach or in the Pacific Ocean. The Discharger shall not cause violation of the following water quality objectives. Compliance with these water quality objectives shall be determined by samples collected at stations representative of the area within the waste field where initial dilution is completed.

1. Bacterial Characteristics

a. Water Contact Standards

i. State/Regional Water Board Water Contact Standards

In marine water designated for water contact recreation (REC-1), the waste discharged shall not cause the following bacterial standards to be exceeded in the receiving water outside the initial dilution zone.

Geometric Mean Limits

(1) Total coliform density shall not exceed 1,000/100 ml.

(2) Fecal coliform density shall not exceed 200/100 ml.

(3) Enterococcus density shall not exceed 35/100 ml.

Single Sample Maximum (SSM)

(1) Total coliform density shall not exceed 10,000/100 ml.

(2) Fecal coliform density shall not exceed 400/100 ml.

(3) Enterococcus density shall not exceed 104/100 ml.

(4) Total coliform density shall not exceed 1,000/100 ml, when the fecal coliform/total coliform ratio exceeds 0.1.

ii. California Department of Public Health (CDPH) Standards

CDPH has established minimum protective bacteriological standards for coast water adjacent to public beaches and for public water contact sports areas in ocean waters. These standards are found in the California Code of Regulations (CCR), title 17, section 7958, and they are identical to the objectives contained in subsection a. above. When a public beach or public water contact sports area fails to meet these standards, CDPH or the local public health officer may post with warning signs or otherwise restrict use of the public beach or public water contact sports area until the standards are met. The CDPH regulations impose more frequent monitoring and more stringent posting and closure requirements on certain high-use public beaches that are located adjacent to a storm drain that flows in the summer.

For beaches not covered under AB 411 regulations (This incorporation by reference is prospective including future changes to the incorporated provisions as changes take effect), CDPH imposes the same standards as contained in title 17, CCR, and requires weekly sampling but allows the county health officer more discretion in making posting and closure decisions.

b. Shellfish Harvesting Standards

At all areas where shellfish may be harvested for human consumption, as determined by the Regional Water Board, the waste discharged shall not cause the following bacterial standards to be exceeded:

The median total coliform density for any 6-month period shall not exceed 70 per 100 ml, and not more than 10 percent of the samples during any 6-month period shall exceed 230 per 100 ml.

c. Implementation Provisions for Bacterial Characteristics

i. If the Discharger is required to conduct receiving water monitoring for bacterial characteristics in the future, then, at a minimum, weekly samples shall be collected from each site. The geometric mean values should be calculated using the five most recent sample results. If sampling occurs more frequently than weekly, all samples taken during the previous 30-day period shall be used to calculate the geometric mean.

ii. If a single sample exceeds any of the SSM standards, repeat sampling at that location shall be conducted to determine the extent and persistence of the exceedance. Repeat sampling shall be conducted within 24 hours of receiving analytical results and continued until the sample result is less than the SSM standard or until a sanitary survey is conducted to determine the source of the high bacterial densities.

When repeat sampling is required because of an exceedance of any one single sample density, values from all samples collected during that 30-day period will be used to calculate the geometric mean.

iii. It is state policy that the geometric mean bacterial objectives are strongly preferred for use in water body assessment decisions (for example, in developing the CWA section 303(d) list of impaired waters) because the geometric mean objectives are a more reliable measure of long-term water body conditions. In making assessment decisions on bacterial quality, SSM data must be considered together with any available geometric mean data. The use of only SSM bacterial data is generally inappropriate unless there is a limited data set, the water is subject to short-term spikes in bacterial concentrations, or other circumstances justify the use of only SSM data.

iv. For monitoring stations outside of the defined water-contact recreation zone (REC-1), samples will be analyzed for total coliform only.

2. Physical Characteristics

The waste discharged shall not:

a. Cause floating particulates and oil and grease to be visible;

b. Cause aesthetically undesirable discoloration of the ocean surface;

c. Significantly reduce the transmittance of natural light at any point outside the initial dilution zone; and,

d. Change the rate of deposition of inert solids and the characteristics of inert solids in ocean sediments such that benthic communities are degraded.

3. Chemical Characteristics

The waste discharged shall not:

a. Cause the dissolved oxygen concentration at any time to be depressed more than 10 percent from that which occurs naturally, as a result of the discharge of oxygen demanding waste materials;

b. Change the pH of the receiving waters at any time more than 0.2 units from that which occurs naturally as a result of the discharge pH;

c. Cause the dissolved sulfide concentration of waters in and near sediments to be significantly increased above that present under natural conditions;

d. Cause the concentration of substances set forth in chapter II, Table B of the Ocean Plan, in marine sediments to be increased to levels that would degrade indigenous biota;

e. Cause the concentration of organic materials in marine sediments to be increased to levels that would degrade marine life; and,

f. Contain nutrients at levels that will cause objectionable aquatic growth or degrade indigenous biota.

4. Biological Characteristics

The waste discharged shall not:

a. Degrade marine communities, including vertebrate, invertebrate, and plant species;

b. Alter the natural taste, odor, and color of fish, shellfish, or other marine resources used for human consumption; and,

c. Cause the concentration of organic materials in fish, shellfish or other marine resources used for human consumption to bioaccumulate to levels that are harmful to human health.

5. Radioactivity

Discharge of radioactive waste shall not degrade marine life.

B. Groundwater Limitations – Not Applicable

V. PROVISIONS

A. Standard Provisions

1. **Federal Standard Provisions.** The Discharger shall comply with all Standard Provisions included in Attachment D of this Order.

2. **Regional Water Board Standard Provisions.** The Discharger shall comply with the following provisions. In the event that there is any conflict, duplication, or overlap between provisions specified by this Order, the more stringent provision shall apply:

   a. Neither the treatment nor the discharge of pollutants shall create a pollution, contamination, or nuisance as defined by section 13050 of the CWC.

   b. Odors, vectors, and other nuisances of sewage or sludge origin beyond the limits of the treatment plant site or the sewage collection system due to improper operation of facilities, as determined by the Regional Water Board, are prohibited.

   c. All facilities used for collection, transport, treatment, or disposal of wastes shall be adequately protected against damage resulting from overflow, washout, or inundation from a storm or flood having a recurrence interval of once in 100 years.

   d. Collection, treatment, and disposal systems shall be operated in a manner that precludes public contact with wastewater.

   e. Collected screenings, sludges, and other solids removed from liquid wastes shall be disposed of in a manner approved by the Executive Officer of the Regional Water Board.

   f. The provisions of this order are severable. If any provision of this Order is found invalid, the remainder of this Order shall not be affected.

   g. Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the discharger from any responsibilities, liabilities or penalties established pursuant to any applicable state law or regulation under authority preserved by section 510 of the CWA.

   h. Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the discharger from any responsibilities, liabilities or penalties to which the discharger is or may be subject to under section 311 of the CWA.

   i. The Discharger must comply with the lawful requirements of municipalities, counties, drainage districts, and other local agencies regarding discharges of storm water to storm drain systems or other water courses under their jurisdiction, including applicable requirements in municipal storm water management programs developed to comply with NPDES permits issued by the Regional Water Board to local agencies.

   j. Discharge of wastes to any point other than specifically described in this Order is prohibited, and constitutes a violation thereof.

   k. The Discharger shall comply with all applicable effluent limitations, national standards of performance, toxic effluent standards, and all federal regulations established pursuant to sections 301, 302, 303(d), 304, 306, 307, 316, 403, and 405 of the federal CWA and amendments thereto.

   l. These requirements do not exempt the operator of the waste disposal facility from compliance with any other laws, regulations, or ordinances which may be applicable; they do not legalize this waste disposal facility, and they leave unaffected any further restraints on the disposal of wastes at this site which may be contained in other statutes or required by other agencies.

m. Oil or oily material, chemicals, refuse, or other polluting materials shall not be stored or deposited in areas where they may be picked up by rainfall and carried off of the property and/or discharged to surface waters. Any such spill of such materials shall be contained and removed immediately.

n. A copy of these waste discharge specifications shall be maintained at the discharge facility so as to be available at all times to operating personnel.

o. If there is any storage of hazardous or toxic materials or hydrocarbons at this facility and if the facility is not manned at all times, a 24-hour emergency response telephone number shall be prominently posted where it can easily be read from the outside.

p. The Discharger shall file with the Regional Water Board a report of waste discharge at least 120 days before making any proposed change in the character, location or volume of the discharge.

q. In the event of any change in name, ownership, or control of these waste disposal facilities, the discharger shall notify the Regional Water Board of such change and shall notify the succeeding owner or operator of the existence of this Order by letter, a copy of which shall be forwarded to the Regional Water Board, 30 days prior to taking effect.

r. CWC section 13385 provides that any person who violates a waste discharge requirement or a provision of the CWC is subject to civil penalties of up to $5,000 per day, $10,000 per day, or $25,000 per day of violation, or when the violation involves the discharge of pollutants, is subject to civil penalties of up to $10 per gallon per day or $25 per gallon per day of violation, or some combination thereof, depending on the violation, or upon the combination of violations.

s. CWC section 13387 provides that any person who knowingly makes any false statement, representation, or certification in any record or other document submitted or required to be maintained under this order, including monitoring reports or reports of compliance or noncompliance, or who knowingly falsifies, tampers with, or renders inaccurate any monitoring device or method required to be maintained in this order is subject to a fine of not less than $5,000 nor more than $50,000, imprisonment in the state prison , or both. For a subsequent conviction, such a person shall be punished by a fine of not more than $100,000 per day of violation, by imprisonment in the state prison for two, four or six years, or by both that fine and imprisonment.

t. The discharge of any waste resulting from the combustion of toxic or hazardous wastes to any waste stream that ultimately discharges to waters of the United States is prohibited, unless specifically authorized elsewhere in this Order.

u. The Discharger shall notify the Executive Officer in writing no later than 6 months prior to planned discharge of any chemical, other than the products previously reported to the Executive Officer, which may be toxic to aquatic life. Such notification shall include:

   i. Name and general composition of the chemical,

ii. Frequency of use,

iii. Quantities to be used,

iv. Proposed discharge concentrations, and

v. USEPA registration number, if applicable.

v. Failure to comply with provisions or requirements of this Order, or violation of other applicable laws or regulations governing discharges from this facility, may subject the Discharger to administrative or civil liabilities, criminal penalties, and/or other enforcement remedies to ensure compliance. Additionally, certain violations may subject the Discharger to civil or criminal enforcement from appropriate local, state, or federal law enforcement entities.

w. In the event the Discharger does not comply or will be unable to comply for any reason, with any prohibition, maximum daily effluent limitation, or receiving water limitation of this Order, the Discharger shall notify the Watershed Regulatory section Chief at the Regional Water Board by telephone (213) 576-6616, or electronically at dhung@waterboards.ca.gov, or by Fax at (213) 576-6660 within 24 hours of having knowledge of such noncompliance, and shall confirm this notification in writing to the Regional Water Board within five days, unless the Regional Water Board waives confirmation. The written notification shall state the nature, time, duration, and cause of noncompliance, and shall describe the measures being taken to remedy the current noncompliance and, prevent recurrence including, where applicable, a schedule of implementation. The written notification shall also be submitted via email with reference to CI-2022 to losangeles@waterboards.ca.gov. Other noncompliance requires written notification as above at the time of the normal monitoring report.

B. Monitoring and Reporting Program (MRP) Requirements

The Discharger shall comply with the MRP, and future revisions thereto, in Attachment E of this Order.

C. Special Provisions

1. Reopener Provisions

a. This Order may be reopened for modification to include an effluent limitation if monitoring establishes that the discharge causes, has the reasonable potential to cause, or contributes to an excursion above an Ocean Plan Table B water quality objective.

b. This Order may be modified, revoked and reissued, or terminated for cause, including, but not limited to:

i. Violation of any term or condition contained in this Order;

ii. Obtaining this Order by misrepresentation or by failure to disclose fully all relevant facts; or,

iii. A change in any condition that requires either a temporary or permanent reduction or elimination of the authorized discharge.

The filing of a request by the Discharger for an Order modification, revocation and issuance, or termination, or a notification of planned changes or anticipated noncompliance does not stay any condition of this Order.

c. If an applicable toxic effluent standard or prohibition (including any schedule of compliance specified in such effluent standard or prohibition) is promulgated under section 307(a) of the CWA for a toxic pollutant and that standard or prohibition is more stringent than any limitation on the pollutant in this Order, the Regional Water Board may institute proceedings under these regulations to modify or revoke and reissue the Order to conform to the toxic effluent standard or prohibition.

d. This Order may be reopened and modified to incorporate new limits based on future reasonable potential analyses to be conducted based on on-going monitoring data collected by the Discharger and evaluated by the Regional Water Board.

e. This Order may be reopened and modified, in accordance with the provisions set forth in title 40, Code of Federal Regulations (40 CFR) parts 122 and 124, to incorporate requirements for the implementation of the watershed management approach.

f. This Order may be modified, in accordance with the provisions set forth in 40 CFR parts 122 and 124, to include new Minimum Levels (ML).

g. This Order may be reopened and modified to revise effluent limitations as a result of future Basin Plan Amendments or the adoption of a TMDL for Ventura Coastal Stream Watershed Management Area.

h. The Regional Water Board may modify or revoke and reissue this Order if present or future investigations demonstrate that the discharge(s) governed by this Order will cause, have the potential to cause, or contribute to adverse impacts on water quality and/or beneficial uses of the receiving waters.

i. This Order may be modified, revoked and reissued, or terminated in accordance with the provisions of 40 CFR parts 122.44, 122.62 to 122.64, 125.62, and 125.64. Causes for taking such actions include, but are not limited to, failure to comply with any condition of this Order, endangerment to human health or the environment resulting from the permitted activity, or acquisition of newly obtained information which would have justified the application of different conditions if known at the time of Order adoption and issuance.

j. The waste discharged shall not cause a violation of any applicable water quality standard for receiving waters. If more stringent applicable water quality standards are promulgated or approved pursuant to section 303 of the CWA, or amendments thereto, the Regional Water Board will revise and modify this Order in accordance with such standards.

k. This Order may be reopened and modified to revise the effluent and receiving water monitoring program as a result of future other ocean outfalls being constructed in proximity to the existing City of Oxnard Discharge Point 001.

l. This Order may be reopened and modified to revise effluent limitations and performance goals, sampling locations as a result of the GREAT program.

2. Special Studies, Technical Reports and Additional Monitoring Requirements

a. Special Study

i. Constituents of Emerging Concern (CECs) in the Effluent

(a) The Discharger shall conduct a special study to investigate the CECs in the effluent discharge. Within 90 days of the effective date of this Order, the Discharger shall submit to the Executive Officer a CEC special study work plan for approval. Upon approval, the Discharger shall implement the work plan.

(b) The Discharger shall follow the requirements of the work plan as discussed in the MRP and the Fact Sheet.

ii. Annual Special Studies

(a) The Discharger and the Regional Water Board shall consult annually to determine the need for special studies. Each year, the Discharger shall submit proposals for any proposed special studies to the Regional Water Board by December 15, for the following year's monitoring effort (July through June). The following year, detailed scopes of work for proposals, including reporting schedules, shall be presented by the Discharger at a Spring Regional Water Board meeting, to obtain the Regional Water Board approval and to inform the public. Upon approval by the Regional Water Board, the Discharger shall implement its special study or studies.

b. Toxicity Reduction Requirements

The Discharger shall prepare and submit a copy of the Discharger's initial investigation TRE work plan to the Executive Officer of the Regional Water Board for approval within 90 days of the effective date of this permit. If the Executive Officer does not disapprove the work plan within 60 days, the work plan shall become effective. The Discharger shall use USEPA manual EPA/833B-99/002 (municipal), or the most current version, as guidance. At a minimum, the initial investigation TRE work plan must contain the provisions in Attachment G. This work plan shall describe the steps the Discharger intends to follow if toxicity is detected, and should include, at a minimum:

i. A description of the investigation and evaluation techniques that will be used to identify potential causes and sources of toxicity, effluent variability, and treatment system efficiency;

ii. A description of the facility's methods of maximizing in-house treatment efficiency and good housekeeping practices, and a list of all chemicals used in the operation of the facility; and,

iii. If a TIE is necessary, an indication of the person who would conduct the TIEs (i.e., an in-house expert or an outside contractor).

If the effluent toxicity test result exceeds the limitation, then the Discharger shall immediately implement accelerated toxicity testing that consists of six additional tests, approximately every two weeks, over a 12-week period. Effluent sampling for the first test of the six additional tests shall commence within five days of receipt of the test results exceeding the toxicity limitation.

If the results of any two of the six tests (any two tests in a 12-week period) exceed the limitation, the Discharger shall initiate a TRE.

If results of the implementation of the facility's initial investigation TRE work plan (as described above) indicate the need to continue the TRE/TIE, the Discharger shall expeditiously develop a more detailed TRE work plan for submittal to the Executive Officer within 15 days of completion of the initial investigation TRE.

Detailed toxicity testing and reporting requirements are contained in section V of the MRP (Attachment E).

c. Treatment Plant Capacity

The Discharger shall submit a written report to the Executive Officer of the Regional Water Board within 90 days after the "30-day (monthly) average" daily dry-weather flow equals or exceeds 75 percent of the design capacity of waste treatment and/or disposal facilities. The Discharger's senior administrative officer shall sign a letter, which transmits that report and certifies that the discharger's policy-making body is adequately informed of the report's contents. The report shall include the following:

i. The average daily flow for the month, the date on which the peak flow occurred, the rate of that peak flow, and the total flow for the day;

ii. The best estimate of when the monthly average daily dry-weather flow rate will equal or exceed the design capacity of the facilities; and,

iii. A schedule for studies, design, and other steps needed to provide additional capacity for waste treatment and/or disposal facilities before the waste flow rate equals the capacity of present units.

This requirement is applicable to those facilities which have not reached 75 percent of capacity as of the effective date of this Order. For those facilities that have reached 75 percent of capacity by that date but for which no such report has been previously submitted, such a report shall be filed within 90 days of the issuance of this Order.

3. Best Management Practices and Pollution Prevention

a. Storm Water Pollution Prevention Plan (SWPPP) – (Not Applicable)

Under previous permits, all of the storm water runoff traversing the treatment areas of the Facility premises was captured and treated in the plant. With the 2008 expansion of the treatment plant, including the new headworks facility, this is no longer the case. Runoff from the facility is now regulated under the Municipal Separate Storm Sewer System Permit for Ventura County (Ventura MS4 Permit) as a public agency activity subject to development and implementation of a SWPPP. As the SWPPP is now implemented under the Ventura MS4 permit, it is not required in this Order.

b. Spill Clean-up Contingency Plan (SCCP)

Within ninety days, the Discharger is required to submit a SCCP, which describes the activities and protocols to address clean-up of spills, overflows, and bypasses of untreated or partially treated wastewater from the Discharger's collection system or treatment facilities that reach water bodies, including dry channels and beach sands. At a minimum, the plan shall include sections on spill clean-up and containment measures, public notification, and monitoring. The Discharger shall review and amend the plan as appropriate after each spill from the facility or in the service area of the Facility. The Discharger shall include a discussion in the annual summary report of any modifications to the Plan and the application of the Plan to all spills during the year.

The updated SCCP shall include a conceptual monitoring protocol for spills greater than 10,000 gallons to beach sands to: (1) define the extent of waste discharged to beach sands and adjacent surface waters, and (2) to confirm the conclusion and effectiveness of the clean-up and/or mitigation measures. The plan shall include a protocol for coordination with the local health department during such an event. This component of the plan shall be posted on the Regional Water Board website for stakeholder review and comment for 30 days prior to Executive Officer approval.

c. Pollutant Minimization Program (PMP)

Reporting protocols in the MRP (Attachment E) section IX.B.4 describe sample results that are to be reported as Detected but Not Quantified (DNQ) or Not Detected (ND). Definitions for a reported Minimum Level (ML) and Method Detection Limit (MDL) are provided in Attachment A.

These reporting protocols and definitions are used in determining the need to conduct a PMP as follows.

The Discharger shall develop and conduct a PMP as further described below when there is evidence (e.g., sample results reported as DNQ when the effluent limitation is less than the MDL; sample results from analytical methods more sensitive than those methods required by this Order; presence of whole effluent toxicity; health advisories for fish consumption; or, results of benthic or aquatic organism tissue sampling) that a pollutant is present in the effluent above an effluent limitation and either of the following is true:

i. The concentration of the pollutant is reported as DNQ and the effluent limitation is less than the reported ML; or,

ii. The concentration of the pollutant is reported as ND and the effluent limitation is less than the MDL, using definitions described in Attachment A and reporting protocols described in the MRP.

The goal of the PMP shall be to reduce all potential sources of a pollutant through pollutant minimization (control) strategies, including pollution prevention measures as appropriate, to maintain the effluent concentration at or below the effluent limitation. Pollution prevention measures may be particularly appropriate for persistent bioaccumulative priority pollutants where there is evidence that beneficial uses are being impacted. The Regional Water Board may consider cost-effectiveness when establishing the requirements of a PMP. The completion and implementation of a Pollution Prevention Plan (PPP), if required pursuant to CWC section 13263.3(d), shall be considered to fulfill the PMP requirements.

The PMP shall include, but not be limited to, the following actions and submittals acceptable to the Regional Water Board:

i. An annual review and semi-annual monitoring of potential sources of the reportable pollutant(s), which may include fish tissue monitoring and other bio-uptake sampling;

ii. Quarterly monitoring for the reportable pollutant(s) in the influent to the wastewater treatment system;

iii. Submittal of a control strategy designed to proceed toward the goal of maintaining concentrations of the reportable pollutant(s) in the effluent at or below the effluent limitation;

iv. Implementation of appropriate cost-effective control measures for the reportable pollutant(s), consistent with the control strategy; and

v. An annual status report that shall be sent to the Regional Water Board including:

(a) All PMP monitoring results for the previous year;

(b) A list of potential sources of the reportable pollutant(s);

(c) A summary of all actions undertaken pursuant to the control strategy; and

(d) A description of actions to be taken in the following year.

4. Construction, Operation and Maintenance Specifications

a. Wastewater treatment facilities subject to this Order shall be supervised and operated by persons possessing certificates of appropriate grade pursuant to CCR, title 23, division 3, chapter 26 (CWC sections 13625 – 13633).

b. The Discharger shall maintain in good working order a sufficient alternate power source for operating the wastewater treatment and disposal facilities. All equipment shall be located to minimize failure due to moisture, liquid spray, flooding, and other physical phenomena. The alternate power source shall be designed to permit inspection and maintenance and shall provide for periodic testing. If such alternate power source is not in existence, the discharger shall halt, reduce, or otherwise control all discharges upon the reduction, loss, or failure of the primary source of power.

c. The Discharger shall provide standby or emergency power facilities and/or storage capacity or other means so that in the event of plant upset or outage due to power failure or other cause, discharge of raw or inadequately treated sewage does not occur.

5. Special Provisions for Municipal Facilities (POTWs Only)

a. Sludge Disposal Requirements

i. All sludge generated at the wastewater treatment plant must be disposed of, treated, or applied to land in accordance with federal regulations contained in 40 CFR part 503. These requirements are enforceable by USEPA.

ii. The Discharger shall ensure compliance with the requirements in State Water Board Order No. 2004-10-DWQ, *General WDRs for the Discharge of Biosolids to Land for Use as a Soil Amendment in Agricultural, Silvicultural, Horticultural and Land Reclamation Activities* for those sites receiving the Discharger's biosolids which a Regional Water Quality Control Board has placed under this general order, and with the requirements in individual WDRs issued by a Regional Water Board for sites receiving the Discharger's biosolids.

iii. The Discharger shall comply, if applicable, with WDRs issued by other Regional Water Boards to which jurisdiction the biosolids are transported and applied.

iv. The Discharger shall furnish this Regional Water Board with a copy of any report submitted to USEPA, the State Water Board or other Regional Water Board, with respect to municipal sludge or biosolids.

b. Pretreatment Requirements

i. This Order includes the Discharger's Pretreatment Program as previously submitted to this Regional Water Board. Any change to the program shall be reported to the Regional Water Board in writing and shall not become effective until approved by the Executive Officer in accordance with procedures established in 40 CFR part 403.18.

ii. Please refer to Attachment J – Pretreatment Reporting Requirements.

c. Collection System Requirements

i. The Discharger's collection system is part of the system that is subject to this Order. As such, the Discharger must properly operate and maintain its collection system (40 CFR part 122.41(e)). The Discharger must report any non-compliance (40 CFR part 122.41(l)(6) and (7)) and mitigate any discharge from the collection system in violation of this Order (40 CFR part 122.41(d)). See the Order at Attachment D, subsections I.D, V.E, V.H, and I.C., and the following section of this Order.

6. Spill Reporting Requirements

a. Initial Notification

Although state and Regional Water Board staff do not have duties as first responders, this requirement is an appropriate mechanism to ensure that the agencies that do have first responder duties are notified in a timely manner in order to protect public health and beneficial uses. For certain spills, overflows and bypasses, the Discharger shall make notifications as required below:

i. In accordance with the requirements of Health and Safety Code section 5411.5, the Discharger shall provide notification to the local health officer or the director of environmental health with jurisdiction over the affected water body of any unauthorized release of sewage or other waste that causes, or probably will cause, a discharge to any waters of the state as soon as possible, but no later than two hours after becoming aware of the release.

ii. In accordance with the requirements of CWC section 13271, the Discharger shall provide notification to the California Emergency Management Agency (Cal EMA) of the release of reportable amounts of hazardous substances or sewage that causes, or probably will cause, a discharge to any waters of the state as soon as possible, but not later than two hours after becoming aware of the release. The CCR, Title 23, section 2250, defines a reportable amount of sewage as being 1,000 gallons. The phone number for reporting these releases to the Cal EMA is (800) 852-7550.

iii. The Discharger shall notify the Regional Water Board of any unauthorized release of sewage from its POTWs that causes, or probably will cause, a discharge to a water of the state as soon as possible, but not later than two hours after becoming aware of the release. This initial notification does not need to be made if the Discharger has notified Cal EMA and the local health officer or the director of environmental health with jurisdiction over the affected waterbody. The phone number for reporting these releases of sewage to the Regional Water Board is (213) 576-6657. The phone numbers for after hours and weekend reporting of releases of sewage to the Regional Water Board are (213) 305-2284 and (213) 305-2253.

At a minimum, the following information shall be provided to the Regional Water Board:

(1) The location, date, and time of the release;

(2) The water body that received or will receive the discharge;

(3) An estimate of the amount of sewage or other waste released and the amount that reached a surface water at the time of notification;

(4) If ongoing, the estimated flow rate of the release at the time of the notification;

(5) The name, organization, phone number and email address of the reporting representative; and,

(6) A certification that the State Office of Emergency Services and the local health officer or directors of environmental health with jurisdiction over the affected water bodies have been notified of the discharge.

b. Monitoring

For spills, overflows and bypasses reported under section V.C.6.a, the Discharger shall monitor as required below:

i. To define the geographical extent of the spill's impact, the Discharger shall obtain grab samples (if feasible, accessible, and safe) for all spills, overflows or bypasses of any volume that reach any waters of the State (including surface and ground waters). The Discharger shall analyze the samples for total coliform, fecal coliform, E. coli (if fecal coliform test shows positive), enterococcus, and relevant pollutants of concern, upstream and downstream of the point of entry of the spill (if feasible, accessible, and safe). This monitoring shall be done on a daily basis from the time the spill is known until the results of two consecutive sets of bacteriological monitoring indicate the return to the background level or the County Department of Public Health authorizes cessation of monitoring.

c. Reporting

The initial notification required under section V.C.6.a shall be followed by:

i. As soon as possible, but not later than twenty-four hours after becoming aware of an unauthorized discharge of sewage or other waste from its wastewater treatment plant to a water of the state, the Discharger shall submit a statement to the Regional

Water Board by email at aanijielo@waterboards.ca.gov . If the discharge is 1,000 gallons or more, this statement shall certify that Cal EMA has been notified of the discharge in accordance with CWC section 13271. The statement shall also certify that the local health officer or director of environmental health with jurisdiction over the affected water bodies has been notified of the discharge in accordance with Health and Safety Code section 5411.5. The statement shall also include at a minimum the following information:

(1) Agency, NPDES No., Order No., and MRP CI No., if applicable;

(2) The location, date, and time of the discharge;

(3) The water body that received the discharge;

(4) A description of the level of treatment of the sewage or other waste discharged;

(5) An initial estimate of the amount of sewage or other waste released and the amount that reached a surface water;

(6) The Cal EMA control number and the date and time that notification of the incident was provided to Cal EMA; and,

(7) The name of the local health officer or director of environmental health representative notified (if contacted directly); the date and time of notification; and the method of notification (e.g., phone, fax, email).

ii. A written preliminary report five working days after disclosure of the incident is required. Submission to the Regional Water Board of the California Integrated Water Quality System (CIWQS) Sanitary Sewer Overflow (SSO) event number shall satisfy this requirement. Within 30 days after submitting the preliminary report, the Discharger shall submit the final written report to this Regional Water Board. (A copy of the final written report, for a given incident, already submitted pursuant to a statewide General WDRs for Wastewater Collection System Agencies, may be submitted to the Regional Water Board to satisfy this requirement.) The written report shall document the information required in paragraph d below, monitoring results and any other information required in provisions of the Standard Provisions document including corrective measures implemented or proposed to be implemented to prevent/minimize future occurrences. The Executive Officer for just cause can grant an extension for submittal of the final written report.

iii. The Discharger shall include a certification in the annual summary report (due according to the schedule in the MRP) that states that the sewer system emergency equipment, including alarm systems, backup pumps, standby power generators, and other critical emergency pump station components were maintained and tested in accordance with the Discharger's preventive maintenance plan. Any deviations from or modifications to the Plan shall be discussed.

d. Records

The Discharger shall develop and maintain a record of all spills, overflows or bypasses of raw or partially treated sewage from its collection system or treatment plant. This record shall be made available to the Regional Water Board upon request and a spill summary shall be included in the annual summary report. The records shall contain:

i. The date and time of each spill, overflow, or bypass;

ii. The location of each spill, overflow, or bypass;

iii. The estimated volume of each spill, overflow, and bypass including gross volume, amount recovered and amount not recovered, monitoring results as required by section V.C.6.b;

iv. The cause of each spill, overflow, or bypass;

v. Whether each spill, overflow, or bypass entered a receiving water and, if so, the name of the water body and whether it entered via storm drains or other man-made conveyances;

vi. Any mitigation measures implemented;

vii. Any corrective measures implemented or proposed to be implemented to prevent/minimize future occurrences; and,

viii. The mandatory information included in SSO online reporting for finalizing and certifying the SSO report for each spill, overflow, or bypass under the SSO WDR.

e. Activities Coordination

In addition, Regional Water Board expects that the Publicly-Owned Treatment Work's (POTW) owners/operators will coordinate their compliance activities for consistency and efficiency with other entities that have responsibilities to implement: (i) this NPDES permit, including the Pretreatment Program; (ii) a MS4 NPDES permit that may contain spill prevention, sewer maintenance, reporting requirements; and, (iii) the SSO WDR.

f. Consistency with SSO WDRs

The CWA prohibits the discharge of pollutants from point sources to surface waters of the United States unless authorized under an NPDES permit. (33 United States Code sections 1311, 1342). The State Water Board adopted *General Waste Discharge Requirements for Sanitary Sewer Systems*, (WQ Order No. 2006-0003-DWQ; SSO WDR) on May 2, 2006, to provide a consistent, statewide regulatory approach to address sanitary sewer overflows. The SSO WDR requires public agencies that own or operate sanitary sewer systems to apply for coverage under the SSO WDR, develop and implement sewer system management plans, and report all SSO to the State Water Board's online SSOs database. Regardless of the coverage obtained under the SSO WDR, the Discharger's collection system is part of the Publicly Owned Treatment Works (POTW) that is subject to this NPDES permit. As such, pursuant to federal regulations, the Discharger must properly operate and maintain its collection system (40 CFR 122.41 (e)), report any non-compliance (40 CFR 122.41(1)(6) and (7)), and mitigate any discharge from the collection system in violation of this NPDES permit (40 CFR 122.41(d)).

The requirements contained in this Order in sections V.C.3.b (SCCP Plan section), V.C.4 (Construction, Operation and Maintenance Specifications section), and V.C.6 (Spill Reporting Requirements section) are intended to be consistent with the requirements of the SSO WDR. The Regional Water Board recognizes that there may be some overlap between these NPDES permit provisions and SSO WDR requirements, related to the collection systems. The requirements of the SSO WDR are considered the minimum thresholds (see finding 11 of State Water Board Order No. 2006-0003-DWQ). To encourage efficiency, the Regional Water Board will accept the documentation prepared by the Permittees under the SSO WDR for compliance purposes as satisfying the requirements in sections V.C.3.b, V.C.4, and V.C.6 provided the more stringent provisions contained in this NPDES permit are also addressed. Pursuant to SSO WDR, section D, provision 2(iii) and (iv), the provisions of this NPDES permit supercede the SSO WDR, for all purposes, including enforcement, to the extent the requirements may be deemed duplicative

g. The Discharger shall provide standby or emergency power facilities and/or storage capacity or other means so that in the event of plant upset or outage due to power failure or other cause, discharge of raw or inadequately treated sewage does not occur.

VI. COMPLIANCE DETERMINATION

Compliance with the effluent limitations contained in section IV of this Order will be determined as specified below:

A. General

Compliance with effluent limitations for priority pollutants shall be determined using sample reporting protocols defined in the MRP and Attachment A of this Order. For purposes of reporting and administrative enforcement by the Regional and State Water Boards, the Discharger shall be deemed out of compliance with effluent limitations if the concentration of the priority pollutant in the monitoring sample is greater than the effluent limitation and greater than or equal to the RL.

B. Multiple Sample Data

When determining compliance with a measure of central tendency (arithmetic mean, geometric mean, median, etc.) of multiple sample analyses and the data set contains one or more reported determinations of DNQ or ND, the Discharger shall compute the median in place of the arithmetic mean in accordance with the following procedure:

1. The data set shall be ranked from low to high, ranking the reported ND determinations lowest, DNQ determinations next, followed by quantified values (if any). The order of the individual ND or DNQ determinations is unimportant.

2. The median value of the data set shall be determined. If the data set has an odd number of data points, then the median is the middle value. If the data set has an even number of data points, then the median is the average of the two values around the middle unless one or both of the points are ND or DNQ, in which case the median value shall be the lower of the two data points where DNQ is lower than a value and ND is lower than DNQ.

C. Sufficient Sampling and Analysis

Sufficient sampling and analysis shall be required to determine compliance with the effluent limitation. If the analytical result of any single sample (daily discharge) monitored monthly, quarterly, semiannually, or annually, exceeds the average monthly effluent limitation (AMEL), the Discharger shall increase sampling frequency to weekly until compliance with the AMEL is demonstrated. All analytical results shall be reported as specified in the MRP.

D. Average Monthly Effluent Limitation (AMEL)

If the average (or when applicable, the median determined by subsection B above for multiple sample data) of daily discharges over a calendar month exceeds the AMEL for a given parameter, this will represent a single violation, though the Discharger may be considered out of compliance for each day of that month for that parameter (e.g., resulting in 31 days of non-compliance in a 31-day month). If only a single sample is taken during the calendar month and the analytical result for that sample exceeds the AMEL, the Discharger may be considered out of compliance for that calendar month. The Discharger will only be considered out of compliance for days when the discharge occurs. For any one calendar month during which no sample (daily discharge) is taken, no compliance determination can be made for that calendar month with respect to the AMEL.

If the analytical result of a single sample, monitored monthly, quarterly, semiannually, or annually, does not exceed the AMEL for a given parameter, the Discharger will have demonstrated compliance with the AMEL for each day of that month for that parameter.

If the analytical result of any single sample, monitored monthly, quarterly, semiannually, or annually, exceeds the AMEL for any parameter, the Discharger may collect up to four additional samples within the same calendar month. All analytical results shall be reported in the monitoring report for that month. The concentration of pollutant (an arithmetic mean or a median) in these samples estimated from the "Multiple Sample Data Reduction" section above, will be used for compliance determination.

In the event of noncompliance with an AMEL, the sampling frequency for that parameter shall be increased to weekly and shall continue at this level until compliance with the AMEL has been demonstrated.

E. Average Weekly Effluent Limitation (AWEL)

If the average of daily discharges over a calendar week exceeds the AWEL for a given parameter, an alleged violation will be flagged and the discharger will be considered out of compliance for each day of that week for that parameter, resulting in seven days of non-compliance. The average of daily discharges over the calendar week that exceeds the AWEL for a parameter will be considered out of compliance for that week only. If only a single sample is taken during the calendar week and the analytical result for that sample exceeds the AWEL, the discharger will be considered out of compliance for that calendar week. For any one calendar week during which no sample (daily discharge) is taken, no compliance determination can be made for that calendar week with respect to the AWEL.

A calendar week will begin on Sunday and end on Saturday. Partial calendar weeks at the end of calendar month will be carried forward to the next month in order to calculate and report a consecutive seven-day average value on Saturday.

F. Maximum Daily Effluent Limitation (MDEL)

If a daily discharge exceeds the MDEL for a given parameter, an alleged violation will be flagged and the discharger will be considered out of compliance for that parameter for that day only within the reporting period. For any day during which no sample is taken, no compliance determination can be made for that day with respect to the MDEL.

G. Instantaneous Minimum Effluent Limitation

If the analytical result of a single grab sample is lower than the instantaneous minimum effluent limitation for a parameter, a violation will be flagged and the discharger will be considered out of compliance for that parameter for that single sample. Non-compliance for each sample will be considered separately (e.g., the results of two grab samples taken within a calendar day that both are lower than the instantaneous minimum effluent limitation would result in two instances of non-compliance with the instantaneous minimum effluent limitation).

H. Instantaneous Maximum Effluent Limitation

If the analytical result of a single grab sample is higher than the instantaneous maximum effluent limitation for a parameter, a violation will be flagged and the discharger will be considered out of compliance for that parameter for that single sample. Non-compliance for each sample will be considered separately (e.g., the results of two grab samples taken within a calendar day that both exceed the instantaneous maximum effluent limitation would result in two instances of non-compliance with the instantaneous maximum effluent limitation).

I. Six-month Median Effluent Limitation

If the median of daily discharges over any 180-day period exceeds the six-month median effluent limitation for a given parameter, an alleged violation will be flagged and the discharger will be considered out of compliance for each day of that 180-day period for that parameter. The next assessment of compliance will occur after the next sample is taken. If only a single sample is taken during a given 180-day period and the analytical result for that sample exceeds the six-month median, the discharger will be considered out of compliance for the 180-day period. For any 180-period during which no sample is taken, no compliance determination can be made for the six-month median effluent limitation.

I. Percent Removal

The average monthly percent removal is the removal efficiency expressed in percentage across a treatment plant for a given pollutant parameter, as determined from the 30-day average values of pollutant concentrations (C in mg/L) of influent and effluent samples collected at about the same time using the following equation:

Percent Removal (%) = $[1-(C_{Effluent}/C_{Influent})] \times 100\ \%$

When preferred, the Discharger may substitute mass loadings and mass emissions for the concentrations.

J. Mass and Concentration Limitations

Compliance with mass and concentration effluent limitations for the same parameter shall be determined separately with their respective limitations. When the concentration of a constituent in an effluent sample is determined to be ND or DNQ, the corresponding mass emission rate determined from that sample concentration shall also be reported as ND or DNQ.

K. Compliance with single constituent effluent limitations

Dischargers may be considered out of compliance with the effluent limitation if the concentration of the pollutant (see section B "Multiple Sample Data Reduction" above) in the monitoring sample is greater than the effluent limitation and greater than or equal to the RL.

L. Compliance with effluent limitations expressed as a sum of several constituents

Dischargers are out of compliance with an effluent limitation which applies to the sum of a group of chemicals (e.g., PCB's) if the sum of the individual pollutant concentrations is greater than the effluent limitation. Individual pollutants of the group will be considered to have a concentration of zero if the constituent is reported as ND or DNQ.

M. Mass Emission Rate

The mass emission rate shall be obtained from the following calculation for any calendar day:

$$\text{Mass emission rate (lb/day)} = \frac{8.34}{N}\sum_{i=1}^{N} Q_i C_i$$

$$\text{Mass emission rate (kg/day)} = \frac{3.79}{N}\sum_{i=1}^{N} Q_i C_i$$

in which 'N' is the number of samples analyzed in any calendar day. Qi and Ci are the flow rate (mgd) and the constituent concentration (mg/L), respectively, which are associated with each of the 'N' grab samples, which may be taken in any calendar day. If a composite sample is taken, 'Ci' is the concentration measured in the composite sample and Qi is the average flow rate occurring during the period over which samples are composited.

The daily concentration of all constituents shall be determined from the flow-weighted average of the same constituents in the combined waste streams as follows:

$$\text{Daily concentration} = \frac{1}{Q_t}\sum_{i=1}^{N} Q_i C_i$$

in which N is the number of component waste streams. Qi and Ci are the flow rate (mgd) and the constituent concentration (mg/L), respectively, which are associated with each of the N waste streams. Qt is the total flow rate of the combined waste streams.

N. Bacterial Standards and Analysis.

1. The geometric mean used for determining compliance with bacterial standards is calculated with the following equation:

   $$\text{Geometric Mean} = (C_1 \times C_2 \times \ldots \times C_n)^{1/n}$$

   where n is the number of days samples were collected during the period and C is the concentration of bacteria (MPN/100 mL or CFU/100 mL) found on each day of sampling.

2. For bacterial analyses, sample dilutions should be performed so the expected range of values is bracketed (for example, with multiple tube fermentation method or membrane filtration method, 2 to 16,000 per 100 ml for total and fecal coliform, at a minimum, and 1 to 1000 per 100 ml for enterococcus). The detection methods used for each analysis shall be reported with the results of the analyses.

3. Detection methods used for coliforms (total and fecal) shall be those presented in Table 1A of 40 CFR part 136 unless alternate methods have been approved by USEPA pursuant to 40 CFR part 136, or improved methods have been determined by the Executive Officer and/or USEPA.

4. Detection methods used for enterococcus shall be those presented in Table 1A of 40 CFR part 136 or in the USEPA publication EPA 600/4-85/076, *Test Methods for Escherichia coli and Enterococci in Water By Membrane Filter Procedure* or any improved method determined by the Executive Officer and/or USEPA to be appropriate.

O. Single Operational Upset

A single operational upset (SOU) that leads to simultaneous violations of more than one pollutant parameter shall be treated as a single violation and limits the Discharger's liability in accordance with the following conditions:

1. A single operational upset is broadly defined as a single unusual event that temporarily disrupts the usually satisfactory operation of a system in such a way that it results in violation of multiple pollutant parameters.

2. A Discharger may assert SOU to limit liability only for those violations which the Discharger submitted notice of the upset as required in Provision V.E.2(b) of Attachment D – Standard Provisions.

3. For purpose outside of CWC section 13385 (h) and (i), determination of compliance and civil liability (including any more specific definition of SOU, the requirements for Dischargers to assert the SOU limitation of liability, and the manner of counting violations) shall be in accordance with USEPA Memorandum "Issuance of Guidance Interpreting Single Operational Upset" (September 27, 1989).

4. For purposes of CWC section 13385, subdivisions (h) and (i), determination of compliance and civil liability (including any more specific definition of SOU, the requirements for Dischargers to assert the SOU limitation of liability, and the manner of counting violations) shall be in accordance with CWC section 13385, subdivision (f)(2)

ATTACHMENT A – DEFINITIONS

Acute Toxicity

a. Acute Toxicity (TUa)

Expressed in Toxic Units Acute (TUa)

$$TUa = \frac{100}{\text{96-hr LC 50\%}}$$

b. Lethal Concentration 50% (LC 50)

LC 50 (percent waste giving 50% survival of test organisms) shall be determined by static or continuous flow bioassay techniques using standard marine test species as specified in Ocean Plan Appendix III. If specific identifiable substances in wastewater can be demonstrated by the discharger as being rapidly rendered harmless upon discharge to the marine environment, but not as a result of dilution, the LC 50 may be determined after the test samples are adjusted to remove the influence of those substances.

When it is not possible to measure the 96-hour LC 50 due to greater than 50 percent survival of the test species in 100 percent waste, the toxicity concentration shall be calculated by the expression:

$$TUa = \frac{\log(100 - S)}{1.7}$$

where:

S = percentage survival in 100% waste. If S > 99, TUa shall be reported as zero.

Areas of Special Biological Significance (ASBS)
Those areas designated by the State Water Board as ocean areas requiring protection of species or biological communities to the extent that alteration of natural water quality is undesirable. All Areas of Special Biological Significance are also classified as a subset of STATE WATER QUALITY PROTECTION AREAS.

Average Monthly Effluent Limitation (AMEL)
The highest allowable average of daily discharges over a calendar month, calculated as the sum of all daily discharges measured during a calendar month divided by the number of daily discharges measured during that month.

Average Weekly Effluent Limitation (AWEL)
he highest allowable average of daily discharges over a calendar week (Sunday through Saturday), calculated as the sum of all daily discharges measured during a calendar week divided by the number of daily discharges measured during that week.

Chlordane
Shall mean the sum of chlordane-alpha, chlordane-gamma, chlordene-alpha, chlordene-gamma, nonachlor-alpha, nonachlor-gamma, and oxychlordane.

Chronic Toxicity
This parameter shall be used to measure the acceptability of waters for supporting a healthy marine biota until improved methods are developed to evaluate biological response.

a. Chronic Toxicity (TUc)

Expressed as Toxic Units Chronic (TUc)

$$TUc = \frac{100}{NOEL}$$

b. No Observed Effect Level (NOEL)

The NOEL is expressed as the maximum percent effluent or receiving water that causes no observable effect on a test organism, as determined by the result of a critical life stage toxicity test listed in Ocean Plan Appendix II.

Daily Discharge
Daily Discharge is defined as either: (1) the total mass of the constituent discharged over the calendar day (12:00 am through 11:59 pm) or any 24-hour period that reasonably represents a calendar day for purposes of sampling (as specified in the permit), for a constituent with limitations expressed in units of mass or; (2) the unweighted arithmetic mean measurement of the constituent over the day for a constituent with limitations expressed in other units of measurement (e.g., concentration).

The daily discharge may be determined by the analytical results of a composite sample taken over the course of one day (a calendar day or other 24-hour period defined as a day) or by the arithmetic mean of analytical results from one or more grab samples taken over the course of the day.

For composite sampling, if 1 day is defined as a 24-hour period other than a calendar day, the analytical result for the 24-hour period will be considered as the result for the calendar day in which the 24-hour period ends.

DDT (Dichlorodiphenyltrichloroethane)
Shall mean the sum of 4,4'DDT, 2,4'DDT, 4,4'DDE, 2,4'DDE, 4,4'DDD, and 2,4'DDD.

Degrade
Degradation shall be determined by comparison of the waste field and reference site(s) for characteristic species diversity, population density, contamination, growth anomalies, debility, or supplanting of normal species by undesirable plant and animal species. Degradation occurs if there are significant differences in any of three major biotic groups, namely, demersal fish, benthic invertebrates, or attached algae. Other groups may be evaluated where benthic species are not affected, or are not the only ones affected.

Detected, but Not Quantified (DNQ)
Sample results that are less than the reported Minimum Level, but greater than or equal to the laboratory's MDL.

Dichlorobenzenes
Shall mean the sum of 1,2- and 1,3-dichlorobenzene.

Downstream Ocean Waters
Waters downstream with respect to ocean currents.

Dredged Material
Any material excavated or dredged from the navigable waters of the United States, including material otherwise referred to as "spoil".

Enclosed Bays
Indentations along the coast that enclose an area of oceanic water within distinct headlands or harbor works. Enclosed bays include all bays where the narrowest distance between headlands or outermost harbor works is less than 75 percent of the greatest dimension of the enclosed portion of the bay. This definition includes but is not limited to: Humboldt Bay, Bodega Harbor, Tomales Bay, Drakes Estero, San Francisco Bay, Morro Bay, Los Angeles Harbor, Upper and Lower Newport Bay, Mission Bay, and San Diego Bay.

Endosulfan
The sum of endosulfan-alpha and -beta and endosulfan sulfate.

Estuaries and Coastal Lagoons are waters at the mouths of streams that serve as mixing zones for fresh and ocean waters during a major portion of the year. Mouths of streams that are temporarily separated from the ocean by sandbars shall be considered as estuaries. Estuarine waters will generally be considered to extend from a bay or the open ocean to the upstream limit of tidal action but may be considered to extend seaward if significant mixing of fresh and salt water occurs in the open coastal waters. The waters described by this definition include but are not limited to the Sacramento-San Joaquin Delta as defined by section 12220 of the California Water Code (CWC), Suisun Bay, Carquinez Strait downstream to Carquinez Bridge, and appropriate areas of the Smith, Klamath, Mad, Eel, Noyo, and Russian Rivers.

Halomethanes shall mean the sum of bromoform, bromomethane (methyl bromide) and chloromethane (methyl chloride).

HCH shall mean the sum of the alpha, beta, gamma (lindane) and delta isomers of hexachlorocyclohexane.

Initial Dilution
The process that results in the rapid and irreversible turbulent mixing of wastewater with ocean water around the point of discharge.

For a submerged buoyant discharge, characteristic of most municipal and industrial wastes that are released from the submarine outfalls, the momentum of the discharge and its initial buoyancy act together to produce turbulent mixing. Initial dilution in this case is completed when the diluting wastewater ceases to rise in the water column and first begins to spread horizontally.

For shallow water submerged discharges, surface discharges, and non-buoyant discharges, characteristic of cooling water wastes and some individual discharges, turbulent mixing results primarily from the momentum of discharge. Initial dilution, in these cases, is considered to be completed when the momentum induced velocity of the discharge ceases to produce significant mixing of the waste, or the diluting plume reaches a fixed distance from the discharge to be specified by the Regional Board, whichever results in the lower estimate for initial dilution.

Instantaneous Maximum Effluent Limitation
The highest allowable value for any single grab sample or aliquot (i.e., each grab sample or aliquot is independently compared to the instantaneous maximum limitation).

Instantaneous Minimum Effluent Limitation
The lowest allowable value for any single grab sample or aliquot (i.e., each grab sample or aliquot is independently compared to the instantaneous minimum limitation).

Kelp Beds
For purposes of the bacteriological standards of the Ocean Plan, are significant aggregations of marine algae of the genera Macrocystis and Nereocystis. Kelp beds include the total foliage canopy of Macrocystis and Nereocystis plants throughout the water column.

Mariculture
The culture of plants and animals in marine waters independent of any pollution source.

Material
(a) In common usage: (1) the substance or substances of which a thing is made or composed (2) substantial; (b) For purposes of the Ocean Plan relating to waste disposal, dredging and the disposal of dredged material and fill, MATERIAL means matter of any kind or description which is subject to regulation as waste, or any material dredged from the navigable waters of the United States. See also, DREDGED MATERIAL.

Maximum Daily Effluent Limitation (MDEL)
The highest allowable daily discharge of a pollutant.

Method Detection Limit (MDL)
The minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero, as defined in title 40 40 CFR part 136, Attachment B.

Minimum Level (ML)
The concentration at which the entire analytical system must give a recognizable signal and acceptable calibration point. The ML is the concentration in a sample that is equivalent to the concentration of the lowest calibration standard analyzed by a specific analytical procedure, assuming that all the method specified sample weights, volumes, and processing steps have been followed.

Natural Light
Reduction of natural light may be determined by the Regional Water Board by measurement of light transmissivity or total irradiance, or both, according to the monitoring needs of the Regional Water Board.

Not Detected (ND)
Those sample results less than the laboratory's MDL.

Ocean Waters
The territorial marine waters of the state as defined by California law to the extent these waters are outside of enclosed bays, estuaries, and coastal lagoons. If a discharge outside the territorial waters of the state could affect the quality of the waters of the state, the discharge may be regulated to assure no violation of the Ocean Plan will occur in ocean waters.

PAHs (polynuclear aromatic hydrocarbons)
The sum of acenaphthylene, anthracene, 1,2-benzanthracene, 3,4-benzofluoranthene, benzo[k]fluoranthene, 1,12-benzoperylene, benzo[a]pyrene, chrysene, dibenzo[ah]anthracene, fluorene, indeno[1,2,3-cd]pyrene, phenanthrene and pyrene.

PCBs (polychlorinated biphenyls)
The sum of chlorinated biphenyls whose analytical characteristics resemble those of Aroclor-1016, Aroclor-1221, Aroclor-1232, Aroclor-1242, Aroclor-1248, Aroclor-1254 and Aroclor-1260.

PCB derivatives: At a minimum, PCB congeners whose analytical characteristics resemble those of PCB-18, 28, 37, 44, 49, 52, 66, 70, 74, 77, 81, 87, 99, 101, 105, 110, 114, 118, 119, 123, 126, 128, 138, 149, 151, 153, 156, 157, 158, 167, 168, 169, 170, 177, 180, 183, 187, 189, 194, 201, and 206 shall be individually quantified.

Pesticides are, for purposes of this order, those six constituents referred to in 40 CFR, part 125.58 (p) (methoxychlor, demeton, guthion, malathion, mirex, and parathion).

Pollutant Minimization Program (PMP)
PMP means waste minimization and pollution prevention actions that include, but are not limited to, product substitution, waste stream recycling, alternative waste management methods, and education of the public and businesses. The goal of the PMP shall be to reduce all potential sources of Ocean Plan Table B pollutants through pollutant minimization (control) strategies, including pollution prevention measures as appropriate, to maintain the effluent concentration at or below the water quality-based effluent limitation. Pollution prevention measures may be particularly appropriate for persistent bioaccumulative priority pollutants where there is evidence that beneficial uses are being impacted. The Regional Water Board may consider cost effectiveness when establishing the requirements of a PMP. The completion and implementation of a Pollution Prevention Plan, if required pursuant to CWC section 13263.3(d), shall be considered to fulfill the PMP requirements.

Reported Minimum Level (RML)
The ML (and its associated analytical method) chosen by the Discharger for reporting and compliance determination from the MLs included in this Order. The MLs included in this Order correspond to approved analytical methods for reporting a sample result that are selected by the Regional Water Board either from Appendix II of the Ocean Plan in accordance with section III.C.5.a. of the Ocean Plan or established in accordance with section III.C.5.b. of the Ocean Plan. The ML is based on the proper application of method-based analytical procedures for sample preparation and the absence of any matrix interferences. Other factors may be applied to the ML depending on the specific sample preparation steps employed. For example, the treatment typically applied in cases where there are matrix-effects is to dilute the sample or sample aliquot by a factor of ten. In such cases, this additional factor must be applied to the ML in the computation of the reported ML.

Satellite Collection System
The portion, if any, of a sanitary sewer system owned or operated by a different public agency than the agency that owns and operates the wastewater treatment facility that a sanitary sewer system is tributary to.

Shellfish
Organisms identified by the California Department of Health Services as shellfish for public health purposes (i.e., mussels, clams and oysters).

Significant Difference
Defined as a statistically significant difference in the means of two distributions of sampling results at the 95 percent confidence level.

Six-Month Median Effluent Limitation
The highest allowable moving median of all daily discharges for any 180-day period.

Sludge means the solids, semi-liquid suspensions of solids, residues, screenings, grit, scum, and precipitates separated from, or created in, wastewater by the unit processes of a treatment system. It also includes, but is not limited to, all supernatant, filtrate, centrate, decantate, and thickener overflow/underflow in the solids handling parts of the wastewater treatment system.

State Water Quality Protection Areas (SWQPAs)
Non-terrestrial marine or estuarine areas designated to protect marine species or biological communities from an undesirable alteration in natural water quality. All AREAS OF SPECIAL BIOLOGICAL SIGNIFICANCE (ASBS) that were previously designated by the State Water Board in Resolution No.s 74-28, 74-32, and 75-61 are now also classified as a subset of State Water Quality Protection Areas and require special protections afforded by the Ocean Plan.

TCDD Equivalents
The sum of the concentrations of chlorinated dibenzodioxins (2,3,7,8-CDDs) and chlorinated dibenzofurans (2,3,7,8-CDFs) multiplied by their respective toxicity factors, as shown in the table below.

Isomer Group	Toxicity Equivalence Factor
2,3,7,8-tetra CDD	1.0
2,3,7,8-penta CDD	0.5
2,3,7,8-hexa CDDs	0.1
2,3,7,8-hepta CDD	0.01
octa CDD	0.001
2,3,7,8 tetra CDF	0.1
1,2,3,7,8 penta CDF	0.05
2,3,4,7,8 penta CDF	0.5
2,3,7,8 hexa CDFs	0.1
2,3,7,8 hepta CDFs	0.01
octa CDF	0.001

Toxicity Reduction Evaluation (TRE)
A study conducted in a step-wise process designed to identify the causative agents of effluent or ambient toxicity, isolate the sources of toxicity, evaluate the effectiveness of toxicity control options, and then confirm the reduction in toxicity. The first steps of the TRE consist of the collection of data relevant to the toxicity, including additional toxicity testing, and an evaluation of facility operations and maintenance practices, and best management practices. A Toxicity Identification Evaluation (TIE) may be required as part of the TRE, if appropriate. (A TIE is a set of procedures to identify the specific chemical(s) responsible for toxicity. These procedures are performed in three phases (characterization, identification, and confirmation) using aquatic organism toxicity tests.)

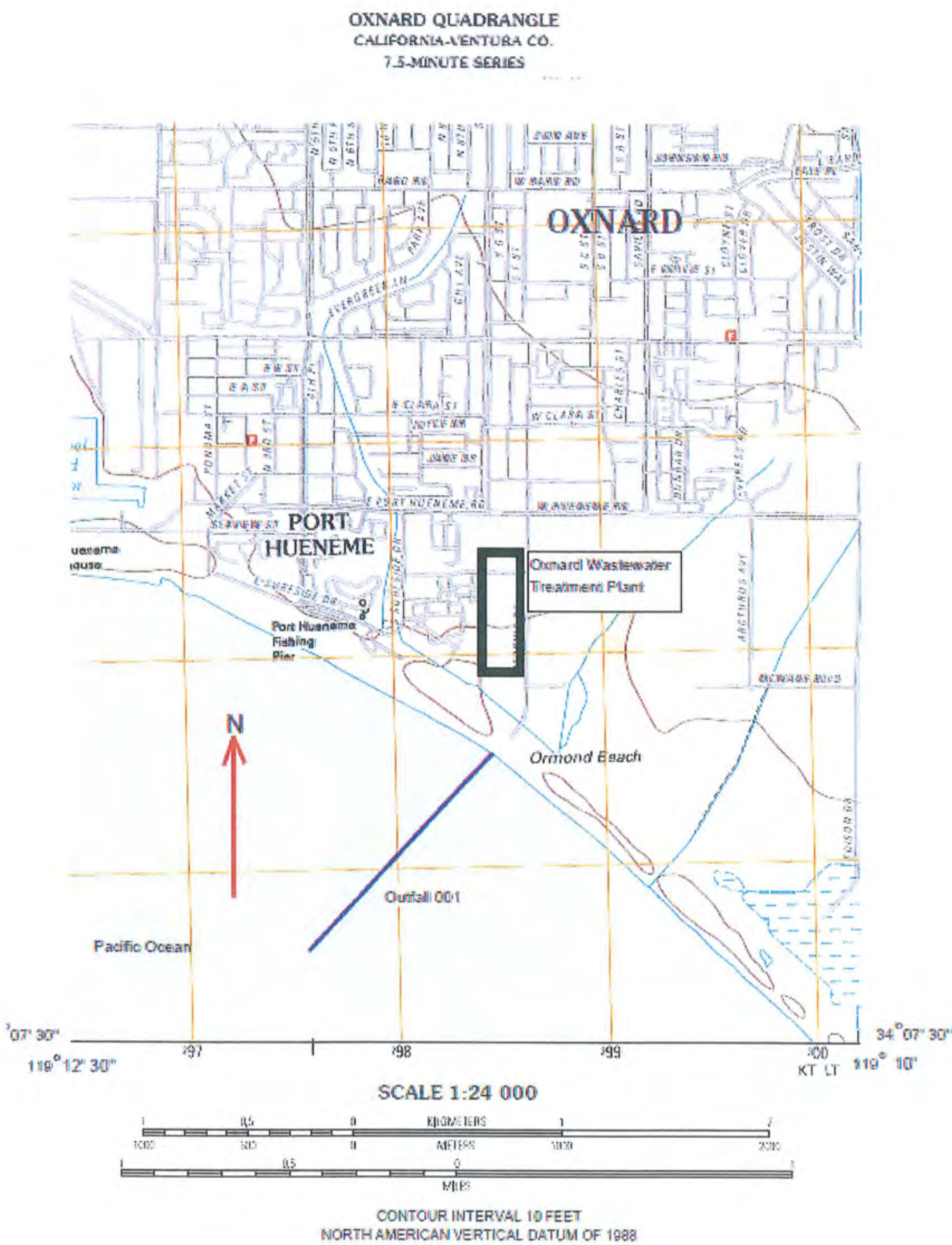
Waste
As used in the Ocean Plan, waste includes a Discharger's total discharge, of whatever origin, i.e., gross, not net, discharge.

Water Reclamation
The treatment of wastewater to render it suitable for reuse, the transportation of treated wastewater to the place of use, and the actual use of treated wastewater for a direct beneficial use or controlled use that would not otherwise occur.

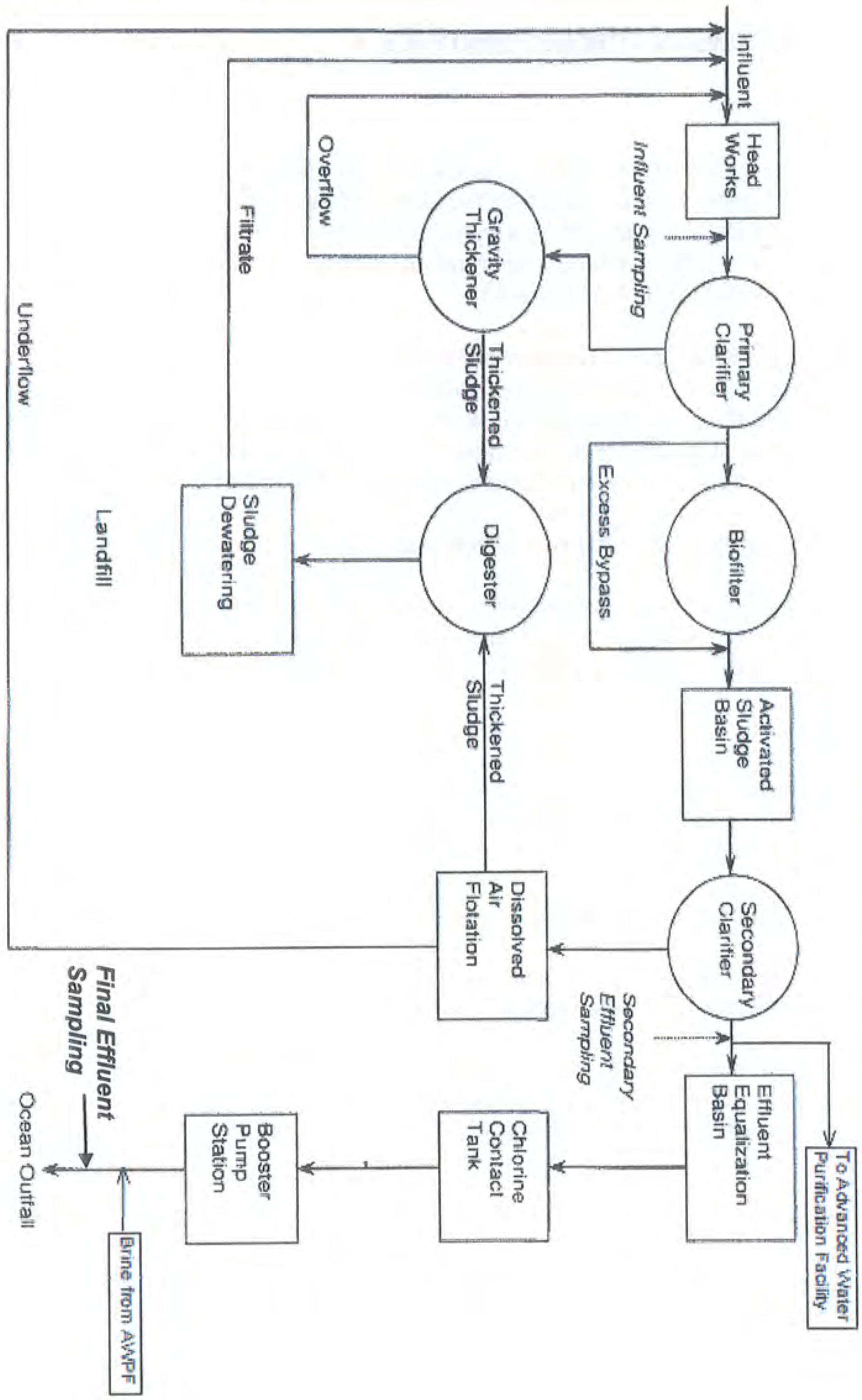
Whole Effluent Toxicity (WET) The total toxic effect of an effluent measured directly with a toxicity test.

Zone of Initial Dilution (ZID) means, for purposes of designating monitoring stations, the region within a horizontal distance equal to a specified water depth (usually depth of outfall or average depth of diffuser) from any point of the diffuser or end of the outfall and the water column above and below that region, including the underlying seabed.

ATTACHMENT B – MAP



ATTACHMENT C – FLOW SCHEMATIC



ATTACHMENT D – STANDARD PROVISIONS

I. STANDARD PROVISIONS – PERMIT COMPLIANCE

A. Duty to Comply

1. The Discharger must comply with all of the conditions of this Order. Any noncompliance constitutes a violation of the Clean Water Act (CWA) and the California Water Code (CWC) and is grounds for enforcement action, for permit termination, revocation and reissuance, or modification; or denial of a permit renewal application. (Title 40, Code of Federal Regulations (40 CFR) part 122.41(a).)

2. The Discharger shall comply with effluent standards or prohibitions established under section 307(a) of the CWA for toxic pollutants and with standards for sewage sludge use or disposal established under section 405(d) of the CWA within the time provided in the regulations that establish these standards or prohibitions, even if this Order has not yet been modified to incorporate the requirement. (40 CFR part 122.41(a)(1).)

B. Need to Halt or Reduce Activity Not a Defense

It shall not be a defense for a Discharger in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this Order. (40 CFR part 122.41(c).)

C. Duty to Mitigate

The Discharger shall take all reasonable steps to minimize or prevent any discharge or sludge use or disposal in violation of this Order that has a reasonable likelihood of adversely affecting human health or the environment. (40 CFR part 122.41(d).)

D. Proper Operation and Maintenance

The Discharger shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the Discharger to achieve compliance with the conditions of this Order. Proper operation and maintenance also includes adequate laboratory controls and appropriate quality assurance procedures. This provision requires the operation of backup or auxiliary facilities or similar systems that are installed by a Discharger only when necessary to achieve compliance with the conditions of this Order. (40 CFR part 122.41(e).)

E. Property Rights

1. This Order does not convey any property rights of any sort or any exclusive privileges. (40 CFR part 122.41(g).)

2. The issuance of this Order does not authorize any injury to persons or property or invasion of other private rights, or any infringement of state or local law or regulations. (40 CFR part 122.5(c).)

F. Inspection and Entry

The Discharger shall allow the Regional Water Board, State Water Board, United States Environmental Protection Agency (USEPA), and/or their authorized representatives (including an authorized contractor acting as their representative), upon the presentation of credentials and other documents, as may be required by law, to (40 CFR part 122.41(i); CWC section 13383):

1. Enter upon the Discharger's premises where a regulated facility or activity is located or conducted, or where records are kept under the conditions of this Order (40 CFR part 122.41(i)(1));

2. Have access to and copy, at reasonable times, any records that must be kept under the conditions of this Order (40 CFR part 122.41(i)(2));

3. Inspect and photograph, at reasonable times, any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this Order (40 CFR part 122.41(i)(3)); and

4. Sample or monitor, at reasonable times, for the purposes of assuring Order compliance or as otherwise authorized by the CWA or the CWC, any substances or parameters at any location. (40 CFR part 122.41(i)(4).)

G. Bypass

1. Definitions

   a. "Bypass" means the intentional diversion of waste streams from any portion of a treatment facility. (40 CFR part 122.41(m)(1)(i).)

   b. "Severe property damage" means substantial physical damage to property, damage to the treatment facilities, which causes them to become inoperable, or substantial and permanent loss of natural resources that can reasonably be expected to occur in the absence of a bypass. Severe property damage does not mean economic loss caused by delays in production. (40 CFR part 122.41(m)(1)(ii).)

2. Bypass not exceeding limitations. The Discharger may allow any bypass to occur which does not cause exceedances of effluent limitations, but only if it is for essential maintenance to assure efficient operation. These bypasses are not subject to the provisions listed in Standard Provisions – Permit Compliance I.G.3, I.G.4, and I.G.5 below. (40 CFR part 122.41(m)(2).)

3. Prohibition of bypass. Bypass is prohibited, and the Regional Water Board may take enforcement action against a Discharger for bypass, unless (40 CFR part 122.41(m)(4)(i)):

   a. Bypass was unavoidable to prevent loss of life, personal injury, or severe property damage (40 CFR part 122.41(m)(4)(i)(A));

   b. There were no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate back-up equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass that occurred during normal periods of equipment downtime or preventive maintenance (40 CFR part 122.41(m)(4)(i)(B)); and

c. The Discharger submitted notice to the Regional Water Board as required under Standard Provisions – Permit Compliance I.G.5 below. (40 CFR part 122.41(m)(4)(i)(C).)

4. The Regional Water Board may approve an anticipated bypass, after considering its adverse effects, if the Regional Water Board determines that it will meet the three conditions listed in Standard Provisions – Permit Compliance I.G.3 above. (40 CFR part 122.41(m)(4)(ii).)

5. Notice

a. Anticipated bypass. If the Discharger knows in advance of the need for a bypass, it shall submit a notice, if possible at least 10 days before the date of the bypass. (40 CFR part 122.41(m)(3)(i).)

b. Unanticipated bypass. The Discharger shall submit notice of an unanticipated bypass as required in Standard Provisions - Reporting V.E below (24-hour notice). (40 CFR part 122.41(m)(3)(ii).)

H. Upset

Upset means an exceptional incident in which there is unintentional and temporary noncompliance with technology based permit effluent limitations because of factors beyond the reasonable control of the Discharger. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance, or careless or improper operation. (40 CFR part 122.41(n)(1).)

1. Effect of an upset. An upset constitutes an affirmative defense to an action brought for noncompliance with such technology based permit effluent limitations if the requirements of Standard Provisions – Permit Compliance I.H.2 below are met. No determination made during administrative review of claims that noncompliance was caused by upset, and before an action for noncompliance, is final administrative action subject to judicial review. (40 CFR part 122.41(n)(2).)

2. Conditions necessary for a demonstration of upset. A Discharger who wishes to establish the affirmative defense of upset shall demonstrate, through properly signed, contemporaneous operating logs or other relevant evidence that (40 CFR part 122.41(n)(3)):

a. An upset occurred and that the Discharger can identify the cause(s) of the upset (40 CFR part 122.41(n)(3)(i));

b. The permitted facility was, at the time, being properly operated (40 CFR part 122.41(n)(3)(ii));

c. The Discharger submitted notice of the upset as required in Standard Provisions – Reporting V.E.2.b below (24-hour notice) (40 CFR part 122.41(n)(3)(iii)); and

d. The Discharger complied with any remedial measures required under Standard Provisions – Permit Compliance I.C above. (40 CFR part 122.41(n)(3)(iv).)

3. Burden of proof. In any enforcement proceeding, the Discharger seeking to establish the occurrence of an upset has the burden of proof. (40 CFR part 122.41(n)(4).)

II. STANDARD PROVISIONS – PERMIT ACTION

A. General

This Order may be modified, revoked and reissued, or terminated for cause. The filing of a request by the Discharger for modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance does not stay any Order condition. (40 CFR part 122.41(f).)

B. Duty to Reapply

If the Discharger wishes to continue an activity regulated by this Order after the expiration date of this Order, the Discharger must apply for and obtain a new permit. (40 CFR part 122.41(b).)

C. Transfers

This Order is not transferable to any person except after notice to the Regional Water Board. The Regional Water Board may require modification or revocation and reissuance of the Order to change the name of the Discharger and incorporate such other requirements as may be necessary under the CWA and the CWC. (40 CFR part 122.41(l)(3); part 122.61.)

III. STANDARD PROVISIONS – MONITORING

A. Samples and measurements taken for the purpose of monitoring shall be representative of the monitored activity. (40 CFR part 122.41(j)(1).)

B. Monitoring results must be conducted according to test procedures under 40 CFR part 136 or, in the case of sludge use or disposal, approved under 40 CFR part 136 unless otherwise specified in 40 CFR part 503 unless other test procedures have been specified in this Order. (40 CFR part 122.41(j)(4); part 122.44(i)(1)(iv).)

IV. STANDARD PROVISIONS – RECORDS

A. Except for records of monitoring information required by this Order related to the Discharger's sewage sludge use and disposal activities, which shall be retained for a period of at least five years (or longer as required by 40 CFR part 503), the Discharger shall retain records of all monitoring information, including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation, copies of all reports required by this Order, and records of all data used to complete the application for this Order, for a period of at least three (3) years from the date of the sample, measurement, report or application. This period may be extended by request of the Regional Water Board Executive Officer at any time. (40 CFR part 122.41(j)(2).)

B. Records of monitoring information shall include:

1. The date, exact place, and time of sampling or measurements (40 CFR part 122.41(j)(3)(i));

2. The individual(s) who performed the sampling or measurements (40 CFR part 122.41(j)(3)(ii));

3. The date(s) analyses were performed (40 CFR part 122.41(j)(3)(iii));

4. The individual(s) who performed the analyses (40 CFR part 122.41(j)(3)(iv));

5. The analytical techniques or methods used (40 CFR part 122.41(j)(3)(v)); and

6. The results of such analyses. (40 CFR part 122.41(j)(3)(vi).)

C. Claims of confidentiality for the following information will be denied (40 CFR part 122.7(b)):

1. The name and address of any permit applicant or Discharger (40 CFR part 122.7(b)(1)); and

2. Permit applications and attachments, permits and effluent data. (40 CFR part 122.7(b)(2).)

V. STANDARD PROVISIONS – REPORTING

A. Duty to Provide Information

The Discharger shall furnish to the Regional Water Board, State Water Board, or USEPA within a reasonable time, any information which the Regional Water Board, State Water Board, or USEPA may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this Order or to determine compliance with this Order. Upon request, the Discharger shall also furnish to the Regional Water Board, State Water Board, or USEPA copies of records required to be kept by this Order. (40 CFR part 122.41(h); CWC section 13267.)

B. Signatory and Certification Requirements

1. All applications, reports, or information submitted to the Regional Water Board, State Water Board, and/or USEPA shall be signed and certified in accordance with Standard Provisions – Reporting V.B.2, V.B.3, V.B.4, and V.B.5 below. (40 CFR part 122.41(k).)

2. All permit applications shall be signed by either a principal executive officer or ranking elected official. For purposes of this provision, a principal executive officer of a federal agency includes: (i) the chief executive officer of the agency, or (ii) a senior executive officer having responsibility for the overall operations of a principal geographic unit of the agency (e.g., Regional Administrators of USEPA). (40 CFR part 122.22(a)(3).).

3. All reports required by this Order and other information requested by the Regional Water Board, State Water Board, or USEPA shall be signed by a person described in Standard Provisions – Reporting V.B.2 above, or by a duly authorized representative of that person. A person is a duly authorized representative only if:

a. The authorization is made in writing by a person described in Standard Provisions – Reporting V.B.2 above (40 CFR part 122.22(b)(1));

b. The authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility or activity such as the position of plant manager, operator of a well or a well field, superintendent, position of equivalent responsibility, or an individual or position having overall responsibility for environmental matters for the company. (A duly authorized representative may thus be either a named individual or any individual occupying a named position.) (40 CFR part 122.22(b)(2)); and

c. The written authorization is submitted to the Regional Water Board and State Water Board. (40 CFR part 122.22(b)(3).)

4. If an authorization under Standard Provisions – Reporting V.B.3 above is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new authorization satisfying the requirements of Standard Provisions – Reporting V.B.3 above must be submitted to the Regional Water Board and State Water Board prior to or together with any reports, information, or applications, to be signed by an authorized representative. (40 CFR part 122.22(c).)

5. Any person signing a document under Standard Provisions – Reporting V.B.2 or V.B.3 above shall make the following certification:

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations." (40 CFR part 122.22(d).)

C. Monitoring Reports

1. Monitoring results shall be reported at the intervals specified in the MRP (Attachment E) in this Order. (40 CFR part 122.22(l)(4).)

2. Monitoring results must be reported on a Discharge Monitoring Report (DMR) form or forms provided or specified by the Regional Water Board or State Water Board for reporting results of monitoring of sludge use or disposal practices. (40 CFR part 122.41(l)(4)(i).)

3. If the Discharger monitors any pollutant more frequently than required by this Order using test procedures approved under 40 CFR part 136 or, in the case of sludge use or disposal, approved under 40 CFR part 136 unless otherwise specified in 40 CFR part 503, or as specified in this Order, the results of this monitoring shall be included in the calculation and reporting of the data submitted in the DMR or sludge reporting form specified by the Regional Water Board. (40 CFR part 122.41(l)(4)(ii).)

4. Calculations for all limitations, which require averaging of measurements, shall utilize an arithmetic mean unless otherwise specified in this Order. (40 CFR part 122.41(l)(4)(iii).)

D. Compliance Schedules

Reports of compliance or noncompliance with, or any progress reports on, interim and final requirements contained in any compliance schedule of this Order, shall be submitted no later than 14 days following each schedule date. (40 CFR part 122.41(l)(5).)

E. Twenty-Four Hour Reporting

1. The Discharger shall report any noncompliance that may endanger health or the environment. Any information shall be provided orally within 24 hours from the time the Discharger becomes aware of the circumstances. A written submission shall also be provided within five (5) days of the time the Discharger becomes aware of the circumstances. The written submission shall contain a description of the noncompliance and its cause; the period of noncompliance, including exact dates and times, and if the noncompliance has not been corrected, the anticipated time it is expected to continue; and steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance. (40 CFR part 122.41(l)(6)(i).)

2. The following shall be included as information that must be reported within 24 hours under this paragraph (40 CFR part 122.41(l)(6)(ii)):

   a. Any unanticipated bypass that exceeds any effluent limitation in this Order. (40 CFR part 122.41(l)(6)(ii)(A).)

   b. Any upset that exceeds any effluent limitation in this Order. (40 CFR part 122.41(l)(6)(ii)(B).)

3. The Regional Water Board may waive the above-required written report under this provision on a case-by-case basis if an oral report has been received within 24 hours. (40 CFR part 122.41(l)(6)(iii).)

F. Planned Changes

The Discharger shall give notice to the Regional Water Board as soon as possible of any planned physical alterations or additions to the permitted facility. Notice is required under this provision only when (40 CFR part 122.41(l)(1)):

1. The alteration or addition to a permitted facility may meet one of the criteria for determining whether a facility is a new source in section 122.29(b) (40 CFR part 122.41(l)(1)(i)); or

2. The alteration or addition could significantly change the nature or increase the quantity of pollutants discharged. This notification applies to pollutants that are subject neither to effluent limitations in this Order nor to notification requirements under section 122.42(a)(1) (see Additional Provisions—Notification Levels VII.A.1). (40 CFR part 122.41(l)(1)(ii).)

3. The alteration or addition results in a significant change in the Discharger's sludge use or disposal practices, and such alteration, addition, or change may justify the application of permit conditions that are different from or absent in the existing permit, including notification of additional use or disposal sites not reported during the permit application process or not reported pursuant to an approved land application plan. (40 CFR part 122.41(l)(1)(iii).)

G. Anticipated Noncompliance

The Discharger shall give advance notice to the Regional Water Board or State Water Board of any planned changes in the permitted facility or activity that may result in noncompliance with General Order requirements. (40 CFR part 122.41(l)(2).)

H. Other Noncompliance

The Discharger shall report all instances of noncompliance not reported under Standard Provisions – Reporting V.C, V.D, and V.E above at the time monitoring reports are submitted. The reports shall contain the information listed in Standard Provision – Reporting V.E above. (40 CFR part 122.41(l)(7).)

I. Other Information

When the Discharger becomes aware that it failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application or in any report to the Regional Water Board, State Water Board, or USEPA, the Discharger shall promptly submit such facts or information. (40 CFR part 122.41(l)(8).)

VI. STANDARD PROVISIONS – ENFORCEMENT

A. The Regional Water Board is authorized to enforce the terms of this permit under several provisions of the CWC, including, but not limited to, sections 13385, 13386, and 13387.

B. The CWA provides that any person who violates section 301, 302, 306, 307, 308, 318 or 405 of the CWA, or any permit condition or limitation implementing any such sections in a permit issued under section 402, or any requirement imposed in a pretreatment program approved under sections 402(a)(3) or 402(b)(8) of the CWA, is subject to a civil penalty not to exceed $25,000 per day for each violation. The CWA provides that any person who *negligently* violates sections 301, 302, 306, 307, 308, 318, or 405 of the CWA, or any condition or limitation implementing any of such sections in a permit issued under section 402 of the CWA, or any requirement imposed in a pretreatment program approved under section 402(a)(3) or 402(b)(8) of the CWA, is subject to criminal penalties of $2,500 to $25,000 per day of violation, or imprisonment of not more than one year, or both. In the case of a second or subsequent conviction for a negligent violation, a person shall be subject to criminal penalties of not more than $50,000 per day of violation, or by imprisonment of not more than two years, or both. Any person who *knowingly* violates such conditions or limitations is subject to criminal penalties of $5,000 to $50,000 per day of violation, or imprisonment for not more than three years, or both. In the case of a second or subsequent conviction for a knowing violation, a person shall be subject to criminal penalties of not more than $100,000 per day of violation, or imprisonment of not more than 6 years, or both. Any person who *knowingly* violates section 301, 302, 303, 306, 307, 308, 318 or 405 of the CWA, or any permit condition or limitation implementing any of such sections in a permit issued under section 402 of the CWA, and who knows at that time that he thereby places another person in imminent danger of death or serious bodily injury, shall, upon conviction, be subject to a fine of not more than $250,000 or imprisonment of not more than 15 years, or both. In the case of a second or subsequent conviction for a knowing endangerment violation, a person shall be subject to a fine of not more than $500,000 or by imprisonment of not more than 30 years, or both. An organization, as defined in section 309(c)(3)(B)(iii) of the CWA, shall, upon conviction of violating the imminent danger provision, be subject to a fine of not more than $1,000,000 and can be fined up to $2,000,000 for second or subsequent convictions (40 CFR 122.41(a)(2)).

C. Any person may be assessed an administrative penalty by the Administrator for violating section 301, 302, 306, 307, 308, 318 or 405 of this CWA, or any permit condition or limitation implementing any of such sections in a permit issued under section 402 of the CWA. Administrative penalties for Class I violations are not to exceed $10,000 per violation, with the maximum amount of any Class I penalty assessed not to exceed $25,000. Penalties for Class II violations are not to exceed $10,000 per day for each day during which the violation continues, with the maximum amount of any Class II penalty not to exceed $125,000. (40 CFR part 122.41(a)(3))

D. The CWA provides that any person who falsifies, tampers with, or knowingly renders inaccurate any monitoring device or method required to be maintained under this permit shall, upon conviction, be punished by a fine of not more than $10,000, or by imprisonment for not more than two years, or both. If a conviction of a person is for a violation committed after a first conviction of such person under this paragraph, punishment is a fine of not more than $20,000 per day of violation, or by imprisonment of not more than four years, or both. (40 CFR part 122.41(j)(5)).

E. The CWA provides that any person who knowingly makes any false statement, representation, or certification in any record or other document submitted or required to be maintained under this permit, including monitoring reports or reports of compliance or non-compliance shall, upon conviction, be punished by a fine of not more than $10,000 per violation, or by imprisonment for not more than six months per violation, or by both. (40 CFR part 122.41(k)(2)).

VII. ADDITIONAL PROVISIONS – NOTIFICATION LEVELS

A. Publicly-Owned Treatment Works (POTWs)

All POTWs shall provide adequate notice to the Regional Water Board of the following (40 CFR part 122.42(b)):

1. Any new introduction of pollutants into the POTW from an indirect discharger that would be subject to sections 301 or 306 of the CWA if it were directly discharging those pollutants (40 CFR part 122.42(b)(1)); and

2. Any substantial change in the volume or character of pollutants being introduced into that POTW by a source introducing pollutants into the POTW at the time of adoption of the Order. (40 CFR part 122.42(b)(2).)

3. Adequate notice shall include information on the quality and quantity of effluent introduced into the POTW as well as any anticipated impact of the change on the quantity or quality of effluent to be discharged from the POTW. (40 CFR part 122.42(b)(3).)

ATTACHMENT E – MONITORING AND REPORTING PROGRAM (MRP)

Table of Contents

List of Tables

ATTACHMENT E – MONITORING AND REPORTING PROGRAM (MRP), CI-2022

Title 40 of the Code of Federal Regulations (40 CFR) part 122.48 requires that all NPDES permits specify monitoring and reporting requirements. CWC sections 13267 and 13383 also authorize the Regional Water Quality Control Board (Regional Water Board) to require technical and monitoring reports. This MRP establishes monitoring and reporting requirements, which implement the federal and California law and regulations.

I. GENERAL MONITORING PROVISIONS

A. Principles, Framework, and Design of Monitoring Program

1. NPDES compliance monitoring focuses on the effects of a specific point source discharge. Generally, it is not designed to assess impacts from other sources of pollution (e.g., nonpoint source runoff, aerial fallout) or to evaluate the current status of important ecological resources in the waterbody. The scale of existing compliance monitoring programs does not match the spatial and, to some extent, temporal boundaries of the important physical and biological processes in the ocean. In addition, the spatial coverage provided by compliance monitoring programs is less than ten percent of the nearshore ocean environment. Better technical information is needed about status and trends in ocean waters to guide management and regulatory decisions, to verify the effectiveness of existing programs, and to shape policy on marine environmental protection.

2. The Regional Water Board and the United States Environmental Protection Agency (USEPA), working with other groups, have developed a comprehensive basis for effluent and receiving water monitoring appropriate to large publicly owned treatment works (POTWs) discharging to waters of the Southern California Bight. This effort has culminated in the publication by the Southern California Coastal Water Research Project (SCCWRP) of the Model Monitoring Program guidance document (Schiff, K.C., J.S. Brown and S.B. Weisberg. 2001. *Model Monitoring Program for Large Ocean Dischargers in Southern California*. SCCWRP Tech. Rep #357. Southern California Coastal Water Research Project, Westminster, CA. 101 pp.). This guidance provides the principles, framework and recommended design for effluent and receiving water monitoring elements that have guided development of the monitoring program described below.

3. The conceptual framework for the Model Monitoring Program has three components that comprise a range of spatial and temporal scales: (1) core monitoring; (2) regional monitoring; and (3) special studies.

   a. Core monitoring is local in nature and focused on monitoring trends in quality and effects of the point source discharge. This includes effluent monitoring as well as some aspects of receiving water monitoring. In the monitoring program described below these core components are typically referred to as local monitoring.

   b. Regional monitoring is focused on questions that are best answered by a region-wide approach that incorporates coordinated survey design and sampling techniques. The major objective of regional monitoring is to collect information required to assess how safe it is to swim in the ocean, how safe it is to eat seafood from the ocean, and whether the marine ecosystem is being protected. Key components of regional monitoring include elements to address pollutant mass emission estimations, public health concerns, monitoring of trends in natural resources, assessment of regional impacts from all contaminant sources, and protection of beneficial uses. The final design of regional monitoring programs is developed by means of steering committees and technical committees comprised of participating agencies and organizations, and is not specified in this permit. Instead, for each regional component, the degree and nature of participation of the Discharger is specified. For this permit, these levels of effort are based upon past participation of the City of Oxnard in regional monitoring programs.

The Discharger shall participate in regional monitoring activities coordinated by the SCCWRP or any other appropriate agency approved by the Regional Water Board. The procedures and time lines for the Regional Water Board approval shall be the same as detailed for special studies, below.

c. Special studies are focused on refined questions regarding specific effects or development of monitoring techniques and are anticipated to be of short duration and/or small scale, although multiyear studies may also be needed. Questions regarding effluent or receiving water quality, discharge impacts, ocean processes in the area of the discharge, or development of techniques for monitoring the same, arising out of the results of core or regional monitoring, may be pursued through special studies. These studies are by nature ad hoc and cannot be typically anticipated in advance of the five-year permit cycle.

The Discharger and the Regional Water Board shall consult annually to determine the need for special studies. Each year, the Discharger shall submit proposals for any proposed special studies to the Regional Water Board by December 15, for the following year's monitoring effort (July through June). The following year, detailed scopes of work for proposals, including reporting schedules, shall be presented by the Discharger at a Spring Regional Water Board meeting, to obtain the Regional Water Board approval and to inform the public. Upon approval by the Regional Water Board, the Discharger shall implement its special study or studies.

4. In an attempt to bridge the foregoing gap in information, this monitoring program for the City of Oxnard is comprised of requirements to demonstrate compliance with the conditions of the NPDES permit, ensure compliance with state water quality standards, and mandate participation in regional monitoring and/or area-wide studies.

5. Discharger participation in regional monitoring programs is required as a condition of this permit. The Discharger shall complete collection and analysis of samples in accordance with the schedule established by the Steering Committee directing the bight-wide regional monitoring surveys. The level of participation shall be similar to that provided by the Discharger in previous regional surveys conducted in 1994, 1998, 2003 and 2008. The regional programs which must be conducted under this permit include:

a. Future Southern California Bight regional surveys, including benthic infauna, sediment chemistry, fish communities and fish predator risk;

b. Central Region Kelp Monitoring Program – coordinated by the Regional Water Board; and,

c. Central Bight Water Quality Cooperative Program – coordinated monitoring conducted by the Orange County Sanitation District, County Sanitation Districts of Los Angeles County, the City of Los Angeles and the City of Oxnard through appropriate agencies for water quality monitoring.

6. Future Southern California Bight Regional Surveys

Regular regional monitoring for the Southern California Bight has been established, occurring at four- to five-year intervals, and coordinated through SCCWRP with discharger agencies and numerous other entities. The fourth regional monitoring program (Bight '08) took place during 2008 and 2009. The fifth regional monitoring program is expected to begin during 2013. While participation in regional programs is required under this Order, revisions to the Discharger's monitoring program at the direction of the Regional Water Board may be necessary to accomplish the goals of regional monitoring or to allow the performance of special studies to investigate regional or site-specific water issues of concern. These revisions may include a reduction or increase in the number of parameters to be monitored, the frequency of monitoring, or the number and size of samples to be collected. Such changes may be authorized by the Executive Officer upon written notification to the Discharger.

7. Central Region Kelp Monitoring Program

The Regional Water Board has helped to establish the Central Region Kelp Survey Consortium to conduct regional kelp bed monitoring. This program is designed to require ocean dischargers in the Regional Water Board's jurisdiction to undertake a collaborative program (which may include participation by Orange County ocean dischargers) to monitor kelp beds in the Southern California Bight, patterned after the successful program implemented by the San Diego Regional Water Board since 1985. Data collected in this regional survey will be used to assess status and trends in kelp bed health and spatial extent. The regional nature of the survey will allow the status of beds local to specific dischargers to be compared to regional trends. The regional kelp monitoring survey was initiated during 2003.

The regional survey will consist primarily of quarterly aerial overflights to assess the size and health of existing kelp beds. The Discharger shall participate in the management and technical committee's responsibility for the final survey design and shall provide appropriate financial support to help fund the survey (share base) on the number of participates in the study, but not to exceed a maximum of $10,000 per year.

B. All samples shall be representative of the waste discharge under conditions of peak load. Quarterly effluent analyses shall be performed during the months of February, May, August, and November. Semiannual analyses shall be performed during the months of February and August. Annual analyses shall be performed during the month of August. Should there be instances when monitoring could not be done during these specified months, the Discharger must notify the Regional Water Board, state the reason why monitoring could not be conducted, and obtain approval from the Executive Officer for an alternate schedule. Results of quarterly, semiannual, and annual analyses shall be reported in the monthly monitoring report following the analyses.

C. Pollutants shall be analyzed using the analytical methods described in 40 CFR parts 136.3, 136.4, and 136.5; or where no methods are specified for a given pollutant, by methods approved by this Regional Water Board or the State Water Board. Laboratories analyzing effluent samples and receiving water samples shall be certified by the California Department of Public Health (CDPH) Environmental Laboratory Accreditation Program (ELAP) or approved by the Executive Officer and must include quality assurance/quality control (QA/QC) data in their reports. A copy of the laboratory certification shall be provided each time a new certification and/or renewal of the certification is obtained from ELAP.

D. Water/wastewater samples must be analyzed within allowable holding time limits as specified in 40 CFR part 136.3. All QA/QC analyses must be run on the same dates that samples are actually analyzed. The Discharger shall retain the QA/QC documentation in its files and make available for inspection and/or submit them when requested by the Regional Water Board. Proper chain of custody procedures must be followed and a copy of that documentation shall be submitted with the monthly report.

E. The Discharger shall calibrate and perform maintenance procedures on all monitoring instruments and to ensure accuracy of measurements, or shall ensure that both equipment activities will be conducted.

F. For any analyses performed for which no procedure is specified in the USEPA guidelines, or in the MRP, the constituent or parameter analyzed and the method or procedure used must be specified in the monitoring report.

G. Each monitoring report must affirm in writing that "all analyses were conducted at a laboratory certified for such analyses by the California Department of Public Health or approved by the Executive Officer and in accordance with current USEPA guideline procedures or as specified in this Monitoring and Reporting Program."

H. The monitoring report shall specify the USEPA analytical method used, the Method Detection Limit (MDL), and the Reporting Level (RL) [the applicable minimum level (ML) or reported Minimum Level (RML)] for each pollutant. The MLs are those published by the State Water Board in the 2009 Ocean Plan, Appendix II. The ML represents the lowest quantifiable concentration in a sample, based on the proper application of all method-based analytical procedures and the absence of any matrix interference. When all specific analytical steps are followed and after appropriate application of method specific factors, the ML also represents the lowest standard in the calibration curve for that specific analytical technique. When there is deviation from the method analytical procedures, such as dilution or concentration of samples, other factors may be applied to the ML depending on the sample preparation. The resulting value is the reported ML.

I. The Discharger shall select the analytical method that provides an ML lower than the permit limit established for a given parameter, unless the Discharger can demonstrate that a particular ML is not attainable, in accordance with procedures set forth in 40 CFR part 136, and obtains approval for a higher ML from the Executive Officer, as provided for in section K. below. If the effluent limitation is lower than all the MLs in Appendix II of the 2009 Ocean Plan, the Discharge must select the method with the lowest ML for compliance purposes. The Discharger shall include in the Annual Summary Report a list of the analytical methods employed for each test.

J. The Discharger shall instruct its laboratories to establish calibration standards so that the ML (or its equivalent if there is differential treatment of samples relative to calibration standards) is the lowest calibration standard. At no time is the Discharger to use analytical data derived from extrapolation beyond the lowest point of the calibration curve. In accordance with section K. below, the Discharger's laboratory may employ a calibration standard lower than the ML in Appendix II of the 2009 Ocean Plan.

K. In accordance with section III.C.5.b of the 2009 Ocean Plan, the Regional Water Board Executive Officer, in consultation with the State Water Board's Quality Assurance Program Manager, may establish an ML that is not contained in Appendix II of the 2009 Ocean Plan to be included in the discharger's permit in any of the following situations:

1. When a pollutant under consideration is not listed in Appendix II;

2. When the discharger and the Regional Water Board agree to include in the permit a test method that is more sensitive than those specified in 40 CFR part 136;

3. When the discharger agrees to use an ML that is lower than those listed in Appendix II;

4. When the discharger demonstrates that the calibration standard matrix is sufficiently different from that used to establish the ML in Appendix II and proposes an appropriate ML for the matrix; or,

5. When the discharger uses a method, which quantification practices are not consistent with the definition of the ML. Examples of such methods are USEPA-approved method 1613 for dioxins, and furans, method 1624 for volatile organic substances, and method 1625 for semi-volatile organic substances. In such cases, the discharger, the Regional Water Board, and the State Water Board shall agree on a lowest quantifiable limit and that limit will substitute for the ML for reporting and compliance determination purposes.

L. If the Discharger samples and performs analyses (other than for process/operational control, startup, research, or equipment testing) on any influent, effluent, or receiving water constituent more frequently than required by this program using approved analytical methods, the results of those analyses shall be included in the report. These results shall be reflected in the calculation of the average used in demonstrating compliance with average effluent, receiving water, etc., limitations.

M. The Discharger shall develop and maintain a record of all spills and bypasses of raw or partially treated sewage from its collection system or treatment plant according to the requirements in the WDR section of this Order. This record shall be made available to the Regional Water Board upon request and a spill summary shall be included in the Annual Summary Report.

N. For all bacteriological analyses, sample dilutions should be performed so the expected range of values is bracketed (for example, with multiple tube fermentation method or membrane filtration method, 2 to 16,000 per 100 ml for total and fecal coliform, at a minimum, and 1 to 1000 per 100 ml for enterococcus). The detection methods used for each analysis shall be reported with the results of the analyses.

1. Detection methods used for coliforms (total and fecal) shall be those presented in Table 1A of 40 CFR part 136, unless alternate methods have been approved in advance by the USEPA pursuant to 40 CFR part 136.

2. Detection methods used for enterococcus shall be those presented in Table 1A of 40 CFR part 136 or in the USEPA publication EPA 600/4-85/076, Test Methods for Escherichia coli and Enterococci in Water By Membrane Filter Procedure, or any improved method determined by the Regional Water Board to be appropriate.

O. Laboratory Certification

Laboratories analyzing monitoring samples shall be certified by the CDPH, in accordance with the provision of CWC section 13176, and must include QA/QC data with their reports.

II. MONITORING LOCATIONS

The Discharger shall establish the following monitoring locations to demonstrate compliance with the effluent limitations, discharge specifications, and other requirements in this Order:

The City of Oxnard is currently constructing a permanent sampling facility to incorporate a sampling location that enables complete mixing of the secondary-treated effluent and the brine waste from the AWPF. This sampling facility is expected to be completed by December 2013. This sampling point is referred to as monitoring location EFF-001B. Once this permanent sampling facility becomes operable, the interim monitoring location EFF-001A shall be automatically superseded by monitoring location EFF-001B, which will become the final effluent point of compliance.

Table 1. Monitoring Station Locations

Influent and Effluent Monitoring Stations		
Discharge Point Name	**Monitoring Location Name**	**Monitoring Location Description**
--	**INF-001**	Sampling stations shall be established at each point of inflow to the sewage treatment plant and shall be located upstream of any in-plant return flows and where representative samples of the influent can be obtained.
001	**EFF-001A**	The interim effluent sampling station shall consist of sampling stations at: (1) a location that will represent the secondary-treated effluent before mixing with the brine waste, and (2) a location that will represent the total brine waste discharged to the outfall. The samples collected from (1) and (2) will be combined proportionate to the flow, and shall conduct the required testing analysis on a single, blended sample.
001	**EFF-001B**	The effluent sampling station shall be located downstream of any in-plant return flows and after the brine waste produced from the AWPF has commingled with the final secondary effluent, where representative samples of the effluent can be obtained.

Receiving Water Column Monitoring Stations								
Station	RWC-4101 RWC-4102 RWC-4102 RWC-4104 RWC-4105 RWC-4106	RWC-4201 RWC-4202 RWC-4203 RWC-4204 RWC-4205 RWC-4206	RWC-4301 RWC-4302 RWC-4303 RWC-4304 RWC-4305 RWC-4306	RWC-4391 RWC-4392 RWC-4393 RWC-4394 RWC-4395 RWC-4396	RWC-4401 RWC-4402 RWC-4403 RWC-4404 RWC-4405 RWC-4406	RWC-4501 RWC-4502 RWC-4503 RWC-4504 RWC-4505 RWC-4506	RWC-4601 RWC-4602 RWC-4603 RWC-4604 RWC-4605 RWC-4606	RWC-4701 RWC-4702 RWC-4703 RWC-4704 RWC-4705 RWC-4706
Latitude	34°03'54.4" 34°02'57.1" 34°01'68.8" 33°99'22.2" 33°97'15.4" 33°94'65.2"	34°06'18.4" 34°05'43.9" 34°04'70.3" 34°02'75.6" 34°00'42.3" 33°97'66.7"	34°09'35.8" 34°08'61.2" 34°06'62.8" 34°04'71.9" 34°03'02.1" 34°00'90.5"	34°07'57.5" 34°07'29.8" 34°06'59.7" 34°06'02.8" 34°04'17.2" 34°03'10.2"	34°13'50. 6" 34°12'22.5" 34°10'87.1" 34°09'25.3" 34°07'94.1" 34°06'68.7"	34°15'65.9" 34°15'16.7" 34°14'80.7" 34°13'99.2" 34°12'87.6" 34°11'83.9"	34°23'06.5" 34°22'73.2" 34°22'16.6" 34°21'45.2" 34°20'63.7" 34°19'53.1"	34°27'12.3" 34°26'35.0" 34°25'55.7" 34°24'85.3" 34°24'05.4" 34°23'30.3"
Longitude	118°90'77.3" 118°91'23.5" 118°91'68.5" 118°92'71.3" 118°93'64.5" 118°94'70.6"	119°00'71.6" 119°01'03.5" 119°01'41.3" 119°02'27.3" 119°03'31.4" 119°04'53.2"	119°09'77.4" 119°10'06.0" 119°11'03.1" 119°11'95.5" 119°12'65.9" 119°13'77.9"	119°11'25.6" 119°11'53.6" 119°12'10.0" 119°12'44.9" 119°13'40.6" 119°14'10.3"	119°19'02.0" 119°20'38.1" 119°21'82.7" 119°23'64.3" 119°25'04.3" 119°26'41.1"	119°22'99.3" 119°24'17.8" 119°25'16.1" 119°27'19.9" 119°30'29.9" 119°32'96.8"	119°26'73.0" 119°27'85.0" 119°29'41.3" 119°31'48.3" 119°33'99.7" 119°37'20.7"	119°31'04.1" 119°32'90.9" 119°35'09.1" 119°37'05.8" 119°39'23.9" 119°41'25.7"

Station Depth (m)	10 49 60 100 450 788	12 30 60 100 100 782	28 60 149 100 325 525	11 30 30 60 134 333	12 30 60 100 205 282	10 20 20 20 30 81	10 11 30 30 30 30	10 20 20 23 30 30
Dist. From Outfall Transect (km)	24.3	16.0	8.3	0.1	0.1	4.9	10.0	15.4

Receiving Water Benthic Monitoring Stations							
Station	RWS-001	RWS-002	RWS-003	RWS-004	RWS-005	RWS-006	RWS-007
Latitude	34^{0}07’65.01”	34^{0}07’39.59”	34^{0}07’37.21	34^{0}07’36.52	34^{0}07’34.20	34^{0}07’28.00	34^{0}05’34.15
Longitude	119^{0}02’84.87”	119^{0}11’45.75”	119^{0}11’42.33”	119^{0}11’41.34”	119^{0}11’36.24”	119^{0}11’25.20”	119^{0}11’32.25”
Station Depth (m)	15.0	15.0	15.3	15.0	15.3	15.3	15.3
Dist. From Outfall Transect (m)	1000	150	18	18	150	500	4000

Receiving Water Trawl Stations			
Station	RWT-001	RWT-002	RWT-003
Latitude	34^{0}07’56.79”	34^{0}07’26.96”	34^{0}05’31.73”
Longitude	119^{0}11’40.42”	119^{0}11’33.32”	119^{0}09’35.22”
Station Depth (m)	15.6	15.6	15.6
Dist. From Outfall Transect (m)	380	380	4000

Ventura County Shoreline Bacteriological Monitoring Stations

Ventura County ID	Location	Latitude	Longitude
35000	Hollywood Beach, Los Robles St	34^{0}09’45”	119^{0}13’48”
37000	Channel Islands Harbor Beach	34^{0}09’34”	119^{0}13’19”
38000	Silverstrand Beach, San Nicholas Ave	34^{0}09’26”	119^{0}13’31”
39000	Silverstrand Beach, Santa Paula Ave	34^{0}09’09”	119^{0}13’11”
40000	Silverstrand Beach, Sawtell, Ave	34^{0}08’51”	119^{0}12’59”
41000	Port Hueneme Beach Park	34^0 08’30”	119^{0}11’40”
42000	Ormond Beach, J Street Drain	34^0 08’20”	119^{0}11’20”
43000	Ormond Beach, Industrial Drain	34^{0}08’09”	119^{0}11’03”
44000	Ormond Beach, Arnold Rd	34^{0}07’11”	119^{0}09’36”

III. INFLUENT MONITORING REQUIREMENTS

Influent monitoring is required to:

- Determine compliance with NPDES permit conditions.
- Assess treatment plant performance.
- Assess effectiveness of the Pretreatment Program.

A. Monitoring Location INF-001

1. The Discharger shall monitor influent to the facility at INF001 as follows:

Table 2. Influent Monitoring

Parameter	Units	Sample Type	Minimum Sampling Frequency	Required Analytical Test Method
Flow	mgd	Recorder/totalizer	Continuous[1]	[2]
pH	pH units	Grab	Daily	[2]
TSS	mg/L	24-hr composite	Daily	[2]
$BOD_5$20°C	mg/L	24-hr composite	Daily	[2]
Oil and grease	mg/L	Grab[3]	Weekly	[2]
Benzidine	µg/L	24-hr composite	Quarterly	[2]
Heptachlor epoxide	µg/L	24-hr composite	Quarterly	[2]
PCBs	µg/L	24-hr composite	Quarterly	[2]
TCDD equivalents	ng/L	24-hr composite	Quarterly	[2]
Remaining pollutants in Table B of the 2009 Ocean Plan (excluding residual chlorine, acute and chronic toxicity, and ammonia)	µg/L	24-hr composite, or grab, as applicable according to 40 CFR part 136	Semiannually	[2]
Pesticides	µg/L	24-hr composite	Semiannually	[2]

IV. EFFLUENT MONITORING REQUIREMENTS

Effluent monitoring is required to:

- Determine compliance with NPDES permit conditions and water quality standards.
- Assess plant performance, identify operational problems and improve plant performance.

1 When continuous monitoring of flow is required, total daily flow and peak daily flow (24-hr basis) should be reported.
2 Pollutants shall be analyzed using the analytical methods described in 40 CFR part 136; where no methods are specified for a given pollutant, by methods approved by this Regional Water Board or State Water Board. For any pollutant whose effluent limitation is lower than all the MLs specified in Appendix II of the Ocean Plan, the analytical method with the lowest ML must be selected.
3 Oil and grease monitoring in the influent and effluent shall consist of a single grab sample at peak flow over a 24-hour period.

- Provide information on wastewater characteristics and flows for use in interpreting water quality and biological data.

A. Monitoring Location EFF-001A or EFF-001B

1. The Discharger shall monitor effluent at EFF-001A (interim location) or EFF-001B (upon becoming operable) as follows. If more than one analytical test method is listed for a given parameter, the Discharger must select from the listed methods and corresponding ML:

Table 3. Effluent Monitoring

Parameter	Units	Sample Type	Minimum Sampling Frequency	Required Analytical Test Method
Total waste flow	mgd	Continuous[1]	--	--
Total residual chlorine	mg/L	Continuous[1]	---	[2]
Turbidity	NTU	Continuous[1]	---	[2]
Temperature	°C	Grab	---	[2]
pH	pH unit	Grab	Daily	[2]
Settleable solids	mL/L	Grab	Daily	[2]
Suspended solids	mg/L	24-hr composite	Daily	[2]
Oil and grease	mg/L	Grab	Daily	[2]
$BOD_5$20°C	mg/L	24-hr composite	Daily	[2]
Total coliform	MPN/ 100mL or CFU/100ml	Grab	Daily	[2]
Fecal coliform	MPN/ 100mL or CFU/100ml	Grab	5 times/month	[2]
Enterococcus	MPN/ 100mL or CFU/100ml	Grab	5 times/month	[2]
Ammonia nitrogen	mg/L	24-hr composite	Monthly	[2]
Nitrate nitrogen	mg/L	24-hr composite	Monthly	[2]
Nitrite nitrogen	mg/L	24-hr composite	Monthly	[2]
Organic nitrogen	mg/L	24-hr composite	Monthly	[2]
Chronic toxicity	TUc	24-hr composite	Monthly	[2]
Benzidine	ng/L	24-hr composite	Quarterly	[2]
Heptachlor epoxide	ng/L	24-hr composite	Quarterly	[2]
PCBs	µg/L	24-hr composite	Quarterly	[2]
TCDD equivalents	pg/L	24-hr composite	Quarterly	[2]
Remaining pollutants in Table B of the 2009 Ocean Plan (excluding acute toxicity)	µg/L	24-hr composite, or grab, as applicable according to 40 CFR part 136	Semiannually	[2]
Radioactivity[4]				

[4] Analyze these radiochemicals by the following USEPA methods: method 900.0 for Gross alpha and Gross beta, method 903.0 or 903.1 for Radium-226, method 904.0 for Radium-228, method 906.0 for Tritium, method 905.0 for Strontium-90, and method 908.0 for Uranium. Analysis for combined Radium-226 & 228

Parameter	Units	Sample Type	Minimum Sampling Frequency	Required Analytical Test Method
(Including gross alpha, gross beta, combined radium-226 and radium-228, tritium, strontium-90 and uranium)	pCi/L	24-hr composite	Semiannually	2
Pesticides[5]	µg/L	24-hr composite	Semiannually	2

V. WHOLE EFFLUENT TOXICITY TESTING REQUIREMENTS

A. Chronic Toxicity Testing

1. **Methods and test species**. The Discharger shall conduct critical life stage chronic toxicity tests on 24-hour composite, 100 percent effluent samples in accordance with USEPA's *Short Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to West Coast Marine and Estuarine Organisms*, (EPA/600/R-95/136, 1995). Pursuant to the 2009 California Ocean Plan, upon the approval of the Executive Officer of the Regional Water Board, the Discharger may use a second tier organism (e.g., silverside) if first tier organisms (e.g., topsmelt) are not available. However, the Discharger is required to immediately resume the chronic toxicity test using the original testing organism as soon as this organism becomes available.

2. **Frequency**

   a. Screening - The Discharger shall conduct the first chronic toxicity test screening for three consecutive months in 2014. Re-screening is required every 24 months. The Discharger shall re-screen with a marine vertebrate species, a marine invertebrate species, and a marine alga species and continue to monitor with the most sensitive species. If the first suite of re-screening tests demonstrate that the same species is the most sensitive, then the re-screening does not need to include more than one suite of tests. If a different species is the most sensitive or if there is ambiguity, then the Discharger shall proceed with suites of screening tests for a minimum of three, but not to exceed five, suites.

   b. Regular toxicity tests - After the screening period, monitoring shall be conducted monthly using the most sensitive species.

3. **Toxicity Units.** The chronic toxicity of the effluent shall be expressed and reported in Chronic Toxic Units, TUc, where,

$$TU_c = \frac{100}{NOEC}$$

The No Observable Effect Concentration (NOEC) is expressed as the maximum percent effluent concentration that causes no observable effect on test organisms, as determined by the results of a critical life stage toxicity test.

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shall be conducted only if Gross alpha results for the same sample exceed 15 pCi/L or Beta greater than 50 pCi/L. If Radium-226 & 228 exceeds the stipulated criteria, analyze for Tritium, Strontium-90 and Uranium.

5 Pesticides are, for purposes of this order, those six constituents referred to in 40 CFR part 125.58(p) (Methoxychlor, Demeton, Guthion, Malathion, Mirex, and Parathion).

B. Quality Assurance

1. Concurrent testing with a reference toxicant shall be conducted. Reference toxicant tests shall be conducted using the same test conditions as the effluent toxicity tests (e.g., same test duration, etc).

2. If either the reference toxicant test or effluent test does not meet all test acceptability criteria (TAC) as specified in the test methods manual (EPA-821-R-02-012 and/or EPA/600/R-95/136), then the Discharger must re-sample and re-test within 14 days.

3. Control and dilution water should be laboratory water, as appropriate, as described in the manual. If the dilution water used is different from the culture water, a second control using culture water shall be used.

4. A series of at least five dilutions and a control shall be tested. The dilution series shall include the instream waste concentration (IWC), and two dilutions above and two below the IWC. The chronic IWC for Discharge Serial No. 001 is 0.01% effluent. (0.01% is the result of 1 divided by 99, which is sum of dilution credit 98 plus 1).

5. Following paragraph 10.2.6.2 of USEPA's chronic freshwater test methods manual (EPA/821/R-02/013, 2002, as specified in CFR part 136), the Discharger shall review the concentration-response relationship for each multi-concentration test to ensure that calculated test results are interpreted appropriately. All WET test results should be reviewed and reported following *Method Guidance and Recommendations for WET Testing* (EPA/821/B-00-004, 2000).

6. Because this permit requires sublethal hypothesis testing endpoints from the 1995 West Coast marine and estuarine WET test methods manual and the 2002 East Coast marine and estuarine WET test methods manual, within test variability must be reviewed and variability criteria [e.g., Minimum Significance Difference (MSD) bound, Percent, Minimum Significance Difference (PMSD) bounds] must be applied, as specified in the test methods manuals. The calculated MSD (or PMSDs) for both reference toxicant test and effluent toxicity test results must meet the MDS bound (or PMSD bounds) variability criteria specified in the test methods manuals.

7. pH drift during the toxicity test may contribute to artifactual toxicity when pH-dependent toxicants (e.g., ammonia, metals) are present in an effluent. To determine whether or not pH drift during the toxicity test is contributing to artifactual toxicity, the Discharger shall conduct three sets of parallel toxicity tests, in which the pH of one treatment is controlled at the pH of the effluent and the pH of the other treatment is not controlled, as described in section 11.3.6.1 of the test methods manual, *Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms* (EPA/821/R-02/013, 2002). Toxicity is confirmed to be artifactual and due to pH drift when no toxicity above the chronic WET permit limit or trigger is observed in the treatments controlled at the pH of the effluent. If toxicity is confirmed to be artifactual and due to pH drift, then following written approval by the permitting authority, the Discharger may use the procedures outlined in section 11.3.6.2 of the test methods manual to control sample pH during the toxicity test.

C. Accelerated Monitoring

If the effluent toxicity test result exceeds the limitation, then the Discharger shall immediately implement accelerated toxicity testing that consists of six additional tests, approximately every two weeks, over a 12-week period. Effluent sampling for the first test of the six additional tests shall commence within five working days of receipt of the test results exceeding the toxicity limitation.

1. If all the results of the six additional tests are in compliance with the toxicity limitation, the Discharger may resume regular monthly testing.

2. If the result of any of the six additional tests exceeds the limitation, then the Discharger shall continue to monitor once every two weeks until six consecutive biweekly tests are in compliance. At that time, the Discharger may resume regular monthly testing.

3. If the results of any two of the six tests (any two tests in a 12-week period) exceed the limitation, the Discharger shall initiate a Toxicity Identification Evaluation (TIE) and implement the initial investigation Toxicity Reduction Evaluation (TRE) work plan.

4. If implementation of the initial investigation TRE work plan (see item E below) indicates the source of toxicity (e.g., a temporary plant upset, etc.), then the Discharger shall return to the regular testing frequency.

D. Preparation of an Initial Investigation TRE Work Plan

The Discharger shall prepare and submit a copy of the Discharger's initial investigation TRE (TRE) work plan to the Executive Officer of the Regional Water Board for approval within 90 days of the effective date of this permit. If the Executive Officer does not disapprove the work plan within 60 days, the work plan shall become effective. The Discharger shall use USEPA manual EPA/833B-99/002 (municipal) as guidance, or most current version. At a minimum, the TRE work plan must contain the provisions in Attachment G. This work plan shall describe the steps the Discharger intends to follow if toxicity is detected, and should include the following, at a minimum:

1. A description of the investigation and evaluation techniques that will be used to identify potential causes and sources of toxicity, effluent variability, and treatment system efficiency.

2. A description of the facility's methods of maximizing in-house treatment efficiency and good housekeeping practices, and a list of all chemicals used in the operation of the facility; and,

3. If a TIE is necessary, an indication of the person who would conduct the TIEs (i.e., an in-house expert or an outside contractor). See MRP section V.E.3 below for guidance manuals.

E. Steps in TRE and TIE

1. If results of the implementation of the facility's initial investigation TRE work plan indicate the need to continue the TRE/TIE, the Discharger shall expeditiously develop a more detailed TRE work plan for submittal to the Executive Officer within 15 days of completion of the initial investigation TRE. The detailed work plan shall include, but not be limited to the following:

   a. Further actions to investigate and identify the cause of toxicity;

   b. Actions the Discharger will take to mitigate the impact of the discharge and prevent the recurrence of toxicity; and,

   c. A schedule for these actions.

2. The following section summarizes the stepwise approach used in conducting the TRE:

   a. Step 1 includes basic data collection.

   b. Step 2 evaluates optimization of the treatment system operation, facility housekeeping, and selection and use of in-plant process chemicals.

   c. If Steps 1 and 2 are unsuccessful, Step 3 implements a TIE and employment of all reasonable efforts using currently available TIE methodologies. The objective of the TIE shall be to identify the substance or combination of substances causing the observed toxicity.

   d. Assuming successful identification or characterization of the toxicant(s), Step 4 evaluates final effluent treatment options.

   e. Step 5 evaluates in-plant treatment options.

   f. Step 6 consists of confirmation once a toxicity control method has been implemented.

   Many recommended TRE elements parallel source control, pollution prevention, and storm water control program best management practices (BMPs). To prevent duplication of efforts, evidence of compliance with those requirements may be sufficient to comply with TRE requirements. By requiring the first steps of a TRE to be accelerated testing and review of the facility's TRE work plan, a TRE may be ended in its early stages. All reasonable steps shall be taken to reduce toxicity to the required level. The TRE may be ended at any stage if monitoring indicates there are no longer toxicity violations.

3. The Discharger may initiate a TIE as part of the TRE process to identify the cause(s) of toxicity. The Discharger shall use the USEPA acute manual, chronic manual, EPA/600/R-96-054 (Phase I), EPA/600/R-92/080 (Phase II), and EPA-600/R-92/081 (Phase III), as guidance.

4. If a TRE/TIE is initiated prior to completion of the accelerated testing required in section V.C. of this program, then the accelerated testing schedule may be terminated, or used as necessary in performing the TRE/TIE, as determined by the Executive Officer .

5. The Regional Water Board recognizes that toxicity may be episodic and identification of causes of and reduction of sources of toxicity may not be successful in all cases. Consideration of enforcement action by the Board will be based, in part, on the Discharger's actions and efforts to identify and control or reduce sources of consistent toxicity.

F. Ammonia Removal

1. Except with prior approval from the Executive Officer of the Regional Water Board, ammonia shall not be removed from bioassay samples. The Discharger must demonstrate the effluent toxicity is caused by ammonia because of increasing test pH when conducting the toxicity test. It is important to distinguish the potential toxic effects of ammonia from other pH sensitive chemicals, such as certain heavy metals, sulfide, and cyanide. The following may be steps to demonstrate that the toxicity is caused by ammonia and not other toxicants before the Executive Officer would allow for control of pH in the test.

a. There is consistent toxicity in the effluent and the maximum pH in the toxicity test is in the range to cause toxicity due to increased pH.

b. Chronic ammonia concentrations in the effluent are greater than 4 mg/L total ammonia.

c. Conduct graduated pH tests as specified in the TIE methods. For example, mortality should be higher at pH 8 and lower at pH 6.

d. Treat the effluent with a zeolite column to remove ammonia. Mortality in the zeolite treated effluent should be lower than the non-zeolite treated effluent. Then add ammonia back to the zeolite-treated samples to confirm toxicity due to ammonia.

2. When it has been demonstrated that toxicity is due to ammonia because of increasing test pH, pH may be controlled using appropriate procedures which do not significantly alter the nature of the effluent, after submitting a written request to the Regional Water Board, and receiving written permission expressing approval from the Executive Officer of the Regional Water Board.

G. Reporting

The Discharger shall submit a full report of the toxicity test results, including any accelerated testing conducted during the month, as required by this permit. Test results shall be reported in Chronic Toxicity Units (TUc), as required, with the self-monitoring report (SMR) for the month in which the test is conducted.

If an initial investigation indicates the source of toxicity and accelerated testing is unnecessary, pursuant to section V.C.4, then those results also shall be submitted with the SMR for the period in which the investigation occurred.

1. The full report shall be received by the Regional Water Board by the 15th day of the second month following sampling.

2. The full report shall consist of (1) the results; (2) the dates of sample collection and initiation of each toxicity test; (3) the toxicity limit.

3. Test results for toxicity tests also shall be reported according to the appropriate manual chapter on Report Preparation and shall be attached to the SMR. Routine reporting shall include the following, at a minimum, as applicable, for each test, as appropriate:

   a. sample date(s)

   b. test initiation date

   c. test species

   d. end point values for each dilution (e.g. number of young, growth rate, percent survival)

   e. LC_{50} value(s) in percent effluent

   f. TUa value(s) $\left(TU_a = \frac{100}{LC50}\right)$

g. NOEC value(s) in percent effluent

h. TUc values $\left(TU_c = \frac{100}{NOEC}\right)$

i. Mean percent mortality (+standard deviation) after 96 hours in 100% effluent (if applicable)

j. IC/EC_{25} values(s) in percent effluent

Inhibition Concentration (IC_P) is a point estimate of the toxicant concentration that causes a given percent reduction (p) in a non-quantal biological endpoint (e.g., reproduction, growth) calculated from a continuous model (e.g., EPA Interpolation Model).

Effective Concentration (EC_P) is a point estimate of the toxicant concentration that causes a given percent reduction (p) in a quantal biological measurement (e.g., development, survival) calculated from a continuous model (e.g., Probit).

k. NOEC and LOEC (Lowest Observable Effect Concentration) values for reference toxicant test(s)

l. Available water quality measurements for each test (e.g., pH, D.O., temperature, conductivity, hardness, salinity, ammonia).

4. The Discharger shall provide a compliance summary that includes a summary table of toxicity data from at least eleven of the most recent samples.

5. The Discharger shall notify this Regional Water Board immediately of any toxicity exceedance and in writing 14 days after the receipt of the results of an effluent limit. The notification will describe actions the Discharger has taken or will take to investigate and correct the cause(s) of toxicity. It may also include a status report on any actions required by the permit, with a schedule for actions not yet completed. If no actions have been taken, the reasons shall be given.

VI. RECLAMATION MONITORING REQUIREMENTS

The reuse of the reclaimed water is regulated under a separate WDRs and Water Recycling Requirements (WRRs) for City of Oxnard Groundwater Recovery, Enhancement, and Treatment Program – Non Potable Reuse Phase 1 Project (GREAT Program – Phase 1 Project), Order No. R4-2008-0083 as amended by Order No. R4-2011-0079, File No. 64-104 and File No. 08-070, CI-9456.

VII. RECEIVING WATER MONITORING REQUIREMENTS – SURFACE WATER AND GROUNDWATER

A. Offshore Water Quality Monitoring

This survey addresses the compliance questions: "Are Ocean Plan and Basin Plan objectives for parameters listed in Tables 4a and 4b being met?" Data collected provide the information necessary to demonstrate compliance with the standards for local monitoring. In addition, data collected by the Discharger contribute to the Central Bight Cooperative Water Quality Survey. This regionally coordinated survey provides integrated water quality surveys on a quarterly basis. These surveys cover 200 kilometers of coast in Ventura, Los Angeles, and Orange Counties, from the nearshore to approximately 10 kilometers offshore. This cooperative program contributes to a regional understanding of seasonal patterns in nearshore water column structure. The regional view provides context for determining the significance and causes of locally observed patterns in the area of wastewater outfalls.

1. The Discharger shall monitor receiving water quality at 48 Receiving Water Column Monitoring Stations from RWC-4101 to RWC-4706 (See Table 1) as follows:

Table 4a. Receiving Water Monitoring Requirements – 1

Parameter	Units	Sample Type	Minimum Sampling Frequency	Required Analytical Test Method
Dissolved oxygen	mg/L	continuous profile	quarterly	[2]
Water temperature	°C	continuous profile	quarterly	[2]
Light transmittance	% transmittance	continuous profile	quarterly	[6]
Salinity	ppt	continuous profile	quarterly	[2]
pH	pH units	continuous profile	quarterly	[2]
Chlorophyll a	µg/L	continuous profile	quarterly	[2]
Visual observations	---	---	quarterly	[7]

Sampling techniques shall follow protocols described in the most current edition of the *Field Operations Manual for Marine Water-Column, Benthic, and Trawl Monitoring in Southern California, SCCWRP*. Data shall be analyzed to approximate the typical wastewater plume movement and data from 1998 and forward shall be analyzed to determine and map out the wastewater plume movement under different seasonal and weather conditions.

2. The Discharger shall monitor bacteria and ammonia at 18 receiving water column monitoring stations of RWC-4301 to RWC-4306, and RWC-4391 to RWC-4396, and RWC-4401 to RWC-4406 (See Table 1) as follows:

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6 Light transmittance (transmissivity) shall be measured with a transmissometer, using equipment and procedure similar to that described by L.V. Whitney [*Transmission of Solar Energy and the Scattering Produced by Suspensoids in Lake Waters*, Transactions of the Wisconsin Academy of Sciences, Arts, and Letters, Vol. 31 (1938)]. Results shall be expressed as the percent of light transmittance. Path length of transmissometer should be noted.

7 Observations of wind (direction and speed), weather (e.g., cloudy, sunny, or rainy), current (e.g., direction), and tidal conditions (e.g., high or low tide) shall be made and recorded (every four hours during offshore sampling) at the time samples of the waters of the Pacific Ocean (shore, nearshore, and all offshore stations) are collected.
Observations of water color, discoloration, oil and grease, turbidity, odor, materials of sewage origin in the water or on the beach, and unusual or abnormal amounts of floating or suspended matter in the water or on the beach, rocks and jetties, or beach structures shall also be made and recorded at stations or while in transit. The character and extent of such matter shall be described. The dates, times and depths of sampling and these observations shall also be reported.

Table 4b. Receiving Water Monitoring Requirements – 2

Parameter	Units	Sample Type	Minimum Sampling Frequency	Required Analytical Test Method
Total coliform	MPN or CFU/100 mL	grab, surface and mid-depth and near bottom[8]	quarterly	[2]
Fecal coliform	MPN or CFU/100 mL	grab, surface and mid-depth and near bottom[8]	quarterly	[2]
Enterococcus	MPN or CFU/100 mL	grab, surface and mid-depth and near bottom[8]	quarterly	[2]
Ammonia nitrogen	mg/L	grab, surface and mid-depth and near bottom[8]	quarterly	[2]

B. Benthic Monitoring

Benthic monitoring includes Infauna and sediment. The Discharger shall annually monitor Infauna and sediment at 7 receiving water benthic monitoring stations of RWS-001 to RWS-007 (See Table E-1).

1. **Local Benthic Survey** – This survey addresses the question: "Are benthic conditions under the influence of the discharge changing over time?" The data collected are used for regular assessment of trends in sediment contamination and biological response along a fixed grid of sites within the influence of the discharge.

   a. Local Benthic Trends Survey

      (1) Infaunal Community Survey – The benthic stations shall be conducted for benthic infaunal sampling[9]. These stations shall be sampled during late summer (August/ September). Bottom samples for benthic infaunal analyses shall be taken at each benthic station prior to trawl sampling. The following determinations shall be made at each station, where appropriate:

         i. Identification of all organisms to lowest possible taxon (usually species); and,

         ii. Total biomass of:

         - Mollusks;
         - Echinoderms;
         - Annelids/polychaetes;
         - Crustaceans; and,
         - All other macroinvertebrates.

[8] Bottom sampling shall be done 2.0 m (6.6 ft) above the seabed.

[9] These bottom samples shall be taken by means of a 0.1 m^2 (1.1 ft^2) modified Van Veen sediment grab sampler. The entire contents of each sample shall be passed through a 1.0 mm (0.039 in.) mesh screen to retrieve the benthic organisms. These organisms shall be fixed in 10% buffered formalin and transferred to 70% ethanol within two to seven days for storage. Organisms can be strained with Rose Bengalto to facilitate sorting. All specimens retrieved shall be archived.

iii. Community structure analysis for benthic infaunal[10] for each station and each replicate.

Mean, median, range, standard deviation, and 95% confidence limits, if appropriate, for values determined above in iii. The Discharger may be required to conduct additional "statistical analyses" to determine temporal and spatial trends in the marine environment.

(2) Sediment Chemistry Survey – All benthic sediment samples shall be taken at each station by means of a 0.1 m^2 (1.1 ft^2) modified Van Veen sediment grab sampler. Sub-samples (upper two centimeters) of sediment from each sample shall be collected and analyzed separately for the following parameters at each station:

i. Total organic carbon (TOC) (mg/kg dry wt);

ii. Dissolved sulfides (water soluble) (mg/kg dry wt);

iii. Total Kjeldahl nitrogen (mg/kg dry wt);

iv. Grain size (sufficiently detailed to calculate percent weight in relation to phi size); and,

v. Arsenic; Cadmium; Chromium (total); Copper; Lead; Mercury; Nickel; Silver; Zinc; Cyanide; Phenolic compounds (non-chlorinated); Phenolic compounds (chlorinated); Total halogenated organic compounds; Aldrin and Dieldrin; Endrin; HCH; Chlordane and related compounds; Total DDT; DDT derivatives; Total PCB; PCB derivatives; Toxaphene; Total PAH; PAH derivatives. The data for these parameters shall be expressed in μg/kg dry weight.

Annual testing shall be required for these parameters during late summer (August/ September). Bottom samples for sediment chemistry analyses shall be taken at each benthic station prior to trawl sampling.

In August/September of the third year of the permit, full priority pollutant scans shall be performed on sediment samples from all stations.

(3) Sediment Toxicity Survey – Sediment toxicity testing shall be conducted annually (August/September) at two receiving water sediment monitoring stations of RWS-003 and RWS-007. Three replicate samples shall be collected for testing at each station. Sub-samples (upper two centimeters) shall be taken from each sediment sample and tested with amphipod Eohaustorius - survival end point; using standard protocols approved by the Executive Officer of this Regional Water Board.

[10] Community structure analysis of benthic infauna shall include number of species, number of individuals per species, total numerical abundance, species abundance per grab, species richness, species diversity (e.g., Shannon-Wiener), species evenness and dominance per station and replicate, similarity analyses (e.g., Bray-Curtis, Jaccard or Sorensen), cluster analyses (using unweighted pair-group method) or other appropriate multivariate statistical techniques approved by the Executive Officer of this Regional Water Board and USEPA Region IX, and the Infaunal Index.

2. Regional Benthic Survey

a. This regional survey addresses the questions: 1) What is the extent, distribution, magnitude and trend of ecological change in soft-bottom benthic habitats within the Southern California Bight? and 2) What is the relationship between biological response and contaminant exposure? The data collected will be used to assess the condition of the sea-floor environment and the health of the biological resources in the Bight.

b. Sampling Design - A regional survey of benthic conditions within the Southern California Bight took place in 2008 (Bight'08). The final survey design was determined cooperatively by the participants represented on the Regional Steering Committee. The Discharger provided support to the Bight'08 benthic survey by participating in or performing the following activities:

(1) Participation on the Steering Committee;

(2) Participation on the relevant Technical Committees (e.g., Information Management, Field Methods & Logistics, Benthos, and Chemistry);

(3) Field sampling at sea;

(4) Infaunal sample analysis;

(5) Sediment chemistry analysis; and,

(6) Data management

This level of participation in the 2008 survey was consistent with that provided by the Discharger during the 1994, 1998 and 2003 Regional Benthic Surveys. The next regional survey is expected to take place in 2013 and the Discharger's level of participation shall be consistent with that provided in previous survey.

C. Fish and Macroinvertebrate Monitoring

1. **Local Fish and Macroinvertebrate Survey** – This survey addresses two questions: 1) "Are the health of demersal fish and epibenthic invertebrate communities?" and 2) "Are fish tissue contamination levels in the vicinity of the discharge changing over time?" The data collected are used for regular assessment of temporal trends in community structure and bioaccumulation along an array of sites within the influence of the discharge. Data will also be collected on trash and debris to contribute to the Santa Monica Bay Restoration Project (SMBRP's) Sources and Loadings program. The Discharger shall monitor fish and macroinvertebrate at three receiving water trawling stations of RWT-001 to RWT-003 (See Table 1) as follows:

a. Local Fish and Macroinvertebrate Population Survey

(1) The offshore trawling stations shall be sampled annually (August/September) for demersal fish and epibenthic macroinvertebrates.

(2) Trawling methods shall follow the protocols described in the most current edition of the *Field Operations Manual for Marine Water-Column, Benthic, and Trawl Monitoring in Southern California, SCCWRP.*

(3) Fish and macroinvertebrates collected by trawls shall be identified to the lowest taxon possible. At all stations and for each replicate, community structure analysis for fish and macroinvertebrates[11] shall be conducted for fish and macroinvertebrates for each station.

(4) Mean, range, standard deviation, and 95% confidence limits, if appropriate, shall be reported for the values determined in the community analysis. The Discharger may be required to conduct additional "statistical analyses" to determine temporal and spatial trends in the marine environment.

(5) Abnormalities and disease symptoms shall be described and recorded (e.g., fin erosion, external lesions, tumors, ectoparasites, and color anomalies). The frequency of abnormalities and incidence of disease shall be compared between the Zone of Initial Dilution (ZID) boundary and the reference station, and trends in these values shall be measured over time. The results of this inspection shall be included in the monitoring report.

b. Local Fish and Macroinvertebrate Tissue Survey

Fish and macroinvertebrate tissues shall be obtained from fish collected by trawls and from invertebrates collected by trawls or SCUBA at the trawling stations.

Annually, tissues of two species (one demersal fish and one macroinvertebrate) of importance to commercial and/or sport fishers or of obvious ecological significance shall be analyzed for priority pollutants (i.e., for bioaccumulation of toxic pollutants). If possible, for the duration of this permit and order, the same species shall be used at all stations.

(1) Fish Tissues

i. Tissue, as applied to the analysis of priority pollutants, signifies separate analyses for muscle and liver. All tissue samples shall be analyzed for wet weight and percent lipid.

ii. Annual testing shall be required in late summer (August/September) and shall include analysis for: Arsenic; Cadmium; Chromium (total); Copper; Lead; Mercury; Nickel; Silver; Zinc; Cyanide; Phenolic compounds (non-chlorinated); Phenolic compounds (chlorinated); Total halogenated organic compounds; Aldrin and Dieldrin; Endrin; HCH; Chlordane and related compounds; Total DDT; DDT derivatives; Total PCB; PCB derivatives; Toxaphene; Total PAH; PAH derivatives.

iii. The data for these parameters shall be expressed in μg/kg dry weight.

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11 Community structure analysis of fish and macroinvertebrates shall include wet weight of fish and macroinvertebrate species (when combined weight of individuals of one species exceeds 0.2 kg), standard length of each individual, number of species, number of individuals per species, total numerical abundance per station, number of individuals in each 1-cm size class for each species of fish, species abundance per trawl and per station, species richness, species diversity (e.g., Shannon-Wiener), species evenness, similarity analyses (e.g., Bray-Curtis, Jaccard or Sorensen), cluster analyses (using unweighted pair-group method) or other appropriate multivariate statistical techniques approved by the Executive Officer of the Regional Water Board and USEPA Region IX.

iv. In August/September of the third year of the permit, full priority pollutant scans shall be performed on fish tissue samples from all offshore trawling stations.

v. For fish tissue analysis, individuals of the species of interest shall be combined from the trawls to form a single pooled sample at a station[12]. Three composite samples shall be analyzed for each of the tissue types. Each composite sample shall consist of tissues[13] taken from fish of one species and include at least six individuals. In order to obtain the required number of individuals, additional trawls may be necessary.

vi. Reference specimens for tissue analysis may be collected at a different depth or area beyond the reference station (RWT-003), if necessary. If areas other than RWT-003 are sampled for reference material, data on the location and depth of the sampling point(s) shall be provided to this Regional Board and the USEPA Region IX.

vii. The following fish species are recommended for the tissue analysis of priority pollutants: White Croaker (Genyonemus lineatus) and Speckled sanddab (Citharichthys stigmaeus).

(2) Macroinvertebrate Tissues

i. Tissue, as applied to the analysis of priority pollutants in macroinvertebrates, signifies analyses for muscle or other tissue, if muscle is impractical. All tissue samples shall be analyzed for wet weight and percent lipid.

ii. Annual testing shall be required in late summer (August/September) and shall include analysis for: Arsenic; Cadmium; Chromium (total); Copper; Lead; Mercury; Nickel; Silver; Zinc; Cyanide; Phenolic compounds (non-chlorinated); Phenolic compounds (chlorinated); Total halogenated organic compounds; Aldrin and Dieldrin; Endrin; HCH; Chlordane and related compounds; Total DDT; DDT derivatives; Total PCB; PCB derivatives; Toxaphene; Total PAH; PAH derivatives.

iii. The data for these parameters shall be expressed in μg/kg dry weight.

iv. In August/September of the third year of the permit, full priority pollutant scans shall be performed on macroinvertebrate tissue samples from all offshore trawling stations.

v. For macroinvertebrate tissue analysis, individuals of the species of interest shall be combined from the trawls to form a single pooled sample at a station. Three composite samples shall be analyzed for each of the tissue types. Each composite sample shall consist of sufficient tissue taken from at least three individual organisms of one species. In order to obtain the required number of individuals, additional trawls may be necessary. When feasible, tissues from

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[12] Where appropriate, individuals (from trawls) comprising the smallest 10 percent by weight shall not be used as part of the composite sample. Individuals for tissue analysis shall be randomly selected from the remaining organisms.

[13] Tissue samples removed from individuals shall be of uniform weight. To the extent feasible, individual fish selected for analysis should be of the same sex.

organisms of the same species should be analyzed from year to year to facilitate comparability.

vi. Reference specimens for tissue analysis may be collected at a different depth or area beyond the reference station (RWT-003), if necessary. If areas other than RWT-003 are sampled for reference material, data on the location and depth of the sampling point(s) shall be provided to the LA Regional Board and USEPA Region IX.

vii. The following macroinvertebrate species are recommended for the tissue analysis of priority pollutants: Sandstar (Astropecten spp), Shrimp (Crangon spp), and Crab (Cancer spp).

(3) Bagged Mussel Tissue

i. The City of Oxnard currently is conducting a special study using bagged bivalves to assess bioaccumulation of contaminants in mussel tissue. If the results of this special study support a change, the City of Oxnard may request written approval from the Executive Officer to substitute mussels in lieu of the fish and invertebrate species identified above.

2. Regional Fish and Macroinvertebrate Survey

a. This survey addresses the questions: 1) What is the extent, distribution, magnitude and trend of ecological change in demersal fish and epibenthic communities within the Southern California Bight? and 2) What is the relationship between biological response and contaminant exposure? The data collected will be used to assess the condition of the seafloor environment and health of biological resources in the Bight.

b. A regional survey of trawl-caught demersal fish and epibenthic invertebrates within the Southern California Bight took place in 2008 (Bight'08). The final survey design was determined cooperatively by the participants as represented on the Regional Steering Committee. The Discharger provided support to the Bight'08 surveys by participating in or performing the following activities:

i. Participation on the Steering Committee;

ii. Participation on the relevant Technical Committees (e.g., Information Management, Field Methods and Logistics, Fish and Invertebrates);

iii. Field sampling at sea;

iv. Trawl sample analysis; and,

v. Data management

The level of participation in the 2008 survey was consistent with that provided by the Discharger during the 1998 and 2003 Regional Surveys. The next regional survey is expected to take place in 2013 and the Discharger's level of participation shall be consistent with that provided in previous surveys.

D. Seafood Safety Monitoring

1. Local Seafood Safety Survey

a. This survey addresses two questions: 1) Where seafood consumption advisories exist locally, do tissue concentrations of contaminants continue to exceed the Advisory Tissue Concentration (ATC)? and 2) What are the tissue contaminant trends relative to the ATC in other species not currently subject to local consumption advisories? The data collected will be used to provide information necessary for the management of local seafood consumption advisories.

b. One species from each of five groups of fish (rockfish, kelpbass, sandbass, surfperches and croakers) shall be sampled from each of the three zones in years one, three and five of the permit. For rockfishes, scorpionfish (Scorpaena guttata) is the preferred species, followed by bocaccio (Sebastes paucispinis) and then by any other abundant and preferably benthic rockfish species. For surfperches, black surfperch (Embiotoca jacksoni) is the preferred species, followed by white surfperch (Phanerodon furcatus) and then by walleye surfperch (Hyperprosopon argenteum).

c. For fish tissue analysis, one composite sample of ten individuals of each target shall be collected within each of the three zones. Sampling should take place within the same season of the year (preferably late summer/early fall) and should focus upon a consistent size class of fish. All tissue samples shall be analyzed for: Mercury, DDTs, PCBs, Aldrin, Dieldrin, Endrin and Chlordane.

2. Regional Seafood Safety Survey

a. This regional survey addresses the question: "Are seafood tissue levels within the Southern California Bight below levels that ensure public safety?" The data collected will be used to assess levels of contaminants in the edible tissue of commercial or recreationally important fish within the Bight relative to Advisory Tissue Concentrations.

b. Sampling Design - A regional survey of edible tissue contaminant levels in fish within the Southern California Bight shall be conducted at least once every ten years, encompassing a broader set of sampling sites and target species than those addressed in the local seafood survey. The objective is to determine whether any unexpected increases or decreases in contaminant levels have occurred in non-target species and/or at unsampled sites. The final survey design may be determined cooperatively by participants represented on a Regional Steering Committee or by the State of California's Office of Environmental Health and Hazard Assessment. A regional seafood safety survey within the Southern California Bight took place in 2009 (Bight'08). The final survey design was determined cooperatively by participants represented on the Regional Steering Committee and the Surface Water Ambient Monitoring Program (SWAMP). The Discharger provided support to the Bight'08 Seafood Safety Survey by participating in or performing the following activities:

   i. Participation on the Steering Committee;

   ii. Participation on relevant Technical Committees (e.g., Information Management, Field Methods & Logistics, and Chemistry); and,

   iii. Tissue chemical analysis.

This level of participation in the Bight'08 survey was consistent with that provided by the Discharger to the previous surveys. The next regional survey is expected to occur in 2013 and the Discharger's level of participation shall be consistent with that provided in previous surveys.

E. Kelp Bed Monitoring

1. This regional survey is to address the question: "Is the extent of kelp beds in the Southern California Bight changing over time and are some beds changing at rates different than others?" The data collected in this regional survey will be used to assess status and trends in kelp bed health and spatial extent. The regional nature of the survey will allow the status of beds local to the discharge to be compared to regional trends.

2. The Discharger shall participate in the Central Region Kelp Survey Consortium (CRKSC) to conduct regional kelp bed monitoring in Southern California coastal waters. The CRKSC design is based upon quarterly measures of kelp canopy extent using aerial imaging. The Discharger shall provide up to $10,000 per year in financial support to the CRKSC (annual level of support will depend on the number of participants in the program). The Discharger shall participate in the regional management and technical committees responsible for the development of the survey design and implementation of the assessment of kelp bed resources in the Bight. This support is intended to ensure that kelp beds in Ventura County are included in the quarterly surveys of kelp beds in the Bight, and that these beds are included in any data products resulting from those surveys.

3. In the event that Ventura County kelp beds are found to deviate from the broader regional pattern, the Discharger will carry out special studies to address unexplained deterioration of local beds.

F. Sampling, Analysis, and Reporting Notes for Receiving Water Monitoring

1. Receiving water monitoring shall be performed during daylight hours.

2. In addition to reporting the actual concentration of bacterial organisms obtained in each sample collected from shoreline, nearshore, and offshore stations, the running median of the latest 6-month period shall also be determined and reported each month. Bacterial data obtained at shoreline stations during or within 48 hours following a major storm event shall not be used in determining medians.

3. Reports regarding receiving water monitoring shall be transmitted with the corresponding effluent monitoring reports. Ocean water quality monitoring (shoreline, nearshore, and offshore components) reports shall be submitted with the effluent reports by the fifteenth day of the second month following the sampling period. The offshore sediment and biological monitoring data shall be submitted with the annual report.

4. Currently, Ventura County monitors nine shoreline stations for bacteriological indicators in the area of Oxnard's previous shoreline monitoring program (see Table 1 in section II).

5. Ventura County shoreline bacteriological monitoring data from these stations shall be included with the bacteriological data from Oxnard's water quality sampling in monthly reports and the annual assessment report.

6. If Ventura County reduces the shoreline bacteriological monitoring program in frequency (less often then weekly) or seasonally, or reduces the number of stations in the area defined by these stations, then the Discharger shall initiate a weekly shoreline bacteriological monitoring program to replace the Ventura County's effort. This program shall be submitted to this Regional Water Board for approval by the Executive Officer.

7. If Ventura County restores the shoreline bacteriological monitoring program, the Discharger shall inform this Regional Water Board for authorization to rescind the shoreline bacteriological monitoring program conducted by the Discharger.

VIII. OTHER MONITORING REQUIREMENTS

A. Special Study

1. CEC Monitoring in the Effluent

In recent years, the Los Angeles Regional Water Board has incorporated monitoring of a select group of man-made chemicals, particularly pesticides, pharmaceuticals and personal care products, known collectively as CECs, into permits issued to publicly-owned treatment works (POTWs) to better understand the propensity, persistence and effects of CECs in our environment. Recently adopted permits in this region contain requirements for CEC effluent monitoring and submittal of a work plan identifying the CECs to be monitored in the effluent, sample type, sampling frequency and sampling methodology. Based on feedback we have received from permittees and our review of the results of a recent CEC-related study by the Southern California Coastal Water Research Project (SCCWRP) and the State Water Board, we have modified our CEC monitoring program to respond to feedback while proceeding to fill identified data gaps without overly burdening any one permittee.

The Discharger shall conduct a special study to investigate the CECs in the effluent discharge as listed in the Table below. These consituents shall be monitored annually for at least 2 years. The Regional Water Board has determined that 2 years is an appropriate time period to determine those CECs that are present in POTW effluent. Monitoring results shall be reported as part of the annual report. Within six months of the effective date of this Order, the Discharger shall submit to the Executive Officer a CECs special study work plan for approval. Upon approval, the Discharger shall implement the work plan.

Table 5. CEC Monitoring Requirements

Parameter	Unit	Sample Type	Minimum Sampling Frequency	Analytical Test Method and (Minimum Level, units)
17α-Ethinyl Estradiol	ng/L	To be proposed	Annually	To be proposed
17β-Estradiol	ng/L	To be proposed	Annually	To be proposed
Estrone	ng/L	To be proposed	Annually	To be proposed
Bisphenol A	ng/L	To be proposed	Annually	To be proposed
Nonylphenol & Nonylphenol polyethoxylates	ng/L	To be proposed	Annually	To be proposed
Octylphenol & octylphenol polyethoxylates	ng/L	To be proposed	Annually	To be proposed
Polybrominated diphenyl ethers	ng/L	To be proposed	Annually	To be proposed

Parameter	Unit	Sample Type	Minimum Sampling Frequency	Analytical Test Method and (Minimum Level, units)
Acetaminophen	ng/L	To be proposed	Annually	To be proposed
Amoxicillin	ng/L	To be proposed	Annually	To be proposed
Azithromycin	ng/L	To be proposed	Annually	To be proposed
Carbamazepine	ng/L	To be proposed	Annually	To be proposed
Caffeine	ng/L	To be proposed	Annually	To be proposed
Ciprofloxacin	ng/L	To be proposed	Annually	To be proposed
N,N-Diethyl-m-toluamide (DEET)	ng/L	To be proposed	Annually	To be proposed
Dilantin	ng/L	To be proposed	Annually	To be proposed
Gemfibrozil	ng/L	To be proposed	Annually	To be proposed
Ibuprofen	ng/L	To be proposed	Annually	To be proposed
Lipitor (Atorvastain)	ng/L	To be proposed	Annually	To be proposed
Iodinated contrast media (iopromide)	ng/L	To be proposed	Annually	To be proposed
Sulfamethoxazole	ng/L	To be proposed	Annually	To be proposed
Trimethoprim	ng/L	To be proposed	Annually	To be proposed
Salicylic acid	ng/L	To be proposed	Annually	To be proposed
TCEP, TCPP and TDCPP	ng/L	To be proposed	Annually	To be proposed
Triclosan	ng/L	To be proposed	Annually	To be proposed
Bifenthrin	ng/L	To be proposed	Annually	To be proposed
Permethrin	ng/L	To be proposed	Annually	To be proposed
Chlorpyrifos	ng/L	To be proposed	Annually	To be proposed
Galaxolide	ng/L	To be proposed	Annually	To be proposed
Diclofenac	ng/L	To be proposed	Annually	To be proposed
Butylbenzyl Phthalate	ng/L	To be proposed	Annually	To be proposed
Perfluorooctane Sulfonate (PFOS)	ng/L	To be proposed	Annually	To be proposed
Fipronil	ng/L	To be proposed	Annually	To be proposed
Meprobamate	ng/L	To be proposed	Annually	To be proposed

B. Outfall and Diffuser Inspection

An annual survey shall be performed in October or November. This shall consist of:

1. An examination of the outfall and diffuser port system for plugs, leaks, rotation, and flow distribution. A detailed structural analysis of the pipes every five years submitted with the Report of Waste Discharge (ROWD) shall be conducted using underwater television/videotape and submarine visual inspection, where appropriate, to provide a

comprehensive report on the discharge pipe systems from shallow water to their respective termini. The annual visual inspection shall be conducted on the external condition of the outfall, diffuser, and ballast systems. A written report documenting conditions shall be prepared and submitted with the Annual Summary Report to this Regional Water Board.

2. A visual inspection at and in the vicinity of the outfall and diffuser port system to determine thickness of any "cloud" of unsettled solids, bottom flora and fauna, and any other biological and physical conditions. Inspections shall include general observations and photographic records of the outfall pipe and the surrounding ocean bottom. A report (including photographs) discussing the above information shall be submitted with the Annual Summary Report to this Regional Water Board.

C. Sludge Monitoring and Reporting

1. The Discharger must comply with all requirements of 40 CFR parts 257, 258, 501, and 503, including all applicable monitoring, record keeping, and reporting requirements.

2. The Discharger must comply with the monitoring and reporting requirements outlined in Attachment I in this Order, [Biosolids/Sludge Management].

3. A monthly report shall be provided, noting the moisture content, weight, and volume of screenings, sludges, grit, and other solids removed from the wastewater. The point(s) from which these wastes were obtained and the disposal sites to which waste solids are transported shall be specified in the monthly reports.

IX. REPORTING REQUIREMENTS

A. General Monitoring and Reporting Requirements

1. The Discharger shall comply with all Standard Provisions (Attachment D) related to monitoring, reporting, and recordkeeping.
2. If there is no discharge during any reporting period, the report shall so state.
3. Each monitoring report shall contain a separate section titled "Summary of Non-Compliance" which discusses the compliance record and the corrective actions taken or planned that may be needed to bring the discharge into full compliance with waste discharge requirements. This section shall clearly list all non-compliance with discharge requirements, as well as all excursions of effluent limitations.
4. The Discharger shall inform the Regional Water Board well in advance of any proposed construction activity that could potentially affect compliance with applicable requirements.

B. Self-Monitoring Reports (SMRs)

1. At any time during the term of this permit, the State or Regional Water Board may notify the Discharger to electronically submit Self-Monitoring Reports (SMRs) using the State Water Board's California Integrated Water Quality System (CIWQS) Program website (http://www.waterboards.ca.gov/ciwqs/index.html). Until such notification is given, the Discharger shall submit hard copy SMRs. The CIWQS website will provide additional directions for SMR submittal in the event there will be service interruption for electronic submittal.

2. The Discharger shall report in the SMR the results for all monitoring specified in this MRP under sections III through VIII. The Discharger shall submit monthly, quarterly, semiannual, annual SMRs including the results of all required monitoring using USEPA-approved test methods or other test methods specified in this Order. If the Discharger monitors any pollutant more frequently than required by this Order, the results of this monitoring shall be included in the calculations and reporting of the data submitted in the SMR.

3. Monitoring periods and reporting for all required monitoring shall be completed according to the following schedule:

Table 6. Monitoring Periods and Reporting Schedule

Sampling Frequency	Monitoring Period Begins On...	Monitoring Period	SMR Due Date
Continuous	Permit effective date	All	Submit with monthly SMR
Hourly	Permit effective date	Hourly	Submit with monthly SMR
Daily	Permit effective date	(Midnight through 11:59 PM) or any 24-hour period that reasonably represents a calendar day for purposes of sampling.	Submit with monthly SMR
Weekly	Sunday following permit effective date or on permit effective date if on a Sunday	Sunday through Saturday	Submit with monthly SMR
Monthly	First day of calendar month following permit effective date or on permit effective date if that date is first day of the month	1st day of calendar month through last day of calendar month	By the 15th day of the second month after the month of sampling
Quarterly	Closest of January 1, April 1, July 1, or October 1 following (or on) permit effective date	January 1 through March 31 April 1 through June 30 July 1 through September 30 October 1 through December 31	May 15 August 15 November 15 February 15
Semiannually	Closest of January 1 or July 1 following (or on) permit effective date	January 1 through June 30 July 1 through December 31	August 15 February 15
Annually	January 1 following (or on) permit effective date	January 1 through December 31	April 15

4. The Discharger shall submit SMRs in accordance with the following requirements:

   a. The Discharger shall arrange all reported data in a tabular format. The data shall be summarized to clearly illustrate whether the facility is operating in compliance with interim and/or final effluent limitations. The Discharger is not required to duplicate the submittal of data that is entered in a tabular format within CIWQS. When electronic submittal of data is required and CIWQS does not provide for entry into a tabular format within the system, the Discharger shall electronically submit the data in a tabular format as an attachment.

   b. The Discharger shall attach a cover letter to the SMR. The information contained in the cover letter shall clearly identify violations of the WDRs; discuss corrective actions taken or planned; and the proposed time schedule for corrective actions. Identified violations must include a description of the requirement that was violated and a description of the violation.

c. SMRs must be submitted to the Regional Water Board, signed and certified as required by the Standard Provisions (Attachment D). Paper SMRs should be converted to a Portable Document Format (PDF). Documents that are less than 10 megabytes (MB) should be emailed to losangeles@waterboards.ca.gov. Documents that are 10 MB or larger should be transferred to a disk and mailed to the address listed below: (Reference the reports to **Compliance File No. 2022** to facilitate routing to the appropriate staff and file.)

California Regional Water Quality Control Board
Los Angeles Region
320 West 4th Street, Suite 200
Los Angeles, CA 90013
Attention: Information Technology Unit

Dischargers who have been certified to only submit electronic SMRs to CIWQS should continue doing so, as previously required.

C. Discharge Monitoring Reports (DMRs)

1. As described in section IX.B.1 above, at any time during the term of this permit, the state or Regional Water Board may notify the Discharger to electronically submit SMRs that will satisfy federal requirements for submittal of Discharge Monitoring Reports (DMRs). Until such notification is given, the Discharger shall submit DMRs in accordance with the requirements described below.

2. DMRs must be signed and certified as required by the standard provisions (Attachment D). The Discharger shall submit the original DMR and one copy of the DMR to the address listed below:

Standard Mail	FedEx/UPS/ Other Private Carriers
State Water Resources Control Board Division of Water Quality c/o DMR Processing Center PO Box 100 Sacramento, CA 95812-1000	State Water Resources Control Board Division of Water Quality c/o DMR Processing Center 1001 I Street, 15th Floor Sacramento, CA 95814

3. All discharge monitoring results must be reported on the official USEPA pre-printed DMR forms (USEPA Form 3320-1). Forms that are self-generated will not be accepted unless they follow the exact same format of USEPA Form 3320-1.

D. Other Reports

1. Annual Summary Report

By April 15 of each year, the Discharger shall submit an annual summary report containing a discussion of the previous year's influent/effluent analytical results and receiving water bacterial monitoring data. The annual summary report shall also contain an overview of any plans for upgrades to the treatment plant's collection system, the treatment processes, or the outfall system, and sewer and plant maintenance activities. The Discharger shall submit an electronic annual report to the Regional Water Board in accordance with the requirements described in subsection B.4 above.

Each annual monitoring report shall contain a separate section titled "Reasonable Potential Analysis" which discusses whether or not reasonable potential was triggered for pollutants which do not have a final effluent limitation in the NPDES permit. This section shall contain the following statement: "The analytical results for this sampling period did/ did not trigger reasonable potential." If reasonable potential was triggered, then the following information should also be provided:

a. A list of the pollutant(s) that triggered reasonable potential;

b. The Basin Plan or CTR criteria that was exceeded for each given pollutant;

c. The concentration of the pollutant(s);

d. The test method used to analyze the sample; and,

e. The date and time of sample collection.

The Discharger shall submit to the Regional Water Board, together with the first monitoring report required by this permit, a list of all chemicals and proprietary additives which could affect this waste discharge, including quantities of each. Any subsequent changes in types and/or quantities shall be reported promptly.

2. Receiving Water Monitoring Report

An annual summary of the receiving water monitoring data collected during each sampling year (January-December) shall be prepared and submitted so that it is received by the Regional Water Board by August 15 of the following year.

A detailed receiving water monitoring biennial assessment report of the data collected during the two previous calendar sampling years (January-December) shall be prepared and submitted so that it is received by the Regional Water Board by August 15 of every other year. This report shall include an annual data summary and shall also include an in-depth analysis of the biological and chemical data following recommendations in the Model Monitoring Program guidance document (Schiff, K.C., J.S. Brown and S.B. Weisberg. 2001. Model Monitoring Program for Large Ocean Dischargers in Southern California. SCCWRP Tech. Rep #357. SCCWRP, Westminster, CA. 101 pp.). Data shall be tabulated, summarized, and graphed where appropriate, analyzed, interpreted, and generally presented in such a way as to facilitate ready understanding of its significance. Spatial and temporal trends shall be examined and compared. The relation of physical and chemical parameters to biological parameters shall be evaluated. See, also, section V.G. of this MRP. All receiving water monitoring data shall be submitted in accordance with the data submittal formats developed for the Southern California Bight Regional Monitoring Surveys.

The first assessment report shall be due August 15, 2015, and cover the sampling periods of January-December 2013 and January-December 2014. Subsequent reports shall be due August 1, 2017, and August 1, 2019, to cover sampling periods of January 2015-December 2016 and January 2017-December 2018, respectively.

3. Outfall Inspection Report

A summary report of the Outfall Inspection findings shall be provided annually. This written report, augmented with videographic and/or photographic images, shall provide a description of the observed external condition of the discharge pipes from shallow water to their respective termini. This report shall be submitted so that it is received by August 15 of the following year.

ATTACHMENT F – FACT SHEET

Table of Contents

List of Tables

ATTACHMENT F – FACT SHEET

As described in section I of this Order, the Regional Water Board incorporates this Fact Sheet as findings of the Regional Water Board supporting the issuance of this Order. This Fact Sheet includes the legal requirements and technical rationale that serve as the basis for the requirements of this Order.

This Order has been prepared under a standardized format to accommodate a broad range of discharge requirements for Dischargers in California. Only those sections or subsections of this Order that are specifically identified as "not applicable" have been determined not to apply to this Discharger. Sections or subsections of this Order not specifically identified as "not applicable" are fully applicable to this Discharger.

I. PERMIT INFORMATION

The following table summarizes administrative information related to the facility.

Table 1. Facility Information

WDID	4A560105001
Discharger	City of Oxnard Municipal Corporation
Name of Facility	Oxnard Wastewater Treatment Plant and its associated wastewater collection system and outfall, City of Oxnard
Facility Address	6001 South Perkins Road
	Oxnard, CA 93033-9047
	Ventura County
Facility Contact, Title and Phone	Mark S. Moise, Wastewater Operations Manager, (805) 271-2203
Authorized Person to Sign and Submit Reports	Mark S. Moise, Wastewater Operations Manager, (805) 271-2203
Mailing Address	SAME
Billing Address	SAME
Type of Facility	POTW
Major or Minor Facility	Major
Threat to Water Quality	1
Complexity	A
Pretreatment Program	Yes
Reclamation Requirements	Producer
Facility Permitted Flow	31.7 (million gallons per day)
Facility Design Flow	31.7 (million gallons per day)
Watershed	Ventura Coastal Stream Watershed Management Area
Receiving Water	Pacific Ocean
Receiving Water Type	Ocean waters

A. The City of Oxnard Municipal Corporation (Discharger) owns and operates a publicly-owned treatment works (POTW) comprised of Oxnard Wastewater Treatment Plant (Oxnard WWTP or Facility) and its associated wastewater collection system and outfalls.

For the purposes of this Order, references to the "discharger" or "permittee" in applicable federal and state laws, regulations, plans, or policy are held to be equivalent to references to the Discharger herein.

B. The Facility discharges wastewater to the Pacific Ocean, a water of the United States. The Discharger was previously regulated by Order No. R4-2008-0029, as amended by Order No R4-2010-0048, adopted on May 1, 2008, and March 4, 2010, respectively. These orders expired on April 10, 2013. The terms and conditions of the current order have been automatically continued and remain in effect until new Waste Discharge Requirements (WDRs) and National Pollutant Discharge Elimination System (NPDES) permit are adopted pursuant to this Order. Attachment B provides a map of the area around the Facility. Attachment C provides a flow schematic of the Facility.

On March 4, 2010, Order No. R4-2008-0029 was amended by Order No. R4-2010-0048 to reflect the diversion of 8 to 9 mgd of secondary effluent for further treatment at the advanced water purification facility (AWPF) under the City of Oxnard's Groundwater Enhancement and Treatment (GREAT) Program for non-potable reuse. The GREAT Program operates under a separate Water Recycling Requirement and Waste Discharge Requirements Order No. R4-2008-0083, as amended by Order No. R4-2011-0079.

The backwash wastewater produced at the AWPF will be returned to the Facility's headworks. The brine waste produced at the AWPF, commingled with the treatment plant's secondary-treated effluent will be discharged to the Pacific Ocean through Discharge Point 001.

C. The Discharger filed a report of waste discharge (ROWD) and submitted an application for renewal of its WDRs and NPDES permit on October 23, 2012. Supplemental information was requested on November 2, 2012, and received on November 13, 2012. The application was deemed complete on November 13, 2012. A site visit was conducted on March 28, 2013, to observe operations and collect additional data to develop permit limitations and requirements for waste discharge.

II. FACILITY DESCRIPTION

A. Description of Wastewater and Biosolids Treatment or Controls

1. The treatment system consists of bar screening, aerated grit removal, primary clarification, bio-filtration, activated sludge, secondary clarification, flow equalization, chlorine disinfection, and dechlorination. Solid fractions recovered from the wastewater treatment processes include screenings, grit, primary sludge and skimmings, and thickened waste activated sludge. The fine solids (screenings and grit) which are primarily inorganic materials are hauled away to a landfill. The remaining solid fractions (primary sludge, skimmings, and thickened waste activated sludge) are anaerobically digested at the treatment plant. The digested solids are dewatered using belt filter presses. The dewatered cake contains approximately 20% solids (Class B biosolids). The Facility generates approximately 500 wet tons of Class B biosolids per week. The biosolids are taken to the Toland Landfill in Ventura County. The biosolids at Toland are either added to the landfill, or dried in a dryer to approximately 70%, and then used as alternative daily cover (ADC).

   In addition, the Discharger operates an oil and grease program through which it cleans interceptors for food establishments and uses the oil and grease in its digesters to increase methane production. The methane is then used to generate electricity, providing approximately 60% of total electricity needed for the Facility.

2. The Facility serves a population of approximately 230,900 in the city of Oxnard, the city of Port Hueneme, the United States Naval Base, Ventura County, and some unincorporated areas of Ventura County. Flow to the plant consists of domestic, commercial and industrial wastewater. For Fiscal Year 2012, industrial wastewater represented about 11% (low peak) and 21% (high peak) of the total flow to the Facility.

B. Discharge Points and Receiving Waters

1. The secondary-treated wastewater is discharged through an ocean outfall (Discharge Point No. 001) off Ormond Beach into the Pacific Ocean, a water of the United States. The brine waste produced at the AWPF will also be discharged through Discharge Point No. 001. The description of the outfall is as follows:

Table 2. Outfall Description

Discharge Point Number	001
Diameter of Pipe at Discharge Terminus (feet)	4
Outfall Distance Offshore (feet)	5,950 (including a 1,016-foot diffuser section)
Discharge Depth Below Surface Water (feet)	60
Latitude	34° 07' 34" North
Longitude	119° 11' 26" West

2. The receiving water (Pacific Ocean) off Ormond Beach for the Oxnard WWTP discharge is part of the open coastline of the Regional Water Board-designated Ventura Coastal Watershed Management Area. In addition to the Oxnard WWTP, there are two other major dischargers to the Ventura Coastal Watershed Management Area – Ormond Beach and Mandalay Generating Stations, owned by Reliant Energy, Inc. (formerly owned by Southern California Edison).

C. Summary of Existing Requirements and Self-Monitoring Report (SMR) Data

Effluent limitations contained in the existing Order for discharges from Discharge Point 001 (Monitoring Location EFF-001) and representative monitoring data from the term of the previous Order are as follows:

Table 3. Historic Effluent Limitations and Monitoring Data

Parameter	Units	Effluent Limitation			Monitoring Data (From August 2008 –December 2012)		
		Average Monthly	Average Weekly	Maximum Daily	Highest Average Monthly Discharge	Highest Average Weekly Discharge	Highest Daily Discharge
Conventional/Non-Conventional							
Biochemical Oxygen Demand (BOD)	mg/L	30	45	--	23		

Parameter	Units	Effluent Limitation			Monitoring Data (From August 2008 –December 2012)		
		Average Monthly	Average Weekly	Maximum Daily	Highest Average Monthly Discharge	Highest Average Weekly Discharge	Highest Daily Discharge
Total Suspended Solids (TSS)	mg/L	30	45	--	12		
Oil & Grease	mg/L	25	40	--	6.8		
Settleable Solids	mL/L	1.0	1.5	3.0	<0.1		
Total Coliform	MPN/100mL	--	--	--	136420		
Fecal Coliform	MPN/100mL	--	--	--	118800		
Enterococcus	MPN/100mL	--	--	--	12400		
Nitrate-N	mg/L	--	--	--	3.4		
Nitrite-N	mg/L	--	--	--	2.4	--	--
Organic-N	mg/L	--	--	--	5.1	--	--
pH	pH Unit	6.0 – 9.0			7.5		
Temperature	^{o}C				26		
Turbidity	NTU	75	100	225	7.6		
Marine Aquatic Life							
Arsenic (As)	µg/L	--	--	--	2	--	--
Cadmium (Cd)	µg/L	--	--	--	0.8	--	--
Chromium Total (Cr)	µg/L	--	--	--	8	--	--
Copper (Cu)	µg/L	--	--	--	30	--	--
Lead (Pb)	µg/L	--	--	--	<5	--	--
Mercury (Hg)	µg/L	--	--	--	<0.2	--	--
Nickel (Ni)	µg/L	--	--	--	8	--	--
Selenium (Se)	µg/L	--	--	--	4.7	--	--
Silver (Ag)	µg/L	--	--	--	2.3	--	--
Zinc (Zn)	µg/L	--	--	--	36	--	--
Cyanide	µg/L	--	--	--	<5	--	--
Residual Chlorine	mg/L	--	--	--	0.13	--	--
Ammonia-N	mg/L	--	--	--	31.7	--	--
Acute Toxicity	TUa	--	--	--	--	--	--
Chronic Toxicity (Survival)	TUc	--	--	--	100	--	--
Chronic Toxicity (Growth)	TUc	--	--	--	17.86	--	--
Non-Chlorinated Phenolic Compouds	µg/L	--	--	--	<40	--	--
Chlorinated Phenolic Compouds	µg/L	--	--	--	<40	--	--
Endosulfan	µg/L	--	--	--	<0.005	--	--
Endrin	µg/L	--	--	--	<0.005	--	--
HCH	µg/L	--	--	--	<0.02	--	--
Radioactivity							
Gross alpha	pCi/L	--	--	15			16.8

Parameter	Units	Effluent Limitation			Monitoring Data (From August 2008 –December 2012)		
		Average Monthly	Average Weekly	Maximum Daily	Highest Average Monthly Discharge	Highest Average Weekly Discharge	Highest Daily Discharge
Gross beta	pCi/L	--	--	50			46.5
Human Health - Noncarcinogens							
Acrolein	µg/L	--	--	--	<20	--	--
Antimony	µg/L	--	--	--	<2	--	--
Bis (2-Chloroethoxy) methane	µg/L	--	--	--	<20	--	--
Bis (2-Chloroisopropyl) ether	µg/L	--	--	--	<20	--	--
Chlorobenzene	µg/L	--	--	--	<2	--	--
Chromium III (Cr)	µg/L	--	--	--	--	--	--
Di-n-Butyl Phthalate	µg/L	--	--	--	0.19	--	--
Dichlorobenzene	µg/L	--	--	--	<20	--	--
Diethyl phthalate	µg/L	--	--	--	<20	--	--
Dimethyl phthalate	µg/L	--	--	--	0.06	--	--
4,6-dinitro-2-methylphenol	µg/L	--	--	--	<40	--	--
2,4-dinitrophenol	µg/L	--	--	--	0.14	--	--
Ethylbenzene	µg/L	--	--	--	<2	--	--
Fluoranthene	µg/L	--	--	--	0.04	--	--
Hexachlorocyclopentadiene	µg/L	--	--	--	<20	--	--
Nitrobenzene	µg/L	--	--	--	<40	--	--
Thallium	µg/L	--	--	--	<2	--	--
Toluene	µg/L	--	--	--	<2	--	--
Tributyltin	µg/L	--	--	--	<0.002	--	--
1,1,1-trichloroethane	µg/L	--	--	--	<2	--	--
Human Health - Carcinogens							
Acrylonitrile	µg/L	--	--	--	<10	--	--
Aldrin	µg/L	--	--	--	<0.005	--	--
Benzene	µg/L	--	--	--	<2	--	--
Benzidine	µg/L	0.0068	--	--	<40	--	--
Berylium (Be)	µg/L	--	--	--	<0.5	--	--
Bis (2-Chloroethyl) ether	µg/L	--	--	--	<20	--	--
Bis(2-ethylhexyl)-phthalate	µg/L	--	--	--	86	--	--
Carbon tetrachloride	µg/L	--	--	--	<5	--	--
Chlordane	µg/L	--	--	--	<0.1	--	--
Chlorodibromomethane	µg/L	--	--	--	0.61	--	--
Chloroform	µg/L	--	--	--	1.2	--	--
DDT	µg/L	--	--	--	0.0086	--	--

Parameter	Units	Effluent Limitation			Monitoring Data (From August 2008 –December 2012)		
		Average Monthly	Average Weekly	Maximum Daily	Highest Average Monthly Discharge	Highest Average Weekly Discharge	Highest Daily Discharge
1,4-Dichlorobenzene	µg/L	--	--	--	0.041	--	--
3,3'-Dichlorobenzidine	µg/L	--	--	--	<40	--	--
1,2-dichloroethane	µg/L	--	--	--	<2	--	--
1,1-dichloroethylene	µg/L	--	--	--	<2	--	--
Dichlorobromomethane	µg/L	--	--	--	<2	--	--
Dichloromethane	µg/L	--	--	--	<5	--	--
1,3-dichloropropene	µg/L	--	--	--	<2	--	--
Dieldrin	µg/L	--	--	--	<0.005	--	--
2,4-Dinitrotolulene	µg/L	--	--	--	<10	--	--
1,2-Diphenylhydrazine	µg/L	--	--	--	<40	--	--
Halomethanes	µg/L	--	--	--	<10	--	--
Heptachlor	µg/L	--	--	--	<0.01	--	--
Heptachlor epoxide	µg/L	0.002	--	--	<0.1	--	--
Hexachlorobenzene	µg/L	--	--	--	<20	--	--
Hexachlorobutadiene	µg/L	--	--	--	<20	--	--
Hexachloroethane	µg/L	--	--	--	<20	--	--
Isophorone	µg/L	--	--	--	<20	--	--
N-Nitrosodimethylamine	µg/L	--	--	--	<40	--	--
N-Nitrosodi-N-propylamine	µg/L	--	--	--	<20	--	--
N-Nitrosodiphenylamine	µg/L	--	--	--	<20	--	--
PAH	µg/L	--	--	--	<20	--	--
PCBs	µg/L	0.0019	--	--	<0.5	--	--
TCDD	µg/L	0.00000039	--	--	<10	--	--
1,1,2,2-tetrachloroethane	µg/L	--	--	--	<2	--	--
Tetrachloroethylene	µg/L	--	--	--	<2	--	--
Toxaphene	µg/L	--	--	--	<0.5	--	--
Trichloroethylene	µg/L	--	--	--	<5	--	--
1,1,2-trichloroethane	µg/L	--	--	--	<2	--	--
2,4,6-Trichlorophenol	µg/L	--	--	--	0.35	--	--
Vinyl chloride	µg/L	--	--	--	<5	--	--

D. Compliance Summary

Below is the preliminary list of effluent and reporting violations abstracted from CIWQS that occurred during the permit cycle 2008-2012.

Table 4. Preliminary List of Exceedances

Date of Exceedance	Description of Exceedance
04/04/2012	Bypass of approximately 20,000 gallons of primary effluent commingled with secondary effluent and was discharged at the outfall.
09/02/2011	Bypass of approximately 100,000 gallons of primary effluent commingled with secondary effluent and was discharged at the outfall.
05/18/2009	Influent flow was not measured.
02/04/2009	Reported detection limit for benzidine exceeded the permit effluent limit (0.050 / 0.0068 ug/L).

E. Planned Changes

The Discharger has completed the construction of an AWPF. The GREAT Program - Phase I is designed to produce 6.25 mgd of recycled water. Phase II is designed to produce an additional 25 mgd of recycled water. Recycled water is produced by further processing a portion of the secondary-treated wastewater from the Oxnard WWTP through microfiltration, ultrafiltration, reverse osmosis, and ultraviolet-light-based advanced oxidation.

The diversion of portion of the secondary-treated wastewater will reduce the flow that will be discharged to the Pacific Ocean. The City of Oxnard is currently constructing a permanent sampling facility to incorporate a sampling location that will provide a complete mixing of the secondary-treated effluent and the brine waste from the AWPF. This sampling facility is expected to be completed by December 2013.

III. APPLICABLE PLANS, POLICIES, AND REGULATIONS

The requirements contained in this Order are based on the requirements and authorities described in this section.

A. Legal Authorities

This Order is issued pursuant to section 402 of the federal Clean Water Act (CWA) and implementing regulations adopted by the United States Environmental Protection Agency (USEPA) and chapter 5.5, division 7 of the California Water Code (CWC; commencing with section 13370). It serves as an NPDES permit for point source discharges from this Facility to surface waters and WDRs pursuant to article 4, chapter 4, division 7 of the CWC (commencing with section 13260).

B. California Environmental Quality Act (CEQA)

Under CWC section 13389, this action to adopt an NPDES permit is exempt from the provisions of chapter 3 of CEQA, (commencing with section 21100) of division 13 of Public Resources Code (PRC).

C. State and Federal Regulations, Policies, and Plans

1. **Basin Plan.** The Regional Water Board adopted a Water Quality Control Plan for the Los Angeles Region (Basin Plan) on June 13, 1994 that designates beneficial uses, establishes water quality objectives, and contains implementation programs and policies to achieve those objectives for the Pacific Ocean. In addition, the Basin Plan implements State Water Board (State Water Board) Resolution No. 88-63, which established state policy that all waters, with certain exceptions, should be considered suitable or potentially suitable for municipal or domestic supply (MUN). On May 26, 2000, the USEPA approved the revised Basin Plan except for the implementation plan for potential MUN-designated water bodies. MUN is not applicable to this discharge.

   Beneficial uses applicable to the Pacific Ocean are as follows:

Table 5. Basin Plan Beneficial Uses

Discharge Point	Receiving Water Name	Beneficial Use(s)
001	Ormond Beach	Existing: Industrial water supply (IND); navigation (NAV); hydropower generation (POW); water contact recreation (REC-1); non-contact water recreation (REC-2); commercial and sport fishing (COMM); marine habitat (MAR); wildlife habitat (WILD); rare, threatened or endangered species (RARE); and, shellfish harvesting (SHELL). Potential: Spawning, reproduction, and/or early development (SPWN).
001	Pacific Ocean Nearshore	Existing: IND, NAV, REC-1, REC-2, COMM, MAR, WILD, preservation of biological habitats (BIOL), RARE, migration of aquatic organisms (MIGR), SPWN, and SHELL. Potential: None.
001	Pacific Ocean Offshore	Existing: NAV, REC-1, REC-2, COMM, MAR, WILD, RARE, MIGR, SPWN, and SHELL. Potential: None.

Requirements of this Order implement the Basin Plan.

The Basin Plan relies primarily on the requirements of the Water Quality Control Plan for Ocean Waters of California (Ocean Plan) for protection of the beneficial uses of the state ocean waters. The Basin Plan, however, may contain additional water quality objectives applicable to the Discharger.

2. **Thermal Plan.** The State Water Board adopted the *Water Quality Control Plan for Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays and Estuaries of California* (Thermal Plan) on May 18, 1972, and amended this plan on September 18, 1975. This plan contains temperature objectives for coastal waters. Requirements of this Order implement the Thermal Plan.

3. **California Ocean Plan.** The State Water Board adopted the *Water Quality Control Plan for Ocean Waters of California, California Ocean Plan* (Ocean Plan) in 1972 and amended it in 1978, 1983, 1988, 1990, 1997, 2000, 2005, and 2009. The State Water Board adopted the most recent amended Ocean Plan on September 15, 2009. The Office of Administration Law approved it on March 10, 2010. USEPA approved it on October 8, 2010. The 2009 Ocean Plan is applicable, in its entirety, to point source discharges to the ocean. The Ocean Plan identifies beneficial uses of ocean waters of the state to be protected as summarized below:

Table 6. Ocean Plan Beneficial Uses

Discharge Point	Receiving Water	Beneficial Uses
Outfall 001	Pacific Ocean	NAV; REC-1; REC-2; COMM; MAR; WILD; RARE; MIGR; SPWN; SHELL; and, preservation and enhancement of designated Areas of Special Biological Significance (ASBS)[1].

In order to protect the beneficial uses, the Ocean Plan establishes water quality objectives and a program of implementation. Requirements of this Order implement the Ocean Plan.

4. **Alaska Rule.** On March 30, 2000, USEPA revised its regulation that specifies when new and revised state and tribal water quality standards (WQS) become effective for CWA purposes (40 CFR part 131.21, 65 Federal Register 24641 (April 27, 2000)). Under the revised regulation (also known as the Alaska Rule), new and revised standards submitted to USEPA after May 30, 2000, must be approved by USEPA before being used for CWA purposes. The final rule also provides that standards already in effect and submitted to USEPA by May 30, 2000, may be used for CWA purposes, whether or not approved by USEPA.

5. **Stringency of Requirements for Individual Pollutants.** This Order contains both technology-based effluent limitations (TBELs) and water quality-based effluent limitations (WQBELs) for individual pollutants. The TBELs consist of restrictions on biological oxygen demand (BOD), total suspended solids (TSS), oil and grease, settleable solids, turbidity, pH, and percent removal of BOD and TSS. Restrictions on BOD, TSS, oil and grease, settleable solids, turbidity, and pH are discussed in section IV.B.2 of the Fact Sheet. This Order's technology-based pollutant restrictions implement the minimum, applicable federal

[1] There is no ASBS designated area in the vicinity of this discharge.

technology-based requirements. In addition, this Order contains effluent limitations more stringent than the minimum, federal technology-based requirements that are carried over from the previous permit.

WQBELs have been scientifically derived to implement water quality objectives that protect beneficial uses. Both the beneficial uses and the water quality objectives have been approved pursuant to federal law and are the applicable federal water quality standards. All beneficial uses and water quality objectives contained in the Basin Plan and the Ocean Plan were approved under state law and submitted to and approved by USEPA prior to May 30, 2000. Any water quality objectives and beneficial uses submitted to USEPA prior to May 30, 2000, but not approved by USEPA before that date, are nonetheless "applicable water quality standards for purposes of the CWA" pursuant to 40 CFR part 131.21(c)(1). Collectively, this Order's restrictions on individual pollutants are no more stringent than required to implement the requirements of the CWA.

6. **Antidegradation Policy.** Section 131.12 requires that the state water quality standards include an antidegradation policy consistent with the federal policy. The State Water Board established California's antidegradation policy in State Water Board Resolution No. 68-16. Resolution No. 68-16 is deemed to incorporate the federal antidegradation policy where the federal policy applies under federal law. Resolution No. 68-16 requires that existing water quality be maintained unless degradation is justified based on specific findings. The Regional Water Board's Basin Plan implements, and incorporates by reference, both the state and federal antidegradation policies. The permitted discharge is consistent with the antidegradation provision of section 131.12 and State Water Board Resolution No. 68-16.

7. **Anti-Backsliding Requirements.** Sections 402(o)(2) and 303(d)(4) of the CWA and federal regulations at 40 CFR section 122.44(l) restrict backsliding in NPDES permits. These anti-backsliding provisions require that effluent limitations in a reissued permit must be as stringent as those in the previous permit, with some exceptions in which limitations may be relaxed. All effluent limitations in the Order are at least as stringent as the effluent limitations in the previous Order.

8. **Endangered Species Act (ESA).** This Order does not authorize any act that results in the taking of a threatened or endangered species or any act that is now prohibited, or becomes prohibited in the future, under either the California ESA (Fish and Game Code (FGC) sections 2050 to 2097) or the federal ESA (16 United States Code (USC) sections 1531 to 1544). This Order requires compliance with effluent limitations, receiving water limitations, and other requirements to protect the beneficial uses of waters of the state. The Discharger is responsible for meeting all requirements of the applicable ESA.

9. **Water Rights.** Prior to making any change in the point of discharge, place of use, or purpose of use of treated wastewater that results in a decrease of flow in any portion of a surface or subterranean stream, the Discharger must file a petition with the State Water Board (State Water Board), Division of Water Rights, and receive approval for such a change. The State Water Board retains the jurisdictional authority to enforce such requirements under CWC section 1211. However, since this is an ocean discharge, CWC section 1211 is not applicable to this permit.

10. **Monitoring and Reporting.** 40 CFR part 122.48 requires that all NPDES permits specify requirements for recording and reporting monitoring results. CWC sections 13267 and 13383 authorize the Regional Water Board to require technical and monitoring reports. The

MRP establishes monitoring and reporting requirements to implement federal and state requirements. This MRP is provided in Attachment E.

11. **Sewage Sludge/Biosolids Requirements.** Section 405 of the CWA and implementing regulations at 40 CFR part 503 require that producers of sewage sludge/biosolids meet certain reporting, handling, and use or disposal requirements. The state has not been delegated the authority to implement this program; therefore, USEPA is the implementing agency. This Order contains sewage sludge/biosolids requirements pursuant to 40 CFR part 503 that are applicable to the Discharger.

D. Impaired Water Bodies on CWA 303(d) List

The State Water Board proposed the California 2008-2010 Integrated Report from a compilation of the adopted Regional Water Boards' Integrated Reports containing 303(d) List of Impaired Waters and 305(b) Reports following recommendations from the Regional Water Boards and information solicited from the public and other interested parties. The Regional Water Boards' Integrated Reports were used to revise their 2006 303(d) List. On August 4, 2010, the State Water Board adopted the California 2008-2010 Integrated Report. On November 12, 2010, the USEPA approved California 2008-2010 Integrated Report Section 303(d) List of Impaired Waters requiring TMDLs for the Los Angeles Region.

Ormond Beach is in the California 2008-2010 Integrated Report. Indicator bacteria from point and non-point sources is the identified pollutant impacting the receiving water.

E. Other Plans, Polices and Regulations

1. **Secondary Treatment Regulations.** 40 CFR part 133 establishes the minimum levels of effluent quality to be achieved by secondary treatment. These limitations, established by USEPA, are incorporated into this Order, except where more stringent limitations are required by other applicable plans, policies, or regulations.

2. **Storm Water.** CWA section 402(p), as amended by the Water Quality Act of 1987, requires NPDES permits for storm water discharges. Pursuant to this requirement, in 1990, USEPA promulgated 40 CFR part 122.26 that established requirements for storm water discharges under an NPDES program. To facilitate compliance with federal regulations, on November 1991, the State Water Board issued the statewide General Industrial Storm Water Permit, *General NPDES Permit No. CAS000001 and Waste Discharge Requirements for Discharges of Storm Water Associated with Industrial Activities.* This permit was amended in September 1992 and reissued on April 17, 1997 in State Water Board Order No. 97-03-DWQ to regulate storm water discharges associated with industrial activity.

   The Discharger developed and currently implements a Storm Water Pollution Prevention Plan (SWPPP) to comply with the State Water Board's (Order No. 97-03-DWQ).

3. **Sanitary Sewer Overflows (SSOs).** The CWA prohibits the discharge of pollutants from point sources to surface waters of the United States unless authorized under an NPDES permit. (33 USC sections 1311 and 1342). The State Water Board adopted General WDRs for Sanitary Sewer Systems, (Water Quality Order No. 2006-0003-DWQ; SSO WDR) on May 2, 2006, to provide a consistent, statewide regulatory approach to address SSOs. The SSO WDR requires public agencies that own or operate sanitary sewer systems to apply for

coverage under the SSO WDR, develop and implement sewer system management plans, and report all SSOs to the State Water Board's online SSO database. Regardless of the coverage obtained under the SSO WDR, the Discharger's collection system is part of the POTW that is subject to this NPDES permit. As such, pursuant to federal regulations, the Discharger must properly operate and maintain its collection system (40 CFR part 122.41 (e)), report any non-compliance (40 CFR part 122.41(1)(6) and (7)), and mitigate any discharge from the collection system in violation of this NPDES permit (40 CFR part 122.41(d)).

The requirements contained in this Order sections V.C.3.b (SCCP section), V.C.4 (Construction, Operation and Maintenance Specifications section), and V.C.6 (Spill Reporting Requirements section) are intended to be consistent with the requirements of the SSO WDR. The Regional Water Board recognizes that there may be some overlap between these NPDES permit provisions and SSO WDR requirements, related to the collection systems. The requirements of the SSO WDR are considered the minimum thresholds (see Finding 11 of State Water Board Order No. 2006-0003-DWQ). To encourage efficiency, the Regional Water Board will accept the documentation prepared by the Permittees under the SSO WDR for compliance purposes as satisfying the requirements in sections V.C.3.b, V.C.4, and V.C.6, provided the more stringent provisions contained in this NPDES permit are also addressed. Pursuant to SSO WDR, section D, provision 2(iii) and (iv), the provisions of this NPDES permit supercede the SSO WDR, for all purposes, including enforcement, to the extent the requirements may be deemed duplicative.

4. **Watershed Management.** This Regional Water Board has been implementing a Watershed Management Approach (WMA) to address water quality protection in Los Angeles and Ventura Counties. The approach is in accordance with USEPA guidance on *Watershed Protection: A Project Focus* (EPA841-R-95-003, August 1995). The objective is to provide a comprehensive and integrated strategy resulting in water resource protection, enhancement and restoration, while balancing economic and environmental impacts within a hydrologically defined drainage basin or watershed. The WMA emphasizes cooperative relationships between regulatory agencies, the regulated community, environmental groups, and other stakeholders in the watershed to achieve the greatest environmental improvements with the resources available. This Order and the accompanying *MRP* (Attachment E) foster implementation of this approach. The *MRP* requires the Discharger to participate in regional water quality and kelp bed monitoring programs in the Southern California Bight. Information about the Ventura Coastal Stream Watershed Management Area and other watersheds in the region can be obtained from the Regional Water Board's website at http://www.waterboards.ca.gov/losangeles and clicking on the word "Watersheds".

IV. RATIONALE FOR EFFLUENT LIMITATIONS AND DISCHARGE SPECIFICATIONS

The CWA requires point source dischargers to control the amount of conventional, non-conventional, and toxic pollutants that are discharged into the waters of the United States. The control of pollutants discharged is established through effluent limitations and other requirements in NPDES permits. There are two principal bases for effluent limitations in the 40 CFR part 122.44(a) requires that permits include applicable technology-based effluent limitations and standards (TBELs); and 40 CFR part 122.44(d) requires that permits include water quality-based effluent limitations (WQBELs) to attain and maintain applicable numeric and narrative water quality criteria to protect the beneficial uses of the receiving water. 40 CFR part 122.44(d) also specifies that WQBELs may be established using: (1) USEPA criteria guidance under CWA section 304(a); (2) proposed state criteria or a state policy interpreting narrative criteria supplemented with other relevant information; or (3) an indicator parameter. NPDES regulations require WQBELs for any pollutant that causes, has the reasonable potential to cause, or contributes to the exceedance of a receiving water quality criterion or objective.

Mass-based effluent limitations are established to ensure that proper treatment, and not dilution, is employed to comply with effluent concentration limitations. 40 CFR part 122.45(f)(1) requires that all permit limitations, standards, or prohibitions be expressed in terms of mass, except under the following conditions: (1) for pH, temperature, radiation, or other pollutants that cannot appropriately be expressed by mass limitations; (2) when applicable standards or limitations are expressed in terms of other units of measure; or (3) if in establishing a technology-based permit limitation on a case-by-case basis, a limitation based on mass is infeasible because the mass of the pollutant cannot be related to a measure of operation, although the limitation must ensure that dilution will not be used as a substitute for treatment.

A. Discharge Prohibitions

The Order authorizes the discharge of secondary-treated wastewater through Discharge Point No. 001. Discharge prohibitions in this Order are based on the requirements in section III.I of the Ocean Plan (2009).

B. Technology-Based Effluent Limitations (TBELs)

1. Scope and Authority

Section 301(b) of the CWA and implementing USEPA permit regulations at 40 CFR part 122.44 require that permits include conditions meeting applicable technology-based requirements at a minimum, and any more stringent effluent limitations necessary to meet applicable water quality standards. The discharge authorized by this Order must meet minimum federal technology-based requirements based on Secondary Treatment Standards at 40 CFR part 133.

2. Applicable TBELs

Pursuant to section 301 (b)(1)(B) and 304 (d)(1) of the CWA, USEPA has established standards of performance for secondary treatment at 40 CFR part 133. Secondary treatment is defined in terms of three parameters: 5-day BOD, TSS, and pH. The following summarizes the technology-based requirements for secondary treatment, which are applicable to the Plant:

Table 7. Summary of TBELs for Secondary Treatment Facility established by 40 CFR part 133.102

Constituent	Average Monthly	Average Weekly	Percent Removal
$BOD_5$20°C	30 mg/L	45 mg/L	85%
TSS	30 mg/L	45 mg/L	85%
pH	6.0 to 9.0		

Table A of the Ocean Plan also establishes the following TBELs for POTWs, which are applicable to the Plant:

Table 8. Summary of TBELs for POTWs established by the Ocean Plan

Constituent	Average Monthly	Average Weekly	Instantaneous Maximum	Percent Removal
Oil & Grease	25 mg/L	40 mg/L	75 mg/L	--
TSS	--	--	--	75%[2]
Settleable Solids	1.0 ml/L	1.5 ml/L	3.0 ml/L	--
Turbidity	75 NTU	100 NTU	225 NTU	--
pH	6.0 to 9.0			

All TBELs from Order No. R4-2008-0029, as amended by Order No. R4-2010-0048 for BOD, TSS, oil and grease, settleable solids, pH, and turbidity, are retained by this Order. All TBELs are independent of the dilution ratio for the discharge outfall. In addition to the concentration-based effluent limitations, mass-based effluent limitations based on a design flow rate of 31.7 mgd are also included.

The following table summarizes the TBELs for the discharge from the Facility.

Table 9. Summary of TBELS for Discharge Point No. 001

Parameter	Units	Effluent Limitations				
		Average Monthly	Average Weekly	Maximum Daily	Instantaneous Minimum	Instantaneous Maximum
$BOD_5 20^0C$	mg/L	30	45	--	--	--
	lbs/day[3]	7,960	11,900	--	--	--
	% removal	85	--	--	--	--
TSS	mg/L	30	45	--	--	--
	lbs/day[5]	7,960	11,900	--	--	--
	% removal	85	--	--	--	--
Oil and Grease	mg/L	25	40	--	--	75
	lbs/day[5]	6,630	10,600	--	--	19,900
Settleable Solids	ml/L	1.0	1.5	--	--	3.0
Turbidity	NTU	75	100	--	--	225
pH	pH unit	--	--	--	6.0	9.0

[2] Dischargers shall, as a monthly average, remove 75% of TSS from the influent stream before discharging wastewaters to the ocean, except that the effluent limitation to be met shall not be lower than 60 mg/L.

[3] The mass emission rates are based on the plant design flow rate of 31.7 mgd, and are calculated as follows: Flow (mgd) x Concentration (mg/L) x 8.34 (conversion factor) = lbs/day. During wet-weather storm events in which the flow exceeds the design capacity, the mass discharge rate limitations shall not apply, and concentration limitations will provide the only applicable effluent limitations.

C. Water Quality-Based Effluent Limitations (WQBELs)

1. Scope and Authority

Section 301(b) of the CWA and 40 CFR part 122.44(d) require that permits include limitations more stringent than applicable federal technology-based requirements where necessary to achieve applicable water quality standards.

40 CFR part 122.44(d)(1)(i) requires that permits include effluent limitations for all pollutants that are or may be discharged at levels that have the reasonable potential to cause or contribute to an exceedance of a water quality standard, including numeric and narrative objectives within a standard. Where reasonable potential has been established for a pollutant, but there is no numeric criterion or objective for the pollutant, WQBELs must be established using: (1) USEPA criteria guidance under CWA section 304(a), supplemented where necessary by other relevant information; (2) an indicator parameter for the pollutant of concern; or (3) a calculated numeric water quality criterion, such as a proposed state criterion or policy interpreting the state's narrative criterion, supplemented with other relevant information, as provided in section 122.44(d)(1)(vi).

The process for determining reasonable potential and calculating WQBELs, when necessary, is intended to protect the designated uses of the receiving water as specified in the Basin Plan, and achieve applicable water quality objectives and criteria that are contained in other state plans and policies, or any applicable water quality criteria contained in the Ocean Plan.

2. Applicable Beneficial Uses and Water Quality Criteria and Objectives

The Basin Plan and the Ocean Plan establish the beneficial uses for ocean waters of the state. The beneficial uses of the receiving waters affected by the discharge have been described previously in this Fact Sheet. The Ocean Plan also contains water quality objectives for bacterial characteristics, physical characteristics, chemical characteristics, biological characteristics, and radioactivity. The Basin Plan also contains the bacteria objectives for water bodies designated for water contact recreation that was amended by Resolution No. 01-018. The water quality objectives from the Ocean Plan and the bacteria objective from the Basin Plan were included as receiving water limitations in this Order.

Table B of the Ocean Plan includes the numerical water quality objectives for toxic pollutants:

a. Six-month median, daily maximum, and instantaneous maximum objectives for 21 chemicals and chemical characteristics, including total residual chlorine, acute and chronic toxicity, for the protection of marine aquatic life;

b. 30-day average objectives for 20 non-carcinogenic chemicals for the protection of human health; and,

c. 30-day average objectives for 42 carcinogenic chemicals for the protection of human health.

3. Expression of WQBELs

Pursuant to 40 CFR part 122.45(d)(2), for POTW continuous discharges, all permit effluent limitations, standards, and prohibitions, including those necessary to achieve water quality standards, shall, unless impracticable, be stated as average weekly and average monthly discharge limitations (AMEL and AWEL). It is impracticable to include only average weekly and average monthly effluent limitations in the permit, because a single daily discharge of certain pollutants, in excess amounts, can cause violations of water quality objectives. The effects of pollutants on aquatic organisms are often rapid. For many pollutants, an average weekly or average monthly effluent limitation alone is not sufficiently protective of beneficial uses. As a result, MDELs, as referenced in 40 CFR part 122.45(d)(1), are included in the permit for certain constituents.

The WQBELs for marine aquatic life toxicants contained in this Order are based on water quality objectives contained in the 2009 Ocean Plan that are expressed as six-month median, daily maximum, and instantaneous maximum water quality objectives. Applying the Anti-backsliding Policy, this Order retains the same approach to set effluent limitations for marine aquatic life toxicants in Table B of the 2009 Ocean Plan as AMELs.

4. Determining the Need for WQBELs

Order No. R4-2008-0029, as amended by Order No. R4-2010-0048, contains effluent limitations for non-conventional and toxic pollutant parameters in Table B of the Ocean Plan. For this Order, the need for effluent limitations based on water quality objectives in Table B of the 2009 Ocean Plan was reevaluated in accordance with the reasonable potential analysis (RPA) procedures contained in Appendix VI of the 2009 Ocean Plan. This statistical RPA method (performed using RPcalc version 2.0) accounts for the averaging period of the water quality objective, accounts for and captures the long-term variability of the pollutant in the effluent, accounts for limitations associated with sparse data sets, accounts for uncertainty associated with censored data sets, and assumes a lognormal distribution of the facility-specific effluent data. The program calculates the upper confidence bound (UCB) of an effluent population percentile after complete mixing. In the evaluation employed in this Order, the UCB is calculated as the one-sided, upper 95th percent confidence bound for the 95th percentile of the effluent distribution after complete mixing. The calculated $UCB_{95/95}$ is then compared to the appropriate objective to determine the potential for an exceedance of that objective and the need for an effluent limitation. For constituents that have insufficient number of monitoring data or have substantial number of non-detected data with a reporting limit higher than the respective water quality objective, the RPA result is likely to be inconclusive. As required by the Ocean Plan, existing effluent limitations for these constituents are retained in the new permit. In addition, the MRP (Attachment E) of this Order also requires the Discharger to continue to monitor for these constituents for the determination of reasonable potential for these constituents in future permit renewals and/or updates.

Using this statistical procedure in combination with effluent data provided by the Discharger from January 2008 to December 2012 and a minimum initial dilution ratio of 98:1 for Discharger Point 001, Regional Water Board staff has determined that no constituents, when discharged through Discharge Point 001 have a reasonable potential to exceed Ocean Plan objectives. However, the results of reasonable potential analysis for Benzidine, Heptachlor epoxide, PCBs, and TCDD were inconclusive. Therefore, effluent limitations for these constituents are carried over from the existing Order No R4-2008-0029, as amended by Order No. R4-2010-0048.

5. WQBEL Calculations

From the Table B water quality objectives of the Ocean Plan, WQBELs are calculated according to the following equation for all pollutants, except for acute toxicity (if applicable) and radioactivity:

$$Ce = Co + Dm(Co - Cs)$$

where

Ce = the effluent limitation (μg/L)

Co = the water quality objective to be met at the completion of initial dilution (μg/L)

Cs = background seawater concentration (μg/L) (see Table below)

Dm = minimum probable initial dilution expressed as parts seawater per part wastewater

The Dm is based on observed waste flow characteristics, receiving water density structure, and the assumption that no currents of sufficient strength to influence the initial dilution process flow across the discharge structure. Prior to issuance of Order No. R4-2002-0129, staff of the State Water Board had determined the minimum probable initial dilution for Discharge Point 001 to be 98:1. In this permit, same dilution ratio of 98:1 has also been applied to Discharge Point 001. Dm is equal to 98.

Initial dilution is the process that results in the rapid and irreversible turbulent mixing of wastewater with ocean water around the point of discharge. For a submerged buoyant discharge, characteristic of most municipal and industrial wastes that are released from the submarine outfalls, the momentum of the discharge and its initial buoyancy act together to produce turbulent mixing. Initial dilution in this case is completed when the diluting wastewater ceases to rise in the water column and first begins to spread horizontally. As site-specific water quality data is not available, in accordance with Table B implementing procedures, Cs equals zero for all pollutants, except the following:

Table 10. Pollutants with Background Seawater Concentrations

Constituent	Background Seawater Concentration (Cs)
Arsenic	3 μg/L
Copper	2 μg/L
Mercury	0.0005 μg/L
Silver	0.16 μg/L
Zinc	8 μg/L

As examples, WQBELs for Copper, Tributylin (neither have effluent limitation in this Order) and Chronic toxicity are calculated as follows:

Table 11. Ocean Plan Water Quality Objectives (Co) for Copper, Chronic Toxicity and Tributyltin

Constituents	6-Month Median	Daily Maximum	Instantaneous Maximum	30 Day Average
Copper	3 μg/L	12 μg/L	30 μg/L	--
Chronic toxicity	--	1 TUc	--	--
Tributyltin	--	--	--	0.0014 μg/L

Using the equation, **Ce=Co+Dm(Co-Cs)**, effluent limitations are calculated as follows before rounding to two significant digits. All calculations are based on discharge through Discharge Point 001 and, therefore, a dilution ratio (Dm) of 98:1 is applied.

Copper (not a prescribed effluent limitation in this Order, for showing calculations only)
Ce = 3 + 98 (3-2) = 101 μg/L (prescribed as Average Monthly, see section 3 above)
Ce = 12 + 98 (12-2) = 992 μg/L (Daily Maximum)
Ce = 30 + 98 (30-2) = 2,774 μg/L (Instantaneous Maximum)

Chronic Toxicity
Ce = 1 + 98 (1-0) = 99 TUc (Daily Maximum)

Tributyltin (not a prescribed effluent limitation in this Order, for showing calculations only)
Ce = 0.0014 + 98 (0.0014-0) = 0.1386 μg/L (Average Monthly)

Based on the procedures described above, WQBELs would have been calculated for all Table B pollutants (excluding radioactivity) from the Ocean Plan and incorporated into this Order as applicable. However, all the constituents show no reasonable potential or were inconclusive.

Determination of radioactivity limitation: Since the descriptive water quality objective for radioactivity in the 2009 California Ocean Plan fails to establish an applicable narrative or numerical effluent limit for radionuclides, Regional Water Board staff used Best Professional Judgment (BPJ) to establish radioactivity limitations for the effluent using Maximum Contaminant Levels (MCLs) for the drinking water specified in Title 22, California Code of Regulations (CCR) because it is the only scientifically-based regulatory criteria available.

Table 12. Summary of WQBELs for Discharge Point No. 001

Parameter	Units	Effluent Limitations					
		Average Monthly	Average Weekly	Maximum Daily	Instantaneous Minimum	Instantaneous Maximum	Six-Month Median
Chronic toxicity	TUc	--	--	99	--	--	--
Radioactivity							--
Gross alpha	pCi/L	--	--	15	--	--	--
Gross beta	pCi/L	--	--	50	--	--	--
Combined Radium-226 & Radium-228	pCi/L	--	--	5.0	--	--	--

Parameter	Units	Effluent Limitations					
		Average Monthly	Average Weekly	Maximum Daily	Instanta-neous Minimum	Instanta-neous Maximum	Six-Month Median
Tritium	pCi/L	--	--	20,000	--	--	--
Strontium-90	pCi/L	--	--	8.0	--	--	--
Uranium	pCi/L	--	--	20	--	--	--
Benzidine	µg/L	0.0068	--	--	--	--	--
	lbs/day[4]	0.0018	--	--	--	--	--
Heptachlor epoxide	µg/L	0.002	--	--	--	--	--
	lbs/day[4]	0.00053	--	--	--	--	--
PCBs	µg/L	0.0019	--	--	--	--	--
	lbs/day[4]	0.0005	--	--	--	--	--
TCDD	µg/L	0.00000039	--	--	--	--	--
	lbs/day[4]	0.0000001	--	--	--	--	--

6. Whole Effluent Toxicity (WET)

The 2009 Ocean Plan specifies that the Discharger shall conduct chronic toxicity testing for ocean water discharges if the minimum dilution of the effluent falls below 100:1 at the edge of the mixing zone. At this dilution ratio condition, the Ocean Plant does not require acute toxicity testing. Since the applicable dilution factor of 98:1 for the Facility outfall is below 100:1, this Order requires the Discharger to only conduct chronic toxicity testing.

Although all chronic toxicity testing results reported during the term of the previous Order exhibited compliance with the chronic toxicity limit, the chronic toxicity limit shall be retained in the Order in order to provide a backstop to prevent the discharge of toxic pollutants in toxic amounts.

D. Final Effluent Limitations

1. Satisfaction of Anti-Backsliding Requirements

Sections 402(o)(2) and 303(d)(4) of the CWA and federal regulations at 40 CFR part 122.44(l) prohibit backsliding in NPDES permits. These anti-backsliding provisions require effluent limitations in a reissued permit to be as stringent as those in the previous permit, with some exceptions where limitations may be relaxed. All effluent limitations in this Order are at least as stringent as the effluent limitations in the previous Order. The results of reasonable potential analyses for benzidine, heptachlor epoxide, PCBs, and TCDDs were inconclusive, therefore, for the purpose of satisfying Anti-Backsliding requirements; the effluent limitations for these four pollutants in Order R4-2008-0029, as amended by Order No. R4-2010-0048, were carried over.

4 The mass emission rates are based on the plant design flow rate of 31.7 mgd, and are calculated as follows: Flow (mgd) x Concentration (mg/L) x 8.34 (conversion factor) = lbs/day, or Flow (mgd) x Concentration (µg/L) x 0.00834 (conversion factor) = lbs/day. During wet-weather storm events in which the flow exceeds the design capacity, the mass discharge rate limitations shall not apply, and concentration limitations will provide the only applicable effluent limitations.

2. Satisfaction of Antidegradation Policy

On October 28, 1968, the State Water Board adopted Resolution No. 68-16, *Maintaining High Quality Water*, establishing an antidegradation policy for the State and Regional Water Boards. The State Water Board has, in State Water Board Order No. 86-17 and an October 7, 1987 guidance memorandum, interpreted Resolution No. 68-16 to be fully consistent with the federal antidegradation policy. Similarly, the CWA section 304(d)(4)(B) and 40 CFR part 131.12 require that all permitting actions be consistent with the federal antidegradation policy. Together, the state and federal policies are designed to ensure that a water body will not be degraded resulting from the permitted discharge. The provisions of this Order are consistent with the antidegradation policies.

E. Performance Goals

Chapter III, section F.1, of the 2009 Ocean Plan allows the Regional Water Board to establish more restrictive water quality objectives and effluent limitations than those set forth in the Ocean Plan, as necessary for the protection of the beneficial uses of ocean waters.

Pursuant to this provision and to implement the recommendation of the Water Quality Advisory Task Force (*Working Together for an Affordable Clean Water Environment, A final report presented to the California Water Quality Control Board, Los Angeles Region by Water Quality Advisory Task Force*, September 30, 1993) that was adopted by the Regional Water Board on November 1, 1993, performance goals that are more stringent than those based on Ocean Plan objectives are prescribed in this Order. This approach is consistent with the antidegradation policy in that it requires the Discharger to maintain its treatment level and effluent quality, recognizing normal variations in treatment efficiency and sampling and analytical techniques. However, this approach does not address substantial changes in treatment plant operations that could significantly affect the quality of the treated effluent.

While performance goals were previously placed in many POTW permits in the Region, they have not been continued for discharges that are to inland surface waters. For inland surface waters, the California Toxics Rule (CTR; 40 CFR part 131.38) has resulted in effluent limits as stringent as many performance goals. However, the Ocean Plan allows for significant dilution, and the continued use of performance goals serves to maintain existing treatment levels and effluent quality and supports state and federal antidegradation policies.

The performance goals are based upon the actual performance of the Oxnard WWTP and are specified only as an indication of the treatment efficiency of the Facility. Performance goals are intended to minimize pollutant loading (primarily for toxics), while maintaining the incentive for future voluntary improvement of water quality whenever feasible, without the imposition of more stringent limits based on improved performance. They are not considered as enforceable limitations or standards for the regulation of the discharge from the treatment facility. The Executive Officer may modify any of the performance goals if the Discharger requests and has demonstrated that the change is warranted.

Procedures for the determination of performance goals

1. For constituents that have been routinely detected in the effluent (at least 20 percent detectable data), performance goals are based on the one-sided, $UCB_{95/95}$ of January 2008 through December 2012 performance data (after complete mixing) using the RPA protocol contained in the 2009 Ocean Plan. Effluent data are assumed lognormally distributed.

Performance goals are calculated according to the equation $C_{PG} = Co+Dm(Co-Cs)$ in the Ocean Plan and by setting $Co=UCB_{95/95}$.

a. If the maximum detected effluent concentration (MEC) is greater than the calculated performance goal, the calculated performance goal is used as the performance goal; or

b. If the MEC is less than the calculated performance goal, the MEC is used as the performance goal.

For example, the performance goals for silver and arsenic at Discharge Point 001 are calculated as follows:

Silver

$Co = UCB_{95/95} = 0.178\ \mu g/L$; $Dm = 98$; $Cs = 0.16\ \mu g/L$; $MEC = 2.3\ \mu g/L$
C_{PG} = Performance Goal = $0.178\ \mu g/L + 98(0.178\ \mu g/L - 0.16\ \mu g/L) = 1.94\ \mu g/L$

Since the MEC of 2.3 μg/L is greater than the calculated PG of 1.94 μg/L, the performance goal for silver is prescribed as 1.94 μg/L.

Arsenic
$Co = UCB_{95/95} = 3\ \mu g/L$; $Dm = 98$; $Cs = 3\ \mu g/L$; $MEC = 2\ \mu g/L$
C_{PG} = Performance Goal = $3\ \mu g/L + 98(3\ \mu g/L - 3\ \mu g/L) = 3\ \mu g/L$

Since the MEC of 2 μg/L is less than the calculated PG of 3 μg/L, the performance goal for Arsenic is prescribed as 2 μg/L.

2. For constituents where monitoring data have consistently shown nondetectable levels (less than 20 percent detectable data), performance goals are set at five times the Minimum Levels (MLs) listed in the 2009 Ocean Plan. However, if the MEC is less than the calculated value based on ML, the MEC is used as the performance goal.

3. For constituents with no effluent limitations, if the performance goal derived from above steps exceeds the respective calculated Ocean Plan effluent limitation, the calculated effluent limitation is then prescribed as the performance goal for that constituent.

4. For constituents with effluent limitations, if the performance goal derived from above steps exceeds respective effluent limitation, then performance goal is not prescribed for that constituent.

The performance goals for Discharge Point 001 are prescribed in this Order. The listed performance goals are not enforceable effluent limitations or standards. However, the Discharger shall maintain, if not improve, its treatment efficiency. Any exceedance of the performance goals shall trigger an investigation into the cause of the exceedance. If the exceedance persists in three successive monitoring periods, the Discharger shall submit a written report within 90 days to the Regional Water Board discussing the nature of the exceedance, the results of the investigation as to the cause of the exceedance, and the corrective actions taken or proposed corrective measures with timetable for implementation, if necessary.

Table 13. Summary of Final Effluent Limitations for Discharge Point No. 001

Parameter	Units	Effluent Limitations				Performance Goal[5]	Basis
		Average Monthly	Average Weekly	Maximum Daily	Instantaneous Maximum		
$BOD_5 20^0C$	mg/L	30	45	--	--	--	Existing/ Secondary treatment standard
	lbs/day[5]	7,960	11,900	--	--		
	% removal	85	--	--	--		
TSS	mg/L	30	45	--	--	--	Existing/ Secondary treatment standard
	lbs/day[5]	7,960	11,900	--	--		
	% removal	85	--	--	--		
pH	pH unit	6.0 – 9.0				--	Existing/Ocean Plan
Oil and Grease	mg/L	25	40	--	75	--	Existing/Ocean Plan
	lbs/day[5]	6,630	10,600	--	19,900		
Settleable Solids	ml/L	1.0	1.5	--	3.0	--	Existing/Ocean Plan
Turbidity	NTU	75	100	--	225	--	Existing/Ocean Plan
Marine Aquatic Life Toxicants							
Arsenic	μg/L	--	--	--	--	2	No RP
	lbs/day[5]	--	--	--	--	0.5	
Cadmium	μg/L	--	--	--	--	1	No RP
	lbs/day[5]	--	--	--	--	0.26	
Chromium (VI)	μg/L	--	--	--	--	8	No RP
	lbs/day[5]	--	--	--	--	2.1	
Copper	μg/L	--	--	--	--	30	No RP
	lbs/day[5]	--	--	--	--	7.9	
Lead	μg/L	--	--	--	--	23	No RP
	lbs/day[5]	--	--	--	--	6.1	
Mercury	μg/L	--	--	--	--	0.3	No RP
	lbs/day[5]	--	--	--	--	0.08	
Nickel	μg/L	--	--	--	--	8	No RP
	lbs/day[5]	--	--	--	--	2.1	
Selenium	μg/L	--	--	--	--	4.7	No RP
	lbs/day[5]	--	--	--	--	1.2	
Silver	μg/L	--	--	--	--	1.9	No RP
	lbs/day[5]	--	--	--	--	0.5	
Zinc	μg/L	--	--	--	--	36	No RP
	lbs/day[5]	--	--	--	--	9.5	
Cyanide	μg/L	--	--	--	--	25	No RP

[5] See Procedures for the determination of performance goals at section IV.E.1. of Fact Sheet.

Parameter	Units	Effluent Limitations				Performance Goal[5]	Basis
		Average Monthly	Average Weekly	Maximum Daily	Instantaneous Maximum		
	lbs/day[5]	--	--	--	--	6.6	
Chlorine Residual	mg/L	--	--	--	--	0.13	No RP
	lbs/day[5]	--	--	--	--	0.03	
Ammonia as N	mg/L	--	--	--	--	32	No RP
	lbs/day[5]	--	--	--	--	8.5	
Phenolic compounds (non-chlorinated)	µg/L	--	--	--	--	5	No RP
	lbs/day[5]	--	--	--	--	1.3	
Phenolic compounds (chlorinated)	µg/L	--	--	--	--	0.42	No RP
	lbs/day[5]	--	--	--	--	0.11	
Endosulfan	µg/L	--	--	--	--	0.05	No RP
	lbs/day[5]	--	--	--	--	0.013	
HCH	µg/L	--	--	--	--	0.1	No RP
	lbs/day[5]	--	--	--	--	0.026	
Endrin	µg/L	--	--	--	--	0.05	No RP
	lbs/day[5]	--	--	--	--	0.013	
Acute toxicity	TUa	--	--	--	--	--	
Chronic toxicity	TUc	--	--	99	--	--	BPJ
Radioactivity							
Gross alpha	pCi/L	--	--	15	--	--	BPJ
Gross beta	pCi/L	--	--	50	--	--	BPJ
Combined Radium-226 & Radium-228	pCi/L	--	--	5.0	--	--	BPJ
Tritium	pCi/L	--	--	20,000	--	--	BPJ
Strontium-90	pCi/L	--	--	8.0	--	--	BPJ
Uranium	pCi/L	--	--	20	--	--	BPJ
Human Health Toxicants – Non Carcinogens							
Acrolein	µg/L	--	--	--	--	10	No RP
	lbs/day[5]	--	--	--	--	2.6	
Antimony	µg/L	--	--	--	--	2.5	No RP
	lbs/day[5]	--	--	--	--	0.66	
Bis(2-chloroethoxy) methane	µg/L	--	--	--	--	25	No RP
	lbs/day[5]	--	--	--	--	6.6	
Bis(2-chloroisopropyl) ether	µg/L	--	--	--	--	10	No RP
	lbs/day[5]	--	--	--	--	2.6	
Chlorobenzene	µg/L	--	--	--	--	2.5	No RP
	lbs/day[5]	--	--	--	--	0.66	
Chromium (III)	µg/L	--	--	--	--	8	No RP
	lbs/day[5]	--	--	--	--	2.1	

Parameter	Units	Effluent Limitations				Performance Goal[5]	Basis
		Average Monthly	Average Weekly	Maximum Daily	Instantaneous Maximum		
Di-n-butyl-phthalate	µg/L	--	--	--	--	0.19	No RP
	lbs/day[5]	--	--	--	--	0.05	
Dichlorobenzenes	µg/L	--	--	--	--	2.5	No RP
	lbs/day[5]	--	--	--	--	0.66	
Diethyl phthalate	µg/L	--	--	--	--	10	No RP
	lbs/day[5]	--	--	--	--	2.6	
Dimethyl phthalate	µg/L	--	--	--	--	10	No RP
	lbs/day[5]	--	--	--	--	2.6	
2-Methyl-4,6-dinitrophenol	µg/L	--	--	--	--	25	No RP
	lbs/day[5]	--	--	--	--	6.6	
2,4-Dinitrophenol	µg/L	--	--	--	--	25	No RP
	lbs/day[5]	--	--	--	--	6.6	
Ethyl benzene	µg/L	--	--	--	--	2.5	No RP
	lbs/day[5]	--	--	--	--	0.66	
Fluoranthene	µg/L	--	--	--	--	0.039	No RP
	lbs/day[5]	--	--	--	--	0.01	
Hexachlorocyclopentadiene	µg/L	--	--	--	--	25	No RP
	lbs/day[5]	--	--	--	--	6.6	
Nitrobenzene	µg/L	--	--	--	--	5	No RP
	lbs/day[5]	--	--	--	--	1.3	
Thallium	µg/L	--	--	--	--	5	No RP
	lbs/day[5]	--	--	--	--	1.3	
Toluene	µg/L	--	--	--	--	2.5	No RP
	lbs/day[5]	--	--	--	--	0.66	
Tributyltin	µg/L	--	--	--	--	0.0263	No RP
	lbs/day[5]	--	--	--	--	0.007	
1,1,1-Trichloroethane	µg/L	--	--	--	--	2.5	No RP
	lbs/day[5]	--	--	--	--	0.66	
Human Health Toxicants – Carcinogens							
Acrylonitrile	µg/L	--	--	--	--	10	No RP
	lbs/day[5]	--	--	--	--	2.6	
Aldrin	µg/L	--	--	--	--	0.025	No RP
	lbs/day[5]	--	--	--	--	0.0066	
Benzene	µg/L	--	--	--	--	2.5	No RP
	lbs/day[5]	--	--	--	--	0.66	
Benzidine	µg/L	0.0068	--	--	--	--	Existing, Carryover
	lbs/day[5]	0.0018	--	--	--	--	
Beryllium	µg/L	--	--	--	--	2.5	No RP

Parameter	Units	Effluent Limitations				Performance Goal[5]	Basis
		Average Monthly	Average Weekly	Maximum Daily	Instantaneous Maximum		
	lbs/day[5]	--	--	--	--	0.66	
Bis(2-chloroethyl) ether	μg/L	--	--	--	--	5	No RP
	lbs/day[5]	--	--	--	--	1.3	
Bis(2-ethylhexyl) phthalate	μg/L	--	--	--	--	50	No RP
	lbs/day[5]	--	--	--	--	13.2	
Carbon tetrachloride	μg/L	--	--	--	--	2.5	No RP
	lbs/day[5]	--	--	--	--	0.66	
Chlordane	μg/L	--	--	--	--	0.5	No RP
	lbs/day[5]	--	--	--	--	0.13	
Chlorodibromomethane	μg/L	--	--	--	--	0.61	No RP
	lbs/day[5]	--	--	--	--	0.16	
Chloroform	μg/L	--	--	--	--	1.2	No RP
	lbs/day[5]	--	--	--	--	0.32	
DDT	μg/L	--	--	--	--	0.25	No RP
	lbs/day[5]	--	--	--	--	0.066	
1,4-Dichlorobenzene	μg/L	--	--	--	--	0.041	No RP
	lbs/day[5]	--	--	--	--	0.011	
3,3'-Dichlorobenzidine	μg/L	--	--	--	--	25	No RP
	lbs/day[5]	--	--	--	--	6.6	
1,2-Dichloroethane	μg/L	--	--	--	--	2.5	No RP
	lbs/day[5]	--	--	--	--	0.66	
1,1-Dichloroethylene	μg/L	--	--	--	--	2.5	No RP
	lbs/day[5]	--	--	--	--	0.66	
Bromodichloromethane	μg/L	--	--	--	--	2.5	No RP
	lbs/day[5]	--	--	--	--	0.66	
Dichloromethane	μg/L	--	--	--	--	2.5	No RP
	lbs/day[5]	--	--	--	--	0.66	
1,3-Dichloropropene	μg/L	--	--	--	--	2.5	No RP
	lbs/day[5]	--	--	--	--	0.66	
Dieldrin	μg/L	--	--	--	--	0.05	No RP
	lbs/day[5]	--	--	--	--	0.013	
2,4-Dinitrotoluene	μg/L	--	--	--	--	25	No RP
	lbs/day[5]	--	--	--	--	6.6	
1,2-Diphenylhydrazine	μg/L	--	--	--	--	5	No RP
	lbs/day[5]	--	--	--	--	1.3	
Halomethanes	μg/L	--	--	--	--	4.4	No RP
	lbs/day[5]	--	--	--	--	1.2	
Heptachlor	μg/L	--	--	--	--	0.05	No RP
	lbs/day[5]	--	--	--	--	0.013	

Parameter	Units	Effluent Limitations				Performance Goal[5]	Basis
		Average Monthly	Average Weekly	Maximum Daily	Instantaneous Maximum		
Heptachlor epoxide	µg/L	0.002	--	--	--	--	Existing, Carryover
	lbs/day[5]	0.00053	--	--	--	--	
Hexachlorobenzene	µg/L	--	--	--	--	5	No RP
	lbs/day[5]	--	--	--	--	1.3	
Hexachlorobutadiene	µg/L	--	--	--	--	5	No RP
	lbs/day[5]	--	--	--	--	1.3	
Hexachloroethane	µg/L	--	--	--	--	5	No RP
	lbs/day[5]	--	--	--	--	1.3	
Isophorone	µg/L	--	--	--	--	5	No RP
	lbs/day[5]	--	--	--	--	1.3	
N-Nitrosodimethylamine	µg/L	--	--	--	--	25	No RP
	lbs/day[5]	--	--	--	--	6.6	
N-Nitrosodi-N-propylamine	µg/L	--	--	--	--	25	No RP
	lbs/day[5]	--	--	--	--	6.6	
N-Nitrosodiphenylamine	µg/L	--	--	--	--	5	No RP
	lbs/day[5]	--	--	--	--	1.3	
PAHs	µg/L	--	--	--	--	0.097	No RP
	lbs/day[5]	--	--	--	--	0.026	
PCBs	µg/L	0.0019	--	--	--	--	Existing, Carryover
	lbs/day[5]	0.0005	--	--	--	--	
TCDD equivalents	µg/L	0.00000039	--	--	--	--	Existing, Carryover
	lbs/day[5]	0.0000001	--	--	--	--	
1,1,2,2-Tetrachloroethane	µg/L	--	--	--	--	2.5	No RP
	lbs/day[5]	--	--	--	--	0.66	
Tetrachloroethylene	µg/L	--	--	--	--	2.5	No RP
	lbs/day[5]	--	--	--	--	0.66	
Toxaphene	µg/L	--	--	--	--	2.5	No RP
	lbs/day[5]	--	--	--	--	0.66	
Trichloroethylene	µg/L	--	--	--	--	2.5	No RP
	lbs/day[5]	--	--	--	--	0.66	
1,1,2-Trichloroethane	µg/L	--	--	--	--	2.5	No RP
	lbs/day[5]	--	--	--	--	0.66	
2,4,6-Trichlorophenol	µg/L	--	--	--	--	0.35	No RP
	lbs/day[5]	--	--	--	--	0.09	
Vinyl chloride	µg/L	--	--	--	--	2.5	No RP
	lbs/day[5]	--	--	--	--	0.66	

F. Reclamation Specifications

The reuse of the reclaimed water is regulated under a separate WDRs and Water Recycling Requirements (WRRs) for GREAT - Phase 1 Project, Order No. R4-2008-0083 as amended by Order No. R4-2011-0079, File No. 64-104 and File No. 08-070, CI-9456.

V. RATIONALE FOR RECEIVING WATER LIMITATIONS

A. Surface Water

The Basin Plan and the Ocean Plan contain numeric and narrative water quality objectives applicable to all surface waters within the Los Angeles Region. Water quality objectives include an objective to maintain the high quality waters pursuant to federal regulations (40 CFR 131.12) and State Water Board Resolution No. 68-16. Receiving water limitations in the tentative Order are included to ensure protection of beneficial uses of the receiving water.

VI. RATIONALE FOR MONITORING AND REPORTING REQUIREMENTS

40 CFR part 122.48 requires that all NPDES permits specify requirements for recording and reporting monitoring results. CWC sections 13267 and 13383 authorize the Regional Water Board to require technical and monitoring reports. The MRP, Attachment E of this Order, establishes monitoring and reporting requirements to implement federal and state requirements. The following provides the rationale for the monitoring and reporting requirements contained in the MRP for this facility.

A. Influent Monitoring

Influent monitoring is required to:

- Determine compliance with NPDES permit conditions;
- Assess treatment plant performance; and,
- Assess effectiveness of the Pretreatment Program

Influent monitoring in this Order follows the influent monitoring requirements in the previous Order.

B. Effluent Monitoring

The Discharger is required to conduct monitoring of the permitted discharges in order to evaluate compliance with permit conditions. Monitoring requirements are given in the proposed MRP (Attachment E). This provision requires compliance with the MRP, and is based on 40 CFR parts 122.44(i), 122.62, 122.63, and 124.5. The MRP is a standard requirement in almost all NPDES permits (including the proposed Order) issued by the Regional Water Board. In addition to containing definition of terms, it specifies general sampling/analytical protocols and the requirements of reporting spills, violation, and routine monitoring data in accordance with NPDES regulations, the CWC, and Regional Water Board policies. The MRP also contains sampling program specific for the Discharger's wastewater treatment plant. It defines the sampling stations and frequency, pollutants to be monitored, and additional reporting requirements. Pollutants to be monitored include all pollutants for which effluent limitations are specified.

Monitoring for those pollutants expected to be present in the discharge from the facility, will be required as shown on the proposed MRP (Attachment E) and as required in the Ocean Plan.

Table 14. Monitoring Frequency Comparison

Parameter	Monitoring Frequency (2008 Permit)	Monitoring Frequency (2013 Permit)
Total waste flow	continuous	continuous
Total residual chlorine	continuous	continuous
Turbidity	continuous	continuous
Temperature	weekly	weekly
pH	daily	daily
Settleable solids	daily	daily
Suspended solids	daily	daily
Oil and grease	daily	daily
BOD520oC	daily	daily
Total coliform	daily	daily
Fecal Coliform	5 times/month	5 times/month
Enterococcus	5 times/month	5 times/month
Ammonia nitrogen	monthly	monthly
Nitrate nitrogen	monthly	monthly
Nitrite nitrogen	monthly	monthly
Organic nitrogen	monthly	monthly
Chronic toxicity	monthly	monthly
Benzidine	quarterly	quarterly
Heptachlor epoxide	quarterly	quarterly
PCBs	quarterly	quarterly
TCDD equivalents	quarterly	quarterly
Remaining pollutants in Table B of the 2009 Ocean Plan	semiannually	semiannually
Radioactivity	semiannually	semiannually
Pesticides	semiannually	semiannually

C. WET Testing Requirements

Chronic Toxicity. The Ocean Plan requires the use of critical life stage toxicity tests specified in Appendix III of the Ocean Plan to measure chronic toxicity, TU_c. A minimum of three test species with approved test protocols shall be used to measure compliance with the toxicity objective. If possible, the test species shall include a fish, an invertebrate, and an aquatic plant. After a screening period, monitoring can be reduced to the most sensitive species. Dilution and control water should be laboratory water. The sensitivity of the test organisms to a reference toxicant shall be determined concurrently with each bioassay test and reported with the test results. Chronic toxicity testing requirements defined in section V.A of the MRP (Attachment E) are specified on the basis of these Ocean Plan requirements.

D. Receiving Water Monitoring

1. Surface Water

Receiving water monitoring is required to determine compliance with receiving water limitations and to characterize the water quality of the receiving water. Requirements are based on the Basin Plan, Bight Regional Monitoring Program, and the Ocean Plan.

The receiving water monitoring program contains the following components: (a) nearshore microbiological monitoring, (b) nearshore/offshore water quality monitoring, and (c) benthic sediments monitoring.

Detail about the monitoring program are contained in Attachment E.

E. Other Monitoring Requirements

1. Outfall Inspection

The data collected will be used for a periodic assessment of the integrity of the outfall pipes and ballasting system.

2. Biosolids/Sludge Monitoring

This section establishes monitoring and reporting requirements for the storage, handling and disposal practices of sludge generated from the operation of this Facility.

VII. RATIONALE FOR PROVISIONS

A. Standard Provisions

Standard Provisions, which apply to all NPDES permits in accordance with 40 CFR part 122.41, and additional conditions applicable to specified categories of permits in accordance with section 122.42, are provided in Attachment D to the order.

Section 122.41(a)(1) and (b) through (n) establish conditions that apply to all state-issued NPDES permits. These conditions must be incorporated into the permits either expressly or by reference. If incorporated by reference, a specific citation to the regulations must be included in the Order.

B. Special Provisions

1. Reopener Provisions

This provision is based on 40 CFR part 123. The Regional Water Board may reopen the permit to modify permit conditions and requirements. Causes for modifications include the promulgation of new regulations, modification in sludge use or disposal practices, or adoption of new regulations by the State Water Board or Regional Water Board, including revisions to the Basin Plan and the Ocean Plan.

2. Special Studies and Additional Monitoring Requirements

a. Constituent of Emerging Concern (CEC).

The Discharger shall conduct a special study to investigate the CECs in the effluent discharge. Within 90 days of the effective date of this Order, the Discharger shall submit to the Executive Officer a CECs special study work plan for approval. Upon approval, the Discharger shall implement the work plan.

The Discharger shall follow the requirements of the special study work plan as discussed in the MRP and the Fact Sheet.

3. Best Management Practices and Pollution Prevention

a. Spill Clean-Up Contingency Plan (SCCP)

Since spill or overflow is a common event in the treatment plant service areas, this Order requires the Discharger to review and update, if necessary, the SCCP after each incident. The Discharger shall ensure that the up-to-date SCCP is readily available to the sewage system personnel at all times and that the sewage personnel are familiar with it.

b. Pollutant Minimization Program.

This provision is based on the requirements of section 2.4.5 of the State Implementation Plan (SIP).

4. Construction, Operation, and Maintenance Specifications

This provision is based on the requirements of 40 CFR part 122.41(e) and the previous Order.

5. Special Provisions for Municipal Facilities

a. Biosolids Requirements.

To implement CWA section 405(d), on February 19, 1993, USEPA promulgated 40 CFR 503 to regulate the use and disposal of municipal sewage sludge. This regulation was amended on September 3, 1999. The regulation requires that producers of sewage sludge meet certain reporting, handling, and disposal requirements. It is the responsibility of the Discharger to comply with said regulations that are enforceable by USEPA, because California has not been delegated the authority to implement this program. The Discharger is also responsible for compliance with WDRs and NPDES permits for the generation, transport and application of biosolids issued by the State Water Board, other Regional Water Boards, Arizona Department of Environmental Quality or USEPA, to whose jurisdiction the Facility's biosolids will be transported and applied.

b. **Pretreatment Requirements.**

This permit contains pretreatment requirements consistent with applicable effluent limitations, national standards of performance, and toxic and performance effluent standards established pursuant to sections 208(b), 301, 302, 303(d), 304, 306, 307, 403, 404, 405, and 501 of the CWA, and amendments thereto. This permit contains requirements for the implementation of an effective pretreatment program pursuant to section 307 of the CWA; 40 CFR parts 35 and 403; and/or section 2233, title 23 CCR.

6. Spill Reporting Requirements

This Order established a reporting protocol for how different types of spills, overflow, or bypasses of raw or partially treated sewage from its collection system or treatment plant covered by this Order shall be reported to regulatory agencies.

The State Water Board issued the SSO WDR on May 2, 2006. The SSO WDR requires public agencies that own or operate sanitary sewer systems with greater than one mile of pipes or sewer lines to enroll for coverage under the SSO WDR. The SSO WDR requires agencies to develop sanitary sewer management plans (SSMPs) and report all SSOs, among other requirements and prohibitions.

Furthermore, the SSO WDR contains requirements for operation and maintenance of collection systems and for reporting and mitigating SSOs. The Discharger must comply with both the SSO WDR and this Order.

VIII. PUBLIC PARTICIPATION

The Regional Water Board is considering the issuance of WDRs that will serve as a NPDES permit for Oxnard WWTP. As a step in the WDR adoption process, the Regional Water Board staff developed tentative WDRs. The Regional Water Board encourages public participation in the WDR adoption process.

A. Notification of Interested Parties

The Regional Water Board notified the Discharger and interested agencies and persons of its intent to prescribe WDRs for the discharge and provided them with an opportunity to submit their written comments and recommendations. Notification was provided through the following: (1) by posting the Notice of Public Hearing at the main entrance gate of the Wastewater Treatment Plant at 6001 S. Perkins Road, Oxnard, CA 93033, and (2) by posting the Notice of Public Hearing to a bulletin board in City Hall at 305 W. Third Street, Oxnard, CA 93030.

The Regional Board's web address is http://www.waterboards.ca.gov/losangeles/. The public was provided access to the agenda including any changes in dates and locations.

B. Written Comments

Interested persons where invited to submit written comments concerning tentative WDRs as provided through the notification process. Comments where due either in person or by mail to the Executive Office at the Regional Water Board at the address above on the cover page of this Order, or by email submitted to losangeles@waterboards.ca.gov.

To be fully responded to by staff and considered by the Regional Water Board, written comments were due at the Regional Water Board offices by 12:00 p.m. (noon) on **May 7, 2013**.

C. Public Hearing

The Regional Water Board held a public hearing on the tentative WDRs during its regular Board meeting on the following date and time and at the following location:

Date: June 6, 2013
Time: 9:00 a.m.
Location: Metropolitan Water District of Southern California, Board Room
700 North Alameda Street
Los Angeles, California

Interested persons were invited to attend and make oral comments. At the public hearing, the Regional Water Board heard testimony pertinent to the discharge and tentative WDRs. For accuracy of the record, important testimony was requested to be in writing.

D. WDRs Petitions

Any aggrieved person may petition the State Water Board to review the decision of the Regional Water Board regarding the final WDRs. The petition must be *received* by the State Water Board within 30 days of the Regional Water Board's action. Petitions should be sent to the following address:

State Water Board
Office of Chief Counsel
P.O. Box 100, 1001 I Street
Sacramento, CA 95812-0100

E. Information and Copying

The tentative WDRs, ROWD, comments received, responses to comments (once generated), and other information are on file and may be inspected at the address above at any time between 8:30 a.m. and 4:45 p.m., Monday through Friday. Copying of documents may be arranged through the Regional Water Board by calling (213) 576-6600.

F. Register of Interested Persons

Any person interested in being placed on the mailing list for information regarding the WDRs and NPDES permit should contact the Regional Water Board, reference this facility, and provide a name, address, and phone number.

G. Additional Information

Requests for additional information or questions regarding this order should be directed to Raul Medina at (213) 620-2160.

ATTACHMENT G – GENERIC TOXICITY REDUCTION EVALUATION (TRE) WORKPLAN (POTW)

1. **Information and Data Acquisition**
   a. **Operations and performance review**
      i. NPDES permit requirements
         (1) Effluent limitations
         (2) Special conditions
         (3) Monitoring data and compliance history
      ii. POTW design criteria
         (1) Hydraulic loading capacities
         (2) Pollutant loading capacities
         (3) Biodegradation kinetics calculations/assumptions
      iii. Influent and effluent conventional pollutant data
         (1) Biochemical oxygen demand (BOD_5)
         (2) Chemical oxygen demand (COD)
         (3) Suspended solids (SS)
         (4) Ammonia
         (5) Residual chlorine
         (6) pH
      iv. Process control data
         (1) Primary sedimentation - hydraulic loading capacity and BOD and SS removal
         (2) Activated sludge - Food-to-microorganism (F/M) ratio, mean cell residence time (MCRT), mixed liquor suspended solids (MLSS), sludge yield, and BOD and COD removal
         (3) Secondary clarification - hydraulic and solids loading capacity, sludge volume index and sludge blanket depth
      v. Operations information
         (1) Operating logs
         (2) Standard operating procedures
         (3) Operations and maintenance practices
      vi. Process sidestream characterization data
         (1) Sludge processing sidestreams
         (2) Tertiary filter backwash
         (3) Cooling water
      vii. Combined sewer overflow (CSO) bypass data
         (1) Frequency
         (2) Volume
      viii. Chemical coagulant usage for wastewater treatment and sludge processing
         (1) Polymer
         (2) Ferric chloride
         (3) Alum

b. POTW influent and effluent characterization data

i. Toxicity

ii. Priority pollutants

iii. Hazardous pollutants

iv. SARA 313 pollutants,

v. Other chemical-specific monitoring results

c. Sewage residuals (raw, digested, thickened and dewatered sludge and incinerator ash) characterization data

i. EP toxicity

ii. Toxicity Characteristic Leaching Procedure (TCLP)

iii. Chemical analysis

d. Industrial waste survey (IWS)

i. Information on IUs with categorical standards or local limits and other significant non-categorical IUs

ii. Number of IUs

iii. Discharge flow

iv. Standard Industrial Classification (SIC) code

v. Wastewater flow
   (1) Types and concentrations of pollutants in the discharge
   (2) Products manufactured

vi. Description of pretreatment facilities and operating practices

vii. Annual pretreatment report

viii. Schematic of sewer collection system

ix. POTW monitoring data
   (1) Discharge characterization data
   (2) Spill prevention and control procedures
   (3) Hazardous waste generation

x. IU self-monitoring data
   (1) Description of operations
   (2) Flow measurements
   (3) Discharge characterization data
   (4) Notice of sludge loading
   (5) Compliance schedule (if out of compliance)

xi. Technically based local limits compliance reports

xii. Waste hauler monitoring data manifests

xiii. Evidence of POTW treatment interferences (i.e., biological process inhibition

ATTACHMENT I – BIOSOLIDS AND SLUDGE MANAGEMENT

I. GENERAL REQUIREMENTS

A. All biosolids generated by the City of Oxnard (Discharger or City) at its Oxnard Wastewater Treatment Plant (Facility) shall be used or disposed of in compliance with the applicable portions of 40 CFR parts 257, 258, and 503, and the applicable portions of the California Biosolids General Order (*State Water Resources Control Board Water Quality Order No. 2004-10-DWQ, General Waste Discharge Requirements for the Discharge of Biosolids to Land for Use as a Soil Amendment in Agricultural, Silvicultural, Horticultural, and Land Reclamation Activities)*, or site-specific Waste Discharge Requirements, issued by the Regional Water Board(s) for land application sites in the jurisdiction(s) in which biosolids from Facility are applied.

B. The Discharger is responsible for assuring that all biosolids produced at Facility are used or disposed of in accordance with these rules, whether the permittee uses or disposes of the biosolids itself or transfers them to another party for further treatment, use, or disposal. The Discharger are responsible for informing subsequent preparers, appliers, and disposers of the requirements that they must meet under these rules, and any monitoring requirements, including required frequencies of monitoring and maximum hold times for pathogen and indicator organism samples.

C. Duty to mitigate: The Discharger shall take all reasonable steps to prevent or minimize any biosolids use or disposal which has a likelihood of adversely affecting human health or the environment.

D. No biosolids shall be allowed to enter wetlands or other waters of the United States.

E. Biosolids treatment, storage, and use or disposal shall not contaminate groundwater.

F. Biosolids treatment, storage, and use or disposal shall be performed in a manner as to minimize nuisances such as objectionable odors or flies.

G. The Discharger shall assure that haulers transporting biosolids off site for treatment, storage, use, or disposal take all necessary measures to keep the biosolids contained. The Discharger shall maintain and have haulers adhere to a spill clean-up plan. Any spills shall be reported to U.S. Environmental Protection Agency (USEPA) and the Regional Water Board or state agency in which the spill occurred. All trucks hauling biosolids shall be thoroughly washed after unloading at the field or at the receiving facility.

H. Trucks used to haul biosolids shall not be used to haul animal feed or food, except if authorized to do so by the Regional Water Board after consultation with USEPA and California Department of Food and Agriculture.

I. If biosolids are stored for over two years from the time they are generated by the Discharger or their contractor, the permittee must ensure compliance with all the requirements for surface disposal under 40 CFR 503 Subpart C, or must submit a written notification to USEPA with the information in 503.20 (b), demonstrating the need for longer temporary storage.

J. Any biosolids treatment, disposal, or storage site shall have facilities adequate to divert surface runoff from adjacent areas, to protect the site boundaries from erosion, and to prevent any conditions that would cause drainage from the materials in the site to escape from the site. Adequate protection is defined as protection from at least a 100-year storm and from the highest tidal stage that may occur.

II. INSPECTION AND ENTRY:

The Los Angeles Regional Water Board and USEPA, or an authorized representative thereof, upon the presentation of credentials, shall be allowed by the City, directly or through contractual arrangements with their biosolids management contractors, to:

A. Enter upon all premises where biosolids produced by the Discharger are treated, stored, used, or disposed, either by the Discharger or by another party to whom the Discharger transfer the biosolids for treatment, storage, use, or disposal,

B. Have access to and copy any records that must be kept under the conditions of this permit or of 40 CFR 503, by the Discharger or by another party to whom the Discharger transfer the biosolids for further treatment, storage, use, or disposal,

C. Inspect any facilities, equipment (including monitoring and control equipment), practices, or operations used in the biosolids treatment, storage, use, or disposal by the Discharger or by another party to whom the Discharger transfer the biosolids for treatment, use, or disposal.

III. MONITORING:

A. A representative sample shall be collected and analyzed on a monthly basis for the pollutants required under the applicable portions of 40 CFR 503, organic nitrogen, and ammonium nitrogen. The results shall be reported on a 100% dry weight basis.

B. Prior to land application, the Discharger shall demonstrate that the biosolids meet Class A or Class B pathogen reduction levels by one of the methods listed in 503.32. If pathogen reduction is demonstrated using a Process to Significantly/Further Reduce Pathogens, the Discharger shall maintain daily records of the operating parameters used to achieve this reduction.

C. If Class A or B pathogen requirements are met by monitoring pathogens and/or indicator organisms, samples must be collected in sterile containers, immediately placed on ice and analysis started within the USEPA-specified holding times for these analyses (24 hours for fecal coliform and salmonella, or 6 hours for fecal coliform in Arizona, 2 weeks for enteric viruses if frozen, one month for helminth ova if cooled to 4 degrees C).

D. For biosolids that are land applied or placed in a surface disposal site, the Discharger shall track and keep records of the operational parameters used to achieve Vector Attraction Reduction requirements in 503.33(b).

E. The biosolids shall be sampled and analyzed once per year using the Toxicity Characteristic Leachate Procedure or California Waste Extraction Test.

F. Biosolids shall be monitored semi-annually for all pollutants listed under Section 307(a) of the CWA. Results shall be expressed in mg pollutant per kg biosolids on a 100% dry weight basis.

NOTIFICATION REQUIREMENTS

A. The Discharger either directly or through contractual arrangements with their biosolids management contractors, shall comply with the following notification requirements:

1. Notification of non-compliance: The Discharger shall notify USEPA Region 9 and the applicable Regional Water Board or State agency of any non-compliance within 24 hours by phone or e-mail if the non-compliance may seriously endanger public health or the environment. A written report shall also be submitted within 5 working days of knowing the non-compliance. For other instances of non-compliance, the Discharger shall notify USEPA Region 9 and the Regional Water Board of the non-compliance in writing within 5 working days of becoming aware of the non-compliance. The Discharger shall require their biosolids management contractors to notify USEPA Region 9 and the Regional Water Board of any non-compliance within the same time-frames.

2. If biosolids are shipped to another state or to Indian Lands, the Discharger must send 30 days prior notice of the shipment to the USEPA and permitting authorities in the receiving State or Indian Land. In case of emergency situations, the Discharger shall notify USEPA and permitting authorities in the receiving State or Indian Lands, by phone or e-mail, 48 hours prior to shipment and shall obtain approval from the State or Indian Land authority prior to shipment.

3. If the Discharger receives complaints of health problems associated with biosolids treatment, use, or disposal directly, or become aware of complaints reported to their biosolids management contractors, the USEPA and applicable County Health Department staff shall be notified of the complaints within 48 hours of such knowledge. The Discharger shall also require that their biosolids management contractors report any complaints of health problems associated with biosolids treatment, use, or disposal, to the USEPA and applicable County Health Department staff within 48 hours of such knowledge.

B. The Discharger shall require their biosolids management contractors that apply Class B biosolids to notify USEPA Region 9 and the applicable Regional Water Board or State Agency by e-mail, at least 24 hours prior to changing application fields, of the new field to which they will be moving. If circumstances arise in which the contractors need to select an alternate field, the Discharger shall require their biosolids management contractors to notify USEPA and the applicable Regional Water Board or State Agency within 72 hours after changing fields.

C. Following completion of application to any field, in the case where actual calculated Plant Available Nitrogen (PAN) exceeds the agronomic rate, the Discharger shall, within 7 days of knowledge of the occurrence, have its contractor submit an explanation of the exceedance.

D. The Discharger shall notify USEPA and the Regional Water Board at least 60 days prior to starting a new use or disposal practice.

V. REPORTING REQUIREMENTS:

A. The Discharger shall submit, and require its contractor(s) to submit an annual biosolids report to the USEPA Region 9 Biosolids Coordinator, Los Angeles Regional Water Quality Control Board, and all other Regional Water Boards/State Agencies where biosolids are applied by February 19 of each year for the period covering the previous calendar year. The report shall include:

1. The amount of biosolids generated that year, in dry metric tons, and the amount used or disposed by each use/disposal practices. For contracted use or disposal, the volume taken by each contractor shall be reported.

2. Results of all monitoring required under Monitoring Requirements above. All results must be reported on a 100% dry weight basis. Locations of sample collection shall be reported.

3. Documentation of those operational parameters used to demonstrate compliance with pathogen reduction and vector attraction reduction, and certifications.

4. For land application sites:

   a. Name of each field; location, ownership, size in acres

   b. Actual dates of applications, seedings, harvesting

   c. Number of truckloads to each field

   d. Actual tonnage applied to field, in actual and dry weight

   e. Calculated Plant Available Nitrogen before and after application, including methodology used to calculate plant available nitrogen and agronomic rate

   f. Copies of applier's certifications of management practices

   g. Copies of applier's certifications of site restrictions

B. Reports shall be submitted to:

Los Angeles Regional Water Quality Control Board
320 West 4th Street, Suite 200
Los Angeles, CA 90013

Regional Biosolids Coordinator
US EPA (WTR-7)
75 Hawthorne St.
San Francisco, CA 94105-3901

ATTACHMENT J – PRETREATMENT REPORTING REQUIREMENTS

The Discharger is required to submit annual Pretreatment Program Compliance Report (Report) to the Regional Water Board and USEPA Region 9. This Attachment outlines the minimum reporting requirements of the Report. If there is any conflict between requirements stated in this attachment and provisions stated in the Waste Discharge Requirements (WDR), those contained in the WDR will prevail.

A. Pretreatment Requirements

1. The City shall be responsible and liable for the performance of all Control Authority pretreatment requirements contained in 40 CFR Part 403, including any subsequent regulatory revisions to Part 403. Where Part 403 or subsequent revision places mandatory actions upon the City as Control Authority but does not specify a timetable for completion of the actions, the City shall complete the required actions within six months from the issuance date of this permit or the effective date of the Part 403 revisions, whichever comes later. For violations of pretreatment requirements, the City shall be subject to enforcement actions, penalties, fines and other remedies by the U.S. Environmental Protection Agency (EPA) or other appropriate parties, as provided in the Act. EPA may initiate enforcement action against a nondomestic user for noncompliance with applicable standards and requirements as provided in the act.

2. The City shall enforce the requirements promulgated under sections 307(b), 307(c), 307(d) and 402(b) of the Act with timely, appropriate and effective enforcement actions. The City shall cause all nondomestic users subject to federal categorical standards to achieve compliance no later than the date specified in those requirements or, in the case of a new nondomestic user, upon commencement of the discharge.

3. The City shall perform the pretreatment functions as required in 40 CFR Part 403 including, but not limited to:

   a. Implement the necessary legal authorities as provided in 40 CFR Part 403.8(f)(1);

   b. Enforce the pretreatment requirements under 40 CFR Part 403.5 and 403.6;

   c. Implement the programmatic functions as provided in 40 CFR Part 403.8(f)(2); and

   d. Provide the requisite funding and personnel to implement the pretreatment program as provided in 40 CFR Part 403.8(f)(3).

4. The City shall submit annually a report to EPA Pacific Southwest Region, and the State describing its pretreatment activities over the previous year. In the event the City is not in compliance with any conditions or requirements of this permit, then the City shall also include the reasons for noncompliance and state how and when the City shall comply with such conditions and requirements. This annual report shall cover operations from January 1 through December 31 and is due on March 1 of each year. The report shall contain, but not be limited to, the following information:

   a. A summary of analytical results from representative, flow proportioned, 24-hour composite sampling of the POTW's influent and effluent for those pollutants EPA has identified under section 307(a) of the Act which are known or suspected to be discharged by nondomestic users. This will consist of an annual full priority pollutant scan, with quarterly samples analyzed only for those pollutants detected in the full scan. The City is not required to sample and analyze for asbestos. Sludge sampling and analysis are covered in the sludge section of this permit. The City shall also provide any influent or effluent monitoring data for nonpriority pollutants which the City believes may be causing or contributing to interference or pass through. Sampling and analysis shall be performed with the techniques prescribed in 40 CFR Part 136;

b. A discussion of Upset, Interference or Pass Through incidents, if any, at the treatment plant which the City knows or suspects were caused by nondomestic users of the POTW system. The discussion shall include the reasons why the incidents occurred, the corrective actions taken and, if known, the name and address of the nondomestic user(s) responsible. The discussion shall also include a review of the applicable pollutant limitations to determine whether any additional limitations, or changes to existing requirements, may be necessary to prevent pass through or interference;

c. An updated list of the City's significant industrial users (SIUs) including their names and addresses, and a list of deletions, additions and SIU name changes keyed to the previously submitted list. The City shall provide a brief explanation for each change. The list shall identify the SIUs subject to federal categorical standards by specifying which set(s) of standards are applicable to each SIU. The list shall also indicate which SIUs are subject to local limitations;

d. The City shall characterize the compliance status of each SIU by providing a list or table which includes the following information:

   i. Name of the SIU;
   ii. Category, if subject to federal categorical standards;
   iii. The type of wastewater treatment or control processes in place;
   iv. The number of samples taken by the POTW during the year;
   v. The number of samples taken by the SIU during the year;
   vi. For an SIU subject to discharge requirements for total toxic organics, whether all required certifications were provided;
   vii. A list of the standards violated during the year. Identify whether the violations were for categorical standards or local limits;
   viii. Whether the facility is in significant noncompliance (SNC) as defined at 40 CFR part 403.8(f)(2)(viii) at any time during the year; and
   ix. A summary of enforcement or other actions taken during the year to return the SIU to compliance. Describe the type of action, final compliance date, and the amount of fines and penalties collected, if any. Describe any proposed actions for bringing the SIU into compliance.

e. A brief description of any programs the POTW implements to reduce pollutants from nondomestic users that are not classified as SIUs;

f. A brief description of any significant changes in operating the pretreatment program which differ from the previous year including, but not limited to, changes concerning the program's administrative structure, local limits, monitoring program or monitoring frequencies, legal authority, enforcement policy, funding levels, or staffing levels;

g. A summary of the annual pretreatment budget, including the cost of pretreatment program functions and equipment purchases; and

h. A summary of activities to involve and inform the public of the program including a copy of the newspaper notice, if any, required under 40 CFR 403.8(f)(2)(viii).

B. LOCAL LIMITS EVALUATION

1. In accordance with 40 CFR 122.44(j)(2)(ii), the POTW shall provide a written technical evaluation of the need to revise local limits under 40 CFR Part 4035.(c)(1) within 180 days of issuance or reissuance of the NPDES permit.

C. SIGNATORY REQUIREMENTS AND REPORT SUBMITTAL

1. Signatory Requirements.

The annual report must be signed by a principal executive officer, ranking elected official or other duly authorized employee if such employee is responsible for the overall operation of the POTW. Any person signing these reports must make the following certification [40 CFR 403.6(a)(2)(ii)]:

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

2. Report Submittal.

An original copy of the Annual Report must be sent to the Pretreatment Program Coordinator of the Regional Water Board and the duplicate copies of the Report must be sent to USEPA through the following addresses:

Information and Technology Unit
Attn: Pretreatment Program Coordinator
California Regional Water Quality Control Board, Los Angeles Region
320 West 4th Street, Suite 200
Los Angeles, CA 90013

Pretreatment Program
CWA Compliance Office (WTR-7)
Water Division
U.S. Environmental Protection Agency, Region IX
75 Hawthorne Street
San Francisco, CA 94105-3901

Attachment K
Derivations of Reasonable Potential Analyses and Performance Goals
Oxnard Wastewater Treatment Plant
(CA0054097, CI-2022)

Constituents	units	Jan-2008	Feb-2008	Mar-2008	Apr-2008	May-2008	Jun-2008	Jul-2008	Aug-2008	Sep-2008	Oct-2008	Nov-2008	Dec-2008
Conventional/NonConventional (3a)	mg/L												
BOD	mg/L	17.7	23.1	18.5	18.0	19.3	14.4	14.4	11.8	11.0	13.2	14.0	14.3
Total Suspended Solids	mg/L	9	12	7	8	9	6	7	5	5	5	4	5
Oil & Grease	mg/L	< 5	< 5	< 5	5.1	< 5	< 5	5	< 5	< 5	< 5	< 5	< 5
Settleable Solids	ml/L	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Total Coliform	MPN/100mL	87,410	77,828	39,845	65,023	79,978	53,714	59,271	57,694	73,510	61,065	57,000	45,675
Fecal Coliform	MPN/100mL	37,500	3,406	21,194	4,840	7,840	3,956	12,160	64,560	38,820	1,754	39,340	1,696
Enterococcus	MPN/100mL	12,400	6,680	4,820	5,040	8,220	4,526	2,434	5,274	1,940	3,774	5,532	4,500
Nitrate-N	mg/L	0.90	0.29	0.33	1.7	0.18	0.73	0.36	0.29	0.25	0.44	0.73	1.50
Nitrite-N	mg/L	0.37	0.65	0.68	0.84	0.51	1	1.2	0.88	1.2	1.1	2.3	2.1
Organic-N	mg/L	5.1	3.2	2.3	2.7	2	2.8	2.2	1.5	1.3	1.3	1.6	1.4
pH		7.3	7.3	7.2	7.2	7.3	7.3	7.3	7.4	7.5	7.5	7.5	7.4
Temp	0C	20	21	22	22	23	24	25	26	25	24	23	21
Turbidity	NTU	6.4	7.5	4.2	5.2	5.4	4.5	4.3	3.3	3	3.1	3.1	3.4
Marine Aquatic Life													
Arsenic (As)	ug/L		2.0			1.0			1.1			1.1	
Cadmium (Cd)	ug/L		<0.2			<0.5			<0.2			<0.5	
Chromium Total (Cr)	ug/L		4			8			5			<5	
Copper (Cu)	ug/L		30			22			12			21	
Lead (Pb)	ug/L		<2.0			<5.0			<2.0			<5.0	
Mercury (Hg)	ug/L		<0.2			<0.2			<0.2			<0.2	
Nickel (Ni)	ug/L		8			<5.0			<5.0			<5.0	
Selenium (Se)	ug/L		4.7						2.1				
Silver (Ag)	ug/L		0.9			1			<0.5			2.3	
Zinc (Zn)	ug/L		35			29			32			36	
Cyanide	ug/L		<5.0			<5.0			<5.0			<5.0	
Residual Chlorine	mg/L	0.023	0.049	0.025	0.036	0.022	0.038	0.048	0.089	0.04	0.036	0.027	0.02
Ammonia-N	mg/L	20	21	18	20	23	23	22	25	25	24	23	21
Acute Toxicity	TUa												
Chronic Toxicity (Survival)	TUc	17.86	17.86	17.86	17.86	17.86	17.86	17.86	17.86	17.86	17.86	17.86	17.86
Chronic Toxicity (Growth)	TUc	17.86	17.86	17.86	17.86	17.86	17.86	17.86	17.86	17.86	17.86	17.86	17.86
Non-Chlorinated Phenolic Compouds	ug/L		<0.1			<0.1			<0.1			<0.1	
Chlorinated Phenolic Compouds	ug/L		<0.2			<0.2			<0.2			<0.2	
Endosulfan	ug/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Endrin	ug/L		<0.001			<0.001			<0.001			<0.001	
HCH	ug/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Radioactivity - Alpha	pCi/L		16.8						1.7				
Radioactivity - Beta	pCi/L		45.6						15.5				
Human Health - Noncarcinogens													
Acrolein	ug/L		<5						<5				
Antimony	ug/L		<1						<2				
Bis (2-Chloroethoxy) methane	ug/L		<0.05			<0.05			<0.05			<0.05	
Bis (2-Chloroisopropyl) ether	ug/L		<0.05			<0.05			<0.05			<0.05	
Chlorobenzene	ug/L		<0.5						<0.5				
Chromium III (Cr)	ug/L												
Di-n-Butyl Phthalate	ug/L		0.094			<0.075			<0.075			<0.075	
Dichlorobenzene	ug/L		<0.05			<0.05			<0.05			<0.05	

Attachment K
Derivations of Reasonable Potential Analyses and Performance Goals
Oxnard Wastewater Treatment Plant
(CA0054097, CI-2022)

Constituents	units	Jan-2008	Feb-2008	Mar-2008	Apr-2008	May-2008	Jun-2008	Jul-2008	Aug-2008	Sep-2008	Oct-2008	Nov-2008	Dec-2008
Diethyl phthalate	ug/L		<0.05			<0.1			<0.1			<0.1	
Dimethyl phthalate	ug/L		<0.05			<0.05			<0.05			<0.05	
4,6-dinitro-2-methylphenol	ug/L		<0.1			<0.1			<0.1			<0.1	
2,4-dinitrophenol	ug/L		<0.1			<0.1			<0.1			<0.1	
Ethylbenzene	ug/L		<0.5						<0.5				
Fluoranthene	ug/L		<0.001			0.0044			0.039			0.0226	
Hexachlorocyclopentadiene	ug/L		<0.05			<0.05			<0.05			<0.05	
Nitrobenzene	ug/L		<0.05			<0.05			<0.05			<0.05	
Thallium	ug/L		<0.2						<0.2				
Toluene	ug/L		<0.5						<0.5				
Tributyltin	ug/L		<0.002						<0.002				
1,1,1-trichloroethane	ug/L		<0.5						<0.5				
Human Health - Carcinogens													
Acrylonitrile	ug/L		<2			<2			<2			<10	
Aldrin	ug/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Benzene	ug/L		<0.5						<0.5				
Benzidine	ug/L		<0.05			<0.05			<0.05			<0.05	
Berylium (Be)	ug/L		<0.2						<0.1			<0.5	
Bis (2-Chloroethyl) ether	ug/L		<0.05			<0.05			<0.05			<0.05	
Bis(2-ethylhexyl)-phthalate	ug/L		0.638			35.4			0.16			1.042	
Carbon tetrachloride	ug/L		<0.5						<0.5				
Chlordane	ug/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chlorodibromomethane	ug/L		<0.5						<0.5				
Chloroform	ug/L		0.5						0.6				
DDT	ug/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,4-Dichlorobenzene	ug/L		<0.5			0.041			0.035			0.03	
3,3'-Dichlorobenzidine	ug/L		<0.05			<0.05			<0.05			<0.05	
1,2-dichloroethane	ug/L		<0.5						<0.5				
1,1-dichloroethylene	ug/L		<0.5						<0.5				
Dichlorobromomethane	ug/L		<0.5						<0.5				
Dichloromethane	ug/L		<0.5						<0.5				
1,3-dichloropropene	ug/L		<0.5						<0.5				
Dieldrin	ug/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
2,4-Dinitrotoluene	ug/L		<0.05			<0.05			<0.05			<0.05	
1,2-Diphenylhydrazine	ug/L		<0.05			<0.05			<0.05			<0.5	
Halomethanes	ug/L		<1						<1				
Heptachlor	ug/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Heptachlor epoxide	ug/L		<0.001			<0.001			<0.001			<0.001	
Hexachlorobenzene	ug/L		<0.001			<0.001			<0.001			<0.001	
Hexachlorobutadiene	ug/L		<0.05			<0.05			<0.05			<0.05	
Hexachloroethane	ug/L		<0.05			<0.05			<0.05			<0.05	
Isophorone	ug/L		<0.05			<0.05			0.053			<0.05	
N-Nitrosodimethylamine	ug/L		<0.05			<0.05			<0.05			<0.05	
N-Nitrosodi-N-propylamine	ug/L		<0.05			<0.05			<0.05			<0.05	
N-Nitrosodiphenylamine	ug/L		<0.05			<0.05			<0.05			<0.05	
PAH	ug/L		<0.02			<0.03			<0.02			<0.03	
PCBs	ug/L	NODI(B)	NODI(B)	NODI(B)	NODI(B)	NODI(B)	NODI(B)	NODI(B)	NODI(B)	NODI(B)	NODI(B)	NODI(B)	NODI(B)

Attacnment K
Derivations of Reasonable Potential Analyses and Performance Goals
Oxnard Wastewater Treatment Plant
(CA0054097, CI-2022)

Constituents	units	Jan-2008	Feb-2008	Mar-2008	Apr-2008	May-2008	Jun-2008	Jul-2008	Aug-2008	Sep-2008	Oct-2008	Nov-2008	Dec-2008
TCDD	pg/L		<1.7			<4.1			<4.5			<0.73	
1,1,2,2-tetrachloroethane	ug/L		<0.5						<0.5				
Tetrachloroethylene	ug/L		<0.5						<0.5				
Toxaphene	ug/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Trichloroethylene	ug/L		<0.5						<0.5				
1,1,2-trichloroethane	ug/L		<0.5						<0.5				
2,4,6-Trichlorophenol	ug/L		<0.1			0.108			0.095			0.062	
Vinyl chloride	ug/L		<0.5						<0.5				

Attachment K
Derivations of Reasonable Potential Analyses and Performance Goals
Oxnard Wastewater Treatment Plant
(CA0054097, CI-2022)

Constituents	units	Jan-2009	Feb-2009	Mar-2009	Apr-2009	May-2009	Jun-2009	Jul-2009	Aug-2009	Sep-2009	Oct-2009	Nov-2009	Dec-2009
Conventional/NonConventional (3a)	mg/L												
BOD	mg/L	17.1	17.0	16.6	19.1	17.2	18.3	13.7	14.7	16.4	16.8	16.2	17.3
Total Suspended Solids	mg/L	5	6	6	6	6	6	5	4	5	6	5	6
Oil & Grease	mg/L	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	5.1
Settleable Solids	ml/L	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Total Coliform	MPN/100mL	55,913	80,829	58,226	45,290	69,323	75,593	88,291	69,678	46,267	105,413	43,677	37,381
Fecal Coliform	MPN/100mL	3,800	29,160	1,454	18,720	1,298	15,740	22,160	4,220	4,760	12,000	5,922	2,036
Enterococcus	MPN/100mL	2,240	5,360	4,260	1,494	7,160	4,600	4,440	4,300	4,296	6,220	5,620	1,200
Nitrate-N	mg/L	1.4	0.81	2.9	3.2	0.93	0.65	0.52	0.29	0.75	0.25	0.29	0.65
Nitrite-N	mg/L	1.6	1.80	2.20	2.20	1.40	1.10	0.97	0.80	1.60	0.75	1.40	0.90
Organic-N	mg/L	1.4	<1	1.4	<1	2.6	1.7	<1	<1	<1	1.8	3.6	2.1
pH		7.4	7.3	7.4	7.4	7.4	7.4	7.4	7.4	7.5	7.5	7.5	7.4
Temp	0C	21	20	21	22	22	24	24	25	25	24	22	21
Turbidity	NTU	3.6	3.5	3.6	3.4	3.6	3.5	3.2	3.1	3	3.6	3	3.6
Marine Aquatic Life													
Arsenic (As)	ug/L		1.4			1.3			<1			<1	
Cadmium (Cd)	ug/L		<0.5			0.8			<0.5			<0.5	
Chromium Total (Cr)	ug/L		<0.3			<5			<5				
Copper (Cu)	ug/L		14			29			18			14	
Lead (Pb)	ug/L		<5			<5			<5			<5	
Mercury (Hg)	ug/L		<0.2			<0.2			<0.2			<0.2	
Nickel (Ni)	ug/L		6.2			<5			<5			6	
Selenium (Se)	ug/L		2			3			3.2			3.3	
Silver (Ag)	ug/L		0.9			0.6			0.7			0.7	
Zinc (Zn)	ug/L		33			26			28			20	
Cyanide	ug/L		<5			<5			<5				
Residual Chlorine	mg/L	0.01	0.02	0.03	0.02	0.03	0.03	0.03	0.04	0.04	0.02	0.03	0.02
Ammonia-N	mg/L	20	22.5	18	18.9	20.8	19.5	21.1	20.7	21.3	22.7	23.4	22.6
Acute Toxicity	TUa												
Chronic Toxicity (Survival)	TUc	17.86	17.86	17.86	17.86	17.86	17.86	17.86	17.86	17.86	17.86	17.86	17.86
Chronic Toxicity (Growth)	TUc	17.86	17.86	17.86	17.86	17.86	17.86	17.86	17.86	17.86	17.86	17.86	17.86
Non-Chlorinated Phenolic Compouds	ug/L		<0.1			<0.1			<0.1			<0.1	
Chlorinated Phenolic Compouds	ug/L		<0.3			<0.4			<0.3			<0.4	
Endosulfan	ug/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Endrin	ug/L		<0.001			<0.001			<0.001			<0.001	
HCH	ug/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Radioactivity - Alpha	pCi/L		2.3						15				
Radioactivity - Beta	pCi/L		46.5						30.7				
Human Health - Noncarcinogens													
Acrolein	ug/L		<20						<4				
Antimony	ug/L		<2			<2			<2			<2	
Bis (2-Chloroethoxy) methane	ug/L		<0.05			<0.05			<0.05			<0.05	
Bis (2-Chloroisopropyl) ether	ug/L		<0.05			<0.05			<0.05			<0.05	
Chlorobenzene	ug/L		<0.5						<2				
Chromium III (Cr)	ug/L												
Di-n-Butyl Phthalate	ug/L		<0.075			<0.075			0.143			0.075	
Dichlorobenzene	ug/L		<0.05			<0.05			<0.05			<0.05	

Attachment K
Derivations of Reasonable Potential Analyses and Performance Goals
Oxnard Wastewater Treatment Plant
(CA0054097, CI-2022)

Constituents	units	Jan-2009	Feb-2009	Mar-2009	Apr-2009	May-2009	Jun-2009	Jul-2009	Aug-2009	Sep-2009	Oct-2009	Nov-2009	Dec-2009
Diethyl phthalate	ug/L		<0.1			<0.1			<0.025			<0.1	
Dimethyl phthalate	ug/L		<0.05			<0.05			<0.05			<0.05	
4,6-dinitro-2-methylphenol	ug/L		<0.1			<0.1			<0.1			<0.1	
2,4-dinitrophenol	ug/L		<0.1			<0.1			<0.1			<0.01	
Ethylbenzene	ug/L		<0.5						<2				
Fluoranthene	ug/L		0.0025			0.0038			0.0091			0.0042	
Hexachlorocyclopentadiene	ug/L		<0.05			<0.05			<0.05			<0.05	
Nitrobenzene	ug/L		<0.05			<0.05			<0.05			<0.05	
Thallium	ug/L		<2			<2			<2			<2	
Toluene	ug/L		<0.5						<2				
Tributyltin	ug/L		<0.002						<0.001				
1,1,1-trichloroethane	ug/L		<0.5						<2				
Human Health - Carcinogens													
Acrylonitrile	ug/L		<2						<2				
Aldrin	ug/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Benzene	ug/L		<0.5						<2				
Benzidine	ug/L		<0.05			<0.05			<0.05			<0.05	
Beryllium (Be)	ug/L		<0.5			<0.5			<0.5			<0.5	
Bis (2-Chloroethyl) ether	ug/L		<0.05			<0.05			<0.05			<0.05	
Bis(2-ethylhexyl)-phthalate	ug/L		4.4			36.2			9.889			21.56	
Carbon tetrachloride	ug/L		<0.5						<5				
Chlordane	ug/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chlorodibromomethane	ug/L		<0.5						<2				
Chloroform	ug/L		<0.5						<2				
DDT	ug/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,4-Dichlorobenzene	ug/L		<0.5			<0.01			<2			0.029	
3,3'-Dichlorobenzidine	ug/L		<0.05			<0.05			<0.05			<0.05	
1,2-dichloroethane	ug/L		<0.5						<2				
1,1-dichloroethylene	ug/L		<0.5						<5				
Dichlorobromomethane	ug/L		<0.5						<2				
Dichloromethane	ug/L		<0.5						<5				
1,3-dichloropropene	ug/L		<0.5						<2				
Dieldrin	ug/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
2,4-Dinitrotoluene	ug/L		<0.05			<0.05			<0.05			<0.05	
1,2-Diphenylhydrazine	ug/L		<0.05			<0.05			<0.05			<0.05	
Halomethanes	ug/L		<2						<10				
Heptachlor	ug/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Heptachlor epoxide	ug/L		<0.001			<0.01			<0.001			<0.1	
Hexachlorobenzene	ug/L		<0.001			<0.01			<0.001			<0.001	
Hexachlorobutadiene	ug/L		<0.05			<0.05			<0.05			<0.05	
Hexachloroethane	ug/L		<0.05			<0.05			<0.05			<0.05	
Isophorone	ug/L		<0.05			<0.05			0.071			<0.05	
N-Nitrosodimethylamine	ug/L		<0.05			<0.05			<0.05			<0.05	
N-Nitrosodi-N-propylamine	ug/L		<0.05			<0.05			<0.05			<0.05	
N-Nitrosodiphenylamine	ug/L		<0.05			<0.05			<0.05			<0.05	
PAH	ug/L		<0.05			<0.05			<0.05			<0.05	
PCBs	ug/L	NODI(B)	NODI(B)	NODI(B)	NODI(B)	NODI(B)	NODI(B)	NODI(B)	NODI(B)	NODI(B)	NODI(B)	NODI(B)	NODI(B)

Adopted: June 6, 2013

Attachment K
Derivations of Reasonable Potential Analyses and Performance Goals
Oxnard Wastewater Treatment Plant
(CA0054097, CI-2022)

Constituents	units	Jan-2009	Feb-2009	Mar-2009	Apr-2009	May-2009	Jun-2009	Jul-2009	Aug-2009	Sep-2009	Oct-2009	Nov-2009	Dec-2009
TCDD	pg/L		<3.4			<5.2			1.6			<9.5	
1,1,2,2-tetrachloroethane	ug/L		<0.5						<2				
Tetrachloroethylene	ug/L		<0.5						<2				
Toxaphene	ug/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Trichloroethylene	ug/L		<0.5						<2				
1,1,2-trichloroethane	ug/L		<0.5						<2				
2,4,6-Trichlorophenol	ug/L		0.064			0.124			0.063			0.061	
Vinyl chloride	ug/L		<0.5						<5				

Attachment K
Derivations of Reasonable Potential Analyses and Performance Goals
Oxnard Wastewater Treatment Plant
(CA0054097, CI-2022)

Constituents	units	Jan-2010	Feb-2010	Mar-2010	Apr-2010	May-2010	Jun-2010	Jul-2010	Aug-2010	Sep-2010	Oct-2010	Nov-2010	Dec-2010
Conventional/NonConventional (3a)	mg/L												
BOD	mg/L	18.3	19.2	18.6	18.0	17.7	19.0	19.9	18.5	15.2	15.2	16.8	16.8
Total Suspended Solids	mg/L	6	7.5	7.5	8	6.5	7.3	8.3	8.6	5.5	5.5	5.7	5.8
Oil & Grease	mg/L	< 5	< 5	5	5.2	5	< 5	5.1	5.1	5.5	5.3	< 5	5.9
Settleable Solids	ml/L	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Total Coliform	MPN/100mL	42,626	43,000	65,455	90,333	57,323	76,800	91,226	112,581	73,800	85,323	57,167	39,652
Fecal Coliform	MPN/100mL	5,360	3,888	2,600	3,560	15,340	15,940	13,020	4,380	20,632	39,940	2,360	2,480
Enterococcus	MPN/100mL	2,520	4,660	5,080	4,300	4,080	4,460	5,740	9,500	1,480	4,630	1,430	2,280
Nitrate-N	mg/L	1.50	0.89	0.56	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.58	0.53
Nitrite-N	mg/L	0.80	1.10	1.00	1.20	0.55	1.40	0.52	0.38	1.20	0.75	0.81	1.40
Organic-N	mg/L	<0.5	<0.5	2.9	0.7	1.9	2.8	<0.5	<0.5	<0.5	2.3	1.5	1
pH		7.4	7.3	7.4	7.4	7.3	7.4	7.4	7.4	7.3	7.4	7.3	7.3
Temp	0C	20	21	21	22	22	23	24	24	24	24	22	21
Turbidity	NTU	3.9	4.2	4.2	4.8	3.6	4.2	4.5	4.6	3.1	3.4	3.4	2.9
Marine Aquatic Life													
Arsenic (As)	ug/L		1			1.1			<1			1.1	
Cadmium (Cd)	ug/L		<0.5			<0.5			<0.5			<0.5	
Chromium Total (Cr)	ug/L		<5						<1				
Copper (Cu)	ug/L		19			14			16			14	
Lead (Pb)	ug/L		<5			<5			<5			<5	
Mercury (Hg)	ug/L		<0.2			<0.2			<0.2			<0.2	
Nickel (Ni)	ug/L		<5			6			<5			6	
Selenium (Se)	ug/L		4.6			1.2			2.2			1.2	
Silver (Ag)	ug/L		<0.5			0.97			0.35			0.97	
Zinc (Zn)	ug/L		32			15			20			15	
Cyanide	ug/L		<5						<5				
Residual Chlorine	mg/L	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.1	0.11	0.12	0.13
Ammonia-N	mg/L	23.6	20	22.3	27.1	23.9	22.2	24.5	23.7	23.1	24	25	21
Acute Toxicity	TUa												
Chronic Toxicity (Survival)	TUc	17.86	17.86	17.86	17.86	17.86	17.86	17.86	17.86	17.86	17.86	17.86	17.86
Chronic Toxicity (Growth)	TUc	17.86	17.86	17.86	17.86	17.86	17.86	17.86	17.86	17.86	17.86	17.86	17.86
Non-Chlorinated Phenolic Compounds	ug/L		<0.02			<0.02			<0.02			<0.02	
Chlorinated Phenolic Compouds	ug/L		<0.6			<0.1			<0.3			<0.1	
Endosulfan	ug/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Endrin	ug/L		<0.001			<0.001			<0.001			<0.001	
HCH	ug/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Radioactivity - Alpha	pCi/L		7.2						7.8				
Radioactivity - Beta	pCi/L		25						21.7				
Human Health - Noncarcinogens													
Acrolein	ug/L		<4						<4				
Antimony	ug/L		<2			<2			<2			<2	
Bis (2-Chloroethoxy) methane	ug/L		<0.05			<0.05			<0.05			<0.05	
Bis (2-Chloroisopropyl) ether	ug/L		<0.05			<0.05			<0.05			<0.05	
Chlorobenzene	ug/L		<0.36						<2				
Chromium III (Cr)	ug/L		<5			2.2			<5			2.2	
Di-n-Butyl Phthalate	ug/L		0.113			0.19			0.113			0.129	
Dichlorobenzene	ug/L		<0.03			<0.03			<0.03			<0.03	

Attachment K
Derivations of Reasonable Potential Analyses and Performance Goals
Oxnard Wastewater Treatment Plant
(CA0054097, CI-2022)

Constituents	units	Jan-2010	Feb-2010	Mar-2010	Apr-2010	May-2010	Jun-2010	Jul-2010	Aug-2010	Sep-2010	Oct-2010	Nov-2010	Dec-2010
Diethyl phthalate	ug/L		<0.1			<0.1			<0.11			<0.1	
Dimethyl phthalate	ug/L		<0.05			0.061			<0.055			0.0647	
4,6-dinitro-2-methylphenol	ug/L		<0.1			<0.1			<0.11			<0.1	
2,4-dinitrophenol	ug/L		<0.1			0.142			0.125			<0.1	
Ethylbenzene	ug/L		<0.25						<2				
Fluoranthene	ug/L		0.013			0.032			0.0187			0.0036	
Hexachlorocyclopentadiene	ug/L		<0.05			<0.05			<0.05			<0.001	
Nitrobenzene	ug/L		<0.05			<0.05			<0.05			<0.05	
Thallium	ug/L		<2			<2			<2			<2	
Toluene	ug/L		<0.36						<2				
Tributyltin	ug/L		<0.001						<0.002				
1,1,1-trichloroethane	ug/L		<0.3						<2				
Human Health - Carcinogens													
Acrylonitrile	ug/L		<1.2						<2				
Aldrin	ug/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Benzene	ug/L		<0.28						<2				
Benzidine	ug/L		<0.05			<0.05			<0.05			<0.05	
Beryllium (Be)	ug/L		<0.5			<0.5			<0.5			<0.5	
Bis (2-Chloroethyl) ether	ug/L		<0.05			<0.05			<0.05			<0.05	
Bis(2-ethylhexyl)-phthalate	ug/L		86.081			9.8			8.4			42.4	
Carbon tetrachloride	ug/L		<0.28						<5				
Chlordane	ug/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chlorodibromomethane	ug/L		0.61						<2				
Chloroform	ug/L		1.2						<2				
DDT	ug/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,4-Dichlorobenzene	ug/L		0.026			<0.01			0.024			0.0178	
3,3'-Dichlorobenzidine	ug/L		<0.05			<0.05			<0.05			<0.05	
1,2-dichloroethane	ug/L		<0.28						<2				
1,1-dichloroethylene	ug/L		<0.42						<5				
Dichlorobromomethane	ug/L		<0.3						<2				
Dichloromethane	ug/L		<0.95						<5				
1,3-dichloropropene	ug/L		<0.22						<2				
Dieldrin	ug/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
2,4-Dinitrotoluene	ug/L		<0.05			<0.05			<0.05			<0.05	
1,2-Diphenylhydrazine	ug/L		<0.05			<0.05			<0.05			<0.05	
Halomethanes	ug/L		<2						<0.05				
Heptachlor	ug/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Heptachlor epoxide	ug/L		<0.001			<0.001			<0.001			<0.001	
Hexachlorobenzene	ug/L		<0.001			<0.001			<0.001			0.001	
Hexachlorobutadiene	ug/L		<0.05			<0.05			<0.05			<0.05	
Hexachloroethane	ug/L		<0.05			<0.05			<0.05			<0.05	
Isophorone	ug/L		<0.05			<0.05			0.102			<0.05	
N-Nitrosodimethylamine	ug/L		<0.05			<0.05			<0.05			<0.05	
N-Nitrosodi-N-propylamine	ug/L		<0.05			<0.05			<0.05			<0.05	
N-Nitrosodiphenylamine	ug/L		<0.05			<0.05			<0.05			<0.05	
PAH	ug/L		<0.05			<0.1			<0.05			<0.05	
PCBs	ug/L	NODI(B)	NODI(B)	NODI(B)	NODI(B)	NODI(B)	NODI(B)	NODI(B)	NODI(B)	NODI(B)	NODI(B)	NODI(B)	NODI(B)

Attacnment K
Derivations of Reasonable Potential Analyses and Performance Goals
Oxnard Wastewater Treatment Plant
(CA0054097, CI-2022)

Constituents	units	Jan-2010	Feb-2010	Mar-2010	Apr-2010	May-2010	Jun-2010	Jul-2010	Aug-2010	Sep-2010	Oct-2010	Nov-2010	Dec-2010
TCDD	pg/L		<9.4			<11			<11			<10	
1,1,2,2-tetrachloroethane	ug/L		<0.3						<2				
Tetrachloroethylene	ug/L		<0.32						<2				
Toxaphene	ug/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Trichloroethylene	ug/L		<0.26						<2				
1,1,2-trichloroethane	ug/L		<0.3						<2				
2,4,6-Trichlorophenol	ug/L		0.352			0.061			0.222			0.0637	
Vinyl chloride	ug/L		<0.4						<5				

Attachment K
Derivations of Reasonable Potential Analyses and Performance Goals
Oxnard Wastewater Treatment Plant
(CA0054097, CI-2022)

Constituents	units	Jan-2011	Feb-2011	Mar-2011	Apr-2011	May-2011	Jun-2011	Jul-2011	Aug-2011	Sep-2011	Oct-2011	Nov-2011	Dec-2011
Conventional/NonConventional (3a)	mg/L												
BOD	mg/L	18.8	19.8	18.5	17.4	18.7	15.8	15.2	15.4	18.7	13.9	15.9	17.0
Total Suspended Solids	mg/L	6	6	6	6	7	7	6	6	5	5	7	5
Oil & Grease	mg/L	5.4	5.5	6.8	6	< 5	5	< 5	< 5	< 5	< 5	< 5	5
Settleable Solids	ml/L	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Total Coliform	MPN/100mL	33,581	67,143	90,774	78,067	106,678	115,500	115,000	88,323	112,400	93,961	106,067	124,162
Fecal Coliform	MPN/100mL	2,258	1,560	40,000	9,480	97,440	56,000	42,400	44,000	52,760	25,880	83,940	45,000
Enterococcus	MPN/100mL	1,440	4,858	6,760	5,260	10,520	6,680	6,540	7,300	8,000	3,238	10,600	8,480
Nitrate-N	mg/L	0.67	1.1	<0.5	0.9	0.7	0.57	<0.5	1.8	0.63	0.7	3.4	0.63
Nitrite-N	mg/L	1.10	1.90	0.89	1.10	1.00	0.26	0.35	0.94	0.46	0.58	0.40	1.00
Organic-N	mg/L	0.6	0.8	<0.5	1.3	0.9	0.7	3.5	1.4	2.1	3	1.8	0.6
pH		7.3	7.3	7.2	7.2	7.2	7.3	7.3	7.2	7.2	7.3	7.3	7.3
Temp	0C	21	21	22	23	23	24	25	25	25	24	23	21
Turbidity	NTU	3.1	3.8	3.6	3.7	4	4.5	3.7	3.6	3.3	3	3.6	3.1
Marine Aquatic Life													
Arsenic (As)	ug/L		<1.0			<1.0			<1.0			1.1	
Cadmium (Cd)	ug/L		<0.5			<0.5			<0.5			<0.5	
Chromium Total (Cr)	ug/L		<1			<1			<1				
Copper (Cu)	ug/L		16			24			17			23	
Lead (Pb)	ug/L		<5			<5			<5			<5	
Mercury (Hg)	ug/L		<0.2			<0.2			<0.2			<0.2	
Nickel (Ni)	ug/L		<5			6			<5			7	
Selenium (Se)	ug/L		3.1			4			4.6			2.3	
Silver (Ag)	ug/L		<0.5			0.6			<0.5			<0.5	
Zinc (Zn)	ug/L		28			18			25			17	
Cyanide	ug/L					<5						<5	
Residual Chlorine	mg/L	0.023	0.017	0.017	0.017	0.016	0.011	0.007	0.012	0.014	0.023	0.035	0.027
Ammonia-N	mg/L	23.9	25	24.7	23.3	24.4	22.8	24.7	26.7	28.2	29.7	31.6	28.5
Acute Toxicity	TUa												
Chronic Toxicity (Survival)	TUc	17.86	17.86	17.86	17.86	17.86	17.86	17.86	17.86	17.86		17.86	17.86
Chronic Toxicity (Growth)	TUc	17.86	17.86	17.86	17.86	17.86	17.86	17.86	17.86	17.86	17.86	17.86	17.86
Non-Chlorinated Phenolic Compouds	ug/L		<10			<20			<10			<20	
Chlorinated Phenolic Compouds	ug/L		<20			<20			<20			<20	
Endosulfan	ug/L	<0.005	<0.01	<0.003	<0.003	<0.01	<0.003	<0.003	<0.0029	<0.0029	<0.003	<0.01	<0.003
Endrin	ug/L		<0.005			<0.005			<0.002			<0.005	
HCH	ug/L	<0.005	<0.01	<0.003	<0.003	<0.01	<0.003	<0.003	<0.0039	<0.003	<0.004	<0.01	<0.004
Radioactivity - Alpha	pCi/L		3.1						8.4				
Radioactivity - Beta	pCi/L		12.2						9.6				
Human Health - Noncarcinogens													
Acrolein	ug/L		<4						<4				
Antimony	ug/L		<2			<2			<2			<2	
Bis (2-Chloroethoxy) methane	ug/L		<10			<10			<2.9			<10	
Bis (2-Chloroisopropyl) ether	ug/L		<10			<10			<2.4			<10	
Chlorobenzene	ug/L		<2						<0.36				
Chromium III (Cr)	ug/L		6			7			<5			<5	
Di-n-Butyl Phthalate	ug/L		<20			<20			<2.9			<20	
Dichlorobenzene	ug/L		<10			<10			<3			<10	

Derivations of Reasonable Potential Analyses and Performance Goals
Oxnard Wastewater Treatment Plant
(CA0054097, CI-2022)

Constituents	units	Jan-2011	Feb-2011	Mar-2011	Apr-2011	May-2011	Jun-2011	Jul-2011	Aug-2011	Sep-2011	Oct-2011	Nov-2011	Dec-2011
Diethyl phthalate	ug/L		<10			<10			<3.4			<10	
Dimethyl phthalate	ug/L		<10			<10			<2.4			<10	
4,6-dinitro-2-methylphenol	ug/L		<20			<20			<3.8			<20	
2,4-dinitrophenol	ug/L		<20			<20			<7.7			<10	
Ethylbenzene	ug/L		<2						<0.25				
Fluoranthene	ug/L		<10			<10			<2.9			<10	
Hexachlorocyclopentadiene	ug/L		<10			<10			<4.8			<10	
Nitrobenzene	ug/L		<20			<20			<2.9			<20	
Thallium	ug/L		<2			<2			<2			<2	
Toluene	ug/L		<2						<0.36				
Tributyltin	ug/L		<0.002						<0.002				
1,1,1-trichloroethane	ug/L		<2						<0.3				
Human Health - Carcinogens													
Acrylonitrile	ug/L		<2						<1.2				
Aldrin	ug/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Benzene	ug/L		<2						<0.28				
Benzidine	ug/L		<20			<20			<9.6			<20	
Berylium (Be)	ug/L		<0.5			<0.5			<0.5			<0.5	
Bis (2-Chloroethyl) ether	ug/L		<10			<10			<2.9			<10	
Bis(2-ethylhexyl)-phthalate	ug/L		<5			16			<5			13	
Carbon tetrachloride	ug/L		<5						<0.28				
Chlordane	ug/L	<0.1	<0.08	<0.1	<0.2	<0.1	<0.1	<0.1	<0.08	<0.1	<0.1	<0.1	<0.1
Chlorodibromomethane	ug/L		<2						<0.4				
Chloroform	ug/L		<2						0.86				
DDT	ug/L	<0.1	<0.02	<0.1	<0.1	<0.1	<0.1	<0.1	0.0086	<0.1	<0.1	<0.1	<0.1
1,4-Dichlorobenzene	ug/L		<2			<10			<2.4			<10	
3,3'-Dichlorobenzidine	ug/L		<20			<20			<7.2			<20	
1,2-dichloroethane	ug/L		<2						<0.28				
1,1-dichloroethylene	ug/L		<2						<0.42				
Dichlorobromomethane	ug/L		<2						<0.3				
Dichloromethane	ug/L		<5						<0.95				
1,3-dichloropropene	ug/L		<2						<0.32				
Dieldrin	ug/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
2,4-Dinitrotoluene	ug/L		<10			<10			<3.4			<10	
1,2-Diphenylhydrazine	ug/L		<20			<20			<2.4			<20	
Halomethanes	ug/L		<5						<1				
Heptachlor	ug/L	<0.005	<0.01	<0.003	<0.003	<0.01	<0.003	<0.003	<0.0029	<0.0029	<0.003	<0.01	<0.003
Heptachlor epoxide	ug/L		<0.005			<0.005			<0.0025			<0.005	
Hexachlorobenzene	ug/L		<10			<10			<2.9			<10	
Hexachlorobutadiene	ug/L		<10			<10			<3.8			<10	
Hexachloroethane	ug/L		<10			<10			<3.4			<10	
Isophorone	ug/L		<10			<10			<2.9			<10	
N-Nitrosodimethylamine	ug/L		<20			<20			<2.4			<20	
N-Nitrosodi-N-propylamine	ug/L		<10			<10			<3.4			<10	
N-Nitrosodiphenylamine	ug/L		<10			<10			<1.9			<10	
PAH	ug/L		<20			<20			<20			<20	
PCBs	ug/L	<0.5	<0.25	<0.5	<0.5	<0.5	<0.5	<0.5	<0.25	<0.5	<0.5	<0.5	<0.5

Attachment K
Derivations of Reasonable Potential Analyses and Performance Goals
Oxnard Wastewater Treatment Plant
(CA0054097, CI-2022)

Constituents	units	Jan-2011	Feb-2011	Mar-2011	Apr-2011	May-2011	Jun-2011	Jul-2011	Aug-2011	Sep-2011	Oct-2011	Nov-2011	Dec-2011
TCDD	pg/L		<9.8			<9.6			<9.8			<10	
1,1,2,2-tetrachloroethane	ug/L		<2						<0.3				
Tetrachloroethylene	ug/L		<2						<0.36				
Toxaphene	ug/L	<0.5	<0.25	<0.5	<0.5	<0.5	<0.05	<0.05	<0.25	<0.05	<0.05	<0.5	<0.05
Trichloroethylene	ug/L		<5						<0.26				
1,1,2-trichloroethane	ug/L		<2						<0.3				
2,4,6-Trichlorophenol	ug/L		<20			<20			<4.3			<20	
Vinyl chloride	ug/L		<1						<0.4				

Attachment K
Derivations of Reasonable Potential Analyses and Performance Goals
Oxnard Wastewater Treatment Plant
(CA0054097, CI-2022)

Constituents	units	Jan-2012	Feb-2012	Mar-2012	Apr-2012	May-2012	Jun-2012	Jul-2012	Aug-2012	Sep-2012	Oct-2012	Nov-2012	Dec-2012
Conventional/NonConventional (3a)	mg/L												
BOD	mg/L	18.5	16.0	13.3	17.2	16.4	16.7	16.2	16.8	14.8	16.0	19.2	16
Total Suspended Solids	mg/L	6	5	5	8	9	11	7	7	6	6	7	6
Oil & Grease	mg/L	< 5	< 5	5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	<5
Settleable Solids	ml/L	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	<0.1
Total Coliform	MPN/100mL	136,420	57,690	66,774	125,600	> 160,000	87,760	99,510	100,258	97,594	93,484	115,167	65752
Fecal Coliform	MPN/100mL	86,400	11,360	5,320	118,800	98,000	43,200	49,460	22,600	21,180	76,950	9,640	4566
Enterococcus	MPN/100mL	7,480	5,680	7,620	> 16,000	9,280	3,974	8,000	8,860	1,320	8,620	4,760	2180
Nitrate-N	mg/L	0.6	1.4	0.6	2.4	<0.50	<0.50	<0.50	<0.50	0.59	<0.50	<0.50	<0.5
Nitrite-N	mg/L	2.4	0.83	1.5	1.9	0.49	0.38	0.38	0.57	0.62	0.66	0.88	0.96
Organic-N	mg/L	<0.5	<0.5	<0.5	2.1	2.2	1.8	1.1	0.5	<0.5	<0.5	1.4	1.7
pH		7.3	7.3	7.4	7.4	7.4	7.5	7.4	7.3	7.3	7.3	7.3	7.1
Temp	0C	22	22	22	22	24	24	25	26	26	26	24	24
Turbidity	NTU	3.5	3	3	4.1	5	7.6	4.7	4.6	3.8	3.9	4	3.6
Marine Aquatic Life													
Arsenic (As)	ug/L		0.6			0.7			0.81			1.0	
Cadmium (Cd)	ug/L		<0.5			<0.5			<0.5			<0.5	
Chromium Total (Cr)	ug/L		<1						<1				
Copper (Cu)	ug/L		20			16			17			16	
Lead (Pb)	ug/L		<5			<5			<5			<5	
Mercury (Hg)	ug/L		<0.2			<0.2			<0.2			<0.2	
Nickel (Ni)	ug/L		<5			<5			<5			<5	
Selenium (Se)	ug/L		1.0			2.0			1.6			1.2	
Silver (Ag)	ug/L		0.48			<0.2			0.43			<0.5	
Zinc (Zn)	ug/L		22			17			13			22	
Cyanide	ug/L					<5						<5	
Residual Chlorine	mg/L	0.02	0.01	0.01	0.02	0.02	0.07	0.02	0.02	0.02	0.01	0.02	0.02
Ammonia-N	mg/L	30	30.3	23.9	26.6	25.5	27.7	30.3	29.2	25	26.6	31.7	31.3
Acute Toxicity	TUa												
Chronic Toxicity (Survival)	TUc	17.86	17.86	17.86	17.86	17.86	17.86	17.86	17.86	17.86	17.86	17.86	17.86
Chronic Toxicity (Growth)	TUc	17.86	17.86	17.86	17.86	17.86	17.86	17.86	17.86	17.86	17.86	17.86	17.86
Non-Chlorinated Phenolic Compounds	ug/L		<5			<40			<20			<20	
Chlorinated Phenolic Compouds	ug/L		<5			<40			<20			<20	
Endosulfan	ug/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Endrin	ug/L		<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
HCH	ug/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02
Radioactivity - Alpha	pCi/L		3.91						7.81				
Radioactivity - Beta	pCi/L		21.8						13.8				
Human Health - Noncarcinogens													
Acrolein	ug/L		<5						<5				
Antimony	ug/L		<2			<2			<2			<2	
Bis (2-Chloroethoxy) methane	ug/L		<0.5			<20			<10			<10	
Bis (2-Chloroisopropyl) ether	ug/L		<0.5			<20			<10			<10	
Chlorobenzene	ug/L		<0.5						<0.5				
Chromium III (Cr)	ug/L		<5			<5			<5			<5	
Di-n-Butyl Phthalate	ug/L		<2			<40			<20			<20	
Dichlorobenzene	ug/L		<0.5			<20			<10			<10	

Attachment K
Derivations of Reasonable Potential Analyses and Performance Goals
Oxnard Wastewater Treatment Plant
(CA0054097, CI-2022)

Constituents	units	Jan-2012	Feb-2012	Mar-2012	Apr-2012	May-2012	Jun-2012	Jul-2012	Aug-2012	Sep-2012	Oct-2012	Nov-2012	Dec-2012
Diethyl phthalate	ug/L		<1			<20			<10			<10	
Dimethyl phthalate	ug/L		<0.5			<20			<10			<10	
4,6-dinitro-2-methylphenol	ug/L		<5			<40			<20			<20	
2,4-dinitrophenol	ug/L		<5			<40			<20			<20	
Ethylbenzene	ug/L		<0.5						<0.5				
Fluoranthene	ug/L		<0.5			<20			<10			<10	
Hexachlorocyclopentadiene	ug/L		<5			<20			<10			<10	
Nitrobenzene	ug/L		<1			<40			<20			<20	
Thallium	ug/L		<2			<2			<2			<2	
Toluene	ug/L		<0.5						<0.5				
Tributyltin	ug/L		<0.002						<0.002				
1,1,1-trichloroethane	ug/L		<0.5						<0.5				
Human Health - Carcinogens													
Acrylonitrile	ug/L		<2						<2				
Aldrin	ug/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Benzene	ug/L		<2						<2				
Benzidine	ug/L		<5			<40			<20			<20	
Beryllium (Be)	ug/L		<0.5			<0.5			<0.5			<0.5	
Bis (2-Chloroethyl) ether	ug/L		<0.5			<20			<10			<10	
Bis(2-ethylhexyl)-phthalate	ug/L		<5			<200			<50			<50	
Carbon tetrachloride	ug/L		<0.5						<0.5				
Chlordane	ug/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chlorodibromomethane	ug/L		<0.5						<0.5				
Chloroform	ug/L		1.0						0.58				
DDT	ug/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,4-Dichlorobenzene	ug/L		<0.5			<20			<10			<10	
3,3'-Dichlorobenzidine	ug/L		<5			<40			<20			<20	
1,2-dichloroethane	ug/L		<0.5						<0.5				
1,1-dichloroethylene	ug/L		<0.5						<0.5				
Dichlorobromomethane	ug/L		<0.5						<0.5				
Dichloromethane	ug/L		<1						<0.5				
1,3-dichloropropene	ug/L		<0.5						<0.5				
Dieldrin	ug/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
2,4-Dinitrotoluene	ug/L		<5						<10				
1,2-Diphenylhydrazine	ug/L		<1			<40			<20			<20	
Halomethanes	ug/L		<0.5						<0.5				
Heptachlor	ug/L		<0.01			<0.01			<0.01			<0.01	
Heptachlor epoxide	ug/L		<0.005			<0.005			<0.005			<0.005	
Hexachlorobenzene	ug/L		<1			<20			<10			<10	
Hexachlorobutadiene	ug/L		<2			<20			<10			<10	
Hexachloroethane	ug/L		<3			<20			<10			<10	
Isophorone	ug/L		<1			<20			<10			<10	
N-Nitrosodimethylamine	ug/L		<2			<40			<20			<20	
N-Nitrosodi-N-propylamine	ug/L		<2			<20			<10			<10	
N-Nitrosodiphenylamine	ug/L		<1			<20			<10			<10	
PAH	ug/L		<20			<20			<20			<20	
PCBs	ug/L	NODI(B)	NODI(B)	NODI(B)	NODI(B)	NODI(B)	NODI(B)	NODI(B)	NODI(B)	NODI(B)	NODI(B)	NODI(B)	NODI(B)

Attacnment K
Derivations of Reasonable Potential Analyses and Performance Goals
Oxnard Wastewater Treatment Plant
(CA0054097, CI-2022)

Constituents	units	Jan-2012	Feb-2012	Mar-2012	Apr-2012	May-2012	Jun-2012	Jul-2012	Aug-2012	Sep-2012	Oct-2012	Nov-2012	Dec-2012
TCDD	pg/L		<10			<10			<10			<11	
1,1,2,2-tetrachloroethane	ug/L		<0.5						<0.5				
Tetrachloroethylene	ug/L		<0.5						<0.5				
Toxaphene	ug/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Trichloroethylene	ug/L		<0.5						<0.5				
1,1,2-trichloroethane	ug/L		<0.5						<0.5				
2,4,6-Trichlorophenol	ug/L		<1			<40			<20			<20	
Vinyl chloride	ug/L		<0.5						<0.5				

Attachment K
Derivations of Reasonable Potential Analyses and Performance Goals
Oxnard Wastewater Treatment Plant
(CA0054097, CI-2022)

Constituents	units	RP to Exceed WQO	% of Data Detected < 20%	ML	Procedure 2: If % of Data Detected < 20%, then PG=ML * 5	MEC	Co=UCB95/95	Dm	Co	Cs	PG UCB95/95	Is MEC<PG UCB95/95?
Conventional/NonConventional (3a)	mg/L											
BOD	mg/L					23.137931						
Total Suspended Solids	mg/L					12						
Oil & Grease	mg/L					6.8						
Settleable Solids	ml/L					0						
Total Coliform	MPN/100mL					136420						
Fecal Coliform	MPN/100mL					118800						
Enterococcus	MPN/100mL					12400						
Nitrate-N	mg/L					3.4						
Nitrite-N	mg/L					2.4						
Organic-N	mg/L					5.1						
pH						7.5						
Temp	0C					26						
Turbidity	NTU					7.6						
Marine Aquatic Life												
Arsenic (As)	ug/L	No	No	2		2	3	98	3	3	3	Yes
Cadmium (Cd)	ug/L	No	Yes	0.2	1	0.8				0	0	
Chromium Total (Cr)	ug/L	No	No	5		8	0.12	98	0.12	0	11.88	Yes
Copper (Cu)	ug/L	No	No	0.5		30	2.29	98	2.29	2	30.71	Yes
Lead (Pb)	ug/L	No	Yes	0.5	2.5	<2		98				
Mercury (Hg)	ug/L	No	Yes	0.5	2.5	0		98		0.0005		
Nickel (Ni)	ug/L	No	No	1		8	0.087	98	0.087	0	8.613	Yes
Selenium (Se)	ug/L	No	No	2		4.7	0.082	98	0.082	0	8.118	Yes
Silver (Ag)	ug/L	No	No	0.2		2.3	0.178	98	0.178	0.16	1.942	No
Zinc (Zn)	ug/L	No	No	1		36	8.34	98	8.34	8	41.66	Yes
Cyanide	ug/L	inconclusive	Yes	5	25	0						
Residual Chlorine	mg/L	No	No			0.13	1.13	98	1.13	0	111.87	Yes
Ammonia-N	mg/L	No	No			31.7	317.6	98	317.6	0	31442.4	Yes
Acute Toxicity	TUa	NA				0						
Chronic Toxicity (Survival)	TUc	No	No			17.86	0.284	98	0.284	0	28.116	No
Chronic Toxicity (Growth)	TUc	No	No			17.86	0.18	98	0.18	0	17.82	No
Non-Chlorinated Phenolic Compouds	ug/L	No	Yes	1	5	0		98		0		
Chlorinated Phenolic Compouds	ug/L	No	Yes			0		98		0		
Endosulfan	ug/L	No	Yes	0.01	0.05							
Endrin	ug/L	No	Yes	0.01	0.05							
HCH	ug/L	No	Yes	0.02	0.1							
Radioactivity - Alpha	pCi/L	No	No			16.8	0.549	98	0.549	0	54.351	Yes
Radioactivity - Beta	pCi/L	No	No			46.5	1.024	98	1.024	0	101.376	Yes
Human Health - Noncarcinogens												
Acrolein	ug/L	No	Yes	2	10							
Antimony	ug/L	No	Yes	0.5	2.5							
Bis (2-Chloroethoxy) methane	ug/L	No	Yes	5	25							
Bis (2-Chloroisopropyl) ether	ug/L	No	Yes	2	10							
Chlorobenzene	ug/L	No	Yes	0.5	2.5							
Chromium III (Cr)	ug/L	No										
Di-n-Butyl Phthalate	ug/L	No	No	10		0.19	0.0023	98	0.0023	0	0.2277	Yes
Dichlorobenzene	ug/L	No	Yes	0.5	2.5							

Adopted: June 6, 2013

Attachment K
Derivations of Reasonable Potential Analyses and Performance Goals
Oxnard Wastewater Treatment Plant
(CA0054097, CI-2022)

Constituents	units	RP to Exceed WQO	% of Data Detected < 20%	ML	Procedure 2: If % of Data Detected < 20%, then PG=ML * 5	MEC	Co=UCB95/95	Dm	Co	Cs	PG UCB95/95	Is MEC<PG UCB95/95?
Diethyl phthalate	ug/L	No	Yes	2	10			98		0		
Dimethyl phthalate	ug/L	No	Yes	2	10	0.0647						
4,6-dinitro-2-methylphenol	ug/L	No	Yes	5	25							
2,4-dinitrophenol	ug/L	No	Yes	5	25	0.142						
Ethylbenzene	ug/L	inconclusive	Yes	0.5	2.5							
Fluoranthene	ug/L	No	No	0.05		0.039	0.0006	98	0.0006	0	0.0594	Yes
Hexachlorocyclopentadiene	ug/L	No	Yes	5	25							
Nitrobenzene	ug/L	No	Yes	1	5							
Thallium	ug/L	No	Yes	1	5							
Toluene	ug/L	inconclusive	Yes	0.5	2.5							
Tributyltin	ug/L	inconclusive	Yes			0						
1,1,1-trichloroethane	ug/L	inconclusive	Yes	0.5	2.5							
Human Health - Carcinogens												
Acrylonitrile	ug/L	inconclusive	Yes	2	10							
Aldrin	ug/L	No	Yes	0.005	0.025							
Benzene	ug/L	inconclusive	Yes	0.5	2.5							
Benzidine	ug/L	inconclusive	Yes	5	25							
Berylium (Be)	ug/L	No	Yes	0.5	2.5							
Bis (2-Chloroethyl) ether	ug/L	inconclusive	Yes	1	5							
Bis(2-ethylhexyl)-phthalate	ug/L	No	No	5		86.081	1.07	98	1.07	0	105.93	Yes
Carbon tetrachloride	ug/L	inconclusive	Yes	0.5	2.5							
Chlordane	ug/L	No	Yes	0.1	0.5							
Chlorodibromomethane	ug/L	inconclusive	Yes	0.5	2.5	0.61						
Chloroform	ug/L	No	No	0.5		1.2	0.0201	98	0.0201	0	1.9899	Yes
DDT	ug/L	No	Yes	0.05	0.25							
1,4-Dichlorobenzene	ug/L	No	No	0.5		0.041	0.0005	98	0.0005	0	0.0495	Yes
3,3'-Dichlorobenzidine	ug/L	inconclusive	Yes	5	25							
1,2-dichloroethane	ug/L	inconclusive	Yes	0.5	2.5							
1,1-dichloroethylene	ug/L	inconclusive	Yes	0.5	2.5							
Dichlorobromomethane	ug/L	inconclusive	Yes	0.5	2.5							
Dichloromethane	ug/L	inconclusive	Yes	0.5	2.5							
1,3-dichloropropene	ug/L	inconclusive	Yes	0.5	2.5							
Dieldrin	ug/L	No	Yes	0.01	0.05							
2,4-Dinitrotoluene	ug/L	No	Yes	5	25							
1,2-Diphenylhydrazine	ug/L	inconclusive	Yes	1	5							
Halomethanes	ug/L	inconclusive	Yes									
Heptachlor	ug/L	No	Yes	0.01	0.05							
Heptachlor epoxide	ug/L	inconclusive	Yes	0.01	0.05							
Hexachlorobenzene	ug/L	inconclusive	Yes	1	5							
Hexachlorobutadiene	ug/L	No	Yes	1	5							
Hexachloroethane	ug/L	No	Yes	1	5							
Isophorone	ug/L	No	Yes	1	5							
N-Nitrosodimethylamine	ug/L	No	Yes	5	25							
N-Nitrosodi-N-propylamine	ug/L	No	Yes	5	25							
N-Nitrosodiphenylamine	ug/L	No	Yes	1	5							
PAH	ug/L	inconclusive	Yes									
PCBs	ug/L	inconclusive	Yes									

Constituents	units	RP to Exceed WQO	% of Data Detected < 20%	ML	Procedure 2: If % of Data Detected < 20%, then PG=ML * 5	MEC	Co=UCB95/95	Dm	Co	Cs	PG UCB95/95	Is MEC<PG UCB95/95?
TCDD	pg/L	Yes				0.0000016	0.000000017	98	1.7E-08	0	0.000001683	
1,1,2,2-tetrachloroethane	ug/L	inconclusive	Yes	0.5	2.5							
Tetrachloroethylene	ug/L	inconclusive	Yes	0.5	2.5							
Toxaphene	ug/L	No	Yes	0.5	2.5							
Trichloroethylene	ug/L	inconclusive	Yes	0.5	2.5							
1,1,2-trichloroethane	ug/L	inconclusive	Yes	0.5	2.5							
2,4,6-Trichlorophenol	ug/L	No	No			0.352	0.0038	98	0.0038	0	0.3762	Yes
Vinyl chloride	ug/L	inconclusive	Yes	0.5	2.5							

Attachment K
Derivations of Reasonable Potential Analyses and Performance Goals
Oxnard Wastewater Treatment Plant
(CA0054097, CI-2022)

Constituents	units	Procedure 1: If MEC<PG UCB95/95, then select MEC as PG	Procedure 1: If MEC>PG UCB95/95, then select PG	Final PG	Previous PG	Comment
Conventional/NonConventional (3a)	mg/L					
BOD	mg/L					
Total Suspended Solids	mg/L					
Oil & Grease	mg/L					
Settleable Solids	ml/L					
Total Coliform	MPN/100mL					
Fecal Coliform	MPN/100mL					
Enterococcus	MPN/100mL					
Nitrate-N	mg/L					
Nitrite-N	mg/L					
Organic-N	mg/L					
pH						
Temp	0C					
Turbidity	NTU					
Marine Aquatic Life						
Arsenic (As)	ug/L	2		2	7.4	more stringent
Cadmium (Cd)	ug/L			1	1	no change
Chromium Total (Cr)	ug/L	8		8	8	no change
Copper (Cu)	ug/L	30		30	32	more stringent
Lead (Pb)	ug/L			23	23	no change, all data ND. Carryover PG
Mercury (Hg)	ug/L			0.3	0.3	no change, all data ND. Carryover PG
Nickel (Ni)	ug/L	8		8	19	more stringent
Selenium (Se)	ug/L	4.7		4.7	4.9	more stringent
Silver (Ag)	ug/L		1.9	1.9	1	less stringent, more detected data available
Zinc (Zn)	ug/L	36		36	38	more stringent
Cyanide	ug/L			25	25	no change, carryover
Residual Chlorine	mg/L	0.13		0.13	0.1	set to MEC
Ammonia-N	mg/L	32		32	26	set to MEC
Acute Toxicity	TUa					
Chronic Toxicity (Survival)	TUc	28.116				
Chronic Toxicity (Growth)	TUc		18	18	18	no change
Non-Chlorinated Phenolic Compouds	ug/L			5	5	no change, carryover
Chlorinated Phenolic Compouds	ug/L		0.416	0.42	0.42	no change, carryover
Endosulfan	ug/L			0.05	0.05	no change
Endrin	ug/L			0.05	0.05	no change
HCH	ug/L			0.1	0.1	no change
Radioactivity - Alpha	pCi/L	16.8		15	15	limit carryover
Radioactivity - Beta	pCi/L	46.5		50	50	limit carryover
Human Health - Noncarcinogens						
Acrolein	ug/L			10	10	no change
Antimony	ug/L			2.5	2.5	no change
Bis (2-Chloroethoxy) methane	ug/L			25	25	no change
Bis (2-Chloroisopropyl) ether	ug/L			10	10	no change
Chlorobenzene	ug/L			2.5	2.5	no change
Chromium III (Cr)	ug/L			8	8	carryover
Di-n-Butyl Phthalate	ug/L	0.19		0.19	0.33	more stringent, new information
Dichlorobenzene	ug/L			2.5	2.5	no change

Attachment K
Derivations of Reasonable Potential Analyses and Performance Goals
Oxnard Wastewater Treatment Plant
(CA0054097, CI-2022)

Constituents	units	Procedure 1: If MEC<PG UCB95/95, then select MEC as PG	Procedure 1: If MEC>PG UCB95/95, then select PG	Final PG	Previous PG	Comment
Diethyl phthalate	ug/L			10	0.25	less stringent, all NDs
Dimethyl phthalate	ug/L			10	10	no change
4,6-dinitro-2-methylphenol	ug/L			25	25	no change
2,4-dinitrophenol	ug/L			25	25	no change
Ethylbenzene	ug/L			2.5	2.5	no change
Fluoranthene	ug/L	0.039		0.039	0.25	more stringent, new information
Hexachlorocyclopentadiene	ug/L			25	25	no change
Nitrobenzene	ug/L			5	5	no change
Thallium	ug/L			5	5	no change
Toluene	ug/L			2.5	0.6	less stringent, all NDs
Tributyltin	ug/L			0.0263	0.0263	no change, carryover
1,1,1-trichloroethane	ug/L			2.5	2.5	no change
Human Health - Carcinogens						
Acrylonitrile	ug/L			10	10	no change
Aldrin	ug/L			0.025	0.025	no change
Benzene	ug/L			2.5	2.5	no change
Benzidine	ug/L			0.0068	0.0068	Limits will be carried over, inconclusive RP
Berylium (Be)	ug/L			2.5	2.5	no change
Bis (2-Chloroethyl) ether	ug/L			5	5	no change
Bis(2-ethylhexyl)-phthalate	ug/L	86		50	2	Revert to previous PG per Discharger's request
Carbon tetrachloride	ug/L			2.5	2.5	no change
Chlordane	ug/L			0.5	0.5	no change
Chlorodibromomethane	ug/L			0.61	1.3	more stringent, new information, set to MEC
Chloroform	ug/L	1.2		1.2	1.4	more stringent, new information
DDT	ug/L			0.25	0.25	no change
1,4-Dichlorobenzene	ug/L	0.041		0.041	3	more stringent, new information
3,3'-Dichlorobenzidine	ug/L			25	25	no change
1,2-dichloroethane	ug/L			2.5	2.5	no change
1,1-dichloroethylene	ug/L			2.5	2.5	no change
Dichlorobromomethane	ug/L			2.5	2.5	no change
Dichloromethane	ug/L			2.5	2.5	no change
1,3-dichloropropene	ug/L			2.5	2.5	no change
Dieldrin	ug/L			0.05	0.05	no change
2,4-Dinitrotoluene	ug/L			25	25	no change
1,2-Diphenylhydrazine	ug/L			5	5	no change
Halomethanes	ug/L			4.4	4.4	no change, carryover previous PG
Heptachlor	ug/L			0.05	0.05	no change
Heptachlor epoxide	ug/L			0.002	0.002	carryover effluent limits
Hexachlorobenzene	ug/L			5	5	no change
Hexachlorobutadiene	ug/L			5	5	no change
Hexachloroethane	ug/L			5	5	no change
Isophorone	ug/L			5	5	no change
N-Nitrosodimethylamine	ug/L			25	25	no change
N-Nitrosodi-N-propylamine	ug/L			25	25	no change
N-Nitrosodiphenylamine	ug/L			5	5	no change
PAH	ug/L			0.1	0.1	no change, carryover previous PG
PCBs	ug/L			0.0019	0.0019	carryover effluent limits

Attacnment K
Derivations of Reasonable Potential Analyses and Performance Goals
Oxnard Wastewater Treatment Plant
(CA0054097, CI-2022)

	Constituents	units	Procedure 1: If MEC<PG UCB95/95, then select MEC as PG	Procedure 1: If MEC>PG UCB95/95, then select PG	Final PG	Previous PG	Comment
	TCDD	pg/L			0.00000039	0.00000039	carryover effluent limits
	1,1,2,2-tetrachloroethane	ug/L			2.5	2.5	no change
	Tetrachloroethylene	ug/L			2.5	2.5	no change
	Toxaphene	ug/L			2.5	2.5	no change
	Trichloroethylene	ug/L			2.5	2.5	no change
	1,1,2-trichloroethane	ug/L			2.5	2.5	no change
	2,4,6-Trichlorophenol	ug/L	0.35		0.35	50	more stringent, new information
	Vinyl chloride	ug/L			2.5	2.5	no change

APPENDIX C – VENTURA AIR POLLUTION CONTROL DISTRICT PERMIT TO OPERATE

Ventura County Air Pollution Control District
669 County Square Drive
Ventura, California 93003
tel 805/645-1400
fax 805/645-1444
www.vcapcd.org
Michael Villegas
Air Pollution Control Officer

PERMIT TO OPERATE
Number 01137

Valid October 1, 2013 to September 30, 2014

This Permit Has Been Issued To The Following:

Company Name / Address:	Facility Name / Address:
City of Oxnard-Wastewater Division 6001 S. Perkins Rd. Oxnard, CA 93033	Oxnard Wastewater Treatment Plant 6001 South Perkins Road Oxnard, CA 93033

Permission Is Hereby Granted To Operate The Following:

2 - 500 BHP Caterpillar Effluent Pump Natural Gas Engines, Model G-398, Rich Burn (as defined in VCAPCD Rule 74.9), each equipped with NSCR 3-Way Catalytic Converter, Oxygen Sensor, and Air/Fuel Ratio Controller, for Rule 74.9 compliance, (Engines Nos. 1 & 3).
3 - 800 BHP Waukesha Electrical Generator Waste Gas Engines (as defined in VCAPCD Rule 74.9), Model P9390G, Rich Burn, equipped with Pre-Stratified Charge for Rule 74.9 compliance (Engines Nos. E7610.00, E7710.00 & E7810.00).
2 - 24000 Cubic Feet Per Hour Varec, Model 239, Waste Gas Burners (24 MMBTU/Hr on Natural Gas), 6" Feed Size, used for Digester Gas Incineration
1 - 48000 Cubic Feet Per Minute Air Capacity Odor Reduction Tower, B.F. Goodrich/Media Koro-Z, for odor reduction and H2S control
1 - Headworks Facilities controlled by a 25,000 SCFM US Filter LO/Pro Odor Control System consisting of a three-stage absorption system using Sodium Hydroxide and Sodium Hypochlorite for hydrogen sulfide removal; and equipped with a hydrogen sulfide analyzer.
1 - Odor Reduction Station (Solids Processing Building and Eastern Trunk Pump Station), Calvert FRP Fine Mist Tower, 10 Feet Diameter x 37 Feet High, 22,000 CFM Capacity, equipped with an Interscan Model LD-17 H2S Analyzer

Emergency Standby Diesel Engines For Electricity Generators

1 - 2250 BHP General Motors Emergency Standby Diesel Engine, Model 16-567-E4, Serial No. 66-HI-1082, no EPA Family Name, Model Year 1966
1 - 2250 BHP General Motors Emergency Standby Diesel Engine, Model 16-567-E-4, Serial No. 66-HI-1161, no EPA Family Name, Model Year 1966
1 - 2172 BHP Caterpillar Emergency Standby Diesel Engine, Model 3512B TA, Serial No. 1GZ02501, EPA Family Name 5CPXL58-6ERK, Model Year 2005
1 - 263 BHP Caterpillar Emergency Standby Diesel Engine, Model 3208, Serial No. 5YF00565, no EPA family Name, Model Year 1989

1 - 636 BHP Caterpillar Emergency Standby Diesel Engine, Model C15, Serial No. FSE00892, EPA Family Name 7CPXL15.2ESK, ARB Executive Order U-R-001-0308

1 - 250 BHP Cummins Emergency Standby Diesel Engine, Model QSB7-G3, Serial No. 73123393, EPA Family Name ACEXL0409AAB, Tier 3, CARB Executive Order No. U-R-002-0516, Located at Advanced Water Purification Site at 5700 South Perkins Road in Oxnard

Emergency Standby Diesel Engine For Air Compressor

1 - 139 BHP (104 KW) John Deere Emergency Diesel Engine, Model 4045HF275C, Serial No. PE 4045H376314, EPA Family Name 5JDXL06.8078, Model Year 2005

This Permit Has Been Issued Subject To The Following Conditions:

1. Permitted Emissions

Permitted Emissions	Tons/Year	Pounds/Hour
Reactive Organics	10.18	8.36
Nitrogen Oxides	15.33	27.76
Particulate Matter	1.16	1.61
Sulfur Oxides	2.54	1.69
Carbon Monoxide	145.35	84.54
Chlorine	0.75	0.52
Hydrogen Sulfide	9.47	2.16

2. Annual fuel consumption in the Caterpillar internal combustion engines, the Waukesha internal combustion engines, and the Varec Waste Gas Burners shall not exceed the following:

   a) Total natural gas consumption in the two (2) 500 HP Caterpillar internal combustion engines (Engine Nos. 1 & 3) shall not exceed 5.0 million cubic feet per year.

   b) Total digester waste gas consumption in the three (3) 800 HP Waukesha internal combustion engines (Engine Nos. E7610.00, E7710.00, & E7810.00) shall not exceed 155.00 million cubic feet per year.

   c) Incineration of digester gas in the Varec Waste Gas Burners shall not exceed 146.0 million cubic feet per year.

   In order to comply with this condition, permittee shall maintain and operate meters to measure and record gas consumption. The meters shall be operated and calibrated according to manufacturer's specifications. The gas meter records shall be summed on a monthly basis. The monthly totals shall be summed for the previous twelve calendar (12) months. Gas consumption totals for any twelve (12) calendar month rolling period in excess of the above limits shall be considered a violation of this condition.

3. Prior to exceeding any of the above limits, permittee shall submit an application to the APCD to increase those limits. Any request

to increase fuel use in the two (2) 500 HP Caterpillar internal combustion engines (Engines Nos. 1 & 3) shall be subject to APCD Rule 26.

4. Permittee shall comply with APCD Rule 74.9, "Stationary Internal Combustion Engines". This includes, but is not limited to, the following permit conditions.

5. Pursuant to Rule 74.9.F, Reporting Requirements, within 45 days of the end date of each permit renewal period, the operator of a permitted engine subject to the provisions of the rule shall provide the District with the following information:

   a) Engine manufacturer, model number, operator identification number and location of each engine.

   b) A summary of maintenance reports during the renewal period, including quarterly screening data if applicable.

   For each engine exempt pursuant to Subsection D.2, total annual operating hours shall be reported annually. For each engine exempt pursuant to subsection D.3, total annual hours of maintenance operaton shall be reported annually. Reports shall be provided to the District after every calendar year by February 15.

6. Emissions of oxides of nitrogen (NOx) from each of the two (2) 500 HP Caterpillar internal combustion engines (Engines Nos. 1 & 3) shall not exceed 25 parts per million (ppmv) as corrected to 15% oxygen.

7. Emissions of oxides of nitrogen (NOx) from each of the three (3) 800 HP Waukesha internal combustion engines (Engines Nos. E7610.00, E7710.00, & E7810.00) shall not exceed 50 parts per million (ppmv) as corrected to 15% oxygen. This condition is applied for APCD Rule 74.9.B.1 compliance. As of January 1, 1997, the NOx limits are 25 parts per million (ppmv) as corrected to 15% oxygen for rich burn engines fired on natural gas and 50 parts per million (ppmv) as corrected to 15% oxygen for rich burn engines fired on waste gas. As detailed in VCAPCD Rule 74.9.I.11, waste gas is defined as fuel gas produced at either waste water/sewage treatment facilities or landfills containing no more than 25 percent by volume supplemental gas.

8. Emissions from each engine shall not exceed 4500 ppm carbon monoxide, as corrected to 15% oxygen, pursuant to APCD Rule 74.9.B.1.

9. Emissions from each engine shall not exceed 250 ppm reactive organic compounds, as corrected to 15% oxygen, pursuant to APCD Rule 74.9.B.1.

10. In order to comply with the engine emission Conditions, permittee shall perform a source test every 24 months as required by VCAPCD

Rule 74.9. In addition, the NSCR system on the Caterpillar engines shall be maintained and operated with a minimum temperature rise across the catalyst of 15 degrees Fahrenheit.

11. Hydrogen Sulfide emissions from the Odor Reduction Tower shall not exceed 5 ppm by volume.

12. Hydrogen Sulfide emissions from the Odor Reduction Station shall not exceed 4 ppm by volume at the Solids Processing Building.

13. Hydrogen sulfide emissions from the 25,000 CFM US Filter LO/PRO Odor Control System three-stage absorption system controlling the Headworks Facilities shall not exceed 3 ppm by volume. The chlorine concentration at the outlet of the 25,000 CFM US Filter LO/PRO Odor Control System three-stage absorption system controlling the Headworks Facilities shall not exceed 0.1 ppm by volume. This condition is applied pursuant to Rule 51, "Nuisance"; and Rule 54, "Sulfur Compounds".

    In order to comply with this condition, permittee shall maintain the control system parameters (i.e., pH of scrubbing solution, ORP of the scrubbing solution, pressure drop across the control system, and space velocity through the control system) at values that ensure that the above hydrogen sulfide and chlorine concentrations are not exceeded.

    Permittee, upon request of the District, shall conduct testing to ascertain the hydrogen sulfide and chlorine emissions from the 25,000 CFM US Filter LO/PRO Odor Control System three-stage absorption system controlling the Headworks Facilities, using APCD approved methods.

14. Permittee shall install and maintain a continuous hydrogen sulfide analyzer at the outlet of the 25,000 SCFM US Filter LO/PRO Odor Control System three-stage absorption system controlling the Headworks Facilities to monitor the hydrogen sulfide concentration in ppm by volume at the outlet of the 25,000 SCFM US Filter LO/PRO Odor Control System three-stage absorption system controlling the Headworks Facilities. The analyzer shall be installed, operated, and calibrated according to the manufacturer's specifications. This condition is applied to ensure compliance with Rule 51, "Nuisance"; and Rule 54, "Sulfur Compounds".

15. Permittee shall install and maintain pH and ORP (oxidation reduction potential) measuring and monitoring devices to measure and record the pH and ORP of the scrubbing solution in the 25,000 SCFM US Filter LO/PRO Odor Control System three-stage absorption system controlling the Headworks Facilities. Permittee shall also install and maintain pressure monitoring devices to monitor the pressure drop across the 25,000 SCFM US Filter LO/PRO Odor Control System three-stage absorption system controlling the Headworks. All devices shall be installed, operated, and calibrated according to the manufacturer's specifications. This condition is applied to

ensure compliance with the requirements of Rule 51, "Nuisance"; and Rule 54, "Sulfur Compounds".

16. The stack height of the 25,000 SCFM US Filter LO/PRO Odor Control System three-stage absorption system controlling the Headworks Facilities shall be no less than 9 meters (29.5 feet). The stack diameter of at the outlet of the 25,000 SCFM US Filter LO/PRO Odor Control System three-stage absorption system controlling the Headworks Facilities shall not exceed 0.9 meters (2.95 feet). The stack gas exit velocity from the 25,000 SCFM US Filter LO/PRO Odor Control System three-stage absorption system controlling the Headworks Facilities shall be no less than 18.5 meters per second (60.7 feet per second). This condition is applied pursuant to Rule 51, "Nuisance"; and pursuant to Rule 54, "Sulfur Compounds".

17. All operations shall comply with the requirements of Rule 51, "Nuisance".

18. All equipment shall be maintained and operated in a manner that ensures compliance with all applicable Rule and permit conditions.

19. Permittee shall maintain records showing, for the 25,000 SCFM US Filter LO/PRO Odor Control System three-stage absorption system controlling the Headworks Facilities, on a monthly basis, a log of operating time for the control system, and monitoring equipment; records of the readings from the monitoring equipment showing the pressure drop across the control system; records of the readings from the monitoring equipment showing the hydrogen sulfide concentrations, pH of the scrubbing solution in the control system, and ORP of the scrubbing solution in the control system; and a log for the control system and monitoring equipment detailing all routine and non-routine maintenance performed. All records shall be compiled into monthly reports and shall be made available to APCD personnel upon request. All records shall be retained for at least two years and shall be made available to APCD personnel upon request.

20. The Hydrogen Sulfide analyzer on the Odor Reduction Tower shall be maintained in good working order at all times. The Hydrogen Sulfide analyzers on the Odor Reduction Station shall be maintained in good working order at all times. Malfunctions are subject to APCD Rule 32 (Breakdowns), as are all other air pollution related breakdowns at the plant. Analyzer outputs shall be continuously recorded on strip charts, or shall be recorded using an electronic data acquisition/storage system. Records or strip charts shall be maintained on site for at least two years and shall be made available to APCD personnel upon request.

21. When sodium hypochlorite is used, chlorine emissions from the Odor Reduction Station (Solids Processing Building and Eastern Trunk Pump Station Odor Reduction Station) shall not exceed 2 ppm by volume. Scrubber drain pH shall be maintained between 8.0 and 9.0 to ensure compliance with this requirement. Operation of the

Solids Processing Building and Eastern Trunk Pump Station Odor Reduction Station using sodium hypochlorite shall be limited to 2562 hours per year. In order to demonstrate compliance with this condition, the permittee shall maintain records of the hours of operation when using sodium hypochlorite and upon the request of the District, shall measure the chlorine emissions from the Odor Reduction Station (Solids Processing Building and Eastern Trunk Pump Station Odor Reduction Station).

22. Under no circumstances shall raw digester gas be vented to the atmosphere without prior approval from the APCD. All digester gas produced at the plant shall be flared, or disposed of in an alternative manner approved by the APCD.

23. Hydrogen Sulfide content of produced digester gas shall not exceed 100 ppm.

24. Hydrogen Sulfide content and heat content of the produced digester gas (in grains/100 cu. ft.) shall be determined by analytical means every 6 months, by an independent laboratory or the laboratory at the City of Oxnard Wastewater Treatment Facility, with results kept on file for inspection by APCD personnel for at least 2 years.

25. Annual hours of operation for maintenance and testing of each emergency engine shall not exceed 20 hours per year, except for the 2172 BHP and 636 BHP Caterpillar Emergency Standby Diesel Engines, which shall not exceed 50 hours per year. This limit does not include emergency operation when electrical line service has failed. When not being operated for maintenance or testing, the emergency engine shall only be used during a failure or loss of all or part of normal electrical power service to the facility. This condition is applied pursuant to the California ARB Airborne Toxic Control Measure (ATCM) for Stationary Compression Ignition Engines.

    In order to comply with this condition, the engine shall be equipped with a non-resettable hour meter and the permittee shall maintain a log that differentiates operation during maintenance and testing from emergency operation. These records shall be compiled into a monthly total. The monthly operating hour records shall be summed for the previous 12 months. Total operating hours for any of these 12 month periods, excluding emergency operation, in excess of the specified annual limit shall be considered a violation of this condition.

26. The emergency diesel engine(s) shall be operated in compliance with all applicable requirements of the California ARB Airborne Toxic Control Measure (ATCM) for Stationary Compression Ignition Engines, Section 93115 through 93115.15, Title 17, California Code of Regulations. This includes, but is not limited to, the following permit conditions.

27. Pursuant to Section 93115.5(b) of the ATCM for Stationary Compression Ignition Engines, effective January 1, 2006, no owner

or operator of an in-use emergency standby stationary diesel-fueled engine shall add to the engine or any fuel tank directly attached to the engine any fuel unless the fuel is CARB diesel fuel or another fuel that meets the requirements of Section 93115.5(b) of the ATCM.

28. Pursuant to Rule 74.9.D.3, an emergency engine is exempt from Rule 74.9, "Stationary Internal Combustion Engines", provided that it is operated during either an emergency or maintenance operation. Maintenance operation is limited to 50 hours per calendar year and is defined as "the use of an emergency standby engine and fuel system during testing, repair, and routine maintenance to verify its readiness for emergency standby use".

29. Permittee shall maintain records for the Hydrogen Sulfide analyzers on the Odor Reduction Tower and the Odor Reduction Station. Permittee shall maintain records of the hours of operation of the Solids Processing Building and Eastern Trunk Pump Station Odor Reduction Station when using sodium hypochlorite. Such records shall include the date and time. These records shall be compiled on a monthly basis. The compiled records shall be maintained for at least two years and shall be made available to APCD personnel upon request.

30. Permittee shall maintain records as required by VCAPCD Rule 74.9.E, and the monthly fuel consumption and hours of operation (when applicable) of the internal combustion engines. Permittee shall also maintain records showing the amount of digester gas produced and the disposition of this gas (amount expended to engines; amount expended to flare). All records shall be compiled into monthly reports and shall be maintained for at least two years.

31. A log of engine operation for the emergency engine shall be maintained based on readings from a non-resettable hour meter. The log shall differentiate operation during maintenance and testing from operation during an emergency. The hours of operation shall be totaled on a monthly basis and shall be summed for the previous 12 months.

    This data shall be maintained for a minimum of three (3) years from the date of each entry and shall be made available to the APCD upon request.

32. On and after October 19, 2013, the two 500 BHP Caterpillar Effluent Pump Natural Gas Engines shall comply with 40 CFR Part 63, Subpart ZZZZ, National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines (RICE NESHAP). This includes, but is not limited to, the following requirements for non-emergency 4 stroke rich burn spark ignited engines rated at less than or equal to 500 BHP that commenced construction before June 12, 2006:

    Pursuant to 40 CFR Part 63.6603, Table 2d, the permittee shall meet the following requirements:

a) Change oil and filter every 1,440 hours of operation, or annually, whichever comes first. Permittee shall have the option to utilize an oil analysis program as described in 40 CFR Part 63.6625(i) in order to extend the specified oil change requirement; and
b) Inspect spark plugs every 1,440 hours of operation, or annually, whichever comes first, and replace as necessary; and
c) Inspect all hoses and belts every 1,440 hours of operation, or annually, whichever comes first, and replace as necessary.

During periods of startup, the permittee shall minimize the RICE time spent at idle and minimize the RICE startup time at startup to a period needed for appropriate and safe loading of the engine, not to exceed 30 minutes. The permittee shall operate and maintain the RICE and after-treatment control device (if any) according to the manufacturer's emission related instructions, or the permittee's own operation and maintenance plan which must provide to the extent practicable for the maintenance and operation of the engine in a manner consistent with good air pollution control practice for minimizing emissions.

The permittee shall keep the records of RICE maintenance (oil, spark plugs, hoses and belts) required by the RICE operation and maintenance plan. The hours of operation records and maintenance records shall be maintained for 5 years following the date of each occurrence and shall be made available to the APCD upon request.

33. On and after October 19, 2013, the three 800 BHP Waukesha Electrical Generator Waste Gas Engines shall comply with 40 CFR Part 63, Subpart ZZZZ, National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines (RICE NESHAP). This includes, but is not limited to, the following requirements for non-emergency spark ignited engines fired on landfill gas or digester gas that commenced construction before June 12, 2006:

Pursuant to 40 CFR Part 63.6603, Table 2d, the permittee shall meet the following requirements:

a) Change oil and filter every 1,440 hours of operation, or annually, whichever comes first. Permittee shall have the option to utilize an oil analysis program as described in 40 CFR Part 63.6625(i) in order to extend the specified oil change requirement; and
b) Inspect spark plugs every 1,440 hours of operation, or annually, whichever comes first, and replace as necessary; and
c) Inspect all hoses and belts every 1,440 hours of operation, or annually, whichever comes first, and replace as necessary.

During periods of startup, the permittee shall minimize the RICE time spent at idle and minimize the RICE startup time at startup to a period needed for appropriate and safe loading of the engine, not to exceed 30 minutes. The permittee shall operate and maintain the RICE and after-treatment control device (if any) according to the manufacturer's emission related instructions, or the permittee's own operation and maintenance plan which must provide to the extent practicable for the maintenance and operation of the engine in a manner consistent with good air pollution control practice for minimizing emissions.

The permittee shall keep the records of RICE maintenance (oil, spark plugs, hoses and belts) required by the RICE operation and maintenance plan. The hours of operation records and maintenance records shall be maintained for 5 years following the date of each occurrence and shall be made available to the APCD upon request.

Note that for the purposes of the RICE NESHAP, the subject engine(s) shall combust no less than 10% landfill gas or digester gas of the gross heat input on an annual basis.

34. The following condition regarding the RICE NESHAP applies to the following "existing" emergency diesel engines:

a) Two 2250 BHP General Motors
b) 2172 BHP Caterpillar
c) 263 BHP Caterpillar
d) 139 BHP John Deere

On and after May 3, 2013, these engines shall comply with 40 CFR Part 63, Subpart ZZZZ, National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines (RICE NESHAP). This includes, but is not limited to, the following requirements for emergency compression ignition engines that commenced construction before June 12, 2006:

Pursuant to 40 CFR Part 63.6603, Table 2d, the permittee shall meet the following requirements:

a) Change oil and filter every 500 hours of operation, or annually, whichever comes first. Permittee shall have the option to utilize an oil analysis program as described in 40 CFR Part 63.6625(i) in order to extend the specified oil change requirement; and
b) Inspect air cleaner every 1,000 hours of operation, or annually, whichever comes first, and replace as necessary; and
c) Inspect all hoses and belts every 500 hours of operation, or annually, whichever comes first, and replace as necessary.

If an emergency RICE is operating during an emergency and it is not possible to perform the above maintenance, or if performing the maintenance would otherwise pose an unacceptable risk under federal, state, or local law, the maintenance can be delayed and should be performed as soon as practicable after the emergency has ended or the unacceptable risk has abated. All such maintenance delays shall be reported to the APCD Compliance Division.

During periods of startup, the permittee shall minimize the RICE time spent at idle and minimize the RICE startup time at startup to a period needed for appropriate and safe loading of the engine, not to exceed 30 minutes. The permittee shall operate and maintain the RICE and after-treatment control device (if any) according to the manufacturer's emission related instructions, or the permittee's own operation and maintenance plan which must provide to the extent practicable for the maintenance and operation of the engine in a manner consistent with good air pollution control practice for minimizing emissions.

Pursuant to 40 CFR Parts 63.6640(f) and 63.6675, the RICE cannot be used for peak shaving, as part of a financial arrangement to supply power into the grid, or as a part of a demand response program, unless specifically allowed by this permit. There is no time limit on the use of emergency RICE in emergency situations.

Pursuant to 40 CFR Parts 63.6655 and 63.6660, the RICE shall be equipped and operated with a non-resettable hour meter. The permittee must document how many hours are spent for emergency operation, including what classified the operation as emergency and how many hours are spent for non-emergency operation, including operation for maintenance and testing. In addition, the permittee shall keep the records of RICE maintenance (oil, air cleaner, hoses and belts) required by the RICE operation and maintenance plan. The hours of operation records and maintenance records shall be maintained for 5 years following the date of each occurrence and shall be made available to the APCD upon request.

35. The 636 BHP Caterpillar and the 250 BHP Cummins emergency diesel engines is exempt from 40 CFR Part 63, Subpart ZZZZ, National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines (RICE NESHAP) because they were constructed on or after June 12, 2006.

Within 30 days after receipt of this permit, the permittee may petition the Hearing Board to review any new or modified condition (Rule 22).

This permit, or a copy, shall be posted reasonably close to the subject equipment and shall be accessible to inspection personnel (Rule 19). This permit is not transferable from one location to another unless the equipment is specifically listed as being portable (Rule 20).

This Permit to Operate shall not be construed to allow any emission unit to operate in violation of any state or federal emission standard or any rule of the District.

Terri Thomas
Engineering Division

For:

Michael Villegas
Air Pollution Control Officer

10/15/2013

This document is released for the purpose of information exchange review and planning only under the authority of Tracy Anne Clinton, September 2017, State of California, PE No. 48199 and Elizabeth Abigail Charbonnet, September 2017, State of California, PE No. 84612

City of Oxnard

Public Works Integrated Master Plan

WASTEWATER

PROJECT MEMORANDUM 3.2
FLOW AND LOAD PROJECTIONS

REVISED FINAL DRAFT
September 2017

Engineers...Working Wonders With Water™

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PREFACE

The analysis and evaluations contained in these Project Memorandum (PM) are based on data and information available at the time of the original date of publication, December 2015. After development of the December 2015 Final Draft PMs, the City continued to move forward on two concurrent aspects: 1) advancing the facilities planning for the water, wastewater, recycled water, and stormwater facilities; and 2) developed Updated Cost of Service (COS) Studies (Carollo, 2017) for the wastewater/collection system and the water/distribution system. The updated 2017 COS studies contain the most recent near-term Capital Improvement Projects (CIP). **The complete updated CIP based on the near-term and long-term projects is contained in the Brief History and Overview of the City of Oxnard Public Works Department's Integrated Planning Efforts: May 2014 – August 2017 section.**

At the time of this Revised PWIMP, minor edits were also incorporated into the PMs. Minor edits included items such as table title changes and updating reports that were completed after the December 2015 original publication date.

City of Oxnard

Public Works Integrated Master Plan

WASTEWATER

PROJECT MEMORANDUM 3.2
FLOW AND LOAD PROJECTIONS

TABLE OF CONTENTS

Page No.

LIST OF TABLES

LIST OF FIGURES

WASTEWATER FLOW AND LOAD PROJECTIONS

1.0 INTRODUCTION

This Project Memorandum (PM) summarizes the City's existing and projected future wastewater flows and pollution loads. Historical trends in flows and loads by discharger type were summarized and noted. These historical trends were then used to inform the forecasting methodology for future wastewater flow and load projections through the planning period for the Public Works Integrated Master Plan (PWIMP) of 2040.

Since this analysis was conducted, the level sensor measuring influent flow was adjusted in the first quarter of 2015. This adjustment indicated that past flows may have been over reported. Given that, this analysis as well as the performance and capacity analysis performed in PM 3.4, *Wastewater - Treatment Plant Performance and Capacity* are conservative.

1.1 Project Memorandums (PMs) Used for Reference

The wastewater flow and load projections outlined in this PM are made in concert with recommendations and analyses from other related PMs:

- PM 1.3 – Overall - Population and Land Use Estimates.
- PM 2.2 - Water System - Water Demand Projections.
- PM 3.1 - Wastewater System - Background Summary.

1.2 Other Reports Used for Reference

In developing the wastewater flow and load projections in this PWIMP, the following reports were used:

- City of Oxnard 2030 General Plan, Development Services Department Planning Division, October 2011 (City of Oxnard General Plan, 2011).
- Wastewater Engineering Treatment and Resource Recovery, Fifth Edition, (Metcalf and Eddy, 2014).
- 2010 United States Census, (U.S. Census Bureau, 2010).
- 2010 Census Traffic Analysis Zone (TAZ), U.S. Department of Commerce, U.S. Census Bureau, Geography Division, (TAZ, 2010).

- Oxnard Industrial Discharge Permits, City of Oxnard, (Industrial Discharge Permits, 2014).

2.0 PROJECTED POPULATION

The Oxnard Wastewater Treatment Plant (OWTP) treats wastewater from the City of Oxnard, the City of Port Hueneme, and a number of significant industrial users. Both the City of Oxnard and the City of Port Hueneme flows were projected in conjunction with their population projections. All other entities contributing wastewater to the OWTP were projected separately and discussed in Section 3.2, 3.3, and 3.4 below. Population projections from the 2030 Oxnard General Plan were used for projecting the City of Oxnard population. As discussed in PM 1.3, *Overall – Population and Land Use Estimates,* the 2030 General Plan outlines four different population projections for the City. The low 2030 General Plan population projections were used for this analysis. Detailed discussion behind this decision can be found in PM 1.3, *Overall - Population and Land Use Estimates.* These population projections are consistent with population projections used for water demand forecasting outlined in PM 2.2, *Water System – Water Demand Projections*.

In addition, the Oxnard Wastewater Treatment Plant (OWTP) treats wastewater from the City of Port Hueneme. US Census data in 2010 for the City of Port Hueneme indicated a population of 21,723 (U.S. Census Bureau, 2010). This is a 0.56 percent decrease in population from their 2000 US Census population. As a conservative estimate, it was assumed that Port Hueneme population would remain constant over the planning period.

3.0 HISTORICAL WASTEWATER FLOWS AND LOADS

Historic influent wastewater flows and loads were analyzed for 2009 through 2013 and are shown in Tables 1 and 2 as well as Figures 1, 2, 3 and 4. These influent flows and loads include residential and commercial users, industrial dischargers, as well as desalter concentrate. Each of these three components are discussed separately in the sections that follow.

Table 1 Historical Wastewater Flows to OWTP (in mgd)
Public Works Integrated Master Plan
City of Oxnard

Flow Condition	Historical Data					
	2009	2010	2011	2012	2013	2009-2013 Average
Average Dry Weather Flow(1)	21.7	21.4	20.1	19.9	19.5	20.5
Average Annual(2)	22.4	22.2	21.6	20.5	19.7	21.3
Average Day Maximum Month(3)	24.2	24.1	24.3	21.4	20.3	22.9

Table 1	**Historical Wastewater Flows to OWTP (in mgd) Public Works Integrated Master Plan City of Oxnard**					
	Historical Data					
Flow Condition	**2009**	**2010**	**2011**	**2012**	**2013**	**2009-2013 Average**
Maximum Week(4)	24.6	26.9	26.0	21.9	20.7	24.0
Maximum Day(5)	26.9	30.5	31.6	25.5	23.5	27.6

Notes:
(1) Average Dry Weather (ADW) Flow = Lowest 90 day running average flow.
(2) Average Annual (AA) = Average for a 365 consecutive day period.
(3) Average Day Maximum Month (ADMM) = Highest 28 day running average flow.
(4) Maximum Week (MW) = Highest 7 day running average flow.
(5) Maximum Day (MD) = Highest observed daily flow.

Table 2	**Historical Wastewater Loads to OWTP Public Works Integrated Master Plan City of Oxnard**					
	Historical Data					
Flow Condition	**2009**	**2010**	**2011**	**2012**	**2013**	**2009-2013 Average**
BOD5(1)						
ADW, klb/d(2)	53.3	50.5	45.1	45.8	48.8	48.7
ADW, mg/L(3)	295	283	269	276	299	284
AA, klb/d	61.4	53.7	49.7	53.1	52.5	54.1
MM, klb/d	67.9	59.1	56.3	59.7	61.4	61.3
MW, klb/d	85.3	64.7	59.4	62.7	66.9	67.8
MD, klb/d	108	88.2	94.2	76.6	92.5	91.9
TSS						
ADW, klb/d	46.4	44.4	41.6	41.5	45.1	43.8
ADW, mg/L	257	249	248	250	277	256
AA, klb/d	49.5	49.2	48.7	46.0	47.8	48.2
ADMM, klb/d	60.5	59.5	65.5	53.1	56.5	59.0
MW, klb/d	89.8	76.5	81.8	64.5	70.7	76.7
MD, klb/d	142	211	190	104	173	164
NH3-N						
ADW, klb/d	6.53	6.26	5.97	6.22	6.30	6.26
ADW, mg/L	36.1	35.1	35.6	37.5	38.7	36.6
AA, klb/d	6.85	6.51	6.63	6.80	6.47	6.65
ADMM, klb/d	7.88	7.51	7.64	7.99	6.83	7.57
MW, klb/d	9.63	8.33	8.24	10.2	7.77	8.83

Table 2	Historical Wastewater Loads to OWTP Public Works Integrated Master Plan City of Oxnard					
	Historical Data					
Flow Condition	**2009**	**2010**	**2011**	**2012**	**2013**	**2009-2013 Average**
MD, klb/d	9.63	8.33	8.24	10.2	7.77	8.83

Notes:
(1) These higher BOD values are likely due to high soluble BOD from the canning and food processing industry.
(2) ADW = Influent load during ADW flow period.
(3) ADW, mg/L calculated as ADW Load (lb/d) / ADWF (mgd) / 8.34.

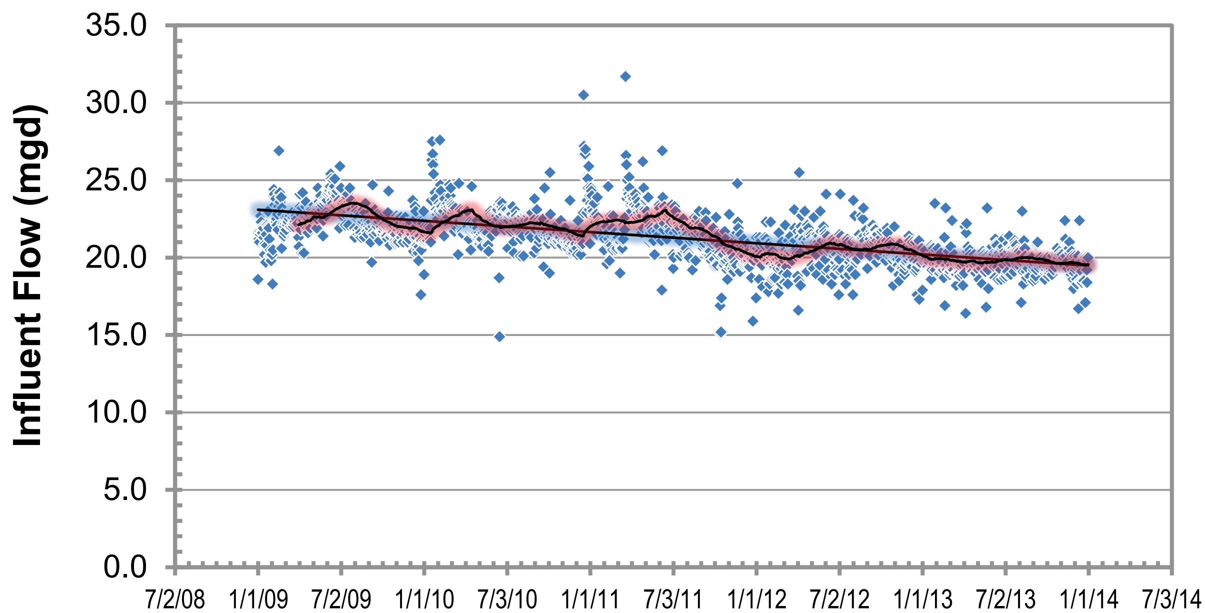

Figure 1 Historical Influent Flow

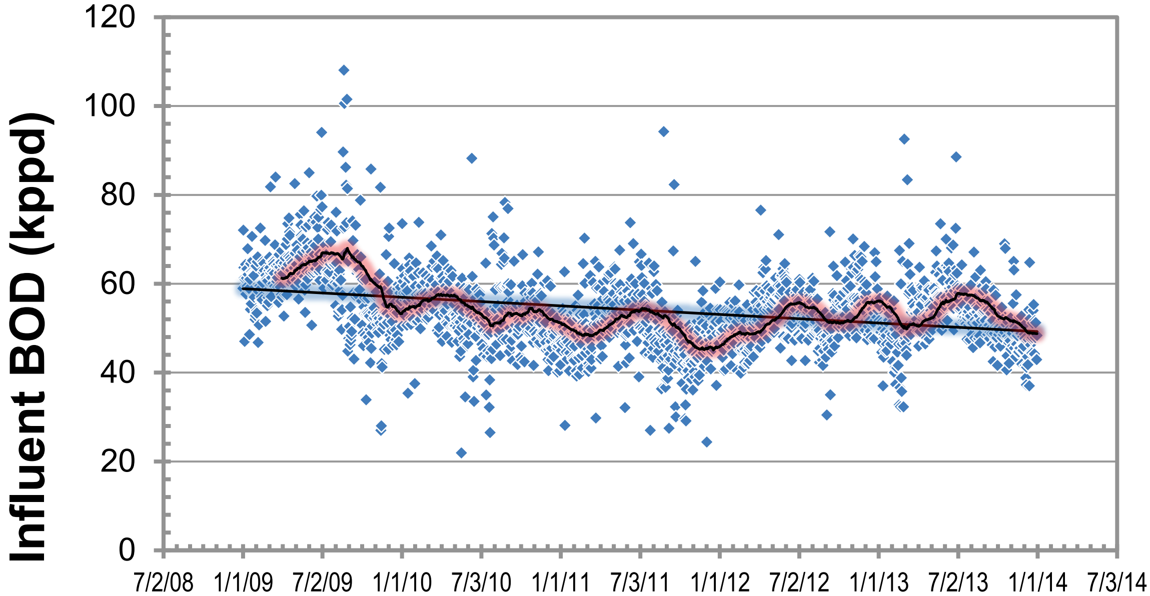

Figure 2 Historical Influent BOD Load

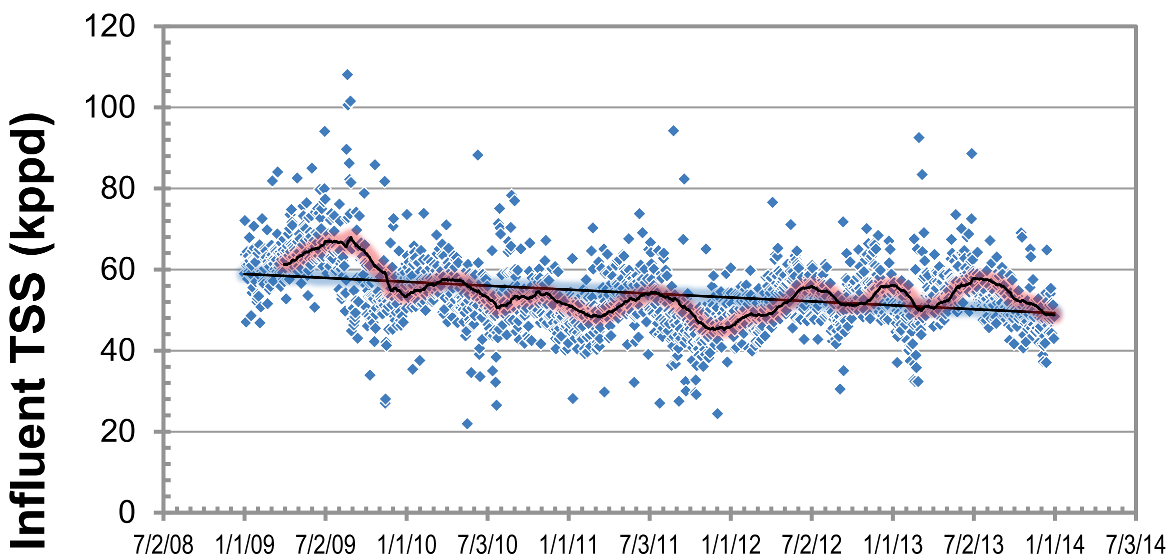

Figure 3 Historical Influent TSS Load

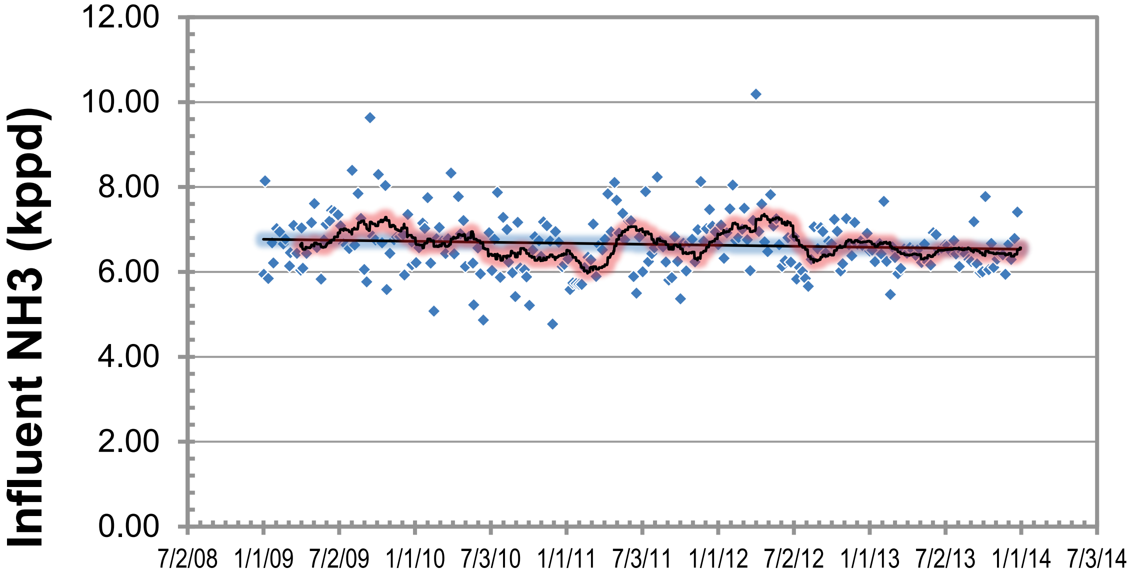

Figure 4 Historical Influent NH3 Load

3.1 Per Capita Flows and Loads (Residential & Commercial)

The majority of flows and BOD and TSS loads entering the OWTP come from residential and commercial dischargers. These commercial and residential discharges are not measured directly and instead must be calculated as the remainder of flow and loads once industrial and desalter concentrate flows and loads are subtracted off using a headworks flow and mass balance approach.

It is typical for these residential and commercial flows and loads to be represented on a per capita basis. For the OWTP, per capita flows and per capita BOD and TSS loads were calculated using 2010 data, which was the most recent US Census data. The 2010 US Census population data for Oxnard and for Port Hueneme as well as recorded 2010 plant influent flows and BOD and TSS loads were used in this analysis. The results are summarized in Table 3. The resulting per capita flows and per capita BOD and TSS loads are within the range given for typical domestic and commercial per capita value (Metcalf and Eddy, 2014).

Table 3 2010 Per Capita Flows and Loads
Public Works Integrated Master Plan
City of Oxnard

	2010		
	Flow (mgd)	**BOD (ppd)**	**TSS (ppd)**
Total OWTP Influent[(1)]	21.4	50,481	44,428
Industrial[(2)]	5.2	6070	5431
Desalter Concentrate[(2)]	1.8	0	63

Table 3	2010 Per Capita Flows and Loads Public Works Integrated Master Plan City of Oxnard		
	2010		
	Flow (mgd)	BOD (ppd)	TSS (ppd)
Residential/Commercial(3)	14.4	44,911	38,935
Per Capita(4)	64 gpd/capita	0.20 ppd/capita	0.17 ppd/capita
Typical Per Capita(5)	40-130 gpd/capita	0.11-0.26 ppd/capita	0.13-0.33 ppd/capita

Notes:
(1) 2010 recorded plant influent flow and loads.
(2) 2010 flows and loads were assumed to be the same as 2014 flows and loads. This flow includes Naval base flow.
(3) Residential and commercial flows and loads were back calculated by subtracting desalter concentrate and industry from total OWTP influent.
(4) Per capita was calculated by dividing residential and commercial by the adjusted 2010 US Census population data for Oxnard and the 2010 US Census population data for Port Hueneme (Total Population: 223,222). Oxnard population data was adjusted to correct for a discrepancy in defined city boundary.
(5) (Metcalf and Eddy, 2014).

Per capita flows were also calculated through Oxnard's collection system model. Dry weather flow monitoring was used to calibrate this model. In the calibration process residential per capita flows were estimated for each subcatchment basin. These estimated per capita flows were multiplied by the population for each subcatchment to determine overall residential flow. Commercial wastewater flows were estimated via water consumption data. As a conservative estimate, it was assumed that the wastewater generation coefficient for these commercial water demands was 1.0. An overall residential and commercial per capita flow was then calculated by taking the overall calibrated wastewater flow from both residential and commercial and dividing it by the overall Oxnard population. The results of this analysis of combined residential and commercial (domestic) per capitas are summarized in Table 4.

As a conservative estimate, the larger per capita flow of 71.6 gpd/capita, as noted in Table 4, was used for domestic (residential and commercial) flow projections at the OWTP.

Table 4	Estimated Domestic Per Capita Flows Based on Collection System Model Public Works Integrated Master Plan City of Oxnard		
	Population(1)	GPCD	Flow (gpd)
Residential - Meter Basin 1	25,526	65	1,659,190
Residential - Meter Basin 2	12,418	90	1,117,620
Residential - Meter Basin 3	28,188	90	2,536,920
Residential - Meter Basin 4	28,355	80	2,268,400

Table 4	Estimated Domestic Per Capita Flows Based on Collection System Model Public Works Integrated Master Plan City of Oxnard		
	Population[1]	**GPCD**	**Flow (gpd)**
Residential - Meter Basin 5	782	90	70,380
Residential - Meter Basin 6	16,309	50	815,450
Residential - Meter Basin 7	11,415	70	799,050
Residential - Meter Basin 8	28,494	50	1,424,700
Residential - Meter Basin 9	17,711	75	1,328,325
Residential - Meter Basin 10	24,981	70	1,748,670
Commercial	--	--	2,205,399
Total:	194,179	--	15,974,104
		Per Capita:	71.6 gpd/capita

Note:
(1) These populations are based on Traffic Analysis Zone (TAZ) 2010 numbers (TAZ, 2010).

3.2 Industrial Flows and Loads

In Oxnard, there are 38 Significant Industrial Users (SIUs) (Industrial Discharge Permits, 2014). Many of these SIUs are food-processing facilities, with functions such as packaging and washing of fresh vegetables. There are also a large number of metals finishing and paper processing plants. In addition, there are two Ventura County Naval Bases: Point Mugu and Port Hueneme. Since these two Ventura County Naval Base SIUs primarily discharge domestic waste, for this analysis they have been broken out separately and are discussed in Section 3.3 below. The remaining 36 SIUs are discussed below.

The largest industrial discharger is the Proctor and Gamble paper processing plant, which discharges on average 31 percent of flow, 21 percent of BOD load, and 46 percent of TSS load contributed by all 36 of the industrial dischargers. Combined, in 2013 all 36 SIUs discharged on average 4.5 mgd of wastewater, 6,070 ppd of BOD, and 5,400 ppd of TSS to the OWTP. Table 5 summarizes these flows and loadings.

Table 5 also summarizes each SIU's permitted flow capacity. The majority of these SIUs are discharging at or above their permitted capacity. There are six SIUs that discharged less than their permitted capacity in 2013. If these six SIUs discharged at their permitted capacity, the additional flow discharged would be 0.08 mgd.

Table 5	2013 Industrial Flows and Loads to Discharged OWTP Public Works Integrated Master Plan City of Oxnard			
Industry Name	ADF[1] Permit Limit (gpd)	2013 ADF (gpd)	2013 Avg BOD (ppd)	2013 Avg TSS (ppd)
Metals				
Alliance Finishing & Manufacturing	No flow at this time	--[2]	--[3]	--[3]
Aluminum Precision Products	7,475	7,000	N/A	1
Arcturus Manufacturing	24,141	25,000	N/A	NA
Coastal Metal Finishing/Limons Metal Finishing	4,000	1,000	N/A	N/A
Elite Metal Finishing	13,500	14,000	N/A	N/A
Raypak	10,850	11,000	N/A	N/A
Simba Cal	750	750	N/A	N/A
Paper				
New Indy	309,000	300,000	70	65
Proctor and Gamble	1,376,291	1,400,000	1,300	2,500
Food Processing				
Boskovich Farms	250,000	250,000	759	367
Cal Sun Produce	32,152	32,000	46	36
Coastal Green Vegetable Co.	220,000	220,000	402	550
Duda Farm Fresh Foods	37,000	37,000	156	48
Frozsun Foods	350,000	350,000	1,083	347
Gill's Onions	250,000	250,000	386	111
Herzog Wine Cellars	10,250	10,000	182	16
J.M. Smucker Co.	148,000	148,000	172	276
Oxnard Lemon Co.	34,500	35,000	--[3]	--[3]
Pacific Ridge Farms	30,000	30,000	140	81
Saticoy Lemon #4	50,000	50,000	55	89
Scarborough Farms	17,000	17,000	4	61
Seaboard Produce Distributors	6,000	25,000	--[3]	--[3]
Terminal Freezer (Del Mar, Suncoast, Tree Top)	730,000	730,000	511	621
Ventura Pacific Co.	70,000	70,000	238	51
Other				
Automotive Racing Products	4,500 – 5,000 per disposal event	--[4]	--[4]	--[4]
Consolidated Precision Products	30,000	11,907	--[3]	--[3]
Crestview Municipal Water Co.	No flow at this time	--[2]	--[3]	--[3]
Deardorff Family Farms	10,000	10,000	3	4
EF Oxnard	15,000	15,000	N/A	N/A

Table 5	2013 Industrial Flows and Loads to Discharged OWTP Public Works Integrated Master Plan City of Oxnard			
Industry Name	**ADF(1) Permit Limit (gpd)**	**2013 ADF (gpd)**	**2013 Avg BOD (ppd)**	**2013 Avg TSS (ppd)**
Harris Water Conditioning	138,000	138,000	2	22
Mission Linen Supply	39,000	39,000	71	44
Parker Hannifin	26,000	26,000	216	2
Puretec Industrial Water	100,000	100,000	12	36
Santa Clara Waste Water Co.	200,000	150,000	231	33
Schlumberger Technology	--(5)	--(5)	--(5)	--(5)
Seminis	18,650	19,000	25	72
Total	**4,600,000**	**4,500,000**	**6,070**	**5,400**

Notes:
(1) ADF = Average Day Flow.
(2) No flow reported for 2013.
(3) No BOD or TSS concentration reported for 2013.
(4) Batch discharger.
(5) Schlumberger has a dewatering (Groundwater) permit.

3.3 Naval Base Ventura County (NBVC) Flows and Loads

There are two naval bases that contribute flows and loads to the OWTP. These naval bases are NBVC at Point Mugu and NBVC at Port Hueneme. In 2013, these two facilities discharged 0.36 mgd of flow. While loadings for these two facilities were not recorded, NBVC at Point Mugu and NBVC at Port Hueneme discharge mainly domestic wastewater. Thus, for the purposes of this analysis, it was assumed that their BOD and TSS concentrations were comparable to the observed overall BOD and TSS concentrations from domestic wastewater within the City of Oxnard. In 2013, NBVC at Point Mugu and NBVC at Port Hueneme discharged substantially less flow their permitted capacity. If these facilities discharged at their permitted capacity, combined they would discharge an additional 0.36 mgd.

3.4 Desalter Concentrate Flows and Loads

In addition to industrial and residential/commercial dischargers, there are also two desalters that discharge their desalter concentrate to the OWTP. These desalters are the City of Oxnard Desalter and the Port Hueneme Water Agency Desalter. In 2013, these two desalter concentrate flows averaged 1.85 mgd. While these two dischargers are classified as SIUs, they have been separated out in this report because, unlike industry, desalter concentrate generally does not contribute substantially to BOD and TSS loadings. Because of these low loadings, these two desalter concentrate dischargers will not have a large impact on the capacity rating of the plant.

4.0 PEAKING FACTORS

Historical peaking factors were also determined for combined influent flows and loadings. Table 6 outlines historical peaking factors for 2009 to 2013 flows. Table 7 outlines historical peaking factors for 2009 to 2013 BOD and TSS loads. The 2009-2013 average peaking factors were used for projecting flows and loads.

Table 6 Historical OWTP Flow Peaking Factors
Public Works Integrated Master Plan
City of Oxnard

Flow Condition	Historical Peaking Factors					
	2009	2010	2011	2012	2013	2009-2013 Average
Average Dry Weather Flow	1.0	1.0	1.0	1.0	1.0	1.0
Average Annual	1.03	1.04	1.08	1.03	1.01	1.04
Maximum Month	1.12	1.13	1.21	1.07	1.04	1.11
Maximum Week	1.14	1.26	1.29	1.10	1.06	1.17
Maximum Day	1.24	1.43	1.58	1.28	1.20	1.35

Table 7 Historical OWTP Load Peaking Factors
Public Works Integrated Master Plan
City of Oxnard

Load Condition	Historical Peaking Factors					
	2009	2010	2011	2012	2013	2009-2013 Average
BOD_5						
Average Dry Weather Load	1.0	1.0	1.0	1.0	1.0	1.0
Average Annual	1.15	1.06	1.10	1.16	1.08	1.11
Maximum Month	1.31	1.17	1.25	1.31	1.26	1.26
Maximum Week	1.60	1.28	1.32	1.37	1.37	1.39
Maximum Day	2.03	1.75	2.09	1.67	1.90	1.89
TSS						
Average Dry Weather Load	1.0	1.0	1.0	1.0	1.0	1.0
Average Annual	1.07	1.11	1.17	1.11	1.06	1.10
Maximum Month	1.30	1.34	1.58	1.28	1.25	1.35
Maximum Week	1.94	1.72	1.97	1.55	1.57	1.75
Maximum Day	3.05	4.75	4.58	2.50	3.84	3.74
NH_3-N						
Average Dry Weather Load	1.0	1.0	1.0	1.0	1.0	1.0
Average Annual	1.05	1.04	1.11	1.09	1.03	1.06
Maximum Month	1.21	1.20	1.28	1.28	1.08	1.21

Table 7 Historical OWTP Load Peaking Factors Public Works Integrated Master Plan City of Oxnard						
	Historical Peaking Factors					
Load Condition	2009	2010	2011	2012	2013	2009-2013 Average
BOD_5						
Average Dry Weather Load	1.0	1.0	1.0	1.0	1.0	1.0
Average Annual	1.15	1.06	1.10	1.16	1.08	1.11
Maximum Month	1.31	1.17	1.25	1.31	1.26	1.26
Maximum Week	1.60	1.28	1.32	1.37	1.37	1.39
Maximum Day	2.03	1.75	2.09	1.67	1.90	1.89
TSS						
Average Dry Weather Load	1.0	1.0	1.0	1.0	1.0	1.0
Average Annual	1.07	1.11	1.17	1.11	1.06	1.10
Maximum Month	1.30	1.34	1.58	1.28	1.25	1.35
Maximum Week	1.94	1.72	1.97	1.55	1.57	1.75
Maximum Day	3.05	4.75	4.58	2.50	3.84	3.74
Maximum Week	1.48	1.33	1.38	1.64	1.23	1.41
Maximum Day	1.48	1.33	1.38	1.64	1.23	1.41

5.0 WASTEWATER FORECASTING METHODOLOGY

This section outlines the methodology used to project future wastewater flows and loadings to the OWTP. Based on a review of the available data, it was determined that the most accurate wastewater forecasting approach for this PWIMP is a combination of a population-based per capita method for domestic (residential and commercial), and a land use based projection method for industry.

5.1 Domestic/Commercial Projections

Residential and commercial wastewater flow and load projections were estimated using the population projections outlined in PM 1.3 plus the 2010 US Census Port Hueneme population. A per capita daily flow of 71.6 gpd/capita, a per capita daily BOD load of 0.20 ppd/capita, and a per capita daily TSS load of 0.17 ppd/capita were used to project flows and loadings to the OWTP in conjunction with population projections.

5.2 Industrial Projections

Industry was projected in two components: existing industry and new industry. For existing industry, it was assumed that the 30 SIUs currently discharging at or above their permitted flow would continue to discharge at existing 2013 flows and loadings through the planning horizon. There are six remaining industries that discharge less flow than what their discharge permit allows. As a conservative estimate, it was assumed that these industries would discharge flow at their permit limit. This additional flow was assumed to have a BOD and TSS concentration consistent with average industry BOD and TSS concentrations. This was assumed since some industries have no historical loading data.

New industry wastewater flow projections were estimated using water demand projections outlined in PM 2.2. In PM 2.2, new industrial developments were discussed for Sakioka Farms, El Camino, and South Shore. Industrial infill was also mentioned. These additional industrial demands were calculated via future land use and allocated for 2020 and for 2040. Table 8 outlines these demands. As a conservative estimate, it was assumed that the wastewater generation coefficient for this additional industrial water demand is 1.0. Additionally, it was assumed that new industry would grow linearly from 0 to the 2020 water demand projections and then linearly again to the 2040 water demand projections. Figure 5 summarizes this industrial growth projection.

BOD and TSS concentrations for this new industrial wastewater component were assumed to be 850 ppd and 400 ppd, respectively. These values were chosen based on a review of the range of historical industrial wastewater strengths, and on best professional judgment.

Table 8 Near-Term Industry Demand and Wastewater Flow Projections
Public Works Integrated Master Plan
City of Oxnard

Map ID	Development Name	Dev. Size acres	Demand Factor (gpd/ac)	ADD by 2020 (mgd)	ADD by 2040 (mgd)
6	Sakioka Farms Industry	280.5	3500	0	0.98
7	El Camino Industry	79.2	3500	0	0.28
13	South Shore Industry	31.63	3500	0	0.11
16	Industrial Infill	106	3500	0.36	0.37
	Total			**0.36**	**1.74**

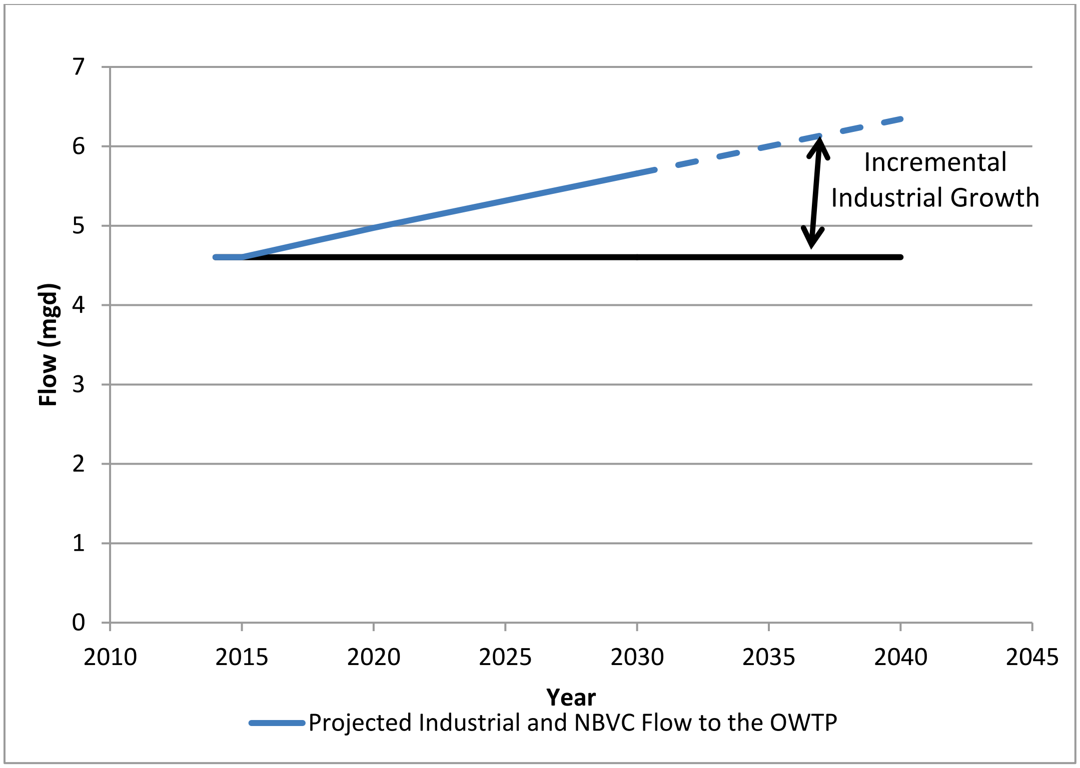

Figure 5 Industrial Growth Projection

5.3 Naval Base Ventura County Projections

Similarly to industrial flow and load projections, it was assumed that both NBVC at Point Mugu and NBVC at Port Hueneme would discharge at their permitted limit throughout the planning period. It was also assumed that the additional flow projected for these NBVCs would have a BOD and TSS concentration consistent with the average residential/ commercial concentrations. This assumption seems reasonable since these two wastewater dischargers are mainly domestic wastewater.

5.4 Desalter Concentrate Projections

Projected desalter concentrate flows and loads from the Oxnard Desalter and Port Hueneme Water Agency Desalter were not included in the flow projections to the OWTP headworks. This is because the desalter concentrate composition of total dissolved solids are not anticipated to impose a demand on the primary and secondary wastewater treatment unit operations at OWTP. Additionally, in the future, it is planned that the desalter concentrate will be discharged to the outfall through a separate concentrate line, bypassing the OWTP.

6.0 FUTURE WASTEWATER DEMAND PROJECTIONS

This section summarizes the flow and load projections anticipated through 2040. The purpose of the master planning projections presented in this section is to allow for a conservative estimate of future wastewater flows and loadings. The projections presented herein are the basis for triggering the preliminary design of future treatment facilities in time to allow for the typical five to seven years that it takes to implement new wastewater capacity. Once the preliminary and final designs of those facilities are triggered, however, the need and timing will be further reviewed and confirmed. Nevertheless, over the 20-year planning horizon, it is anticipated that these projected flows and associated facilities will be realized.

6.1 Flow Projections

The projected ADW flow is summarized in Table 9, categorized by use type; Figure 6 illustrates both ADW flow and ADMM flow projections (in aggregate). While historical flow records indicate a decrease in influent flows to the plant, this observed decline in recent years is likely due to the current drought. The drought has likely caused a reduction in water usage and observed groundwater infiltration in the collection system. Both of these effects result in decreased flows to the OWTP. Therefore, based on our best professional judgment, there should be an allowance for a “rebound” effect following a return to more normal rainfall patterns in the future, as shown in the PWIMP flow projections.

Table 9 OWTP ADWF Projections
Public Works Integrated Master Plan
City of Oxnard

Year	Population	Residential/ Commercial (mgd)	Existing Industry and NBVCs (mgd)	Existing Industry and NBVCs Additional Permitted Flow (mgd)	New Industry (mgd)	Desalter Concentrate (mgd)	Total (mgd)
2015	232,596	16.6	5.20	0.44	0	0	22.3
2020	241,971	17.3	5.20	0.44	0.37	0	23.3
2025	251,345	18.0	5.20	0.44	0.71	0	24.3
2030	260,719	18.7	5.20	0.44	1.06	0	25.3
2035	270,093	19.3	5.20	0.44	1.40	0	26.4
2040	279,468	20.0	5.20	0.44	1.74	0	27.4

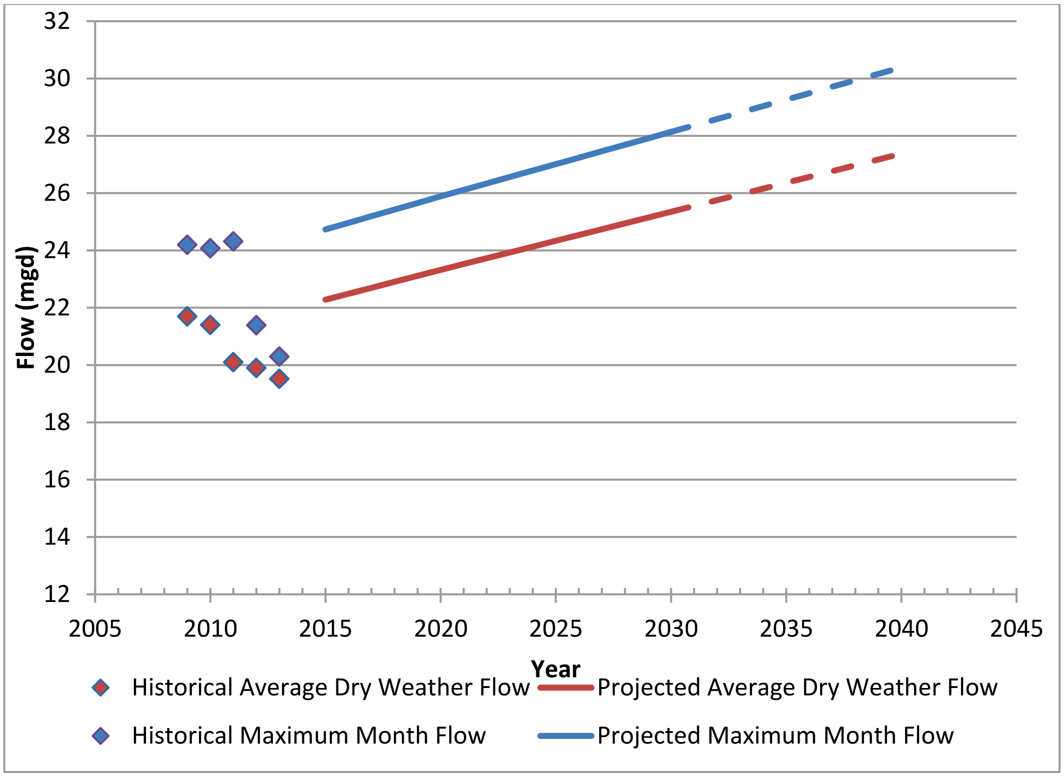

Figure 6 Projected OWTP Influent Flow

6.2 Load Projections

Wastewater ADWL and MM BOD and TSS loading projections are summarized in Tables 10 and 11 and illustrated in Figures 7 and 8. These loading projections are divided by discharge type in the table and shown in aggregate in the figure.

Table 10 OWTP Average Dry Weather BOD Load Projections
Public Works Integrated Master Plan
City of Oxnard

Year	Population	Residential/ Commercial (ppd)	Existing Industry and NBVCs (ppd)	Existing Industry and NBVCs Additional Permitted Flow (ppd)	New Industry (ppd)	Desalter Concentrate (ppd)	Total (ppd)
2015	232,596	46,276	6,070	429	0	0	52,774
2020	241,971	48,141	6,070	429	2,623	0	57,262
2025	251,345	50,006	6,070	429	5,051	0	61,555
2030	260,719	51,871	6,070	429	7,479	0	65,848
2035	270,093	53,736	6,070	429	9,907	0	70,145
2040	279,468	55,601	6,070	429	12,335	0	74,443

Table 11	OWTP Average Dry Weather TSS Load Projections Public Works Integrated Master Plan City of Oxnard						
Year	**Population**	**Residential/ Commercial (ppd)**	**Existing Industry and NBVCs (ppd)**	**Existing Industry and NBVCs Additional Permitted Flow (ppd)**	**New Industry (ppd)**	**Desalter Concentrate (ppd)**	**Total (ppd)**
2015	232,596	40,570	5,431	378	0	0	46,378
2020	241,971	42,205	5,431	378	2,623	0	50,636
2025	251,345	43,840	5,431	378	5,051	0	54,699
2030	260,719	45,475	5,431	378	7,479	0	58,762
2035	270,093	47,110	5,431	378	9,907	0	62,826
2040	279,468	48,745	5,431	378	12,335	0	66,889

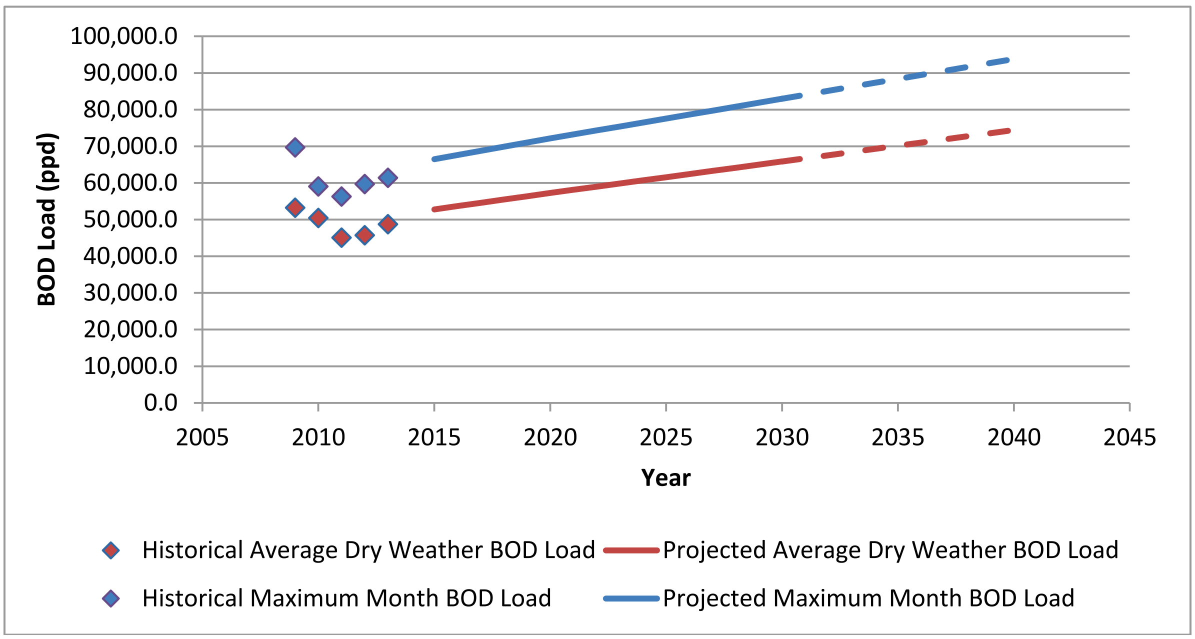

Figure 7 Projected OWTP Influent BOD Load

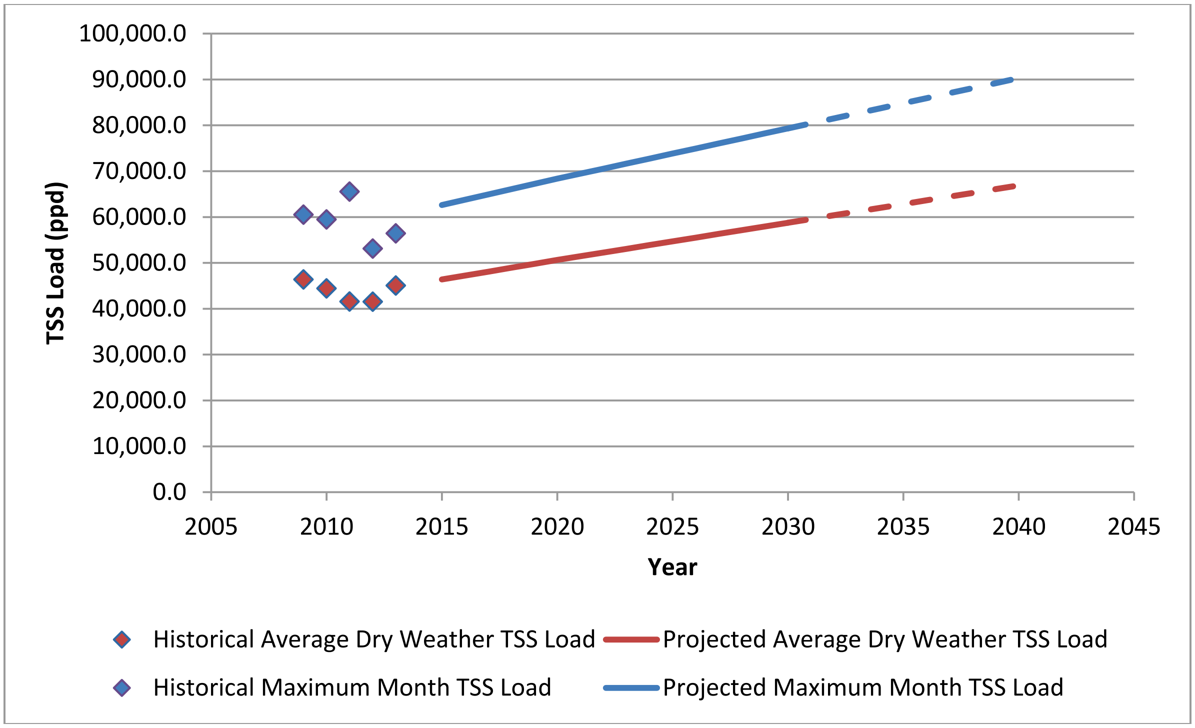

Figure 8 Projected OWTP Influent TSS Load

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City of Oxnard

Public Works Integrated Master Plan

WASTEWATER

PROJECT MEMORANDUM 3.3
INFRASTRUCTURE MODELING AND ALTERNATIVES

REVISED FINAL DRAFT
September 2017

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PREFACE

The analysis and evaluations contained in these Project Memorandum (PM) are based on data and information available at the time of the original date of publication, December 2015. After development of the December 2015 Final Draft PMs, the City continued to move forward on two concurrent aspects: 1) advancing the facilities planning for the water, wastewater, recycled water, and stormwater facilities; and 2) developing Updated Cost of Service (COS) Studies (Carollo, 2017) for the wastewater/collection system and the water/distribution system. The updated 2017 COS studies contain the most recent near-term Capital Improvement Projects (CIP). **The complete updated CIP based on the near-term and long-term projects is contained in the Brief History and Overview of the City of Oxnard Public Works Department's Integrated Planning Efforts: May 2014 – August 2017 section.**

At the time of this Revised PWIMP, minor edits were also incorporated into the PMs. Minor edits included items such as table title changes and updating reports that were completed after the December 2015 original publication date.

City of Oxnard

Public Works Integrated Master Plan

WASTEWATER

PROJECT MEMORANDUM 3.3
INFRASTRUCTURE MODELING AND ALTERNATIVES

TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

INFRASTRUCTURE MODELING AND ALTERNATIVES

1.0 INTRODUCTION

This Project Memorandum (PM) summarizes the process of updating and calibrating the City's existing hydraulic wastewater model. This PM also discusses several wastewater improvement projects needed for the existing system to accommodate design level wet weather flows as well as future flows due to growth that needs to be served by the wastewater collection system.

1.1 PMs Used for Reference

The analyses performed in this PM may be supplemented with additional information found in the following related PMs:

- PM 3.1 - Wastewater System - Background Summary.
- PM 3.2 - Wastewater System - Flow and Load Projections.

2.0 HYDRAULIC MODEL DEVELOPMENT

A hydraulic model of a wastewater collection system is a simplification of the physical network that currently serves residential, commercial, and industrial facilities within the wastewater treatment plant's service area. Typically, a hydraulic model will not include every pipe within the system because many small pipes do not have capacity issues. Therefore the model for the City is skeletonized to include only those major pipes (usually greater than 10-inches in diameter).

The City provided an initial model that was developed previously in SewerGEMS. Carollo has been tasked by the City to update the model with recent information on the pipelines and pump stations, calibrate the model to measured dry and wet weather flows, and project what facilities are needed in the future to serve future expected growth within the service area.

2.1 Modeled Collection System and Skeletonization

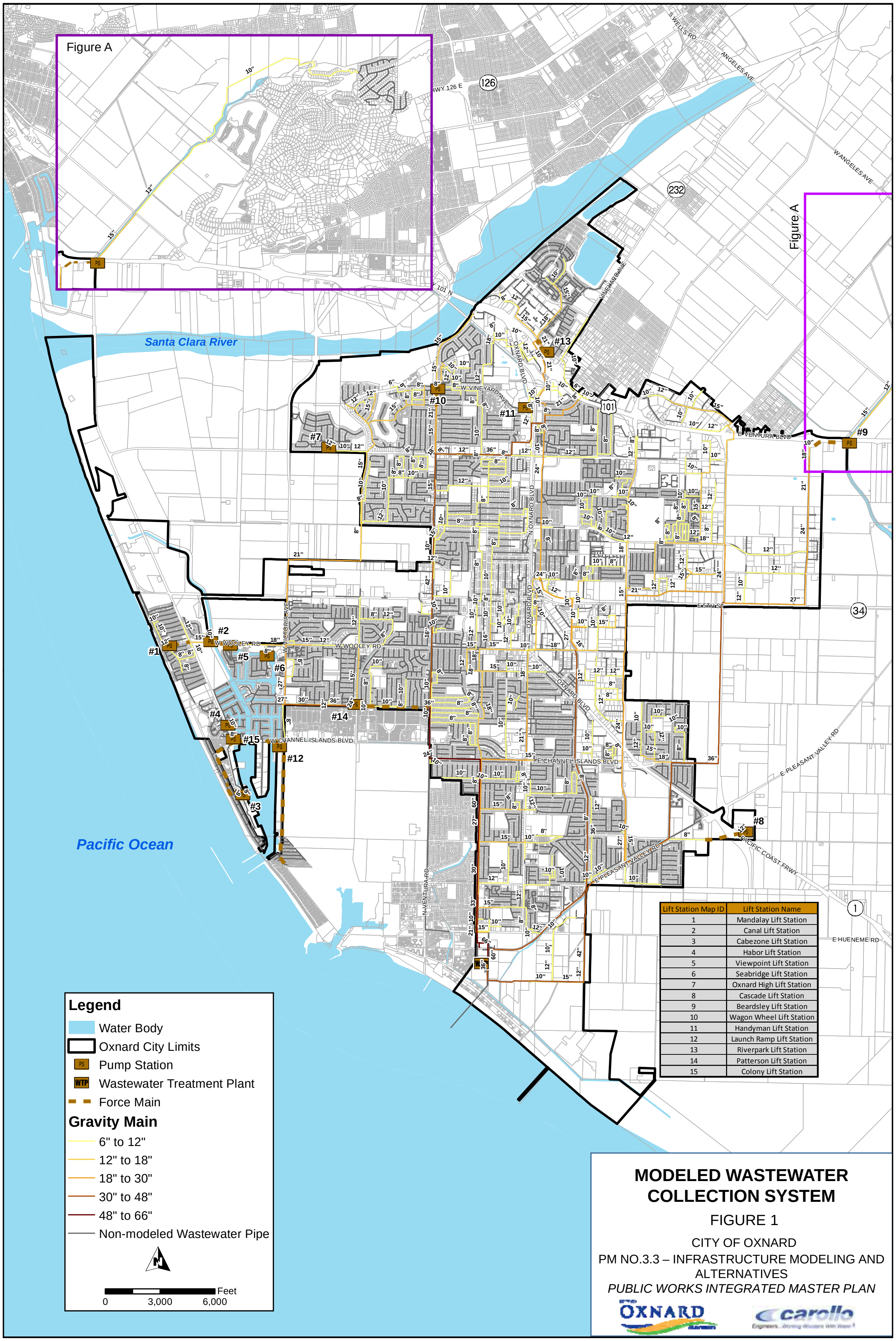
Skeletonization is the process by which sewer system models are stripped of pipelines not considered essential for the intended analysis purpose. The purpose of skeletonizing a system is to develop a model that accurately simulates the hydraulics of a collection system, while at the same time reducing the complexity of the model so that computational run times are kept to a minimum for analysis purposes.

It is common practice in sewer system master planning to exclude small diameter sewers when developing a hydraulic computer model. The City's hydraulic model primarily includes pipelines that are 8-inches in diameter and larger. Some smaller diameter sewers (6-inches in diameter and smaller) are also included in the City's hydraulic model where needed for connectivity.

The modeled sewer system consists of approximately 140 miles of sanitary sewer pipelines ranging in diameter from 4-inches to 66-inches, and 15 sanitary sewer lift stations. Table 1 summarizes the modeled sewer system by diameter and length of pipe. Not included in these totals are smaller sewers that were excluded during model skeletonization and therefore are not modeled. The modeled pipe length equals 736,708 feet which is approximately 32.4 percent of the entire collection system. Table 1 illustrates the City's modeled wastewater collection system, which is also shown in Figure 1. Figure 2 presents an overview of the pipes around the Oxnard Wastewater Treatment Plant (OWTP).

**Table 1 Modeled System Pipeline Summary
Public Works Integrated Master Plan
City of Oxnard**

Pipe Diameter, in.	Length, feet		Percent of Total, %	
	Force Main	Gravity Main	Force Main	Gravity Main
6 and smaller	6,753	1,313	21.4%	0.2%
8	8,586	143,937	27.2%	20.4%
10	4,235	143,327	13.4%	20.3%
12	7,955	94,551	25.2%	13.4%
15	0	86,962	0.0%	12.3%
16	0	1,762	0.0%	0.2%
18	0	42,840	0.0%	6.1%
20	4,000	0	12.7%	0.0%
21	0	33,839	0.0%	4.8%
24	0	30,547	0.0%	4.3%
27	0	21,080	0.0%	3.0%
30	0	6,982	0.0%	1.0%
33	0	2,549	0.0%	0.4%
36	0	50,284	0.0%	7.1%
42	0	27,722	0.0%	3.9%
48	0	94	0.0%	0.0%
60	0	16,322	0.0%	2.3%
66	0	1,068	0.0%	0.2%
Total	**31,529**	**705,179**	**100.0%**	**100.0%**



Lift Station Map ID	Lift Station Name
1	Mandalay Lift Station
2	Canal Lift Station
3	Cabezone Lift Station
4	Habor Lift Station
5	Viewpoint Lift Station
6	Seabridge Lift Station
7	Oxnard High Lift Station
8	Cascade Lift Station
9	Beardsley Lift Station
10	Wagon Wheel Lift Station
11	Handyman Lift Station
12	Launch Ramp Lift Station
13	Riverpark Lift Station
14	Patterson Lift Station
15	Colony Lift Station

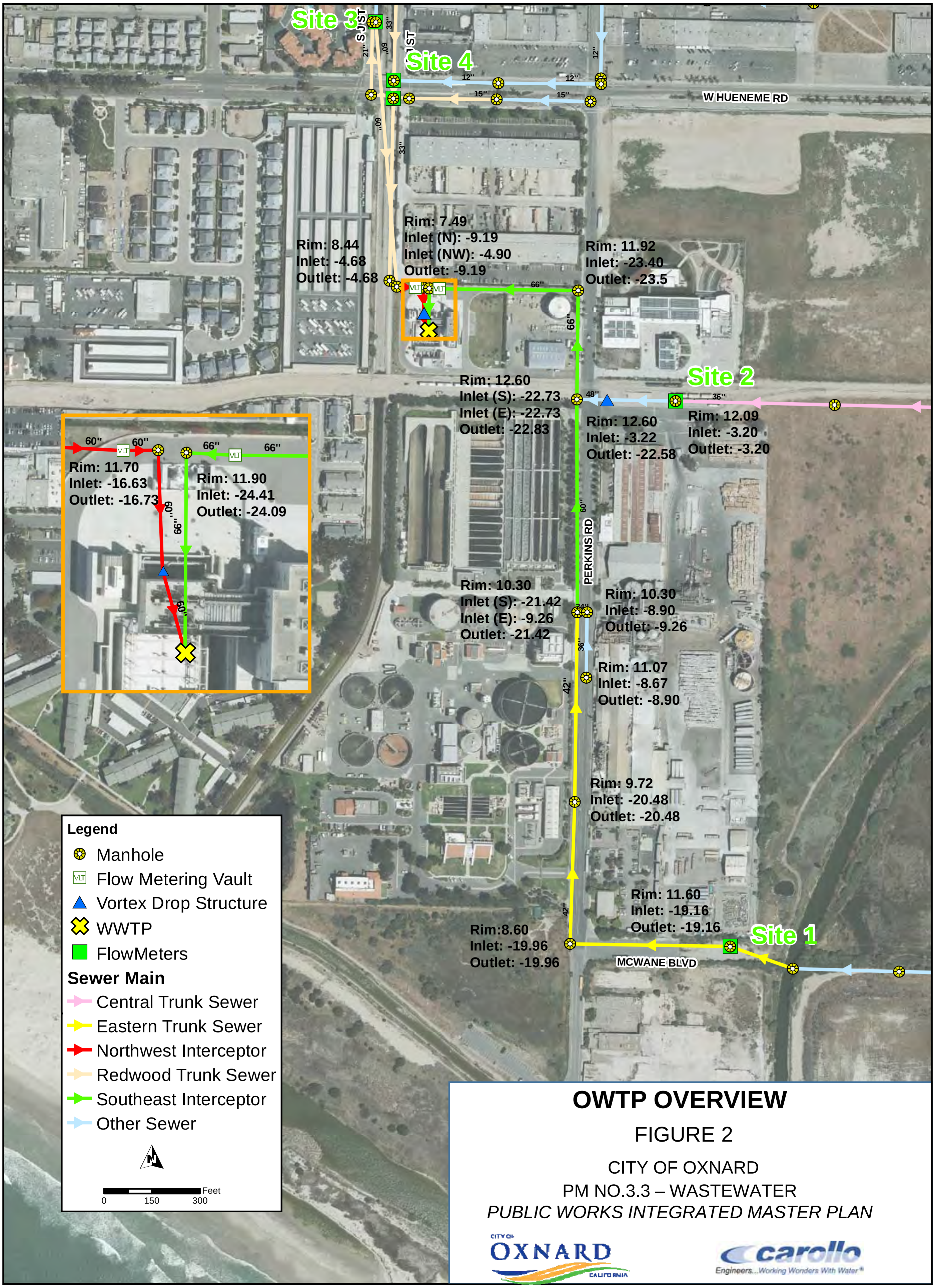
MODELED WASTEWATER COLLECTION SYSTEM

FIGURE 1

CITY OF OXNARD

PM NO.3.3 – INFRASTRUCTURE MODELING AND ALTERNATIVES

PUBLIC WORKS INTEGRATED MASTER PLAN



OWTP OVERVIEW

FIGURE 2

CITY OF OXNARD
PM NO.3.3 – WASTEWATER
PUBLIC WORKS INTEGRATED MASTER PLAN

2.2 Hydraulic Model Elements

The following provides a brief overview of the major elements of the hydraulic model and the required input parameters associated with each:

- **Conduits**: Gravity sewers are represented as conduits in the hydraulic model. Input parameters for pipes include length, friction factor (Manning's n), invert elevations, diameter and entrance and exit loss coefficients (k-factors).

- **Pressure Pipes**: Force mains are represented as pressure pipes in the hydraulic model. Input parameters for pipes include length, friction factor (Hazen Williams), invert elevations, diameter, and entrance and exit loss coefficients (k-factors).

- **Manholes**: Gravity sewer manholes, as well as other locations where gravity pipe sizes change or where gravity pipelines intersect are represented as junctions. Required inputs for junctions include rim elevation, invert elevation and diameter. Junctions are also used to represent locations where flows are split or diverted between two or more gravity sewers.

- **Outfall**: Outfalls represent areas where flow leaves the system. For sewer system modeling, an outfall typically represents the connection to the influent pump station at a wastewater treatment plant.

- **Pumps**: Pumps can be included in the hydraulic model. Input parameters for pumps include pump curve, invert elevation and operational controls (start/stop elevations, as well as any real time control algorithms).

- **Wet Wells**: Wet wells are typically required at pumping stations to store wastewater before it is pumped. Wet wells normally serve as collection/storage nodes for gravity systems. Input parameters for wet wells include, invert elevation, rim elevation, wet well depth, and wet well cross sectional area (depth and cross sectional are used to calculate the volume of the wet well).

- **Pressure Junctions**: Pressure junctions are basically connections between two or more pressure pipes. Inputs for pressure junction include rim elevation and invert elevation.

- **Inflows**: The following are the different types of wastewater flow sources that can be injected into individual model junctions:
  - **External**. External inflows can represent any number of flows into the collection system such as large industrial flow inputs. External inflows are applied to a specific model junction by applying a baseline flow value and a corresponding pattern that varies the flow by a certain time period.
  - **Dry Weather**. Dry weather inflows simulate base sanitary wastewater flows and represent the average flow. The dry weather flows can be multiplied by patterns

that vary the flow by a defined time period. The dry weather diurnal patterns are adjusted during the dry weather calibration process.

– **Rain Derived Infiltration and Inflow (RDII)**. RDII can be applied in the model in different ways, but the method chosen for the City's model is a triple triangular unit hydrograph method. It is applied in the model by assigning a unit hydrograph and a corresponding tributary area to a given junction. The unit hydrographs consist of several parameters that are used to adjust the peak and volume of RDII that enters the system at a given location. These parameters are adjusted during the wet weather calibration process.

2.3 Model Update

The City's hydraulic model combines information on the physical and operational characteristics of the wastewater collection system, and performs calculations to solve a series of mathematical equations to simulate flows in pipes. The City provided the model as a SewerGEMS input file. Carollo is currently applying SewerGEMS v.8i to update the model and apply it for development of a capital improvement program.

The model update process consisted of the following steps, as described below:

- Step 1: The SewerGEMS hydraulic model obtained from the City was updated primarily with the City's GIS data. The Modelbuilder tool in SewerGEMS allowed the importing of the GIS data into a format that would be useable in SewerGEMS. As mentioned previously, the updated model primarily contains pipelines that are 8-inches in diameter and larger. Some smaller diameters were included where needed for connectivity.

- Step 2: Once the GIS data was imported into SewerGEMS, the updated hydraulic model was reviewed to verify that the model data was input correctly and the flow direction, size, and layout of the modeled pipelines were logical. Quality assurance and quality control (QA/QC) involved comparing the updated hydraulic model with limited other data sources such as record drawings, atlas sheets, and discussions with City personnel. Significant data input was not part of this effort.

2.4 Wastewater Load Allocation

An important component of the hydraulic modeling process is to determine the quantity of dry weather wastewater flows generated by a municipality and how these flows are distributed throughout the collection system. Various techniques can be used to assign wastewater flows to individual model junctions, depending on the type of data that is available. Adequate estimates of the volume of wastewater are important in maintaining and sizing sewer system facilities, both for present and future conditions.

Baseline wastewater loads were divided into residential loads and non-residential loads. Residential loads were allocated in the hydraulic model based on 2012 population data from Traffic Analysis Zones (TAZ) provided by the City. Non-residential loads were allocated in the hydraulic model based on water consumption data, which was also provided by the City, from January to March of 2012.

The general process for allocating the wastewater loads is described below:

- Step 1: The City's service area was broken up into 733 individual loading polygons. Each loading polygon represents the geographic area that contributes flows into a single model node (i.e., manhole). In a skeletonized model such as the City's hydraulic model, a loading polygon will usually encompass a group of lots.

- Step 2: For the residential loads, each loading polygon had to be assigned a population value. Since the population data was originally in the TAZ polygons, and certain TAZ polygons overlay one or more loading polygons, a weighted average was used to calculate the population numbers. It was assumed that the loading polygons only had population in the developed areas; information regarding the land type was obtained through the zoning polygons provided by the City. Once the loading polygons had a population number, a gallons per capita per day (gpcd) value, based on engineering judgment was assigned to each polygon to obtain the average residential flow in gallons per day (gpd).

- Step 3: For the non-residential loads, the average non-residential flow in gpd was calculated using water consumption data from January to March of 2012. Water consumption during these months was assumed to be primarily indoor consumption, which would give a good approximation of residential sewer discharges. Once average non-residential flows were obtained, the values were spatially mapped to the corresponding non-residential parcel point. Each parcel point represents the centroid of a non-residential parcel polygon. It was also assumed that all the flows from each non-residential parcel point flows to the loading polygon that it is located in.

- Step 4: The allocated loads were adjusted as necessary during the dry weather flow calibration process (refer to Section 3.2) to closely match the actual measured dry weather flows recorded during the flow monitoring period.

3.0 HYDRAULIC MODEL CALIBRATION

Hydraulic model calibration is a crucial component of the hydraulic modeling effort. Calibrating the model to match data collected during the flow-monitoring period ensures the most accurate results possible. The calibration process consists of calibrating to both dry and wet weather conditions.

For this project, both dry and wet weather flow monitoring were conducted. Refer to PM 3.11 for the Flow Monitoring Report. Dry weather and wet weather flow monitoring was conducted at 10 open-channel flow monitoring sites. Dry weather flow monitoring occurred from August 2, 2014 to August 24, 2014 and wet weather flow monitoring occurred from December 9, 2014 to February 25, 2015. Except for one location, the wet weather monitoring sites were at the same locations as the dry weather monitoring sites. The flow monitoring for Site 4A was performed one manhole upstream from Site 4 as the new site had better hydraulic conditions for flow monitoring. Rainfall data for five rainfall recording sites was obtained from the Ventura County Watershed Protection District Hydrologic Data Server. The location of the flow meters is presented in Figure 3 while a flow metering schematic is presented in Figure 4.

Dry weather flow (DWF) calibration ensures an accurate depiction of base wastewater flow generated within the study area. Wet weather flow (WWF) calibration consists of calibrating the hydraulic model to a specific storm event or events to accurately simulate the peak and volume of infiltration/inflow (I/I) into the sewer system. The amount of I/I is essentially the difference between the WWF and DWF components.

3.1 Calibration Standards

The hydraulic model was calibrated in accordance with international modeling standards. The Wastewater Planning Users Group (WaPUG), a section of the Chartered Institution of Water and Environmental Management (CIWEM), has established generally agreed upon principles for model verification. The dry weather and wet weather calibration focused on meeting the recommendations on model verification contained in the "Code of Practice for the Hydraulic Modeling of Sewer Systems," (http://www.ciwem.org/media/44426/Modelling_COP_Ver_03.pdf) published by the WaPUG (WaPUG 2002), and is summarized below:

- **Dry Weather Calibration Standards**: DWF calibration should be carried out for two dry weather days and the modeled flows and depths should be compared to the field measured flows and depths. Both the modeled and field measured flow hydrographs should closely follow each other in both shape and magnitude.

  In addition to the shape, the observed flow and model hydrographs should also meet the following criteria as a general guide:

  - The timing of the flow peaks and troughs should be within one hour.
  - The peak flow rate should be within the range of ±10 percent.
  - The volume of flow (or the average rate of flow) should be within the range of ± 10 percent. If applicable, care should be taken to exclude periods of missing or inaccurate data.

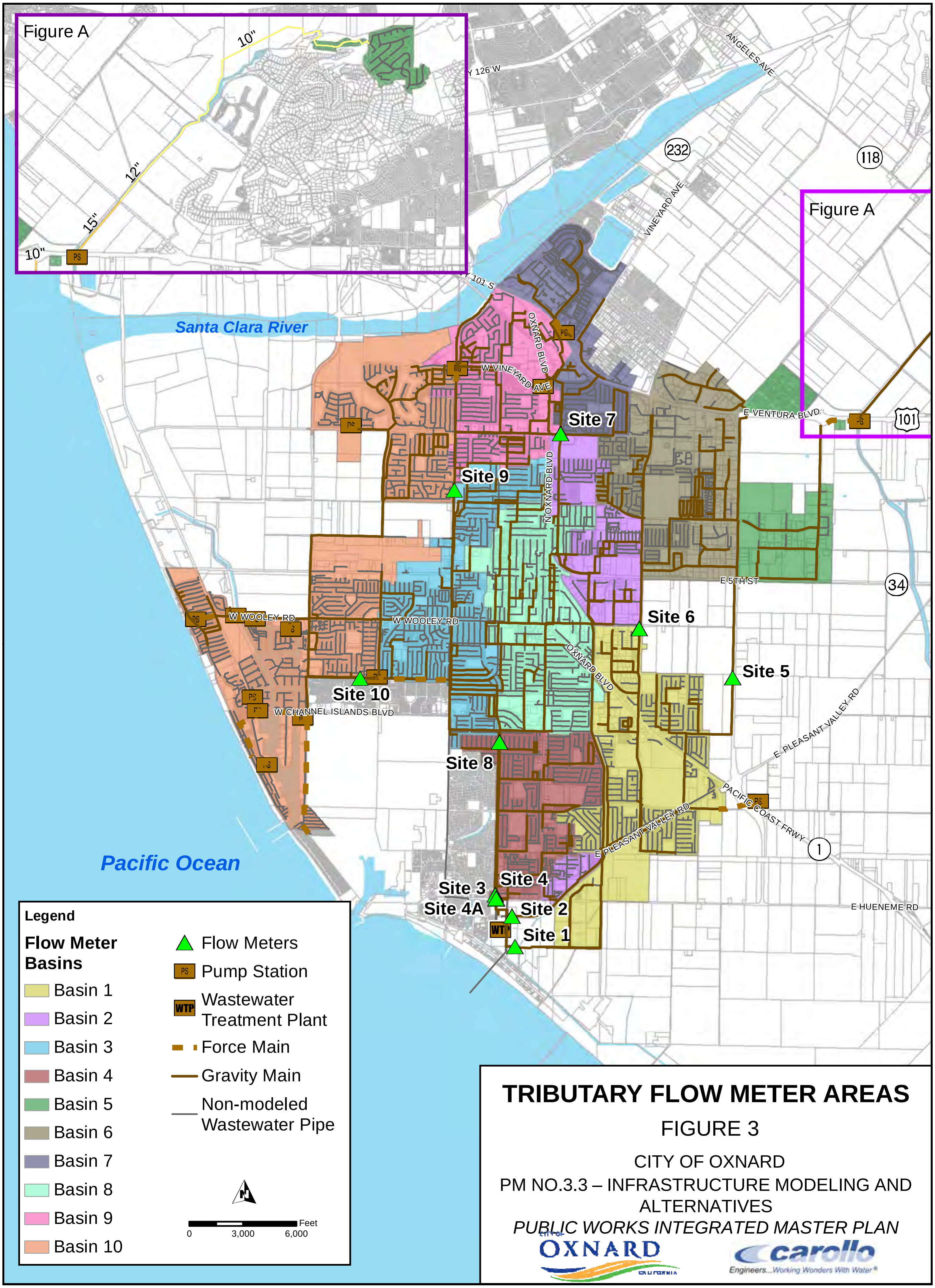


Figure A
10"
12"
15"
10"
PS
Santa Clara River
Pacific Ocean
ANGELES AVE
VINEYARD AVE
232
118
101
34
1
Figure A
E VENTURA BLVD
OXNARD BLVD
W VINEYARD AVE
N OXNARD BLVD
OXNARD BLVD
W WOOLEY RD
W CHANNEL ISLANDS BLVD
E 5TH ST
E PLEASANT VALLEY RD
PACIFIC COAST FRWY
E HUENEME RD
Site 1
Site 2
Site 3
Site 4
Site 4A
Site 5
Site 6
Site 7
Site 8
Site 9
Site 10
WTP
Legend
Flow Meter Basins
Basin 1
Basin 2
Basin 3
Basin 4
Basin 5
Basin 6
Basin 7
Basin 8
Basin 9
Basin 10
Flow Meters
Pump Station
Wastewater Treatment Plant
Force Main
Gravity Main
Non-modeled Wastewater Pipe
Feet
0
3,000
6,000
TRIBUTARY FLOW METER AREAS
FIGURE 3
CITY OF OXNARD
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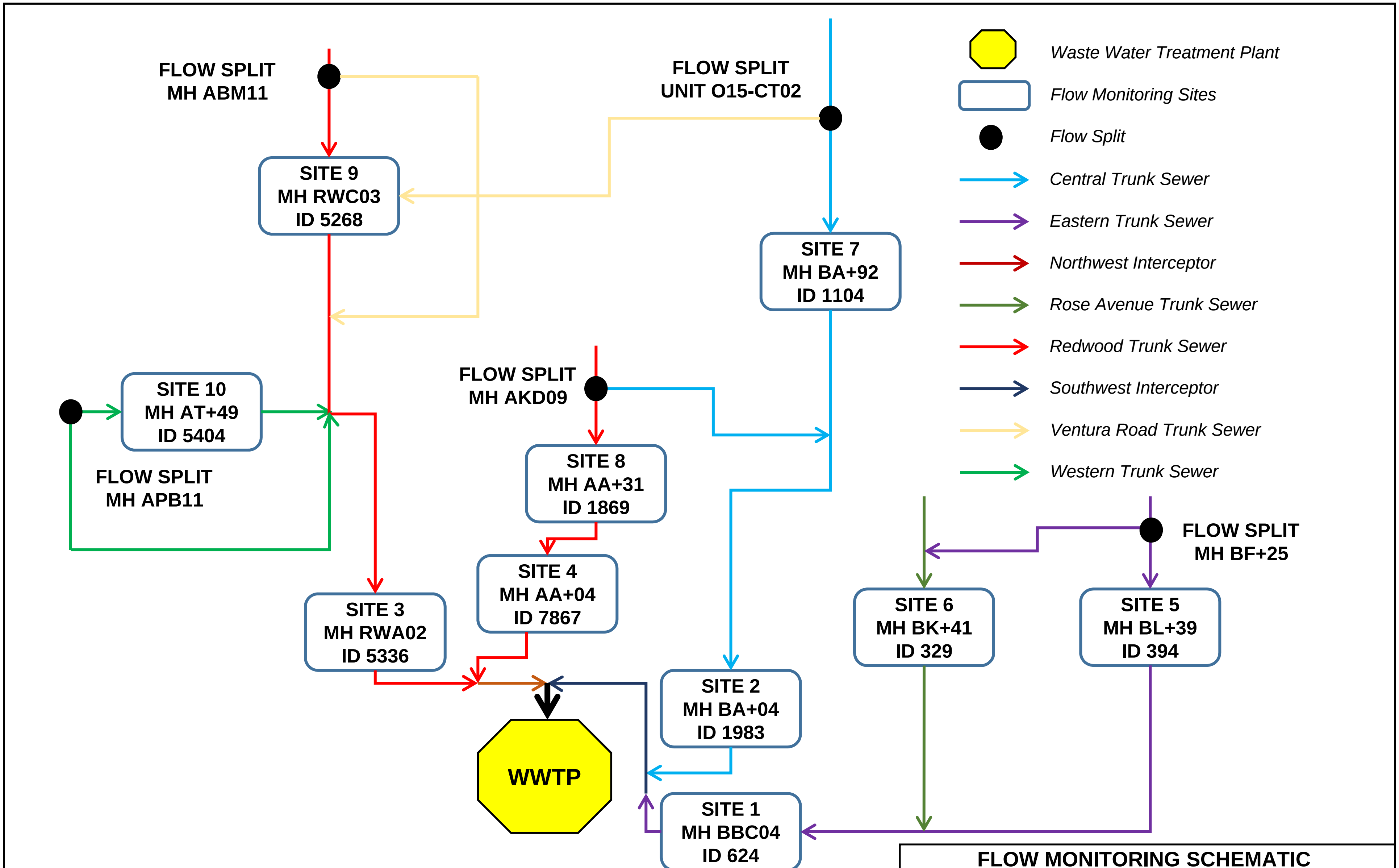

FLOW MONITORING SCHEMATIC

FIGURE 4

CITY OF OXNARD

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- **Wet Weather Calibration Standards**: WWF calibration should be carried out and the modeled flows and depths should be compared to the field measured flows and depths. The flow hydrographs should closely follow each other in both shape and magnitude, until the flow has substantially returned to dry weather flow rates.

  In addition to the shape, the observed and modeled flow hydrographs should also meet the following criteria as a general guide:

  – The timing of the peaks and troughs should be similar with regard to the duration of the event.
  – The peak flow rates at each significant peak should be in the range of +25 percent to -15 percent and should be generally similar throughout the event.
  – The volume of flow (or the average flow rate) should be within the range of +20 percent to -10 percent. Care should be taken to exclude periods of missing or inaccurate data.

3.2 Dry Weather Flow Calibration

The DWF calibration process consists of several elements as outlined below:

- **Develop Tributary Flow Meter Areas**. The first step in the calibration process was dividing the City into flow meter tributary areas. Ten tributary flow areas were created, one for each flow meter. Once the tributary flow meter areas were defined, each loading polygon was assigned to a tributary flow meter area. The tributary flow meter areas can be seen in Figure 3.

- **Calculate Flow Volume within Each Flow Meter Area**. The next step was to define the flow volume within each flow meter area, which was accomplished in the wastewater load allocation. The flow volume was eventually adjusted as part of the calibration process. Adjustments included but were not limited to the following: modifying the gpcd values assigned to each loading polygon, spatially adjusting the location of the non-residential parcel points, and/or assigning external inflows.

- **Create Diurnal Patterns to Match the Temporal Distribution of Flow**. A diurnal pattern is a pattern of hourly multipliers that are applied to the base flow to simulate the variation in flow that occurs throughout the day. Two diurnal patterns were developed for each flow monitoring tributary area, one representing weekday flow and one representing weekend flow. The diurnal patterns were initially developed based on the flow monitoring data and adjusted as part of the calibration process until the model simulated flows closely matched the field measured flows. The calibrated weekday and weekend diurnal curves were developed for each of the meters and its tributary area. These curves are included in Appendix A.

- **Adjust Model Variables**. Once the model simulated flow volumes and diurnal patters acceptably matched the field measured flows, the model simulated velocity and flow depth were compared to the field measured velocity and flow depth. Adjustments were made to various model parameters until the modeled and measured velocity and depth closely matched one another. The primary varied parameter for this process is the amount of sediment in the pipe, since this is a way to adjust the flow depths upward to match measured conditions, while this also adjusts the velocity downward to match measured conditions, and thus matching measured flows. Other parameters can also be adjusted as calibration results are generated.

Table 2 and 3 provide a summary of the dry weather flow calibration using the average and daily peak flow results for both weekday and weekend conditions. As mentioned previously, the flow monitoring for Site 4A was performed one manhole upstream from Site 4 as the new site had better hydraulic conditions for flow monitoring. In general, the model simulated average and peak flows for both weekday and weekend DWF were all within ±10 percent.

Table 2 Dry Weather Weekday Flow Calibration Summary
Public Works Integrated Master Plan
City of Oxnard

Meter Number	Pipe Diameter (in)	Measured Data		Modeled Data		Percent Error(1)	
		Avg. Flow (mgd)	Peak Flow (mgd)	Avg. Flow (mgd)	Peak Flow (mgd)	Avg. Flow (%)	Peak Flow (%)
1	41.5	5.390	7.021	5.343	7.139	-0.9%	1.7%
2	36	2.759	3.111	2.650	2.959	-4.0%	-4.9%
3	60	7.027	9.830	7.036	9.766	0.1%	-0.7%
4A(2)	33	3.131	4.786	3.438	4.639	9.8%	-3.1%
5	36	1.483	2.010	1.442	1.883	-2.8%	-6.3%
6	24	1.440	2.137	1.479	2.072	2.7%	-3.0%
7	24	0.310	0.420	0.314	0.424	1.3%	1.0%
8	27	1.820	2.547	1.979	2.705	8.7%	6.2%
9	42	2.014	2.876	2.172	3.096	7.9%	7.6%
10	37	1.876	2.332	1.908	2.392	1.7%	2.6%

Note:
(1) Percent Error = (Modeled - Measured)/Measured*100.
(2) Flow monitoring for Site 4A was performed one manhole upstream from Site 4. Flow monitoring data for Site 4A was available from December 9, 2014 to February 25, 2015.

Table 3	Dry Weather Weekend Flow Calibration Summary Public Works Integrated Master Plan City of Oxnard						
		Measured Data		Modeled Data		Percent Error[1]	
Meter Number	Pipe Diameter (in)	Avg. Flow (mgd)	Peak Flow (mgd)	Avg. Flow (mgd)	Peak Flow (mgd)	Avg. Flow (%)	Peak Flow (%)
1	41.5	4.547	5.655	4.567	5.812	0.4%	2.8%
2	36	2.352	2.656	2.353	2.757	0.1%	3.8%
3	60	7.515	11.051	7.362	10.783	-2.0%	-2.4%
4A[2]	33	3.378	5.088	3.481	4.887	3.1%	-4.0%
5	36	0.972	1.183	1.037	1.268	6.7%	7.3%
6	24	1.126	1.672	1.140	1.592	1.2%	-4.8%
7	24	0.317	0.444	0.309	0.436	-2.5%	-1.6%
8	27	1.842	2.630	1.996	2.845	8.3%	8.2%
9	42	2.113	3.188	2.259	3.518	6.9%	10.3%
10	37	2.036	2.917	1.942	2.744	-4.6%	-5.9%

Notes:
(1) Percent Error = (Modeled - Measured)/Measured*100.
(2) Flow monitoring for Site 4A was performed one manhole upstream from Site 4. Flow monitoring data for Site 4A was available from December 9, 2014 to February 25, 2015.

Appendix A contains a detailed DWF calibration summary sheet for each of the 10 meter sites. Each calibration sheet provides plots that compare the model simulated and field measured flow, velocity, and level data for both weekday and weekend conditions. In general, there is good overall correlation of the field measured data to the model output results. However, there are a few sites where the modeled levels, and/or velocities were outside the generally accepted calibration tolerances. Although adjustments were tried, these sites could not be further adjusted to any better meet the measured data. Since the flow volumes and peak flows were within the acceptable calibration tolerances, the hydraulic model was considered calibrated for DWFs.

3.3 Wet Weather Flow Calibration

The WWF calibration enables the hydraulic model to accurately simulate I/I entering the collection system during a significant storm. As outlined below, the WWF calibration process consists of several elements:

- **Identify rainfall events for WWF Calibration**. The WWF calibration process consists of running model simulations of rainfall events based on data collected as part of the wet weather flow monitoring. The goal of any wet weather flow monitoring program is to capture and characterize a system's response to a significant rainfall event, preferably during wet antecedent moisture conditions.

As previously stated, WWF monitoring was conducted from December 9, 2014 to February 25, 2015. During this time period, there were two notable rainfall events. Rainfall Event 1 occurred between December 11, 2014 and December 12, 2014; the total amount of rainfall was between 1.89 inches and 2.55 inches for the five rainfall recording sites. Rainfall Event 2 occurred between January 10, 2015 and January 11, 2015; the total amount of rainfall was between 1.46 and 2.26 inches for the five rainfall sites.

The selection of a particular calibration storm is based on a review of the flow and rainfall data. For WWF calibration, the model was run from December 10, 2014 to December 15, 2014 and calibrated to Rainfall Event 1. In general, it is better to use larger storms for WWF calibration. If longer durations are considered, Rainfall Event 1 was greater than a 2-year storm event for a 12-hour duration and greater than a 1-year storm event for a 2-day duration. Rainfall Event 2 was less than a 1-year storm event for all durations.

In order to run a model simulation for Rainfall Event 1, the average hourly rainfall data from the five rainfall recording sites were input into the model. Each flow monitoring tributary area was assigned a similar rainfall hyetograph.

- **Define RDII Tributary Areas**. For the WWF calibration process, RDII flows are superimposed on top of the DWF within the model. The model calculates RDII by assigning RDII flows to each node in the model that has a DWF flow assigned to it. RDII flows consist of both a unit hydrograph and the total developed area that is tributary to the model node. The RDII tributary areas were calculated in GIS using the loading polygons. The RDII tributary areas were composed mostly of developed land area, which meant that any large vacant, open space, or other areas in the City which are not expected to contribute to I/I into the collection system were excluded. The tributary area provides a means to transform hourly rainfall depth from the rainfall hyetographs into a rainfall volume. The rainfall volume is transformed in actual RDII flows using the unit hydrograph, as described in the next step.

- **Create I/I Parameter Database**. The main step in the WWF calibration process involves creating custom unit hydrographs for each flow monitoring tributary area using the RTK Method, which is widely used in collection system master planning. Using the RTK Method, the RDII unit hydrograph is the summation of three separate triangular hydrographs (short term, medium term, and long term), which are each defined by three parameters: R, T and K. R represents the fraction of rainfall over the tributary area that contributes directly to I/I; T represents the time to peak of the hydrograph; and K represents the ratio of time to recession to the time to peak. There are a total of nine separate variables associated with each unit hydrograph. Figure 5 shows the shape of an example unit hydrograph.

The hydrographs utilize the R-values (percentage of rainfall that enters the collection system) calculated for each tributary area to simulate I/I. The nine variables in each unit hydrograph were initially set based on engineering judgment and then adjusted until the model simulated flows (both peak flows and volumes) matched closely with the field measured flows.

Similar to the DWF calibration process, the WWF calibration process compared meter data with the model output. Comparisons were made for average and peak flows as well as the temporal distribution of flow until flows returned to their baseline levels. The hydraulic model was considered to be satisfactorily calibrated based on the WWF calibration standards discussed in Section 3.1.

- **Refine Model Variables**. After the hydraulic model was considered to be satisfactorily calibrated for wet weather flows, the model simulated velocities and flow depths were checked against the field measured velocities and flow depths during the calibration rain event. Refinements were made to the various model parameters so that the modeled and measured velocity and depth closely matched one another.

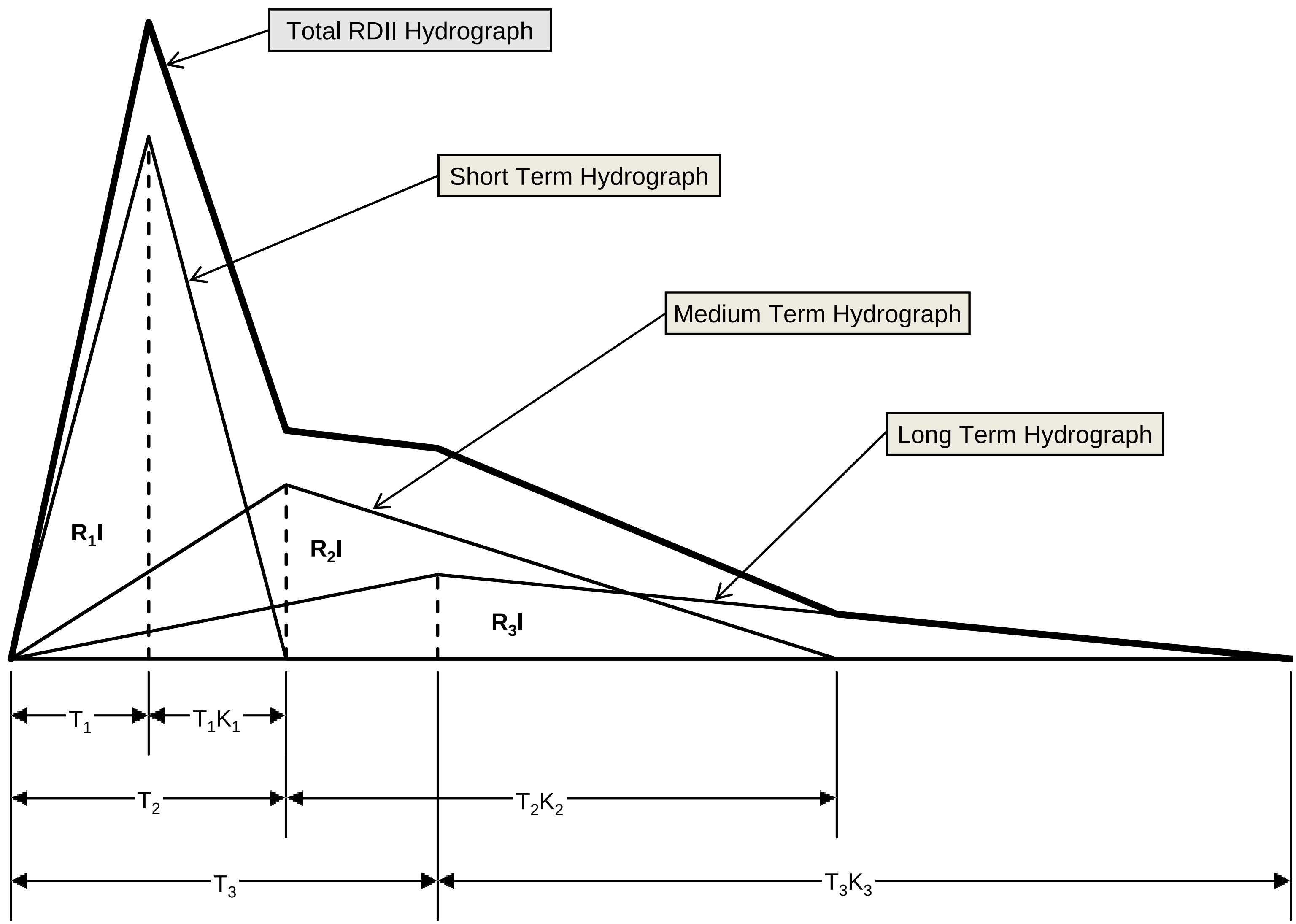
Appendix B contains the detailed wet weather flow calibration summary sheet for each of the ten meter sites as well as the locations of the five rain gages. Each calibration sheet provides plots that compare the model simulated and field measured flow, velocity, and level data for the calibration storm. Table 4 provides a summary of the wet weather flow calibration using the average and peak flow results. In general, the model simulated average and peak flows for all meter sites were within the acceptable tolerances and therefore the model was calibrated and ready to use for capacity analysis purposes.

4.0 COLLECTION SYSTEM ANALYSIS

Once the collection system hydraulic model was calibrated, it was used to assess any capacity restrictions within the existing system. Capacity restrictions need to be defined within the context of a level of service. Level of service can be defined in many ways and will be discussed below as it relates to the existing and future capacity deficiencies.

4.1 Level of Service

Level of service (LOS) assumptions were developed by the City and Carollo to apply to the modeling effort to determine what conditions would need to be planned for in the future. The LOS criteria included assumptions on the level of design storm that would be applied to predict peak wet weather flows, the acceptable surcharge criteria in the pipelines to determine hydraulic deficiencies, and the improvement configurations for existing pipelines (e.g., parallel versus upsizing).



EXAMPLE RDII HYDROGRAPH

FIGURE 5

CITY OF OXNARD
PM NO.3.3 – INFRASTRUCTURE MODELING AND ALTERNATIVES
PUBLIC WORKS INTEGRATED MASTER PLAN

Table 4	Wet Weather Flow Calibration Summary Public Works Integrated Master Plan City of Oxnard						
		Rainfall Event 1 (12/11/2014 - 12/12/2014)					
		Measured Data		Modeled Data		Percent Error(1)	
Meter Number	Pipe Diameter (in)	Avg. Flow (mgd)	Peak Flow (mgd)	Avg. Flow (mgd)	Peak Flow (mgd)	Avg. Flow (%)	Peak Flow (%)
1	41.5	5.284	6.808	5.506	7.395	4.2	8.6
2	36	3.063	5.780	2.744	6.086	-10.4	5.3
3	60	7.739	10.727	7.185	10.352	-7.2	-3.5
4A	33	3.298	4.818	3.779	5.413	14.6	12.3
5	36	1.634	2.663	1.475	2.739	-9.7	2.8
6	24	1.350	1.921	1.517	2.078	12.4	8.2
7	24	0.331	0.503	0.328	0.481	-0.8	-4.5
8	27	2.292	4.191	2.305	4.260	0.6	1.6
9	42	2.301	3.231	2.380	3.421	3.4	5.9
10	37	2.297	3.533	2.169	3.279	-5.6	-7.2

Note:
(1) Percent Error = (Modeled - Measured)/Measured*100.

4.2 Design Storm

It was decided by the City and Carollo that a 10-year, 24-hour design storm would be used to determine inflow conditions that would test the hydraulic capacity of the sewers during wet weather conditions. The 10-year, 24-hour design storm for Oxnard has a peak 1-hour intensity of 1.04 inches per hour and a total volume of 4 inches of rain in 24 hours. This design event was developed using a SCS Type IA distribution.

This level event is commonly used to plan sanitary sewer collection system improvements because it provides a reasonable level of wet weather I/I. But this level event does not tend to overestimate the amount of I/I that can enter a system during very large events, since it is very difficult to quantify flows during extreme flood events (e.g. greater than a 10-year event) due to the unknown interaction between the sanitary and separate storm drain system. This design event will produce the majority of the inflow within the model, but assumptions need to be made to estimate a design condition for infiltration since this short duration, high intensity rainfall event will not produce appreciable wet weather infiltration, which occurs due to long wet periods that saturate the soil conditions.

4.3 Hydraulic Conditions

Two hydraulic conditions are used to examine the hydraulic results in the model; depth to diameter ratio (d/D), and surcharge. A d/D ratio is used to examine the "capacity" of the pipeline under certain flow conditions. The "d" is the depth of peak flow in any give interceptor segment and the "D" is the diameter of the pipes within that segment. Although a d/D of 100 percent typically is referred to as full pipe "capacity," more flow can be conveyed through a sewer pipe under surcharge conditions (when the slope of the hydraulic grade line exceeds the slope of the pipe and the complete sewer segment is surcharged).

Therefore d/D is typically used to assess dry weather flow conditions. DWF (which includes base sanitary flow and dry weather infiltration) are applied in the model and the d/D ratios are examined to judge how efficient the system is in conveying DWFs. This ratio should always be lower than 90 percent and is typically judged acceptable if it is in the 75 to 85 percent range during peak dry weather flows. If this ratio is found to be too low during peak DWF (e.g. 20 percent) then deposition can be a problem since the flushing velocities will be low (e.g., less than 2 feet/second).

The conditions listed above are for PDWF analysis of existing sewers. Parameters used to analyze existing sewers can be different from those same parameters used to design sewers. For example, City design standards indicate that d/D for pipelines 10-inches in diameter and less should be 0.5, while d/D for pipelines 12-inches in diameter and greater should be 0.67. These d/D's are for design, but there can be additional infiltration that occurs in actual sewers over time that cause the d/D to exceed design parameters. Therefore, for this planning analysis of existing sewers the design d/D's will be relaxed to planning level d/D's as mentioned above (0.75 - 0.85).

The wet weather LOS surcharge condition for analysis of deficiencies in the previous master plan was a d/D no greater than 1 (full pipe). This criteria is very conservative for 10-year event and will produce an excessive amount of pipelines in need of replacement.

Therefore, for this analysis, a different LOS was chosen for wet weather conditions. The wet weather LOS for the existing network and future system configurations were chosen to be a peak hydraulic grade line (HGL) no closer than 3 foot below the rim elevation of any manhole along a reach of pipeline during the 10-year, 24-hour design event. This criterion would allow some surcharge during design event conditions, but allowed a margin of safety in the HGL predictions so as to limit the potential for SSOs. If a manhole has a rim elevation less than 3 feet from the crown of the pipe, this criteria does not apply since these shallow manholes are usually sealed and allow for surcharge conditions (or may need to be sealed in the near future - further investigation of these shallow manholes should be undertaken).

However, this surcharge condition does include some associated risk. This risk depends on the invert elevations of the lateral sewers that connect into the interceptor system. These lateral sewers are not included in the model but are the smaller diameter pipelines that directly service residential, commercial, and some industrial facilities. The City indicated that there were very few complaints related to wet weather backups and flooding due to wet weather events within the service area. As growth continues, and rainfall events larger than a 10-year, 24 hour event occur (which will happen, and may be more frequent due to climate change), surcharge and flooding should be closely tracked to make sure lateral sewers aren't being affected due to peak HGLs in the interceptor system.

4.4 Existing System Analysis

The above criteria were applied to the baseline conditions in the existing model to examine what capacity deficiencies are currently present within the interceptor system. The flows generated by the model include the 10-year, 24 hour inflow, the wet weather infiltration, the existing sanitary flow, and the dry weather infiltration. The model was run over a two day period (weekday and weekend). The hydraulic conditions the model produced were then examined based on the LOS criteria for d/D for dry weather and surcharge criteria for wet weather.

4.4.1 Dry Weather Hydraulics

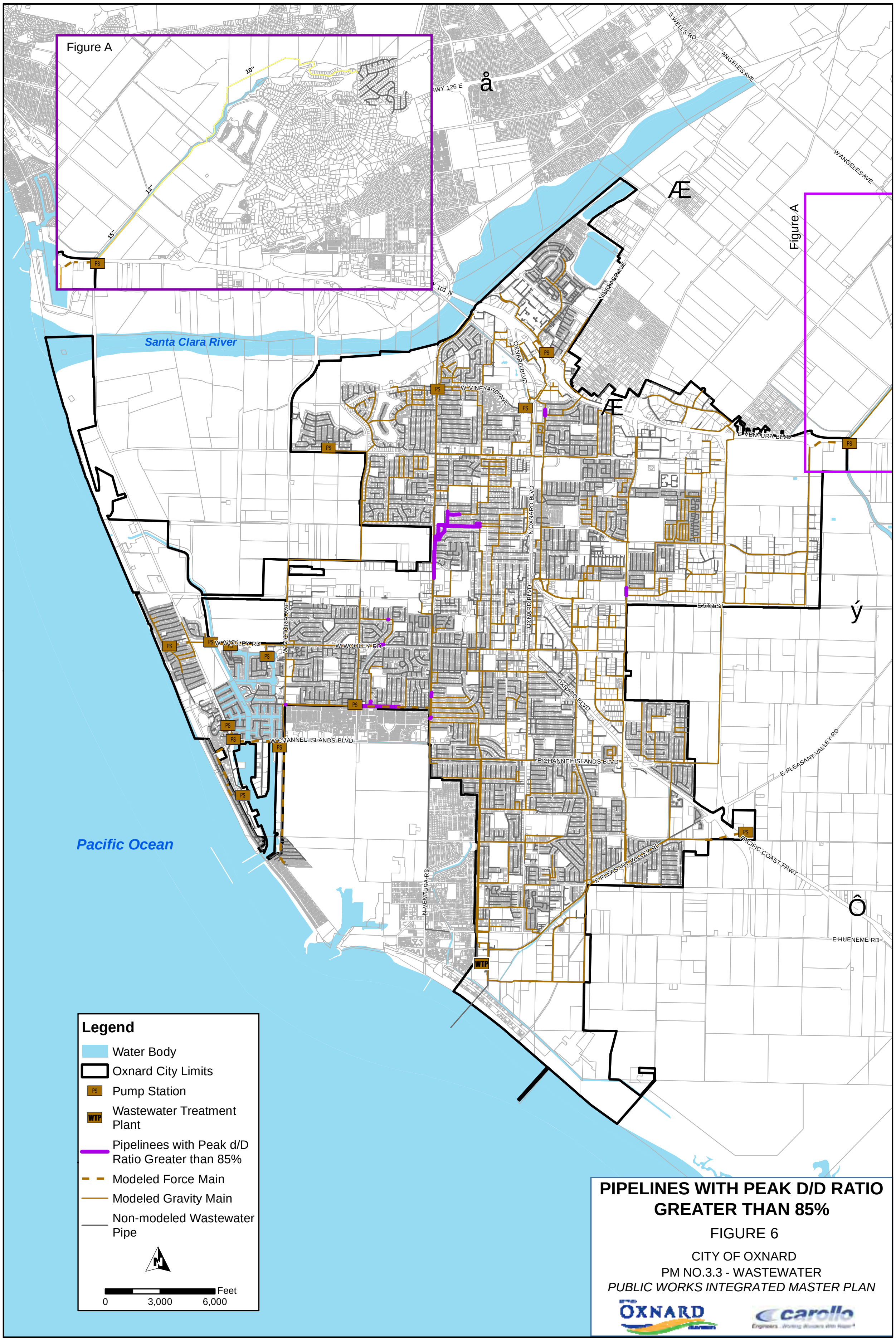
The model was initially run using calibrated DWFs to examine the hydraulic conditions within the interceptor system during typical dry periods. It was found that peak dry weather flow (PDWF) conditions did not contribute to any surcharging in the current interceptor system. The current ADWF equals 18.1 mgd, with a PDWF of 22.9 mgd at the Oxnard Wastewater Treatment Plant (OWTP).

However, PDWFs caused some pipelines to exhibit high depths to diameter (d/D) ratios near 0.85 (or 85 percent capacity). Therefore, the current interceptor is properly sized for existing DWFs, but some interceptor reaches are approaching their peak DWF capacity. Pipes with peak d/D ratios greater than 85 percent are presented in Figure 6.

4.4.2 Wet Weather Hydraulics

The model was also run using the calibrated WWFs to examine if any surcharge was present in the system and if the surcharge criteria were violated during the 10-year, 24-hour event. Since the 10-year event is an intense rainfall event with significant volume over a short period of time, it is not surprising that surcharge will occur in parts of the system. The peak wet weather flow for the design event for existing conditions was 39.5 mgd at the OWTP.

However, since SSOs are not allowed as per the Clean Water Act (CWA), any discharges out of manholes are not allowed and improvements will need to be initiated to remediate this type of hydraulic situation. Based on the design level flows and hydraulics within the model, no junctions in the model showed flooding for the current baseline existing system.



PIPELINES WITH PEAK D/D RATIO GREATER THAN 85%

FIGURE 6

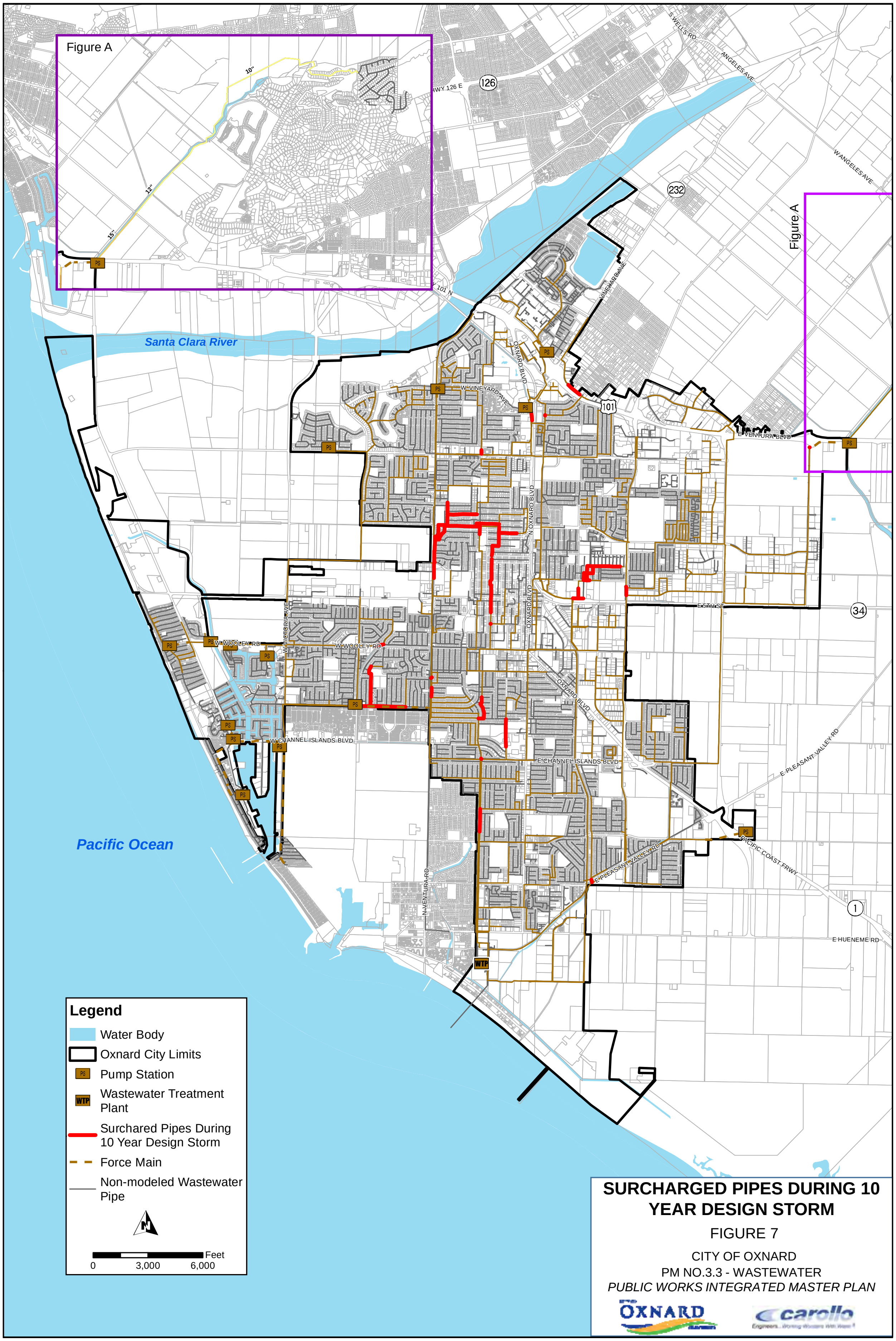
CITY OF OXNARD
PM NO.3.3 - WASTEWATER
PUBLIC WORKS INTEGRATED MASTER PLAN

Surcharge was observed at several locations for existing conditions. Figure 7 illustrates the locations within the interceptor that exhibit surcharge during the 10-year, 24-hour event. None of these locations represent significant surcharge - beyond the above LOS criteria - but do show the general locations of restrictive areas. However, only portions of these areas will include the specific restrictive pipes that will need to be corrected. The locations illustrated on Figure 7 are generally described in Table 5. The pipelines shown summarized in Table 5 are only meant to give a broad sense of potential deficiencies, however, not all of these deficiencies need to be improved. The improvements needed to meet LOS goals in these areas for existing as well as future conditions will be discussed in detail below.

Table 5 Existing System Deficiencies
Public Works Integrated Master Plan
City of Oxnard

Location Description	Pipe Description	Hydraulic Issues
S Rose Ave and La Puerta Ave	Rose Avenue Trunk Sewer (15-inches in diameter)	Pipeline surcharged.
Terrace Ave and E Pleasant Valley Rd	Eastern Trunk Sewer (12-inches in diameter)	Pipeline surcharged.
N Ventura Rd and W Vineyard Ave	Ventura Road Trunk Sewer (8-inches in diameter)	Pipeline surcharged.
N Ventura Rd and W Vineyard Ave	Ventura Road Trunk Sewer (8-inches in diameter)	Pipeline surcharged.
S Marquita St and E Second St	Sewers in the La Colonia Neighborhood (8-inches to 10-inches in diameter	Pipeline surcharged.
Diaz Ave and E Fifth St	Sewers by the Oxnard Metrolink Facility(12-inches to 15-inches in diameter)	Pipeline surcharged.
N H St and Aster St	Ventura Road Trunk Sewer (8-inches to 10-inches in diameter)	Pipeline surcharged.
N Oxnard Blvd and W Vineyard Ave	Central Trunk Sewer (10-inches in diameter)	Pipeline surcharged.
S E St and W Fourth St	Redwood Trunk Sewer (8-inches to 10-inches in diameter)	Pipeline surcharged.
Cary Drive and Deodar Ave	Sewers in the Wilson Neighborhood (8-inches in diameter)	Pipeline surcharged.

Table 5	Existing System Deficiencies Public Works Integrated Master Plan City of Oxnard	
Location Description	**Pipe Description**	**Hydraulic Issues**
N Ventura Rd and S Ventura Rd	Ventura Road Trunk Sewer (8-inches to 15-inches in diameter)	Pipeline surcharged.
S Ventura Services Rd and W Fir Ave	Sewer in the Bartolo Square North Neighborhood (8-inches in diameter)	Pipeline surcharged.
S C St and Maxwood Way	Redwood Trunk Sewer (10-inches in diameter)	Pipeline surcharged.
S E St and Ninth St	Redwood Trunk Sewer (10-inches in diameter)	Pipeline surcharged.
S F St and W Juniper St	Redwood Trunk Sewer (18-inches in diameter)	Pipeline surcharged.
S J St and Redwood St	Redwood Trunk Sewer (18-inches in diameter)	Pipeline surcharged.
S J St and Glacier Ave	Redwood Trunk Sewer (27-inches in diameter)	Pipeline surcharged.
Elsinore Ave and W Hemlock St	Sewers in the Marina West Neighborhood (8-inches to 10-inches in diameter)	Pipeline surcharged.
Novato Dr and W Wooley Rd	Sewers along W Wooley Rd (8-inches in diameter)	Pipeline surcharged.
Sterling Hills Golf Club	Western Trunk Sewer (10-inches in diameter)	Pipeline surcharged.
S Ventura Rd and N Ninth St	Sewer along S Ventura Rd (16-inches in diameter)	Pipeline surcharged.
S Ventura Service Rd and Hill St	Sewer along S Ventura Service Rd (8-inches in diameter)	Pipeline surcharged.
Ventura Blvd and Cortez St	Sewers by the Martinez Shopping Center (6-inches in diameter)	Pipeline surcharged.
S Harbor Blvd and Cabezone Way	Sewers by the Cabezone Pump Station (8-inches in diameter)	Pipeline surcharged.
Stanford Ave and Vanderbilt Dr	Central Trunk Sewer (24-inches in diameter)	Pipeline surcharged.



SURCHARGED PIPES DURING 10 YEAR DESIGN STORM

FIGURE 7

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PM NO.3.3 - WASTEWATER
PUBLIC WORKS INTEGRATED MASTER PLAN

4.5 Future System Analysis

Several time periods in the future were examined based on input from the City to identify changes in growth patterns in the City, which would require improvements within the collection system. Table 6 below summarizes the three future time periods that were analyzed using the collection system model and pertinent statistics (Average Dry Weather Flow (ADWF), Peak Dry Weather Flow (PDWF) and Peak Wet Weather Flow (PWWF)) assumed for those periods.

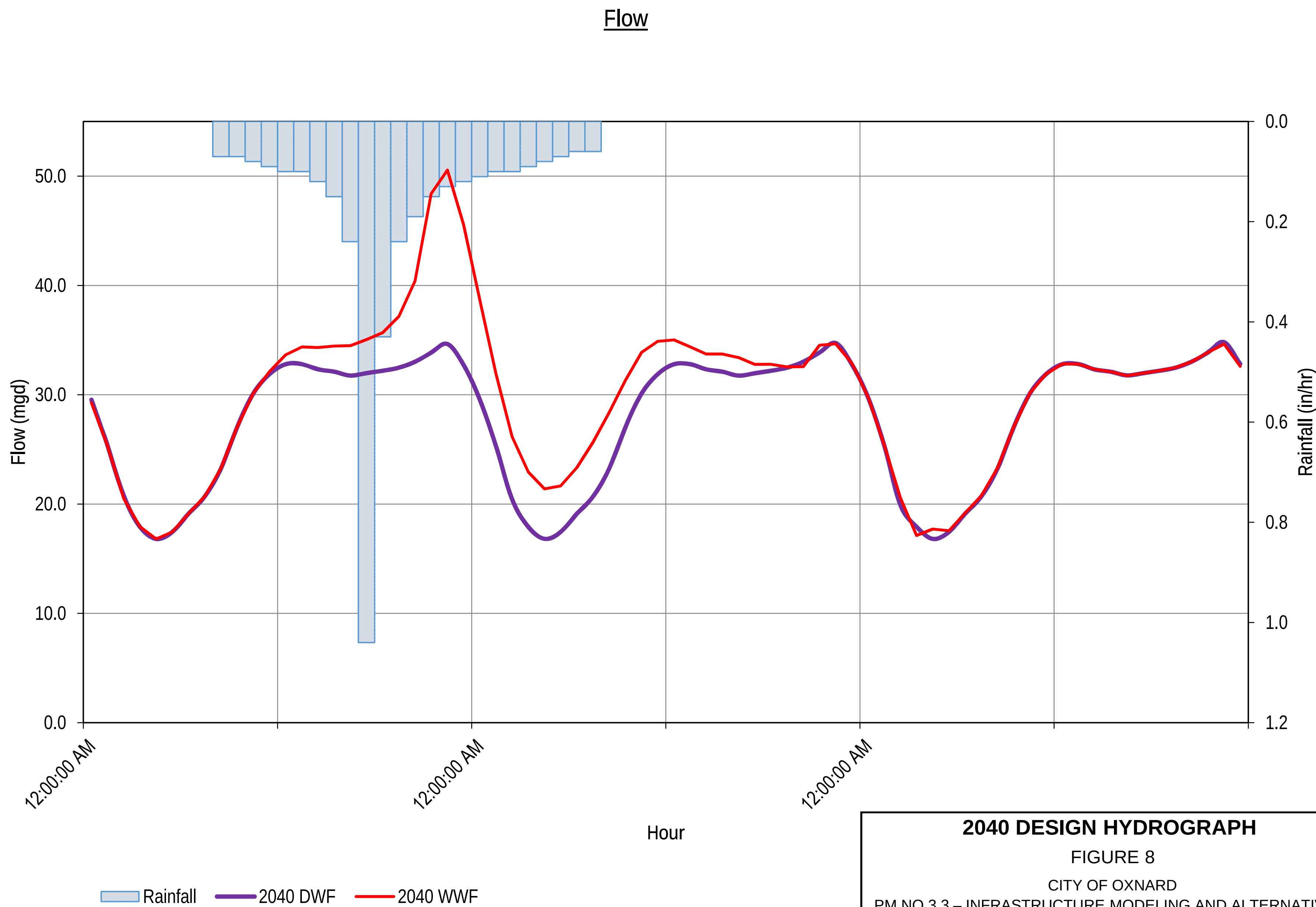
Table 6 Future Period Statistics
Public Works Integrated Master Plan
City of Oxnard

Period	ADWF (mgd)	PDWF (mgd)	PWWF (mgd)
2020	23.7	29.3	45.4
2030	25.8	31.9	48.1
2040	28.0	34.8	50.5

Figure 8 illustrates the design hydrograph for 2040 at the OWTP. This figure includes the DWF's as well as the WWF's and the 10-year rainfall design hyetograph. The ratios for PDWF to ADWF are 1.24 for each of the future years. The ratios for PWWF to ADWF are 1.92, 1.86, and 1.80 for the 2020, 2030, and 2040 respectively.

Future flows consist of residential flows and industrial flows. Residential flows are based on the 2030 General Plan Low Forecast population projections. Industrial flows are based on the 38 Significant Industrial Users (SIUs) and Naval Base Ventura County (NBVC), all of which have been identified in PM 3.2; future industrial developments mentioned in PM 1.3 were also used.

For the residential flows, each loading polygon was assigned a population value. Since the projected population data was originally given for the entire city, a weighted average was used to calculate the population values for each loading polygon. It was assumed that the loading polygons only had population in the developed areas; information regarding the land type was obtained through the zoning polygons provided by the City. Once the loading polygons had a population number, a gpcd value of 71.6 was used to calculate the flow from each loading polygon. The gpcd value is consistent with the estimated domestic per capita flow mentioned in PM 3.2.



2040 DESIGN HYDROGRAPH

FIGURE 8

CITY OF OXNARD
PM NO.3.3 – INFRASTRUCTURE MODELING AND ALTERNATIVES
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For the industrial flows, the location of the industrial users was identified and their flow was assigned to the closest manhole. The projected flows for the industrial users are based on information presented in PMs 1.3 and 32 and they are as follows:

- The 38 SIUs as well as NBVC were assigned flows based on their Average Day Flow (ADF) Permit Limit. It was assumed that all the flows for the projected years would be constant at the ADF Permit Limit.

- The future industrial developments were assigned 2020 and 2040 projected flows based on the Average Day Demands (ADD) identified in PM 2.2. Flows between these years were scaled down linearly.

The flows for the period 2040 were used to size future improvements, along with the I/I generated from the 10-year, 24-hour event, and the LOS criteria described above. Some projects may be needed before 2040, but if a project is completed in 2020 to increase capacity, it should provide enough capacity to accommodate 2040 flows since the useful life of a sewer pipe is well beyond this 20 year time period. Therefore, the scheduling of projects may require pipes to be upsized several years in advance (to account for design and construction time frames), but the diameter of pipeline improvements will need to be able to accommodate future flows as well.

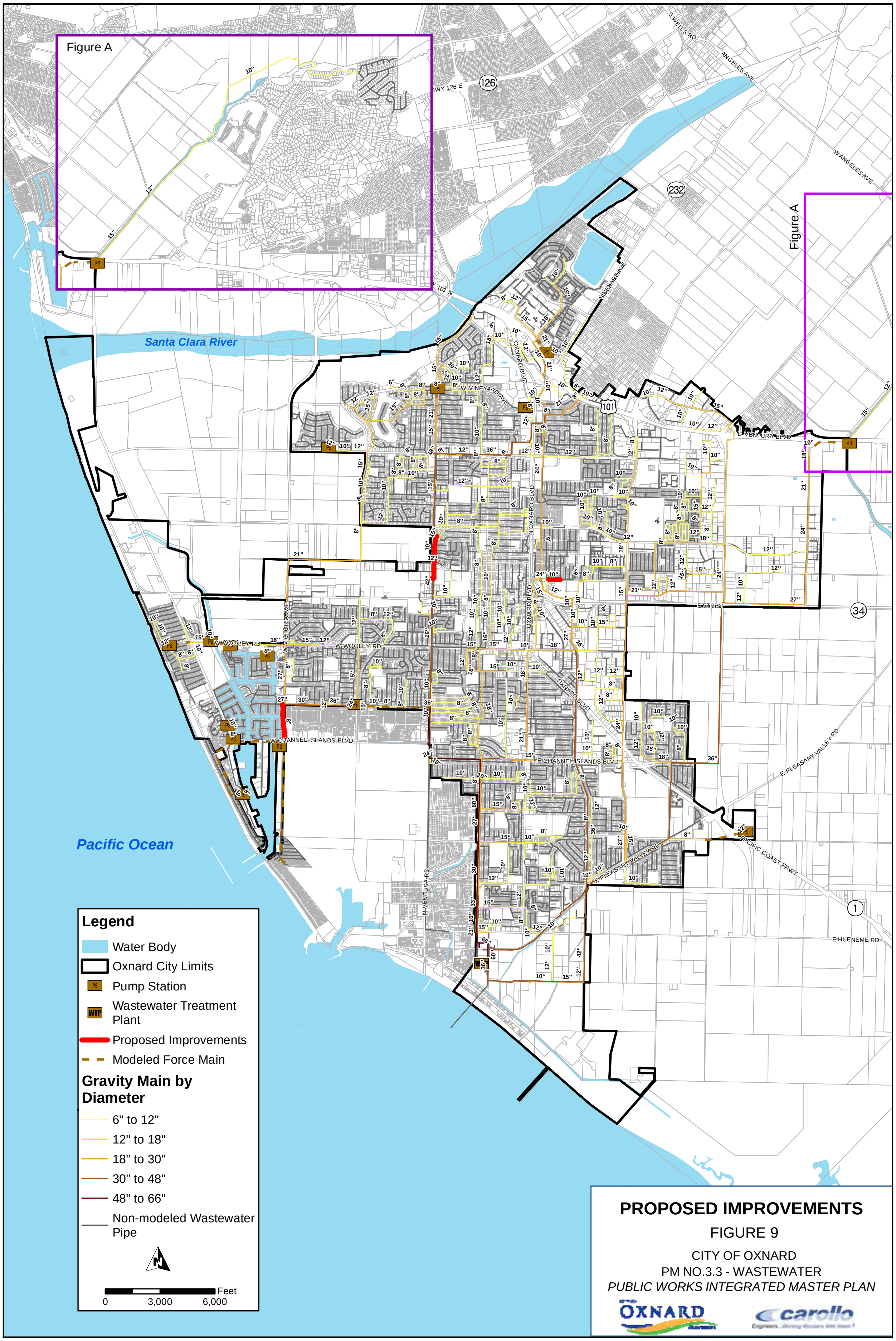
5.0 RECOMMENDED PROJECTS

With additional DWFs due to future growth, the wet weather capacity restrictions will only become more severe. The flows estimated for year 2040 were input to the model and run to examine how severe additional surcharge became in the already restrictive locations (illustrated in Figure 9). If the LOS criteria were violated (e.g., HGL greater than 3-feet below rim elevation), then downstream pipes were examined to identify restrictive elements that need replacement.

5.1 Collection System Improvements

When an increase to capacity is required, existing sewers can be upgraded or a parallel or relief sewer can be constructed. For the purposes of this study, unless otherwise stated, it was assumed that a capacity deficient sewer would be upgraded to a larger diameter. The upgraded pipeline generally followed the same slope as the existing pipeline, with the exception where survey data revealed negative or flat slopes in an existing alignment.

In essence, there are two alternatives for every trunk sewer project, but the decision to replace or construct a parallel sewer should be made during the preliminary design phase. During the preliminary design phase, the existing sewer should be inspected by closed circuit television (CCTV) to determine its structural condition. If severely deteriorated, the existing sewer should be upgraded. If moderately deteriorated, slip lining or cured-in-place pipe lining can rehabilitate the existing sewer.



PROPOSED IMPROVEMENTS

FIGURE 9

CITY OF OXNARD

PM NO.3.3 - WASTEWATER

PUBLIC WORKS INTEGRATED MASTER PLAN

The proposed improvements that will serve future users are sized for build-out conditions. As the City continues to grow, it is recommended that the proposed pipeline diameters be constructed so that the facilities have sufficient capacity for build out conditions. Building a smaller interim project with the plans of upsizing in the future to account for further growth is not recommended due to the extended useful life of the improvements proposed herein. The proposed pipe diameter represents the ultimate diameter for build out conditions.

5.2 Pipeline Improvements

The system was analyzed to examine both DWF and WWF criteria for existing and future flow conditions. Certain portions of the existing system cannot adequately convey both peak DWF and WWF conditions using the LOS criteria defined above. Future flow conditions also stress the system and require upgrades to meet the LOS criteria.

The improvements discussed herein are for pipelines that require upgrades due to capacity deficiencies. Pipeline improvements due to deterioration, such as the Central Trunk improvements, are not discussed herein, but are accounted for in the pipeline costs in the overall CIP. Since limited condition information exists for most of the pipeline in the system (other than the Central Trunk specific condition assessments), no improvements other than those noted due to deterioration can be ascertained at this time.

As flows increase over time, the system will require upgrades to meet capacity restrictions. Both PDWF and PWWF were examined to determine system improvements in the future. By 2040, the system exhibited PDWF that surcharged more sewers. This condition is not acceptable as described in the LOS criteria above. Therefore, pipelines in these areas that exhibited capacity deficiencies were upsized to convey PDWF without surcharge.

PWWFs were also run through the model to examine if the LOS criteria for the design storm were violated. It was found using the LOS criteria above (no HGL could exceed 3-feet below the lowest rim elevation along a pipeline reach) that no improvements are needed through 2040 due to the 10-year design event. There is surcharge throughout the system during these conditions, but no sewers required upgrades because of violation in the criteria. However, the improvements that are needed to accommodate PDWFs also decrease the surcharge in these segments for PWWFs.

For example, Project 1 detailed in Table 7, is needed because the existing PDWF exceeds LOS criteria. Therefore, in upgrading this section of pipe, it also significantly decreases the HGL for the PWWF. Therefore, this project is needed for DWFs but also helps in managing WWFs. If it was just a WWF issue in this area, a cross-connection could be made between this sewer and the Redwood Trunk Sewer which is right across the road. The invert elevations of the two parallel pipelines are similar, and an elevated pipe could be used to balance WWFs into the larger interceptor. However, this is not needed since the Project 1 pipelines are needed for PDWF and therefore must be upgraded regardless. If the City wants to plan in the future for higher design storm flows, then this cross-connection should be reinvestigated.

Table 7 Proposed Pipeline Improvements
Public Works Integrated Master Plan
City of Oxnard

Project	Location Description	Pipe Description	Hydraulic Issues	Conduit	Inlet Node	Outlet Node	Existing Diameter (inches)	Replacement Diameter (inches)	Length (feet)
Project 1									
WW-P-1	N Ventura Rd / S Ventura Rd and W Second St	Ventura Road Trunk Sewer	Pipeline Surcharged	4943	1427	1426	10	15	84
WW-P-1	N Ventura Rd / S Ventura Rd and W Second St	Ventura Road Trunk Sewer	Pipeline Surcharged	4956	1426	1445	10	15	167
WW-P-1	N Ventura Rd / S Ventura Rd and W Second St	Ventura Road Trunk Sewer	Pipeline Surcharged	1429	1445	1480	10	15	310
WW-P-1	N Ventura Rd / S Ventura Rd and W Second St	Ventura Road Trunk Sewer	Pipeline Surcharged	1431	1480	1521	10	15	309
WW-P-1	N Ventura Rd / S Ventura Rd and W Second St	Ventura Road Trunk Sewer	Pipeline Surcharged	1432	1521	1520	10	15	17
WW-P-1	N Ventura Rd / S Ventura Rd and W	Ventura Road Trunk Sewer	Pipeline Surcharged	1443	1520	1583	10	15	368

Table 7 Proposed Pipeline Improvements
Public Works Integrated Master Plan
City of Oxnard

Project	Location Description	Pipe Description	Hydraulic Issues	Conduit	Inlet Node	Outlet Node	Existing Diameter (inches)	Replacement Diameter (inches)	Length (feet)
	Second St								
WW-P-1	N Ventura Rd / S Ventura Rd and W Second St	Ventura Road Trunk Sewer	Pipeline Surcharged	4276	1583	1622	10	15	258
WW-P-1	N Ventura Rd / S Ventura Rd and W Second St	Ventura Road Trunk Sewer	Pipeline Surcharged	1460	1622	1638	10	15	116
WW-P-1	N Ventura Rd / S Ventura Rd and W Second St	Ventura Road Trunk Sewer	Pipeline Surcharged	1461	1638	1684	10	15	369
WW-P-1	N Ventura Rd / S Ventura Rd and W Second St	Ventura Road Trunk Sewer	Pipeline Surcharged	1462	1684	1725	10	15	373
WW-P-1	N Ventura Rd / S Ventura Rd and W Second St	Ventura Road Trunk Sewer	Pipeline Surcharged	1463	1725	L21-RWB20	10	15	49
								Project 1 Subtotal	**2,420**

Table 7 Proposed Pipeline Improvements
Public Works Integrated Master Plan
City of Oxnard

Project	Location Description	Pipe Description	Hydraulic Issues	Conduit	Inlet Node	Outlet Node	Existing Diameter (inches)	Replacement Diameter (inches)	Length (feet)
Project 2									
WW-P-2	Navarro St and E First St	Sewers in the La Colonia Neighborhood		2888	1745	1742	10	12	316
WW-P-2	Navarro St and E First St	Sewers in the La Colonia Neighborhood		2889	1742	1740	10	12	313
								Project 2 Subtotal	**629**
Project 3									
WW-P-3	S Victoria Ave and W Hemlock St	Sewers in the Channel Islands Neighborhood	Pipeline Surcharged	501	3429	3346	8	12	352
WW-P-3	S Victoria Ave and W Hemlock St	Sewers in the Channel Islands Neighborhood	Pipeline Surcharged	{74B96752-98B2-4F5D-AF2A-21B06EE4909C}	3346	3266	8	12	196

Table 7 Proposed Pipeline Improvements
Public Works Integrated Master Plan
City of Oxnard

Project	Location Description	Pipe Description	Hydraulic Issues	Conduit	Inlet Node	Outlet Node	Existing Diameter (inches)	Replacement Diameter (inches)	Length (feet)
WW-P-3	S Victoria Ave and W Hemlock St	Sewers in the Channel Islands Neighborhood	Pipeline Surcharged	P-2471	MH-2420	3429	8	12	1,369
								Project 3 Subtotal	**1,917**
								Total	**4,965**

The same is true for the other projects; Projects 2 and 3 are needed due to PDWF requirements, but also help in managing the peak HGL during WWFs. It should also be noted that Project 3 is a short section of gravity sewer, but drains a significant area upstream where pump stations forcemains discharge into this gravity main.

Figure 9 illustrates the proposed pipeline improvements required to accommodate future flows. Table 7 provides details for each improvement project. Appendix C illustrates the HGLs within these segments for flows estimated in 2040 before and after improvements are made.

5.3 Pump Station Improvements

The pump stations within the model were also analyzed to see if upgrades were necessary for future flows. The City provided pump curves for the pump stations but were not able to provide the start and stop elevations within the wet wells for the operations of the pumps. The pump stations seem to be able to convey future flows adequately, but without the actual stop and start elevations, it is difficult to assess whether the pump stations will be able to accommodate these future flows adequately. Therefore, the City should make a concerted effort to measure these stop and start elevations and the model should be updated in Phase 2.

6.0 RECOMMENDED PROJECT – COSTS AND PHASE

Cost estimates, implementation phase and schedule were also developed for the recommended projects for the collection system projects, as summarized in the previous section. This information will be included in the overall Capital Improvement Program (CIP) and used as the basis for the financial analysis portion of the PWIMP to determine financial impact of the project to the City and its rate payers. The costs and timing presented in this PM represent Carollo's best professional judgment of the capital expenditure needs of the City and of the timing needed to maintain a reliable and compliant system that can meet current and future wastewater generation needs. Timing was set to align with the seven master plan drivers, namely: R&R, regulatory requirements, economic benefit, performance benefit, growth, resource sustainability, and policy decisions. Timing is also based on input from City staff and the condition assessments performed.

While the costs developed in this PM match the costs analyzed as part of the Cost of Service Study, the timing presented may differ. The Cost of Service Study will balance not only the CIP projects identified but also the rates and rate payer affordability based on a yearly balance and also the integrated costs for the different City funds and enterprises.

6.1 Cost Summary

The Collection System project costs for capacity related projects are presented in Table 8 and are based on the preliminary layouts, sizing and configuration. Project costs are estimated based on unit costs developed from estimating guides, equipment manufacturer's information, unit prices and construction costs of similar facilities and other locations. A more detailed discussion of the basis of costs is included in PM 1.4, *Overall - Basis of Cost*.

Sewer pipeline improvements range in size from 12-inches to 15-inches in diameter in this study. At this point, overall unit project costs were used to estimate total project costs. Unit costs for the pipeline projects, include appurtenances (e.g., manholes) are assumed to be $30.00 per in-foot of pipe. Therefore the above diameters and lengths of each pipeline segment were multiplied by this unit cost to estimate the overall cost of each project. The unit costs are for typical field conditions with construction in stable soil at a depth ranging between 10 feet and 15 feet.

Using the costs assumptions presented in the above sections, project cost estimates were developed and are summarized in Table 8. The total estimated project cost is estimated at $3.2. million. The phasing of these projects will be further examined during Phase 2 of this PWIMP.

6.1.1 Rehabilitation Projects

In addition to projects recommended for capacity deficiencies described in the sections above, the collection system CIP also includes rehabilitation projects shown in Table 9. During the collection system assessment, it was determined that only minimal information is known about the existing condition and age of the collection system piping. Thus a detailed system rehabilitation program could not be practically developed as part of this PWIMP. Instead, the CIP recommendations for rehabilitation projects are based on the City's understanding of project needs.

6.2 Project Prioritization

Prioritizing the required capital improvements for the City's sewer system is an important aspect of this study. The projects were grouped into the following phases:

- Phase 1: Proposed facilities address existing LOS issues (dry or wet weather flow).
- Phase 2. - Proposed facilities address LOS issues under planning year 2020 modeling conditions.
- Phase 3. - Proposed facilities address LOS issues under planning year 2030 modeling conditions.
- Phase 4. Proposed facilities address LOS issues under planning year 2040 modeling conditions.

Table 8	Recommended Projects Cost Estimates and Phasing for Collection System Capacity Projects[(1)(2)(3)] Public Works Integrated Master Plan City of Oxnard				
Project	**Location Description**	**Pipe Description**	**Conduit**	**Recommended Project Cost ($)**	**Project Phase**
Project 1					
WW-P-1	N Ventura Rd and S Ventura Rd	Ventura Road Trunk Sewer	4943	$60,708	1
WW-P-1	N Ventura Rd and S Ventura Rd	Ventura Road Trunk Sewer	4956	$120,859	1
WW-P-1	N Ventura Rd and S Ventura Rd	Ventura Road Trunk Sewer	1429	$225,158	1
WW-P-1	N Ventura Rd and S Ventura Rd	Ventura Road Trunk Sewer	1431	$223,950	1
WW-P-1	N Ventura Rd and S Ventura Rd	Ventura Road Trunk Sewer	1432	$12,503	1
WW-P-1	N Ventura Rd and S Ventura Rd	Ventura Road Trunk Sewer	1443	$266,801	1
WW-P-1	N Ventura Rd and S Ventura Rd	Ventura Road Trunk Sewer	4276	$186,837	1
WW-P-1	N Ventura Rd and S Ventura Rd	Ventura Road Trunk Sewer	1460	$84,471	1
WW-P-1	N Ventura Rd and S Ventura Rd	Ventura Road Trunk Sewer	1461	$267,890	1
WW-P-1	N Ventura Rd and S Ventura Rd	Ventura Road Trunk Sewer	1462	$270,365	1
WW-P-1	N Ventura Rd and S Ventura Rd	Ventura Road Trunk Sewer	1463	$35,657	1
			Project 1 Subtotal	**$1,755,197**	
Project 2					
WW-P-2	Navarro St and E First St	Sewers in the La Colonia Neighborhood	2888	$183,218	2
WW-P-2	Navarro St and E First St	Sewers in the La Colonia Neighborhood	2889	$181,651	2
			Project 2 Subtotal	**$364,869**	
Project 3					
WW-P-3	S Victoria Ave and W Hemlock St	Sewers in the Channel Islands Neighborhood	501	$203,996	2

Table 8 Recommended Projects Cost Estimates and Phasing for Collection System Capacity Projects(1)(2)(3)
Public Works Integrated Master Plan
City of Oxnard

Project	Location Description	Pipe Description	Conduit	Recommended Project Cost ($)	Project Phase
WW-P-3	S Victoria Ave and W Hemlock St	Sewers in the Channel Islands Neighborhood	{74B96752-98B2-4F5D-AF2A-21B06EE4909C}	$113,743	2
WW-P-3	S Victoria Ave and W Hemlock St	Sewers in the Channel Islands Neighborhood	P-2471	$794,528	2
			Project 3 Subtotal	**$1,112,267**	
			Total	**$3,232,333**	

Notes:

(1) Pipeline Unit Cost = $30 per inch-foot.
(2) 20-City Average Index ENR CCI of 9,962 was used for February 2015. A R.S. Means Location Factor of 106.6 for Oxnard was used.
(3) Project costs, schedules, and phasing are based on data and information available at the time of the original date of preparation – December 2015. The updated CIP is contained in the Brief History section of the PMs, the Summary Report, and the Executive Summary.

Table 9 Recommended Projects Cost Estimates and Phasing for Collection System Capacity Project[(1)(2)]
Public Works Integrated Master Plan
City of Oxnard

Project	Description	Driver	Recommended Project Cost ($)	Recommended Project Phase
WW-P-4	Central Trunk Condition Assessment	Rehabilitation and Replacement	$200,000	1
WW-P-5	Headworks meter vaults/vortex structures coating	Rehabilitation and Replacement	$1,000,000	1
WW-P-6	Phase 1 Central Trunk manholes reconstruction	Rehabilitation and Replacement	$1,500,000	1
WW-P-7	Existing asbestos concrete pipe (ACP) replacement	Rehabilitation and Replacement	$5,000,000	1
WW-P-8	Harbor Blvd manhole rehabilitation	Rehabilitation and Replacement	$100,000	1
WW-P-9	Redwood tributary manholes rehabilitation	Rehabilitation and Replacement	$200,000	1
WW-P-10	Lift Station 23 - Wagon Wheel Replacement	Rehabilitation and Replacement	$1,000,000	1
WW-P-11	Lift Station 6 - Canal Rehabilitation	Rehabilitation and Replacement	$500,000	1
WW-P-12	Lift Station 4 - Mandaley & Wooley Rehabilitation	Rehabilitation and Replacement	$500,000	1
WW-P-13	Phase 2 Central Trunk manholes reconstruction	Rehabilitation and Replacement	$200,000	2
WW-P-14	Phase 1 Central Trunk replacement	Rehabilitation and Replacement	$36,500,000	1
WW-P-15	Phase 2 Central Trunk replacement	Rehabilitation and Replacement	$30,000,000	2
WW-P-16	Rice Ave (Rice & 5th) sewer replacement	Rehabilitation and Replacement	$1,300,000	1
WW-P-17	Other Collection System Improvements	Rehabilitation and Replacement	$66,600,000	2
WW-P-18	Casden Village Lift Station	Performance	$1,000,000	1
		Total:	**$145,600,000**	

Notes:

(1) 20-City Average Index ENR CCI of 9,962 was used for February 2015. A R.S. Means Location Factor of 106.6 for Oxnard was used.
(2) Project costs, schedules, and phasing are based on data and information available at the time of the original date of preparation – December 2015. The updated CIP is contained in the Brief History section of the PMs, the Summary Report, and the Executive Summary.

The projects were phased based on the best available information for how the City will develop moving forward. The actual implementation of the improvements serving future users ultimately depends on growth. The phases presented below are estimates, and changes in the City's planning assumptions or growth projections could increase or decrease the phase of each improvement.

APPENDIX A – DRY WEATHER FLOW CALIBRATION PLOTS

Table 1 Dry Weather Flow Calibration Results
Public Works Integrated Master Plan
City of Oxnard

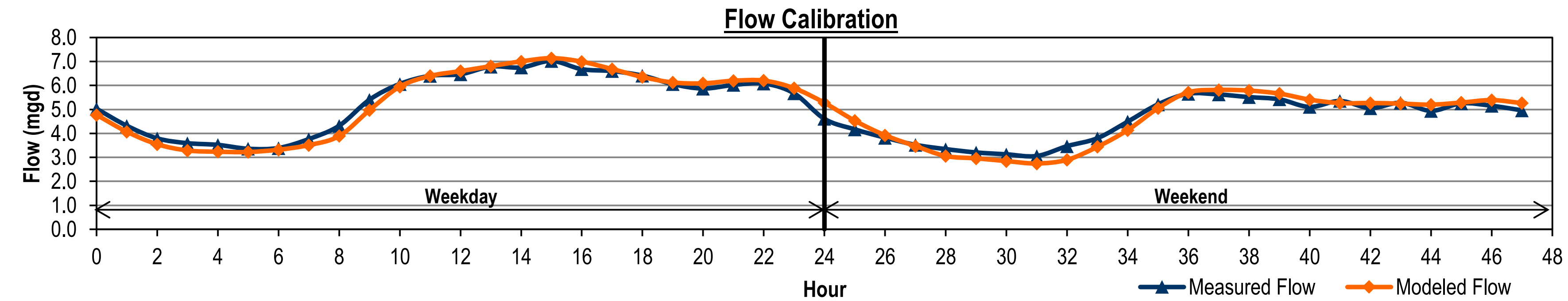
		Weekday Dry Weather Flow												Weekend Dry Weather Flow												Average Dry Weather Flow[4]		
		Measured Data[1]				Modeled Data[2]				Percent Error[3]				Measured Data[1]				Modeled Data[2]				Percent Error[3]						
Meter Number	Pipe Diameter (in)	Avg. Flow (mgd)	Peak Flow (mgd)	Avg. Velocity (ft/s)	Avg. Level (in)	Avg. Flow (mgd)	Peak Flow (mgd)	Avg. Velocity (ft/s)	Avg. Level (in)	Avg. Flow (%)	Peak Flow (%)	Avg. Velocity (%)	Avg. Level (%)	Avg. Flow (mgd)	Peak Flow (mgd)	Avg. Velocity (ft/s)	Avg. Level (in)	Avg. Flow (mgd)	Peak Flow (mgd)	Avg. Velocity (ft/s)	Avg. Level (in)	Avg. Flow (%)	Peak Flow (%)	Avg. Velocity (%)	Avg. Level (%)	Measured ADWF (mgd)	Modeled ADWF (mgd)	Percent Difference (%)
SITE 1	41.5	5.390	7.021	2.53	16.0	5.343	7.139	2.75	15.4	-0.9%	1.7%	8.7%	-3.4%	4.547	5.655	2.42	14.6	4.567	5.812	2.61	14.5	0.4%	2.8%	7.7%	-1.2%	5.149	5.122	-0.5%
SITE 2	36	2.759	3.111	1.70	13.8	2.650	2.958	1.86	13.4	-4.0%	-4.9%	9.1%	-3.1%	2.352	2.656	1.65	12.6	2.353	2.757	1.77	12.9	0.1%	3.8%	7.2%	2.0%	2.643	2.565	-2.9%
SITE 3	60	7.027	9.830	2.35	16.8	7.034	9.771	2.53	17.5	0.1%	-0.6%	7.9%	4.1%	7.515	11.051	2.40	17.1	7.359	10.772	2.56	17.7	-2.1%	-2.5%	6.5%	3.8%	7.166	7.127	-0.5%
SITE 4A	33	3.131	4.786	1.60	17.7	3.438	4.639	1.75	17.6	9.8%	-3.1%	9.5%	-0.8%	3.378	5.088	1.67	18.0	3.481	4.887	1.75	17.6	3.1%	-4.0%	4.9%	-2.1%	3.202	3.450	7.8%
SITE 5	36	1.483	2.010	1.95	11.4	1.442	1.883	1.38	11.7	-2.8%	-6.3%	-29.5%	2.8%	0.972	1.183	1.68	10.2	1.037	1.268	1.18	10.7	6.7%	7.3%	-29.4%	4.3%	1.337	1.327	-0.8%
SITE 6	24	1.440	2.137	1.66	10.4	1.479	2.072	1.97	10.5	2.7%	-3.0%	18.7%	1.2%	1.126	1.672	1.36	10.3	1.140	1.592	1.78	9.5	1.2%	-4.8%	30.7%	-7.5%	1.351	1.382	2.3%
SITE 7	24	0.310	0.420	1.18	4.4	0.314	0.424	1.31	4.5	1.3%	1.0%	10.8%	1.6%	0.317	0.444	1.17	4.5	0.309	0.436	1.29	4.4	-2.5%	-1.6%	10.7%	-0.7%	0.312	0.312	0.2%
SITE 8	27	1.820	2.547	2.47	8.7	1.979	2.705	2.64	9.0	8.7%	6.2%	7.0%	3.6%	1.842	2.630	2.49	8.7	1.996	2.845	2.65	9.0	8.3%	8.2%	6.2%	3.9%	1.826	1.984	8.6%
SITE 9	42	2.014	2.876	3.35	6.3	2.172	3.096	2.49	8.3	7.9%	7.6%	-25.6%	32.5%	2.113	3.188	3.36	6.4	2.259	3.518	2.50	8.4	6.9%	10.3%	-25.6%	31.3%	2.042	2.197	7.6%
SITE 10	37	1.876	2.332	1.38	12.1	1.909	2.391	1.67	12.9	1.7%	2.5%	20.7%	7.2%	2.036	2.917	1.44	12.3	1.942	2.748	1.68	13.0	-4.6%	-5.8%	16.7%	5.1%	1.922	1.918	-0.2%

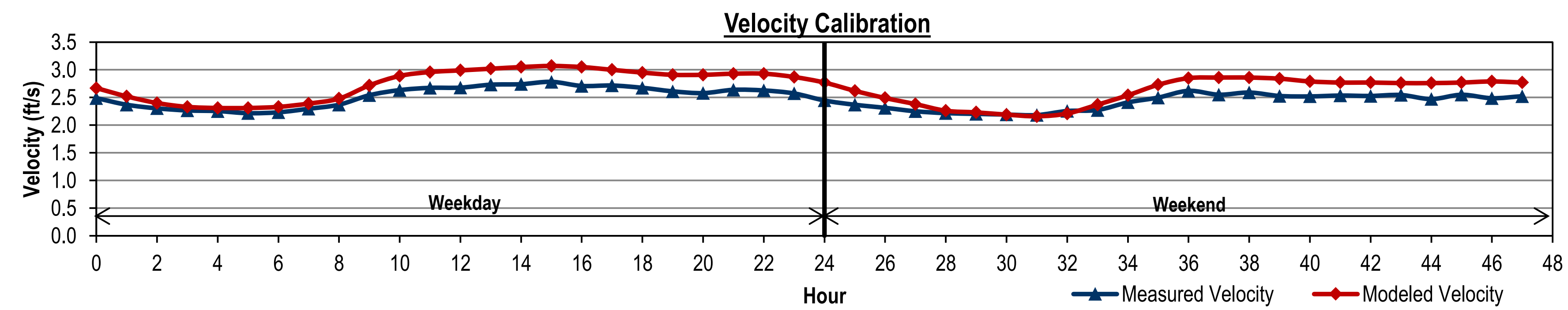
Notes:
1. Temporary Flow Monitoring Program, V&A Consulting Engineers
2. Average flow, level, and velocity are calculated from weekday/weekend dry weather flow monitoring data. Maximum flow values are hourly peaks corresponding to either weekend or weekday conditions, as appropriate.
3. Percent Difference = (Modeled - Measured)/Measured*100.
4. Average Dry Weather Flow = (5*Weekday Dry Weather Flow + 2*Weekend Dry Weather Flow)/7

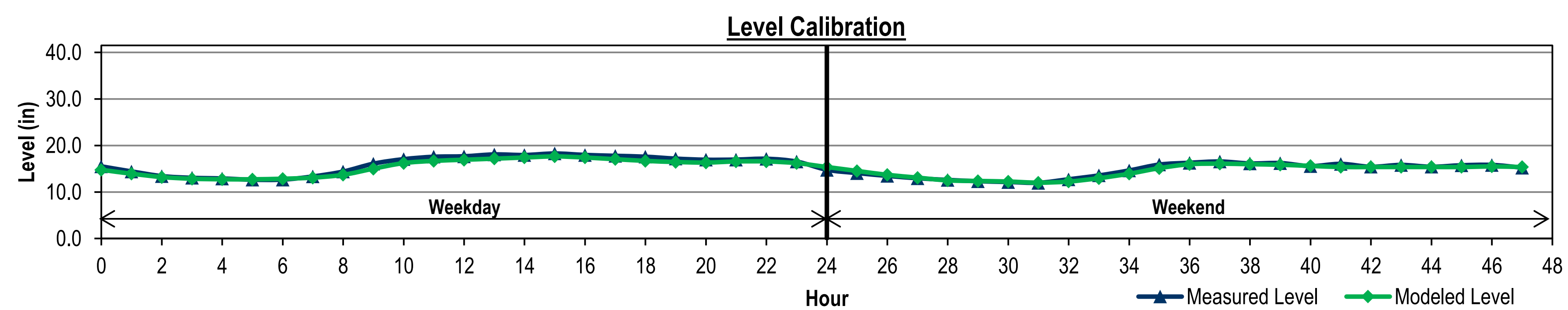
FLOW MONITORING SITE 1 DRY WEATHER FLOW CALIBRATION

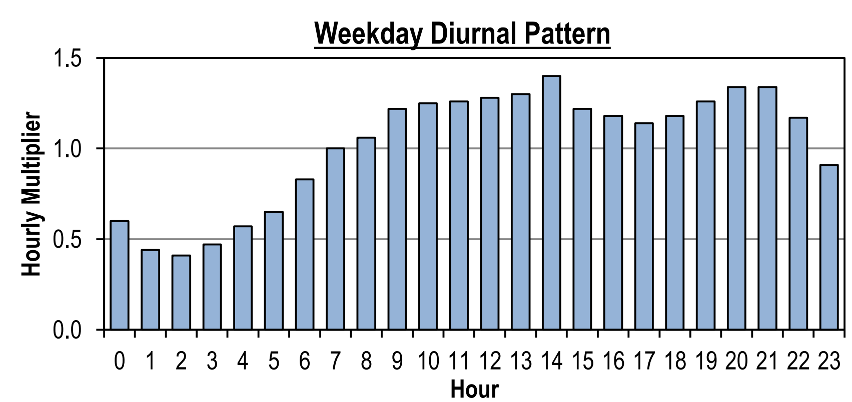
	Hour	Measured Data Flow (mgd)	Measured Data Level (in)	Measured Data Velocity (ft/s)	Modeled Data Flow (mgd)	Modeled Data Level (in)	Modeled Data Velocity (ft/s)	Diurnal Initial Curve	Diurnal Modified Curve	Diurnal Calibrated Diurnal
Weekday	0	5.027	15.5	2.49	4.772	14.8	2.67	0.84	0.60	0.60
	1	4.318	14.4	2.37	4.067	13.9	2.52	0.74	0.44	0.44
	2	3.793	13.4	2.30	3.548	13.2	2.40	0.70	0.41	0.41
	3	3.593	13.0	2.27	3.287	12.8	2.33	0.68	0.47	0.47
	4	3.521	12.9	2.25	3.235	12.7	2.31	0.65	0.57	0.57
	5	3.360	12.6	2.22	3.224	12.7	2.31	0.66	0.65	0.65
	6	3.392	12.7	2.23	3.321	12.8	2.33	0.73	0.83	0.83
	7	3.765	13.3	2.30	3.513	13.1	2.39	0.84	1.00	1.00
	8	4.320	14.4	2.37	3.890	13.7	2.48	1.05	1.06	1.06
	9	5.404	16.1	2.54	4.969	15.0	2.72	1.18	1.22	1.22
	10	6.062	17.0	2.63	5.952	16.2	2.89	1.24	1.25	1.25
	11	6.402	17.6	2.67	6.395	16.7	2.96	1.26	1.26	1.26
	12	6.467	17.7	2.68	6.598	16.9	2.99	1.32	1.28	1.28
	13	6.787	18.1	2.73	6.804	17.2	3.02	1.31	1.30	1.30
	14	6.749	17.9	2.74	7.004	17.4	3.05	1.36	1.40	1.40
	15	7.021	18.3	2.78	7.139	17.6	3.07	1.30	1.22	1.22
	16	6.677	18.0	2.71	6.992	17.4	3.05	1.28	1.18	1.18
	17	6.600	17.8	2.72	6.684	17.0	3.00	1.24	1.14	1.14
	18	6.410	17.6	2.68	6.352	16.7	2.95	1.18	1.18	1.18
	19	6.055	17.2	2.61	6.124	16.4	2.91	1.14	1.26	1.26
	20	5.871	16.9	2.58	6.088	16.3	2.91	1.17	1.34	1.34
	21	6.020	17.0	2.64	6.197	16.6	2.93	1.18	1.34	1.34
	22	6.080	17.1	2.63	6.202	16.6	2.93	1.10	1.17	1.17
	23	5.670	16.5	2.57	5.885	16.2	2.87	0.98	0.91	0.91
Weekend	24	4.605	14.8	2.45	5.275	15.4	2.77	0.81	0.60	0.60
	25	4.169	14.1	2.37	4.528	14.5	2.62	0.74	0.55	0.55
	26	3.822	13.5	2.31	3.921	13.7	2.49	0.68	0.53	0.53
	27	3.522	12.9	2.25	3.471	13.1	2.38	0.65	0.51	0.51
	28	3.345	12.6	2.22	3.056	12.5	2.26	0.62	0.49	0.49
	29	3.205	12.3	2.20	2.959	12.4	2.23	0.61	0.46	0.46
	30	3.127	12.1	2.19	2.845	12.2	2.19	0.59	0.43	0.43
	31	3.057	12.0	2.18	2.745	12.0	2.16	0.67	0.66	0.66
	32	3.469	12.7	2.26	2.899	12.2	2.21	0.74	1.00	1.00
	33	3.799	13.6	2.27	3.440	13.0	2.37	0.87	1.20	1.20
	34	4.491	14.6	2.41	4.139	13.9	2.54	1.01	1.43	1.43
	35	5.214	15.9	2.50	5.053	15.1	2.73	1.10	1.55	1.55
	36	5.655	16.3	2.62	5.713	16.0	2.85	1.09	1.35	1.35
	37	5.624	16.5	2.55	5.812	16.1	2.86	1.07	1.33	1.33
	38	5.514	16.1	2.59	5.785	16.0	2.86	1.05	1.30	1.30
	39	5.421	16.2	2.53	5.659	15.8	2.84	0.99	1.04	1.04
	40	5.104	15.6	2.52	5.408	15.6	2.79	1.04	1.11	1.11
	41	5.353	16.0	2.54	5.263	15.4	2.77	0.98	1.01	1.01
	42	5.055	15.4	2.53	5.267	15.4	2.77	1.02	1.15	1.15
	43	5.278	15.8	2.55	5.242	15.4	2.76	0.96	1.02	1.02
	44	4.942	15.4	2.47	5.199	15.4	2.76	1.02	1.26	1.26
	45	5.253	15.7	2.55	5.286	15.4	2.77	1.00	1.22	1.22
	46	5.152	15.8	2.49	5.389	15.5	2.79	0.96	1.17	1.17
	47	4.961	15.2	2.52	5.263	15.4	2.77	0.89	0.91	0.91
Average										
Weekday		**5.390**	**16.0**	**2.53**	**5.343**	**15.4**	**2.75**	**1.05**	**1.02**	**1.02**
Weekend		**4.547**	**14.6**	**2.42**	**4.567**	**14.5**	**2.61**	**0.88**	**0.97**	**0.97**
ADWF(1)		**5.149**	**15.6**	**2.50**	**5.122**	**15.1**	**2.71**	**1.00**	**1.01**	**1.01**
% Error										
Weekday					-0.9%	-3.4%	8.7%			
Weekend					0.4%	-1.2%	7.7%			

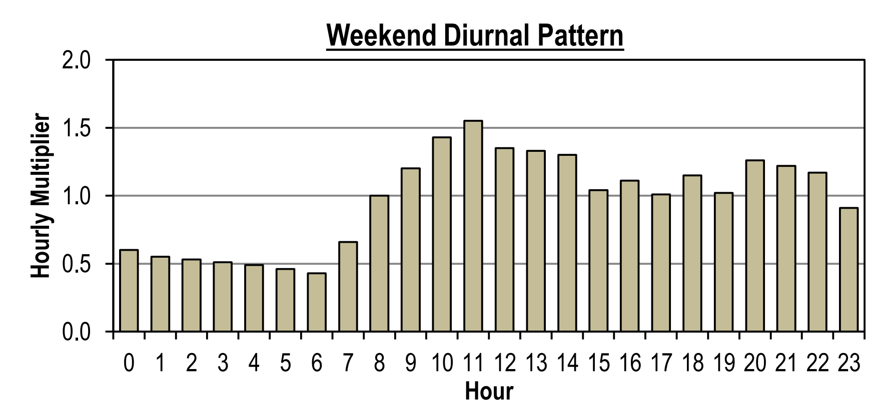
Note:
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7







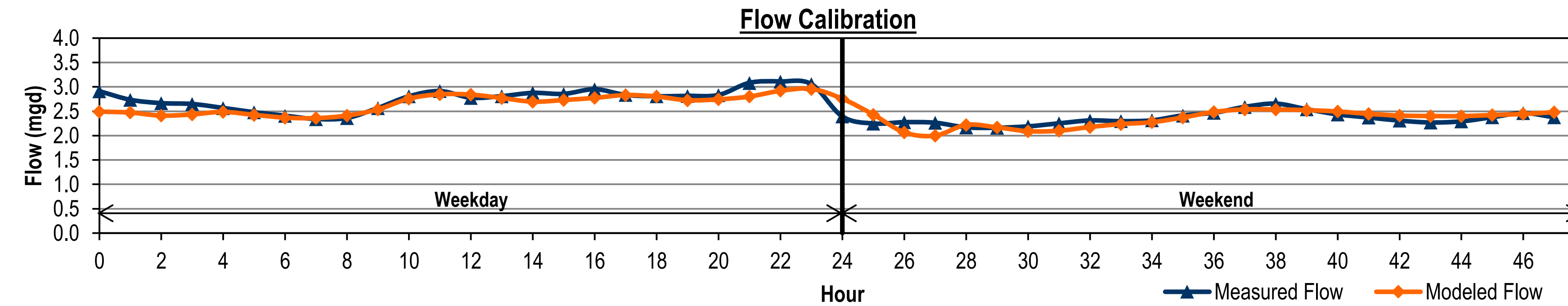


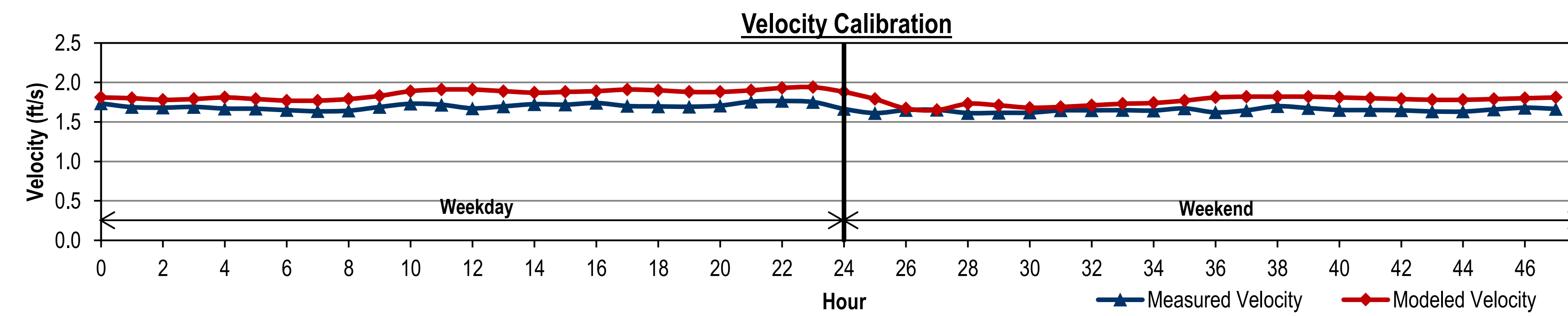


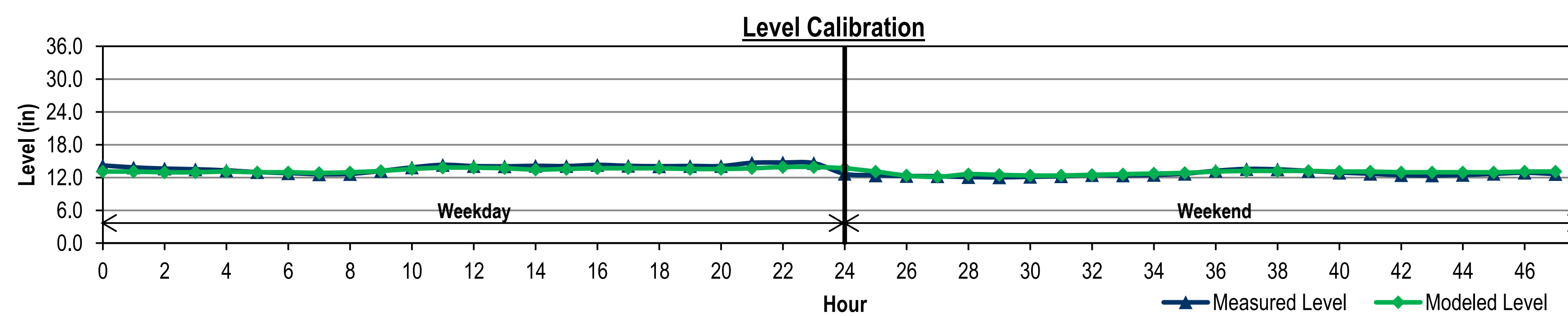
City of Oxnard
Public Works Integrated Master Plan
FLOW MONITORING SITE 2 DRY WEATHER FLOW CALIBRATION

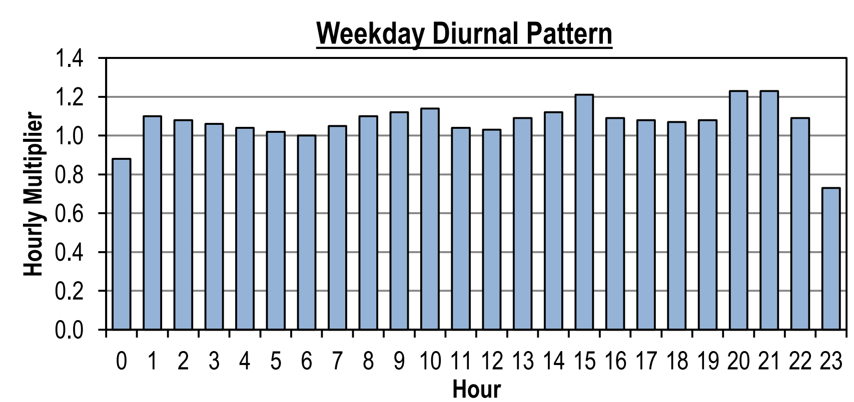
	Hour	Measured Data Flow (mgd)	Measured Data Level (in)	Measured Data Velocity (ft/s)	Modeled Data Flow (mgd)	Modeled Data Level (in)	Modeled Data Velocity (ft/s)	Diurnal Initial Curve	Diurnal Modified Curve	Diurnal Calibrated Diurnal
Weekday	0	2.912	14.2	1.73	2.493	13.1	1.81	1.03	0.88	0.88
	1	2.735	13.8	1.69	2.473	13.1	1.80	1.01	1.10	1.10
	2	2.666	13.6	1.68	2.410	13.0	1.78	1.00	1.08	1.08
	3	2.649	13.5	1.69	2.435	13.0	1.79	0.97	1.06	1.06
	4	2.568	13.3	1.67	2.487	13.1	1.81	0.94	1.04	1.04
	5	2.480	13.0	1.67	2.426	13.0	1.79	0.91	1.02	1.02
	6	2.409	12.8	1.65	2.369	13.0	1.77	0.89	1.00	1.00
	7	2.340	12.6	1.63	2.359	12.8	1.77	0.89	1.05	1.05
	8	2.362	12.7	1.64	2.412	13.0	1.79	0.97	1.10	1.10
	9	2.568	13.2	1.69	2.538	13.2	1.83	1.06	1.12	1.12
	10	2.808	13.8	1.73	2.758	13.6	1.89	1.10	1.14	1.14
	11	2.914	14.3	1.72	2.849	13.8	1.91	1.05	1.04	1.04
	12	2.776	14.1	1.67	2.840	13.8	1.91	1.06	1.03	1.03
	13	2.810	14.0	1.70	2.771	13.7	1.89	1.09	1.09	1.09
	14	2.877	14.1	1.73	2.697	13.4	1.87	1.08	1.12	1.12
	15	2.857	14.1	1.72	2.730	13.6	1.88	1.12	1.21	1.21
	16	2.952	14.3	1.74	2.774	13.7	1.89	1.07	1.09	1.09
	17	2.835	14.1	1.70	2.832	13.7	1.91	1.06	1.08	1.08
	18	2.808	14.1	1.70	2.802	13.7	1.90	1.07	1.07	1.07
	19	2.816	14.1	1.69	2.726	13.6	1.88	1.07	1.08	1.08
	20	2.833	14.1	1.71	2.744	13.6	1.88	1.17	1.23	1.23
	21	3.083	14.7	1.76	2.801	13.7	1.90	1.18	1.23	1.23
	22	3.111	14.7	1.77	2.919	13.9	1.93	1.16	1.09	1.09
	23	3.056	14.6	1.75	2.958	13.9	1.94	1.10	0.73	0.73
Weekend	24	2.393	12.7	1.67	2.757	13.7	1.88	0.85	0.50	0.50
	25	2.249	12.4	1.61	2.432	13.1	1.79	0.86	1.00	1.00
	26	2.276	12.3	1.65	2.067	12.4	1.67	0.86	0.95	0.95
	27	2.264	12.2	1.65	2.000	12.1	1.65	0.82	0.88	0.88
	28	2.169	12.1	1.61	2.220	12.6	1.73	0.82	0.88	0.88
	29	2.162	12.0	1.62	2.169	12.5	1.71	0.83	0.90	0.90
	30	2.190	12.1	1.62	2.091	12.4	1.68	0.85	0.90	0.90
	31	2.252	12.2	1.65	2.100	12.4	1.69	0.87	0.91	0.91
	32	2.311	12.4	1.65	2.177	12.5	1.71	0.87	0.91	0.91
	33	2.297	12.4	1.65	2.237	12.6	1.73	0.88	0.92	0.92
	34	2.313	12.5	1.64	2.275	12.7	1.74	0.91	0.92	0.92
	35	2.415	12.7	1.67	2.372	12.8	1.77	0.93	0.93	0.93
	36	2.468	13.2	1.62	2.486	13.1	1.81	0.98	0.93	0.93
	37	2.590	13.6	1.65	2.538	13.2	1.82	1.01	0.94	0.94
	38	2.656	13.5	1.70	2.536	13.2	1.82	0.96	0.94	0.94
	39	2.542	13.2	1.68	2.522	13.2	1.82	0.92	0.91	0.91
	40	2.435	12.9	1.65	2.495	13.1	1.81	0.90	0.91	0.91
	41	2.371	12.7	1.65	2.446	13.1	1.80	0.87	0.90	0.90
	42	2.308	12.4	1.65	2.411	13.0	1.79	0.86	0.90	0.90
	43	2.269	12.4	1.63	2.402	13.0	1.78	0.87	0.89	0.89
	44	2.292	12.5	1.63	2.400	13.0	1.78	0.90	0.89	0.89
	45	2.378	12.7	1.66	2.422	13.0	1.79	0.93	0.92	0.92
	46	2.463	12.9	1.68	2.444	13.1	1.80	0.90	0.91	0.91
	47	2.376	12.6	1.67	2.482	13.1	1.81	0.91	0.90	0.90
Average										
Weekday		**2.759**	**13.8**	**1.70**	**2.650**	**13.4**	**1.86**	**1.04**	**1.07**	**1.07**
Weekend		**2.352**	**12.6**	**1.65**	**2.353**	**12.9**	**1.77**	**0.89**	**0.90**	**0.90**
ADWF[(1)]		**2.643**	**13.5**	**1.69**	**2.565**	**13.2**	**1.83**	**1.00**	**1.02**	**1.02**
% Error										
Weekday					**-4.0%**	**-3.1%**	**9.1%**			
Weekend					**0.1%**	**2.0%**	**7.2%**			

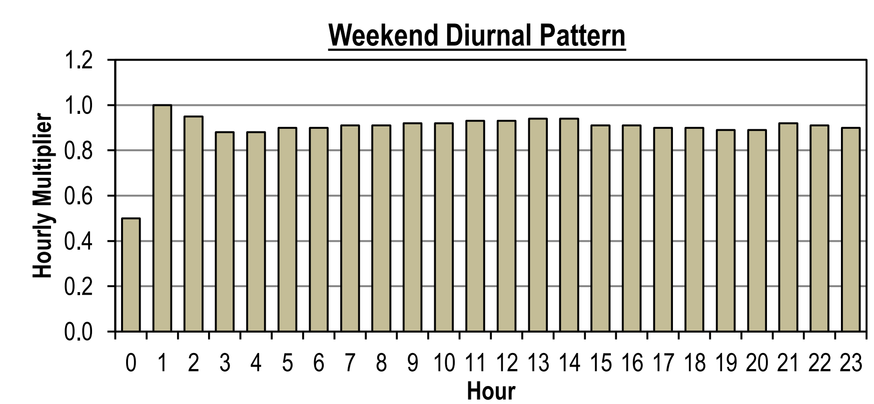
Note:
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7







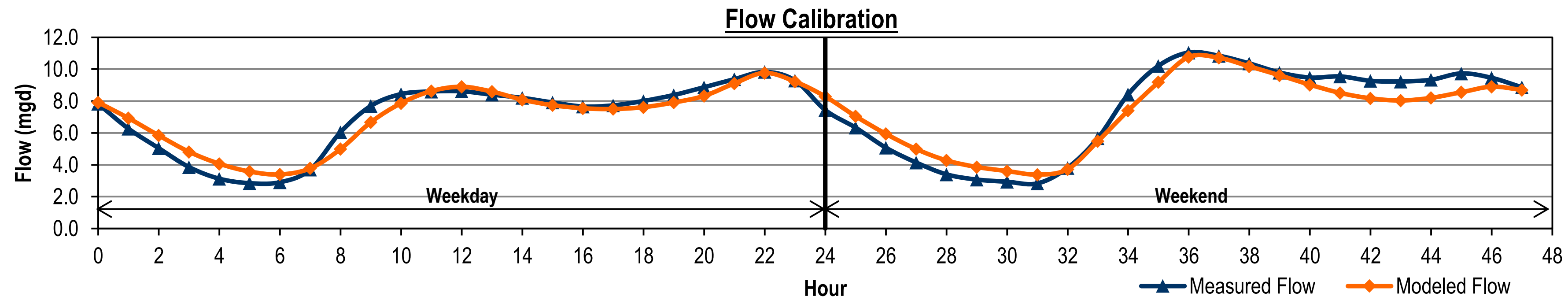


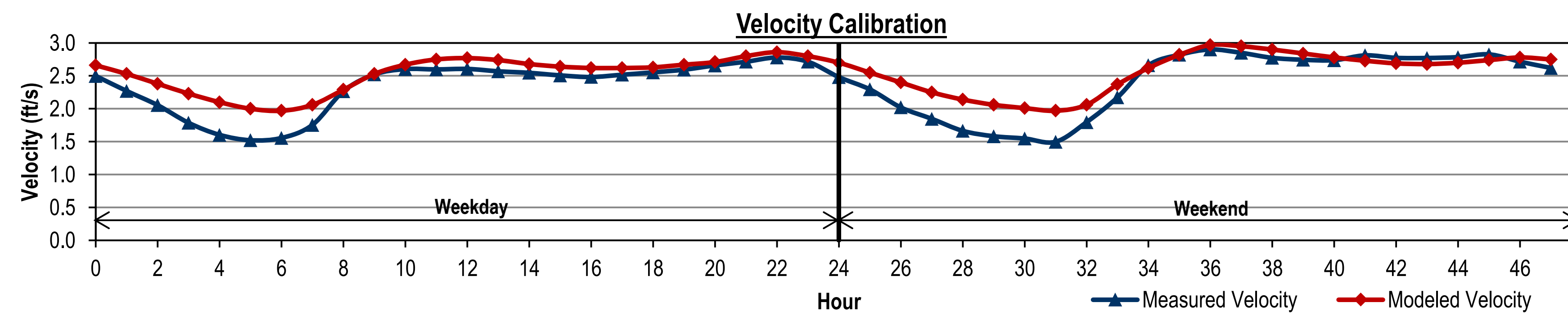


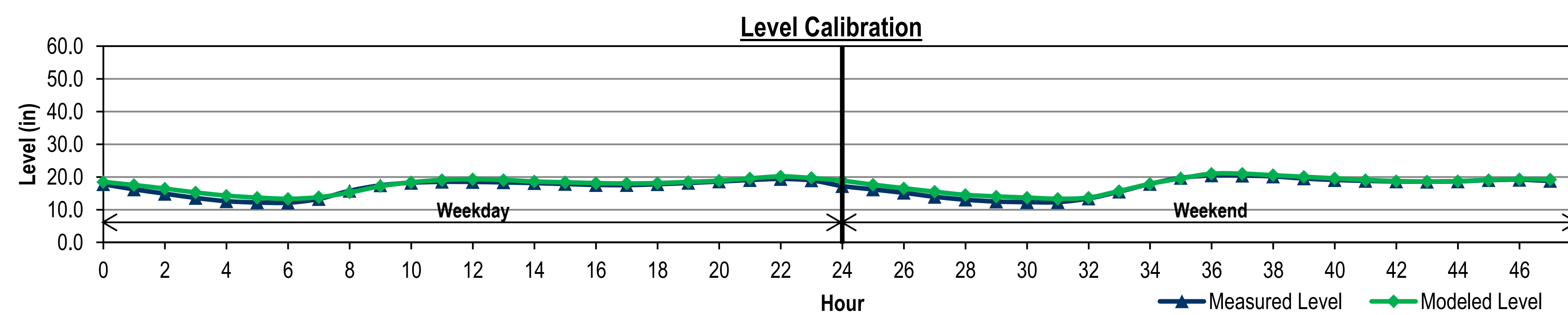
City of Oxnard
Public Works Integrated Master Plan
FLOW MONITORING SITE 3 DRY WEATHER FLOW CALIBRATION

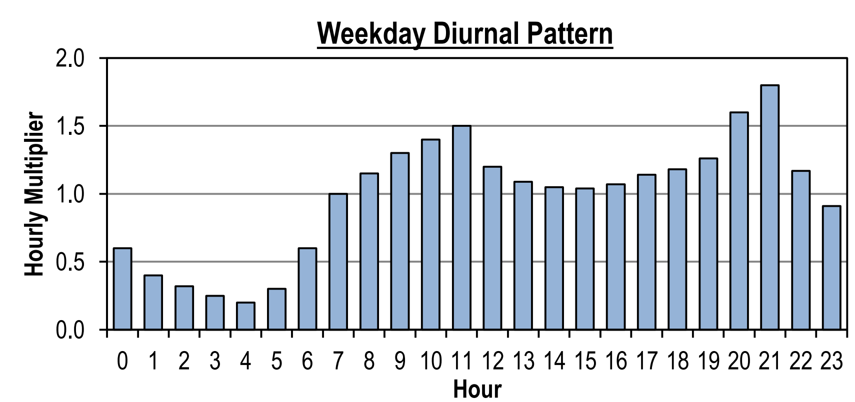
Hour		Measured Data Flow (mgd)	Measured Data Level (in)	Measured Data Velocity (ft/s)	Modeled Data Flow (mgd)	Modeled Data Level (in)	Modeled Data Velocity (ft/s)	Diurnal Initial Curve	Diurnal Modified Curve	Diurnal Calibrated Diurnal
Weekday	0	7.830	17.8	2.50	7.920	18.5	2.66	0.87	0.60	0.60
	1	6.270	16.2	2.27	6.930	17.5	2.53	0.70	0.40	0.40
	2	5.041	14.9	2.05	5.843	16.4	2.38	0.54	0.32	0.32
	3	3.856	13.6	1.79	4.814	15.2	2.23	0.44	0.25	0.25
	4	3.126	12.6	1.60	4.067	14.3	2.10	0.40	0.20	0.20
	5	2.846	12.2	1.52	3.577	13.7	2.00	0.41	0.30	0.30
	6	2.904	12.1	1.56	3.395	13.3	1.97	0.52	0.60	0.60
	7	3.700	13.3	1.76	3.780	13.8	2.06	0.84	1.00	1.00
	8	6.051	15.8	2.27	4.990	15.2	2.29	1.07	1.15	1.15
	9	7.694	17.4	2.52	6.675	17.2	2.53	1.18	1.30	1.30
	10	8.442	18.2	2.60	7.868	18.4	2.67	1.20	1.40	1.40
	11	8.603	18.5	2.60	8.629	19.1	2.75	1.20	1.50	1.50
	12	8.616	18.5	2.61	8.901	19.3	2.77	1.17	1.20	1.20
	13	8.404	18.3	2.57	8.595	19.1	2.74	1.14	1.09	1.09
	14	8.202	18.1	2.55	8.087	18.6	2.68	1.10	1.05	1.05
	15	7.912	17.9	2.51	7.741	18.4	2.64	1.07	1.04	1.04
	16	7.661	17.6	2.48	7.550	18.1	2.62	1.08	1.07	1.07
	17	7.732	17.5	2.52	7.502	18.0	2.62	1.12	1.14	1.14
	18	8.008	17.8	2.55	7.618	18.1	2.63	1.17	1.18	1.18
	19	8.381	18.2	2.59	7.912	18.5	2.67	1.24	1.26	1.26
	20	8.870	18.6	2.66	8.323	18.8	2.71	1.31	1.60	1.60
	21	9.377	19.1	2.71	9.110	19.6	2.80	1.37	1.80	1.80
	22	9.830	19.4	2.78	9.771	20.2	2.86	1.30	1.17	1.17
	23	9.297	18.9	2.72	9.227	19.7	2.80	1.09	0.91	0.91
Weekend	24	7.437	17.2	2.48	8.288	18.8	2.70	0.88	0.60	0.60
	25	6.335	16.2	2.30	7.052	17.6	2.55	0.71	0.44	0.44
	26	5.076	15.1	2.02	5.944	16.6	2.40	0.58	0.39	0.39
	27	4.144	13.9	1.85	4.989	15.5	2.25	0.47	0.33	0.33
	28	3.400	13.0	1.66	4.278	14.5	2.14	0.43	0.28	0.28
	29	3.073	12.5	1.58	3.864	14.0	2.06	0.41	0.25	0.25
	30	2.939	12.3	1.55	3.609	13.7	2.01	0.40	0.20	0.20
	31	2.831	12.3	1.50	3.386	13.3	1.97	0.53	0.80	0.80
	32	3.813	13.4	1.80	3.725	13.7	2.06	0.79	1.36	1.36
	33	5.678	15.5	2.17	5.482	15.7	2.37	1.18	1.75	1.75
	34	8.427	17.9	2.66	7.410	17.9	2.62	1.43	1.90	1.90
	35	10.216	19.7	2.82	9.185	19.6	2.82	1.54	2.10	2.10
	36	11.051	20.4	2.90	10.772	21.0	2.97	1.51	1.50	1.50
	37	10.844	20.4	2.85	10.718	21.0	2.95	1.45	1.40	1.40
	38	10.363	20.2	2.77	10.178	20.5	2.90	1.37	1.30	1.30
	39	9.793	19.5	2.75	9.621	20.0	2.84	1.32	1.20	1.20
	40	9.477	19.1	2.74	9.027	19.6	2.78	1.33	1.07	1.07
	41	9.548	18.8	2.81	8.511	19.1	2.73	1.29	1.14	1.14
	42	9.272	18.6	2.77	8.173	18.7	2.69	1.29	1.18	1.18
	43	9.233	18.6	2.77	8.039	18.6	2.68	1.30	1.26	1.26
	44	9.339	18.7	2.79	8.203	18.7	2.70	1.36	1.34	1.34
	45	9.740	19.0	2.83	8.555	19.1	2.74	1.32	1.34	1.34
	46	9.458	19.2	2.72	8.905	19.3	2.78	1.24	1.17	1.17
	47	8.864	18.8	2.62	8.704	19.2	2.75	1.04	0.91	0.91
Average										
Weekday		**7.027**	**16.8**	**2.35**	**7.034**	**17.5**	**2.53**	**0.98**	**0.98**	**0.98**
Weekend		**7.515**	**17.1**	**2.40**	**7.359**	**17.7**	**2.56**	**1.05**	**1.05**	**1.05**
ADWF[(1)]		**7.166**	**16.9**	**2.36**	**7.127**	**17.5**	**2.54**	**1.00**	**1.00**	**1.00**
% Error										
Weekday					0.1%	4.1%	7.9%			
Weekend					-2.1%	3.8%	6.5%			

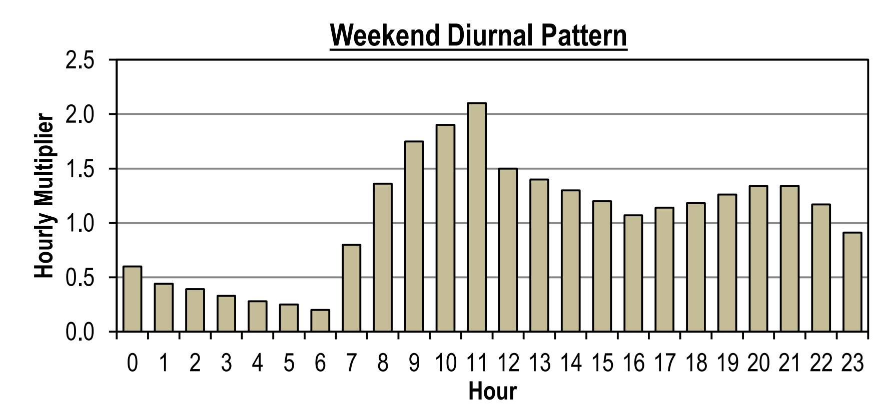
Note:
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7











City of Oxnard

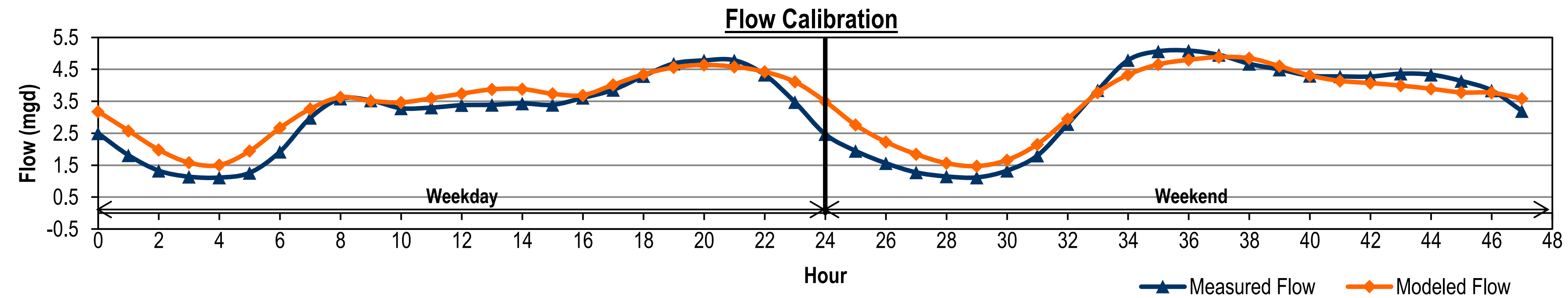
Public Works Integrated Master Plan

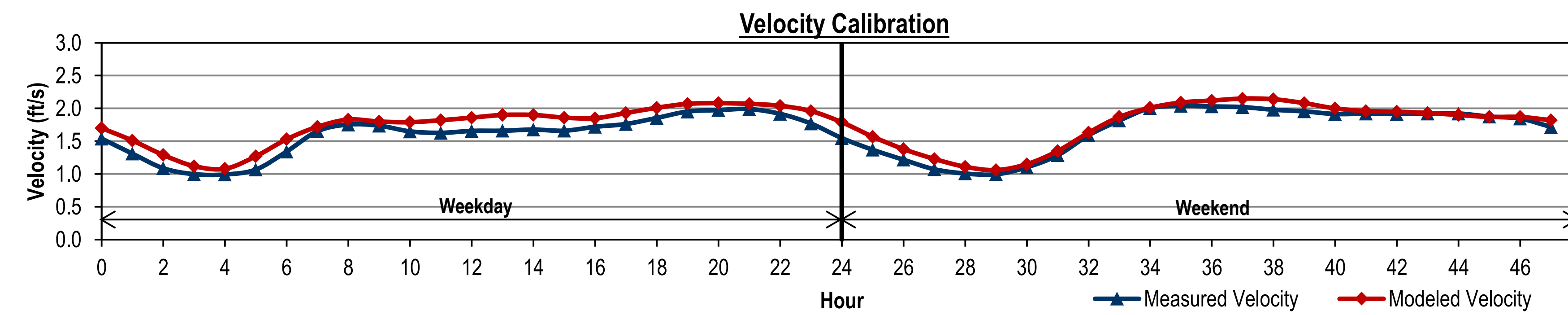
FLOW MONITORING SITE 4A DRY WEATHER FLOW CALIBRATION

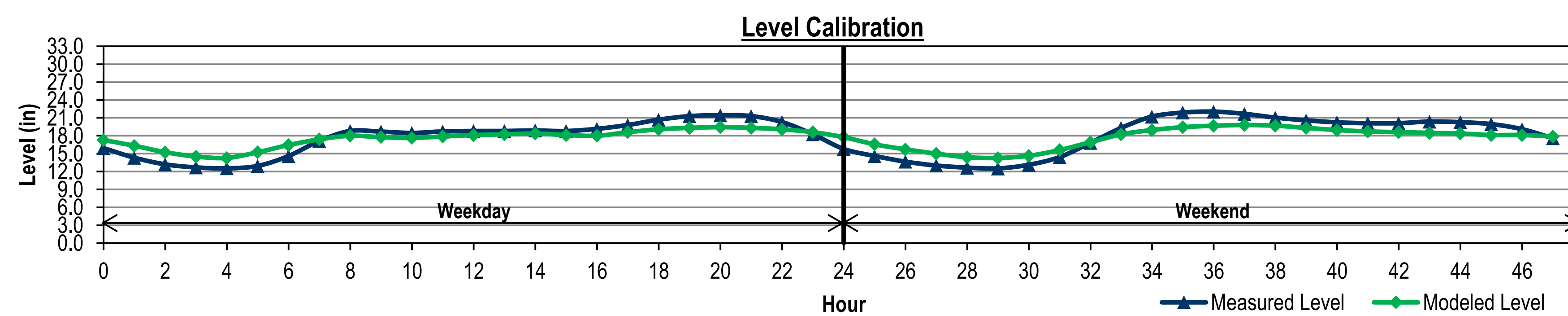
	Hour	Measured Data Flow (mgd)	Measured Data Level (in)	Measured Data Velocity (ft/s)	Modeled Data Flow (mgd)	Modeled Data Level (in)	Modeled Data Velocity (ft/s)	Diurnal Initial Curve	Diurnal Modified Curve	Diurnal Calibrated Diurnal
Weekday	0	2.495	15.9	1.54	3.180	17.3	1.70	0.57	0.55	0.55
	1	1.811	14.3	1.31	2.579	16.3	1.51	0.41	0.39	0.39
	2	1.327	13.2	1.09	1.980	15.2	1.29	0.36	0.34	0.34
	3	1.139	12.7	1.00	1.579	14.5	1.12	0.35	0.33	0.33
	4	1.112	12.5	0.99	1.504	14.3	1.08	0.39	0.75	0.75
	5	1.261	12.9	1.07	1.944	15.2	1.27	0.60	1.25	1.25
	6	1.921	14.6	1.34	2.664	16.4	1.53	0.93	1.43	1.43
	7	2.981	17.1	1.65	3.264	17.4	1.72	1.12	1.60	1.60
	8	3.582	18.8	1.76	3.628	18.0	1.83	1.10	1.10	1.10
	9	3.526	18.7	1.74	3.513	17.8	1.80	1.03	0.81	0.81
	10	3.284	18.5	1.65	3.466	17.6	1.79	1.03	0.81	0.81
	11	3.303	18.7	1.63	3.594	17.9	1.82	1.06	0.81	0.81
	12	3.378	18.8	1.66	3.740	18.1	1.86	1.06	0.81	0.81
	13	3.391	18.8	1.66	3.875	18.2	1.90	1.07	0.81	0.81
	14	3.435	18.9	1.68	3.885	18.4	1.90	1.06	0.81	0.81
	15	3.391	18.8	1.66	3.735	18.1	1.86	1.13	0.81	0.81
	16	3.607	19.2	1.72	3.692	18.0	1.85	1.21	1.25	1.25
	17	3.860	19.8	1.76	4.019	18.6	1.93	1.34	1.47	1.47
	18	4.291	20.7	1.86	4.345	19.1	2.01	1.46	1.57	1.57
	19	4.684	21.3	1.95	4.561	19.3	2.07	1.49	1.57	1.57
	20	4.780	21.4	1.98	4.639	19.4	2.08	1.49	1.45	1.45
	21	4.786	21.3	1.99	4.582	19.3	2.07	1.35	1.24	1.24
	22	4.335	20.3	1.92	4.424	19.1	2.04	1.08	1.10	1.10
	23	3.471	18.3	1.77	4.109	18.6	1.96	0.78	0.91	0.91
Weekend	24	2.470	15.8	1.55	3.495	17.8	1.79	0.61	0.60	0.60
	25	1.947	14.6	1.37	2.759	16.6	1.57	0.49	0.60	0.60
	26	1.562	13.7	1.22	2.230	15.7	1.38	0.40	0.55	0.55
	27	1.274	13.0	1.07	1.843	15.0	1.23	0.36	0.45	0.45
	28	1.147	12.7	1.01	1.562	14.4	1.11	0.35	0.41	0.41
	29	1.116	12.5	1.00	1.471	14.3	1.06	0.41	0.55	0.55
	30	1.329	13.1	1.10	1.660	14.6	1.15	0.56	0.68	0.68
	31	1.798	14.4	1.29	2.153	15.6	1.35	0.87	0.93	0.93
	32	2.785	16.8	1.59	2.945	16.9	1.63	1.20	1.25	1.25
	33	3.850	19.3	1.82	3.777	18.2	1.87	1.50	1.41	1.41
	34	4.791	21.2	2.01	4.331	19.0	2.01	1.58	1.55	1.55
	35	5.067	21.9	2.04	4.658	19.4	2.09	1.59	1.53	1.53
	36	5.088	22.0	2.03	4.799	19.7	2.12	1.55	1.41	1.41
	37	4.953	21.7	2.02	4.887	19.8	2.15	1.46	1.38	1.38
	38	4.675	21.0	1.98	4.850	19.7	2.14	1.40	1.35	1.35
	39	4.494	20.6	1.96	4.602	19.3	2.08	1.34	1.34	1.34
	40	4.303	20.2	1.92	4.309	19.0	2.00	1.34	1.34	1.34
	41	4.281	20.1	1.92	4.139	18.7	1.96	1.34	1.34	1.34
	42	4.276	20.1	1.92	4.072	18.6	1.95	1.36	1.18	1.18
	43	4.366	20.4	1.92	3.991	18.5	1.93	1.35	1.10	1.10
	44	4.335	20.3	1.92	3.893	18.4	1.90	1.29	0.82	0.82
	45	4.137	20.0	1.88	3.777	18.1	1.87	1.20	0.80	0.80
	46	3.841	19.1	1.85	3.769	18.1	1.87	1.00	0.70	0.70
	47	3.193	17.6	1.72	3.583	17.9	1.82	0.77	0.65	0.65
Average										
	Weekday	**3.131**	**17.7**	**1.60**	**3.438**	**17.6**	**1.75**	**0.98**	**1.00**	**1.00**
	Weekend	**3.378**	**18.0**	**1.67**	**3.481**	**17.6**	**1.75**	**1.06**	**1.00**	**1.00**
	ADWF[1]	**3.202**	**17.8**	**1.62**	**3.450**	**17.6**	**1.75**	**1.00**	**1.00**	**1.00**
% Error										
	Weekday				9.8%	-0.8%	9.5%			
	Weekend				3.1%	-2.1%	4.9%			

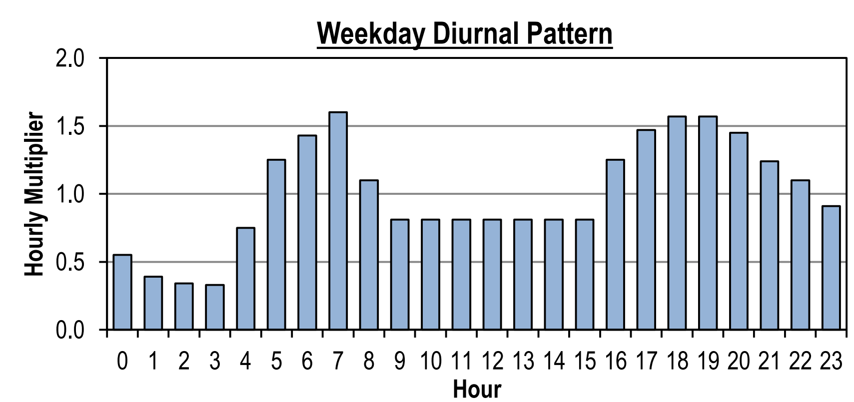
Note:

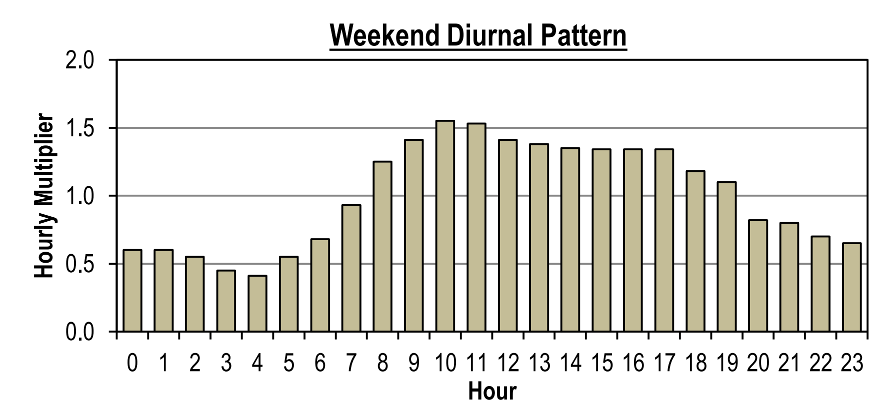
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7











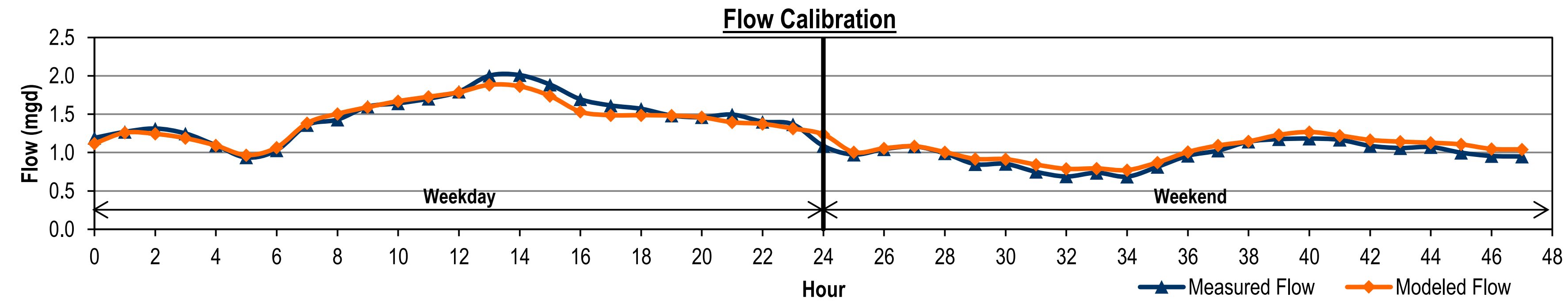
City of Oxnard

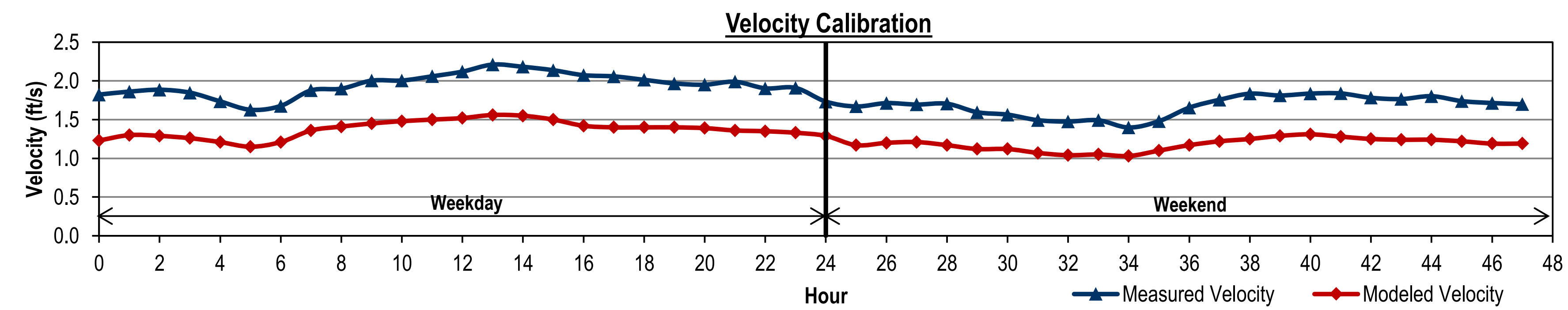
Public Works Integrated Master Plan

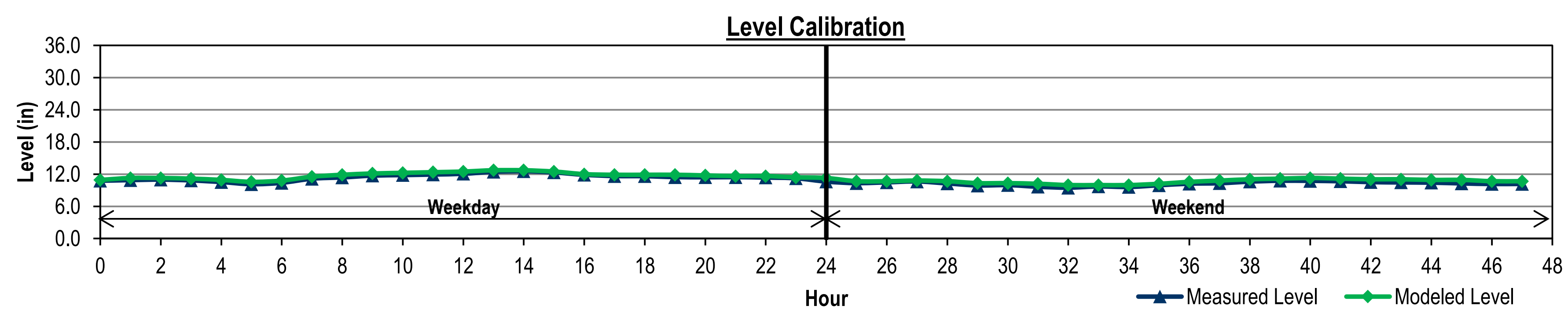
FLOW MONITORING SITE 5 DRY WEATHER FLOW CALIBRATION

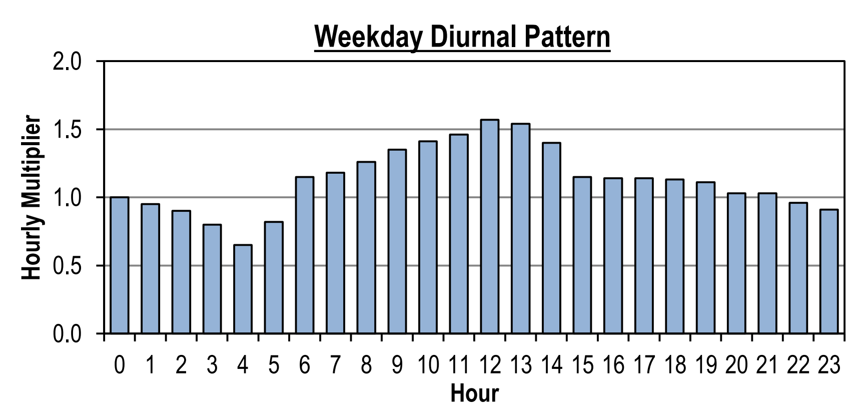
	Hour	Measured Data Flow (mgd)	Measured Data Level (in)	Measured Data Velocity (ft/s)	Modeled Data Flow (mgd)	Modeled Data Level (in)	Modeled Data Velocity (ft/s)	Diurnal Initial Curve	Diurnal Modified Curve	Diurnal Calibrated Diurnal
Weekday	0	1.192	10.8	1.82	1.119	10.9	1.23	0.95	1.00	1.00
	1	1.269	10.9	1.86	1.259	11.3	1.30	0.98	0.95	0.95
	2	1.313	11.0	1.89	1.244	11.3	1.29	0.93	0.90	0.90
	3	1.248	10.8	1.85	1.188	11.2	1.26	0.82	0.80	0.80
	4	1.095	10.5	1.74	1.092	10.9	1.21	0.70	0.65	0.65
	5	0.937	10.1	1.63	0.968	10.6	1.15	0.77	0.82	0.82
	6	1.030	10.4	1.68	1.067	10.8	1.21	1.02	1.15	1.15
	7	1.358	11.1	1.88	1.383	11.5	1.36	1.07	1.18	1.18
	8	1.429	11.4	1.90	1.506	11.9	1.41	1.20	1.26	1.26
	9	1.599	11.7	2.00	1.592	12.1	1.45	1.23	1.35	1.35
	10	1.642	11.8	2.01	1.670	12.2	1.48	1.27	1.41	1.41
	11	1.703	11.9	2.06	1.728	12.4	1.50	1.34	1.46	1.46
	12	1.795	12.1	2.12	1.787	12.5	1.52	1.50	1.57	1.57
	13	2.002	12.4	2.21	1.883	12.7	1.56	1.50	1.54	1.54
	14	2.010	12.5	2.18	1.864	12.7	1.55	1.41	1.40	1.40
	15	1.887	12.3	2.14	1.738	12.5	1.50	1.27	1.15	1.15
	16	1.695	11.9	2.07	1.532	12.0	1.42	1.21	1.14	1.14
	17	1.614	11.6	2.06	1.487	11.9	1.40	1.17	1.14	1.14
	18	1.571	11.6	2.01	1.488	11.9	1.40	1.11	1.13	1.13
	19	1.483	11.4	1.97	1.482	11.9	1.40	1.09	1.11	1.11
	20	1.461	11.4	1.95	1.460	11.8	1.39	1.12	1.03	1.03
	21	1.495	11.4	1.99	1.395	11.6	1.36	1.05	1.03	1.03
	22	1.403	11.4	1.90	1.374	11.6	1.35	1.02	0.96	0.96
	23	1.368	11.2	1.91	1.313	11.4	1.33	0.89	0.91	0.91
Weekend	24	1.087	10.6	1.73	1.237	11.3	1.29	0.73	0.60	0.60
	25	0.975	10.3	1.67	1.006	10.7	1.17	0.78	0.80	0.80
	26	1.045	10.5	1.71	1.056	10.7	1.20	0.81	0.80	0.80
	27	1.080	10.6	1.69	1.082	10.8	1.21	0.74	0.70	0.70
	28	0.990	10.3	1.71	1.006	10.7	1.17	0.64	0.61	0.61
	29	0.849	9.9	1.60	0.918	10.3	1.12	0.64	0.65	0.65
	30	0.853	9.9	1.56	0.914	10.3	1.12	0.56	0.52	0.52
	31	0.749	9.6	1.49	0.844	10.2	1.07	0.51	0.45	0.45
	32	0.689	9.5	1.48	0.788	10.0	1.04	0.55	0.47	0.47
	33	0.737	9.7	1.49	0.793	10.0	1.05	0.51	0.43	0.43
	34	0.687	9.6	1.40	0.772	10.0	1.03	0.61	0.60	0.60
	35	0.814	9.9	1.48	0.871	10.2	1.10	0.72	0.73	0.73
	36	0.958	10.2	1.65	1.008	10.6	1.17	0.77	0.80	0.80
	37	1.026	10.3	1.76	1.093	10.8	1.22	0.85	0.85	0.85
	38	1.143	10.6	1.84	1.146	11.0	1.25	0.88	0.95	0.95
	39	1.175	10.8	1.81	1.230	11.2	1.29	0.88	0.98	0.98
	40	1.183	10.7	1.84	1.268	11.3	1.31	0.87	0.91	0.91
	41	1.167	10.7	1.84	1.222	11.2	1.28	0.81	0.84	0.84
	42	1.088	10.5	1.78	1.165	11.0	1.25	0.79	0.82	0.82
	43	1.060	10.4	1.77	1.142	11.0	1.24	0.80	0.80	0.80
	44	1.072	10.4	1.80	1.128	10.9	1.24	0.75	0.77	0.77
	45	0.999	10.3	1.74	1.106	10.9	1.22	0.71	0.69	0.69
	46	0.956	10.2	1.71	1.048	10.7	1.19	0.71	0.71	0.71
	47	0.949	10.2	1.70	1.041	10.7	1.19	0.81	0.82	0.82
Average										
Weekday		**1.483**	**11.4**	**1.95**	**1.442**	**11.7**	**1.38**	**1.11**	**1.13**	**1.13**
Weekend		**0.972**	**10.2**	**1.68**	**1.037**	**10.7**	**1.18**	**0.73**	**0.72**	**0.72**
ADWF[(1)]		**1.337**	**11.1**	**1.87**	**1.327**	**11.4**	**1.32**	**1.00**	**1.01**	**1.01**
% Error										
Weekday					-2.8%	2.8%	-29.5%			
Weekend					6.7%	4.3%	-29.4%			

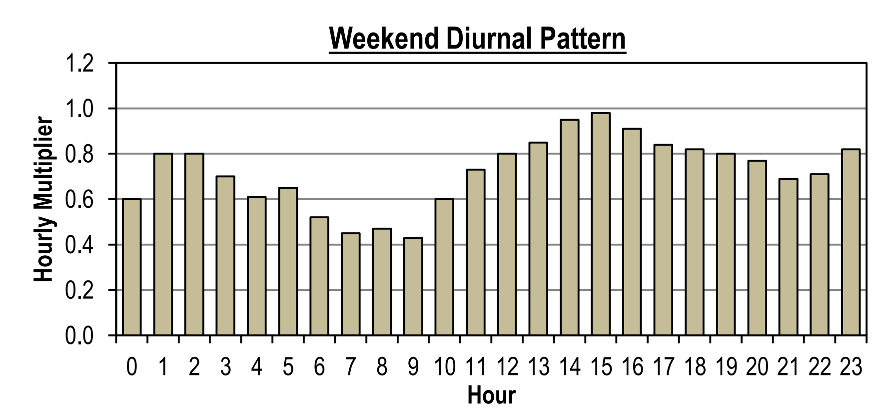
Note:
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7











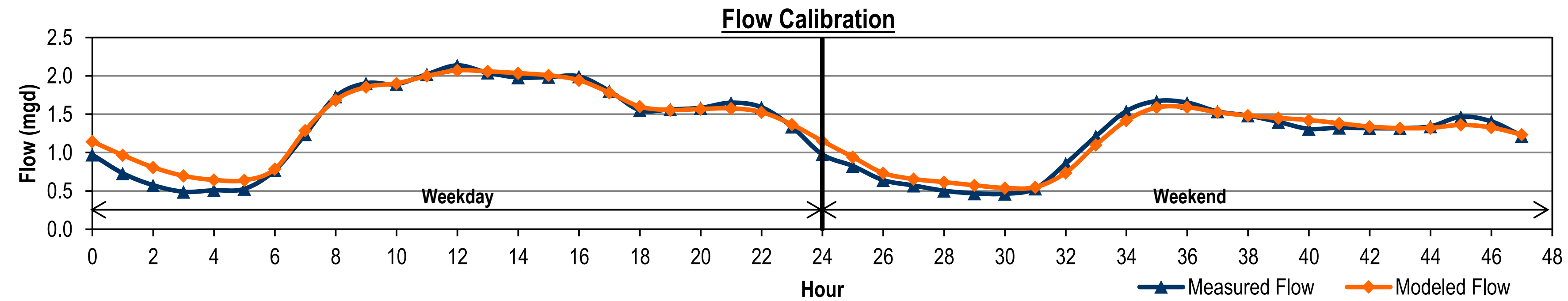
City of Oxnard

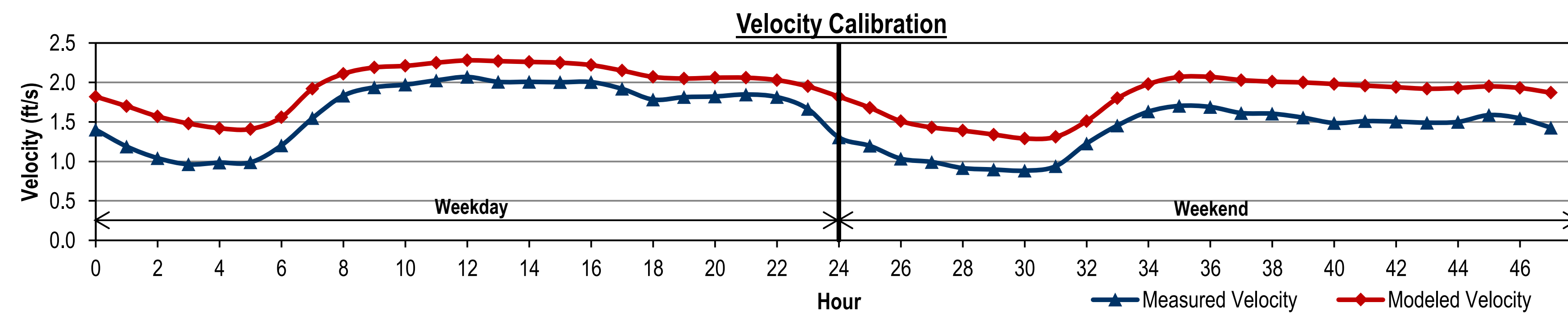
Public Works Integrated Master Plan

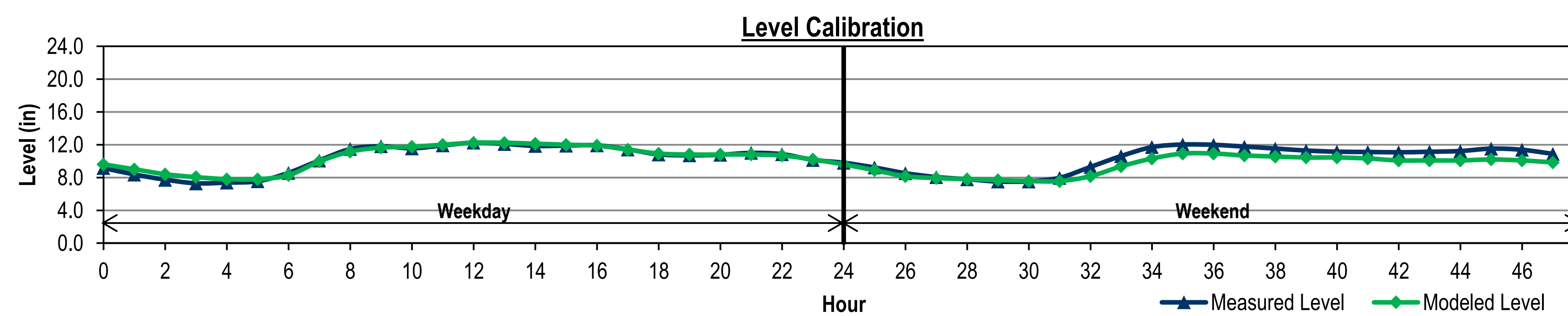
FLOW MONITORING SITE 6 DRY WEATHER FLOW CALIBRATION

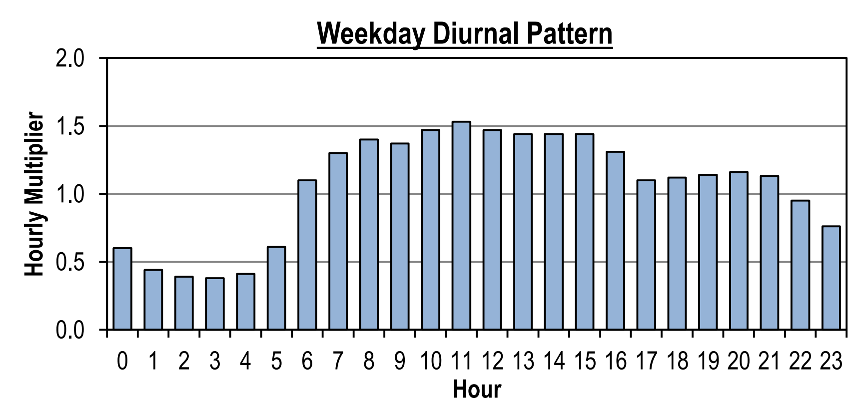
	Hour	Measured Data Flow (mgd)	Measured Data Level (in)	Measured Data Velocity (ft/s)	Modeled Data Flow (mgd)	Modeled Data Level (in)	Modeled Data Velocity (ft/s)	Diurnal Initial Curve	Diurnal Modified Curve	Diurnal Calibrated Diurnal
Weekday	0	0.972	9.2	1.40	1.144	9.6	1.82	0.54	0.60	0.60
	1	0.730	8.4	1.19	0.966	9.0	1.70	0.43	0.44	0.44
	2	0.575	7.7	1.04	0.808	8.4	1.57	0.36	0.39	0.39
	3	0.490	7.3	0.96	0.696	8.0	1.48	0.38	0.38	0.38
	4	0.509	7.4	0.98	0.643	7.8	1.42	0.39	0.41	0.41
	5	0.527	7.5	0.99	0.639	7.8	1.41	0.57	0.61	0.61
	6	0.770	8.6	1.20	0.786	8.3	1.56	0.92	1.10	1.10
	7	1.238	10.1	1.55	1.290	10.0	1.92	1.28	1.30	1.30
	8	1.731	11.5	1.83	1.685	11.2	2.11	1.41	1.40	1.40
	9	1.904	11.8	1.94	1.855	11.6	2.19	1.40	1.37	1.37
	10	1.893	11.6	1.97	1.902	11.8	2.21	1.50	1.47	1.47
	11	2.021	11.9	2.03	1.998	12.0	2.25	1.58	1.53	1.53
	12	2.137	12.2	2.07	2.072	12.2	2.28	1.51	1.47	1.47
	13	2.041	12.1	2.01	2.058	12.2	2.27	1.47	1.44	1.44
	14	1.979	11.8	2.01	2.035	12.1	2.26	1.47	1.44	1.44
	15	1.984	11.9	2.00	2.008	12.0	2.25	1.48	1.44	1.44
	16	1.993	11.9	2.01	1.944	11.9	2.22	1.33	1.31	1.31
	17	1.802	11.4	1.92	1.782	11.4	2.15	1.15	1.10	1.10
	18	1.553	10.8	1.78	1.599	10.9	2.07	1.16	1.12	1.12
	19	1.563	10.7	1.81	1.555	10.8	2.05	1.17	1.14	1.14
	20	1.583	10.8	1.82	1.568	10.8	2.06	1.22	1.16	1.16
	21	1.650	11.0	1.85	1.576	10.8	2.06	1.18	1.13	1.13
	22	1.591	10.8	1.82	1.527	10.7	2.03	0.99	0.95	0.95
	23	1.336	10.2	1.66	1.366	10.2	1.95	0.72	0.76	0.76
Weekend	24	0.976	9.8	1.30	1.150	9.6	1.82	0.61	0.60	0.60
	25	0.826	9.2	1.20	0.942	8.9	1.68	0.47	0.44	0.44
	26	0.641	8.5	1.03	0.734	8.2	1.51	0.42	0.39	0.39
	27	0.571	8.1	0.99	0.655	7.9	1.43	0.37	0.38	0.38
	28	0.503	7.8	0.92	0.616	7.8	1.39	0.35	0.36	0.36
	29	0.468	7.5	0.90	0.573	7.7	1.34	0.34	0.35	0.35
	30	0.463	7.5	0.88	0.538	7.6	1.29	0.39	0.35	0.35
	31	0.531	8.0	0.94	0.549	7.6	1.31	0.63	0.64	0.64
	32	0.855	9.3	1.23	0.736	8.2	1.51	0.90	0.98	0.98
	33	1.213	10.6	1.46	1.100	9.4	1.80	1.14	1.21	1.21
	34	1.541	11.7	1.63	1.418	10.3	1.98	1.24	1.34	1.34
	35	1.672	12.0	1.70	1.588	10.9	2.07	1.22	1.25	1.25
	36	1.651	12.0	1.69	1.592	10.9	2.07	1.14	1.15	1.15
	37	1.535	11.8	1.61	1.524	10.7	2.03	1.10	1.12	1.12
	38	1.482	11.5	1.60	1.482	10.6	2.01	1.04	1.08	1.08
	39	1.400	11.3	1.55	1.451	10.4	2.00	0.97	1.04	1.04
	40	1.309	11.1	1.49	1.424	10.4	1.98	0.98	1.00	1.00
	41	1.325	11.1	1.51	1.381	10.3	1.96	0.98	0.98	0.98
	42	1.318	11.1	1.50	1.339	10.1	1.94	0.98	0.98	0.98
	43	1.318	11.1	1.49	1.319	10.1	1.92	0.99	0.98	0.98
	44	1.342	11.2	1.50	1.322	10.1	1.93	1.09	1.05	1.05
	45	1.467	11.5	1.59	1.361	10.2	1.95	1.04	1.00	1.00
	46	1.406	11.4	1.55	1.326	10.1	1.93	0.90	0.91	0.91
	47	1.218	10.9	1.43	1.234	9.8	1.87	0.72	0.85	0.85
Average										
Weekday		**1.440**	**10.4**	**1.66**	**1.479**	**10.5**	**1.97**	**1.07**	**1.06**	**1.06**
Weekend		**1.126**	**10.3**	**1.36**	**1.140**	**9.5**	**1.78**	**0.83**	**0.85**	**0.85**
ADWF(1)		**1.351**	**10.3**	**1.58**	**1.382**	**10.2**	**1.92**	**1.00**	**1.00**	**1.00**
% Error										
Weekday					2.7%	1.2%	18.7%			
Weekend					1.2%	-7.5%	30.7%			

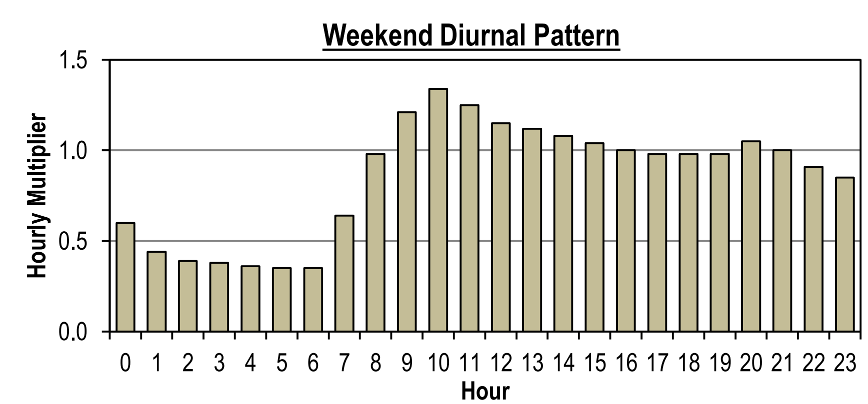
Note:
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7











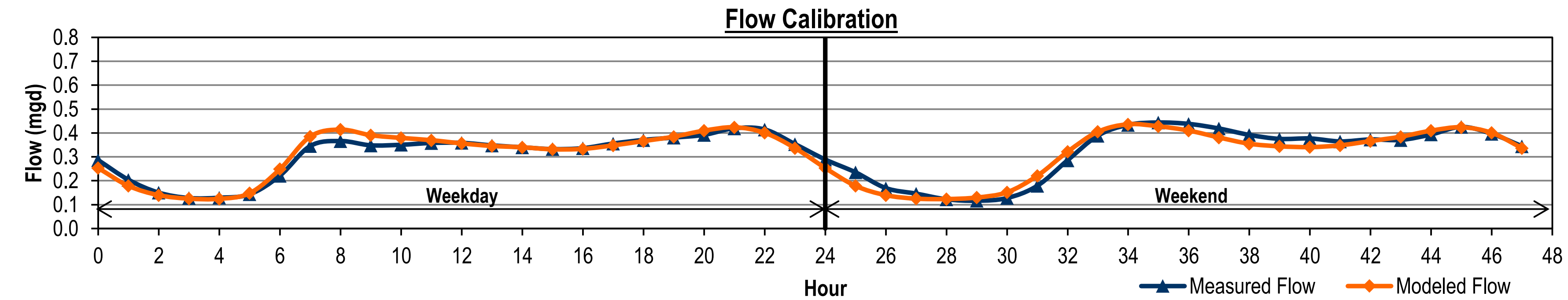
City of Oxnard

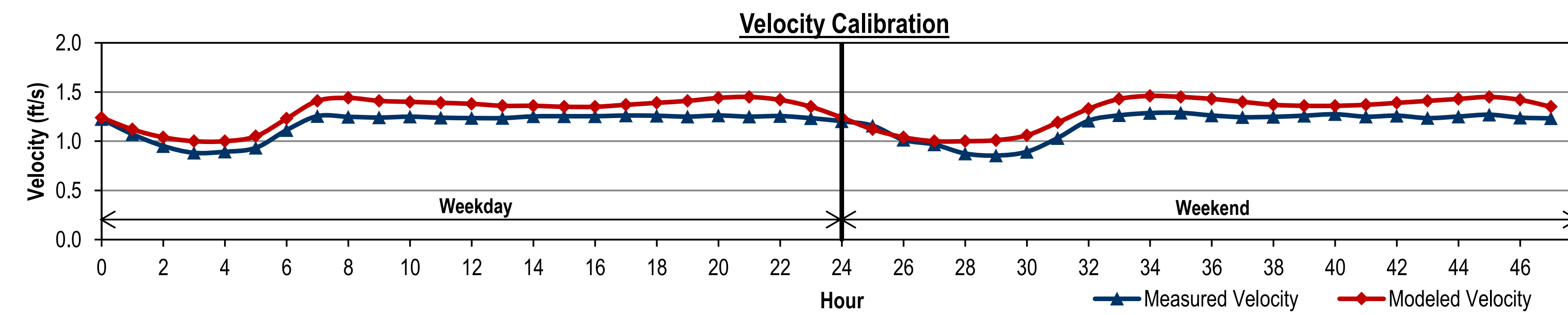
Public Works Integrated Master Plan

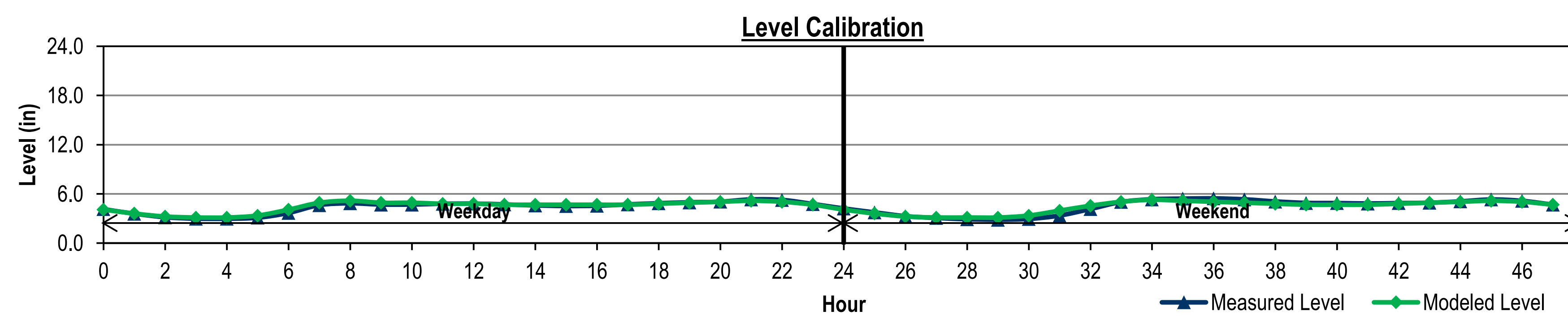
FLOW MONITORING SITE 7 DRY WEATHER FLOW CALIBRATION

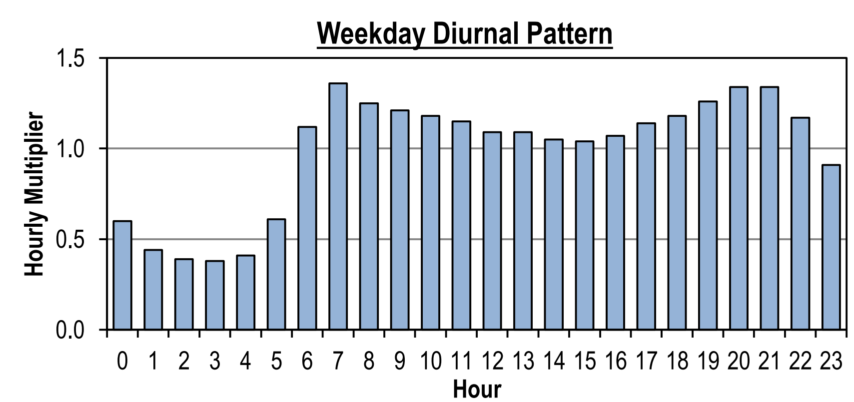
	Hour	Measured Data Flow (mgd)	Measured Data Level (in)	Measured Data Velocity (ft/s)	Modeled Data Flow (mgd)	Modeled Data Level (in)	Modeled Data Velocity (ft/s)	Diurnal Initial Curve	Diurnal Modified Curve	Diurnal Calibrated Diurnal
Weekday	0	0.286	4.1	1.22	0.253	4.1	1.24	0.65	0.60	0.60
	1	0.204	3.6	1.07	0.179	3.6	1.12	0.48	0.44	0.44
	2	0.150	3.2	0.95	0.140	3.2	1.04	0.41	0.39	0.39
	3	0.128	3.0	0.88	0.125	3.1	1.00	0.41	0.38	0.38
	4	0.129	3.0	0.89	0.124	3.1	1.00	0.46	0.41	0.41
	5	0.143	3.1	0.93	0.148	3.4	1.05	0.71	0.61	0.61
	6	0.221	3.7	1.11	0.249	4.1	1.23	1.11	1.12	1.12
	7	0.345	4.6	1.26	0.385	4.9	1.41	1.17	1.36	1.36
	8	0.366	4.8	1.25	0.414	5.2	1.44	1.12	1.25	1.25
	9	0.348	4.7	1.24	0.391	4.9	1.41	1.12	1.21	1.21
	10	0.351	4.7	1.25	0.379	4.9	1.40	1.15	1.18	1.18
	11	0.358	4.8	1.24	0.370	4.8	1.39	1.15	1.15	1.15
	12	0.359	4.8	1.24	0.356	4.8	1.38	1.12	1.09	1.09
	13	0.348	4.7	1.24	0.346	4.7	1.36	1.09	1.09	1.09
	14	0.340	4.6	1.25	0.340	4.7	1.36	1.07	1.05	1.05
	15	0.332	4.5	1.25	0.332	4.7	1.35	1.08	1.04	1.04
	16	0.336	4.6	1.25	0.333	4.7	1.35	1.14	1.07	1.07
	17	0.356	4.7	1.26	0.348	4.7	1.37	1.19	1.14	1.14
	18	0.371	4.9	1.26	0.366	4.8	1.39	1.22	1.18	1.18
	19	0.381	5.0	1.25	0.384	4.9	1.41	1.26	1.26	1.26
	20	0.392	5.0	1.26	0.410	5.0	1.44	1.35	1.34	1.34
	21	0.420	5.3	1.25	0.424	5.2	1.45	1.33	1.34	1.34
	22	0.415	5.3	1.26	0.401	5.0	1.42	1.13	1.17	1.17
	23	0.353	4.8	1.23	0.337	4.7	1.35	0.92	0.91	0.91
Weekend	24	0.289	4.2	1.20	0.253	4.1	1.24	0.75	0.60	0.60
	25	0.235	3.7	1.16	0.179	3.6	1.12	0.54	0.44	0.44
	26	0.169	3.3	1.01	0.140	3.2	1.04	0.47	0.39	0.39
	27	0.146	3.1	0.97	0.125	3.1	1.00	0.39	0.38	0.38
	28	0.122	2.9	0.88	0.123	3.1	1.00	0.37	0.40	0.40
	29	0.116	2.9	0.85	0.130	3.1	1.01	0.41	0.43	0.43
	30	0.128	2.9	0.89	0.152	3.4	1.06	0.57	0.60	0.60
	31	0.179	3.4	1.03	0.221	4.0	1.19	0.92	0.90	0.90
	32	0.286	4.2	1.21	0.322	4.6	1.33	1.25	1.20	1.20
	33	0.389	5.0	1.26	0.405	5.0	1.43	1.39	1.39	1.39
	34	0.434	5.3	1.29	0.436	5.3	1.46	1.42	1.37	1.37
	35	0.444	5.4	1.29	0.428	5.2	1.45	1.40	1.33	1.33
	36	0.438	5.5	1.26	0.410	5.0	1.43	1.34	1.25	1.25
	37	0.419	5.3	1.24	0.381	4.9	1.40	1.26	1.14	1.14
	38	0.392	5.1	1.25	0.355	4.8	1.37	1.20	1.09	1.09
	39	0.375	4.9	1.26	0.344	4.7	1.36	1.21	1.08	1.08
	40	0.377	4.9	1.27	0.341	4.7	1.36	1.17	1.07	1.07
	41	0.365	4.8	1.25	0.348	4.7	1.37	1.20	1.14	1.14
	42	0.373	4.9	1.26	0.366	4.8	1.39	1.19	1.18	1.18
	43	0.371	4.9	1.24	0.384	4.9	1.41	1.26	1.26	1.26
	44	0.394	5.1	1.25	0.410	5.0	1.43	1.36	1.34	1.34
	45	0.425	5.3	1.27	0.424	5.2	1.45	1.27	1.34	1.34
	46	0.396	5.1	1.24	0.400	5.0	1.42	1.11	1.17	1.17
	47	0.345	4.7	1.23	0.337	4.7	1.35	0.93	0.91	0.91
Average										
Weekday		**0.310**	**4.4**	**1.18**	**0.314**	**4.5**	**1.31**	**0.99**	**0.99**	**0.99**
Weekend		**0.317**	**4.5**	**1.17**	**0.309**	**4.4**	**1.29**	**1.02**	**0.98**	**0.98**
ADWF(1)		**0.312**	**4.4**	**1.18**	**0.312**	**4.5**	**1.30**	**1.00**	**0.99**	**0.99**
% Error										
Weekday					1.3%	1.6%	10.8%			
Weekend					-2.5%	-0.7%	10.7%			

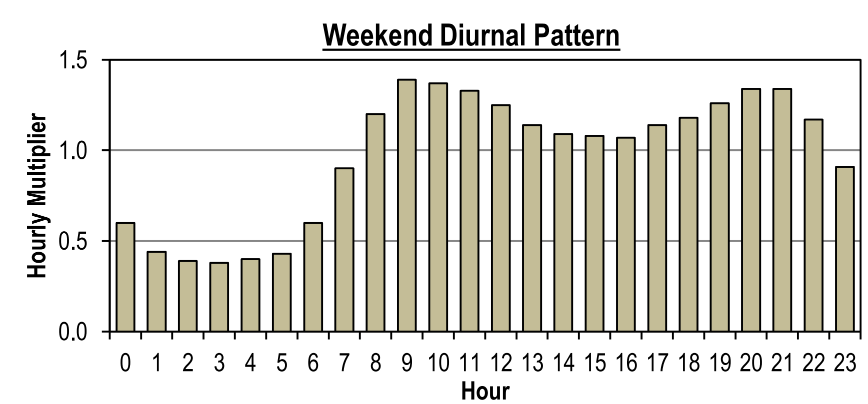
Note:
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7











City of Oxnard

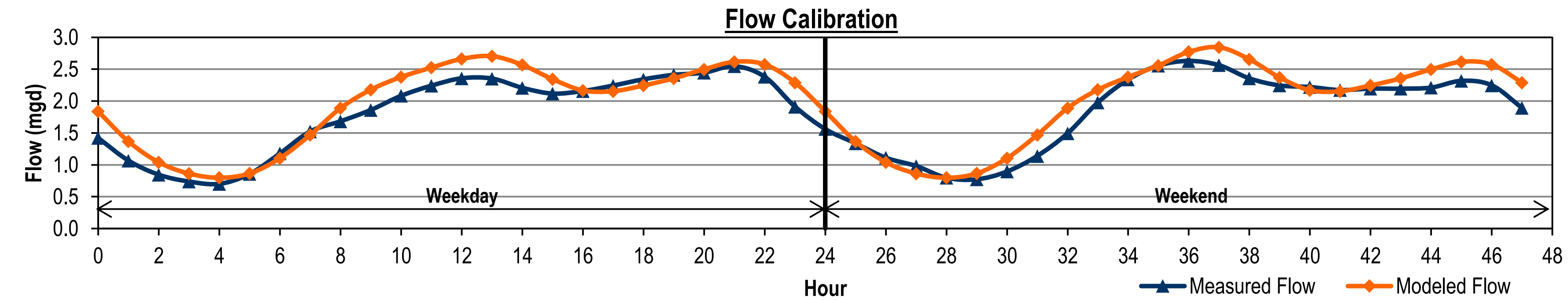
Public Works Integrated Master Plan

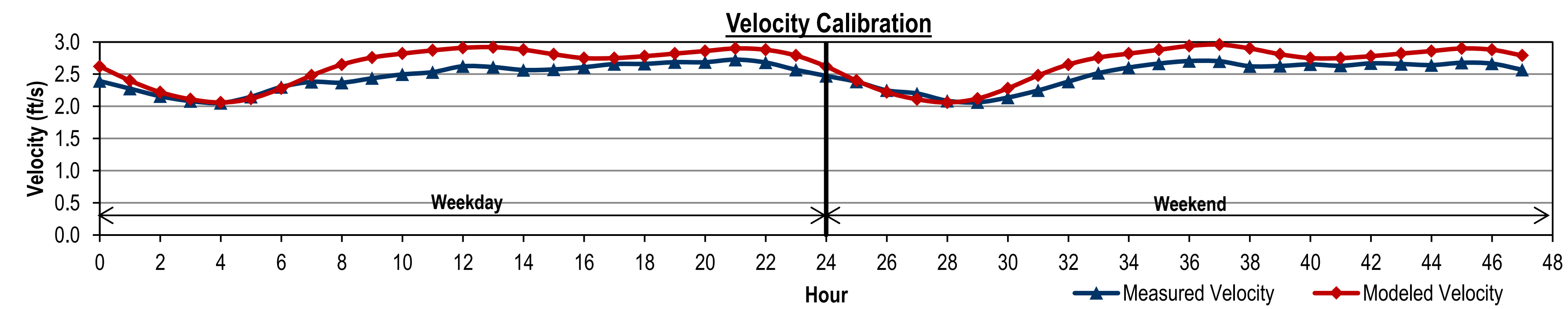
FLOW MONITORING SITE 8 DRY WEATHER FLOW CALIBRATION

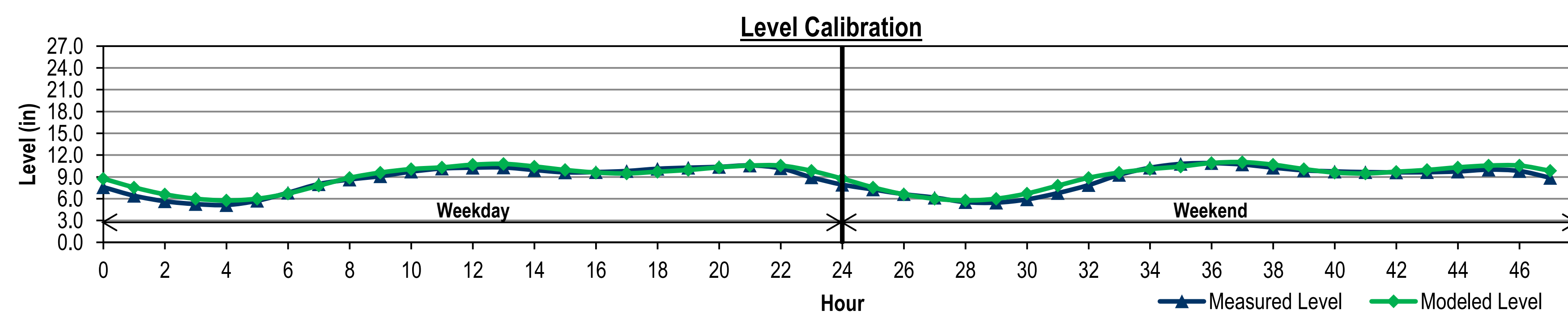
	Hour	Measured Data Flow (mgd)	Measured Data Level (in)	Measured Data Velocity (ft/s)	Modeled Data Flow (mgd)	Modeled Data Level (in)	Modeled Data Velocity (ft/s)	Diurnal Initial Curve	Diurnal Modified Curve	Diurnal Calibrated Diurnal
Weekday	0	1.421	7.6	2.39	1.837	8.8	2.62	0.583	0.60	0.60
	1	1.066	6.4	2.28	1.366	7.6	2.40	0.462	0.44	0.44
	2	0.845	5.7	2.16	1.039	6.6	2.22	0.404	0.39	0.39
	3	0.737	5.3	2.08	0.862	6.0	2.11	0.384	0.38	0.38
	4	0.702	5.1	2.05	0.797	5.8	2.06	0.469	0.41	0.41
	5	0.857	5.7	2.15	0.865	6.0	2.12	0.645	0.61	0.61
	6	1.179	6.8	2.30	1.104	6.7	2.28	0.834	0.75	0.75
	7	1.524	8.0	2.38	1.471	7.8	2.48	0.922	1.00	1.00
	8	1.684	8.6	2.37	1.890	8.9	2.65	1.019	1.10	1.10
	9	1.861	9.1	2.44	2.179	9.6	2.76	1.141	1.22	1.22
	10	2.083	9.7	2.50	2.378	10.1	2.82	1.228	1.27	1.27
	11	2.242	10.2	2.53	2.526	10.3	2.87	1.291	1.35	1.35
	12	2.358	10.3	2.62	2.662	10.7	2.91	1.289	1.42	1.42
	13	2.354	10.3	2.61	2.705	10.8	2.92	1.209	1.30	1.30
	14	2.208	10.0	2.57	2.568	10.4	2.88	1.160	1.18	1.18
	15	2.118	9.6	2.57	2.343	10.0	2.81	1.182	1.04	1.04
	16	2.158	9.7	2.61	2.167	9.6	2.75	1.229	1.07	1.07
	17	2.244	9.8	2.66	2.155	9.5	2.75	1.282	1.14	1.14
	18	2.342	10.1	2.66	2.245	9.7	2.78	1.321	1.18	1.18
	19	2.412	10.3	2.69	2.357	10.0	2.82	1.339	1.26	1.26
	20	2.446	10.4	2.69	2.498	10.3	2.86	1.394	1.34	1.34
	21	2.547	10.6	2.73	2.617	10.6	2.90	1.304	1.34	1.34
	22	2.382	10.2	2.68	2.575	10.6	2.88	1.048	1.17	1.17
	23	1.913	8.9	2.57	2.291	9.8	2.79	0.778	0.91	0.91
Weekend	24	1.561	7.9	2.47	1.837	8.8	2.62	0.732	0.60	0.60
	25	1.337	7.3	2.38	1.367	7.6	2.40	0.608	0.44	0.44
	26	1.111	6.6	2.25	1.039	6.6	2.22	0.537	0.39	0.39
	27	0.981	6.2	2.20	0.862	6.0	2.11	0.436	0.38	0.38
	28	0.797	5.5	2.09	0.797	5.8	2.06	0.423	0.41	0.41
	29	0.772	5.5	2.06	0.865	6.0	2.12	0.490	0.61	0.61
	30	0.895	5.9	2.14	1.104	6.7	2.28	0.624	0.75	0.75
	31	1.140	6.8	2.25	1.470	7.8	2.48	0.818	1.00	1.00
	32	1.495	7.9	2.39	1.890	8.9	2.65	1.084	1.10	1.10
	33	1.979	9.3	2.52	2.179	9.6	2.76	1.281	1.22	1.22
	34	2.340	10.3	2.60	2.378	10.1	2.82	1.401	1.27	1.27
	35	2.558	10.8	2.67	2.559	10.4	2.88	1.440	1.42	1.42
	36	2.630	10.9	2.71	2.772	10.9	2.94	1.403	1.51	1.51
	37	2.563	10.7	2.70	2.845	11.0	2.96	1.290	1.35	1.35
	38	2.356	10.3	2.62	2.656	10.7	2.90	1.230	1.18	1.18
	39	2.246	9.9	2.63	2.370	10.1	2.81	1.216	1.04	1.04
	40	2.221	9.8	2.65	2.170	9.6	2.75	1.190	1.07	1.07
	41	2.173	9.7	2.63	2.155	9.5	2.75	1.202	1.14	1.14
	42	2.196	9.6	2.67	2.245	9.7	2.78	1.202	1.18	1.18
	43	2.195	9.7	2.66	2.357	10.0	2.82	1.211	1.26	1.26
	44	2.212	9.8	2.64	2.498	10.3	2.86	1.269	1.34	1.34
	45	2.318	10.0	2.68	2.617	10.6	2.90	1.231	1.34	1.34
	46	2.248	9.8	2.66	2.575	10.6	2.88	1.036	1.17	1.17
	47	1.893	8.9	2.57	2.291	9.8	2.79	0.855	0.91	0.91
Average										
Weekday		**1.820**	**8.7**	**2.47**	**1.979**	**9.0**	**2.64**	**1.00**	**0.99**	**0.99**
Weekend		**1.842**	**8.7**	**2.49**	**1.996**	**9.0**	**2.65**	**1.01**	**1.00**	**1.00**
ADWF[(1)]		**1.826**	**8.7**	**2.48**	**1.984**	**9.0**	**2.64**	**1.00**	**1.00**	**1.00**
% Error										
Weekday					8.7%	3.6%	7.0%			
Weekend					8.3%	3.9%	6.2%			

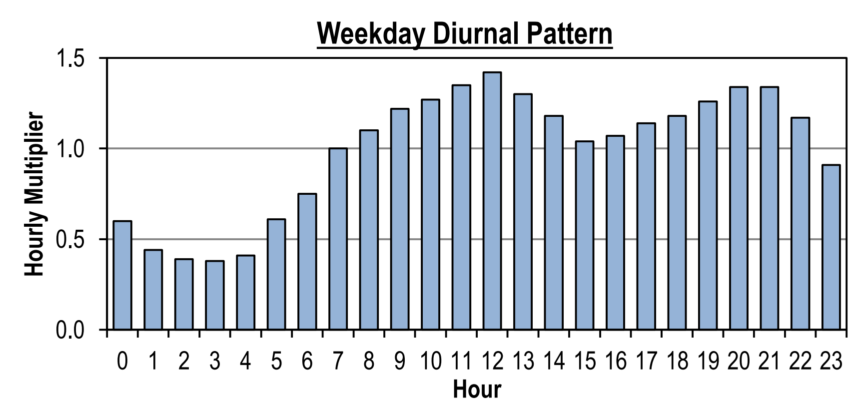
Note:

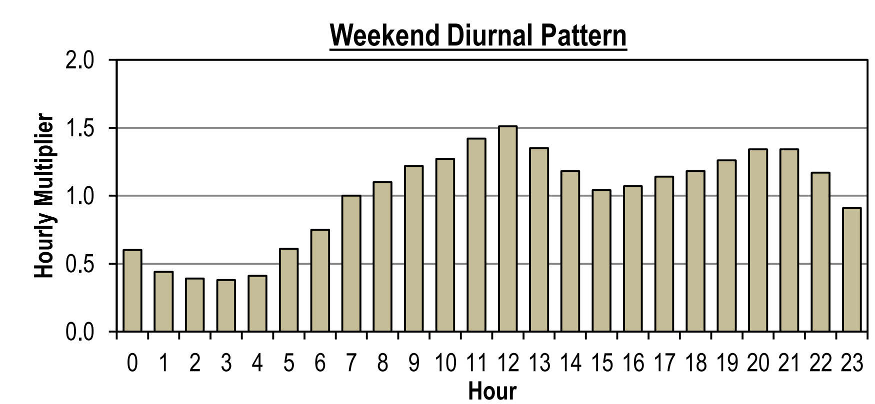
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7











OXNARD

City of Oxnard
Public Works Integrated Master Plan
FLOW MONITORING SITE 9 DRY WEATHER FLOW CALIBRATION

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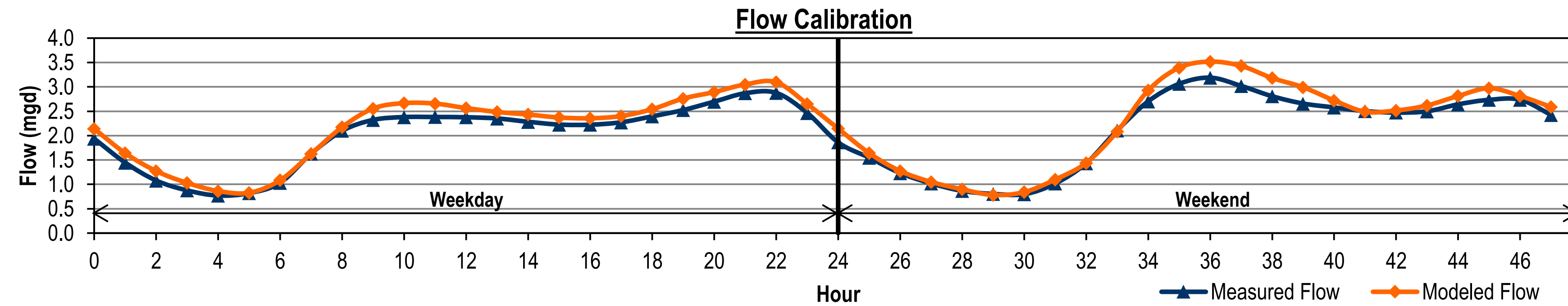
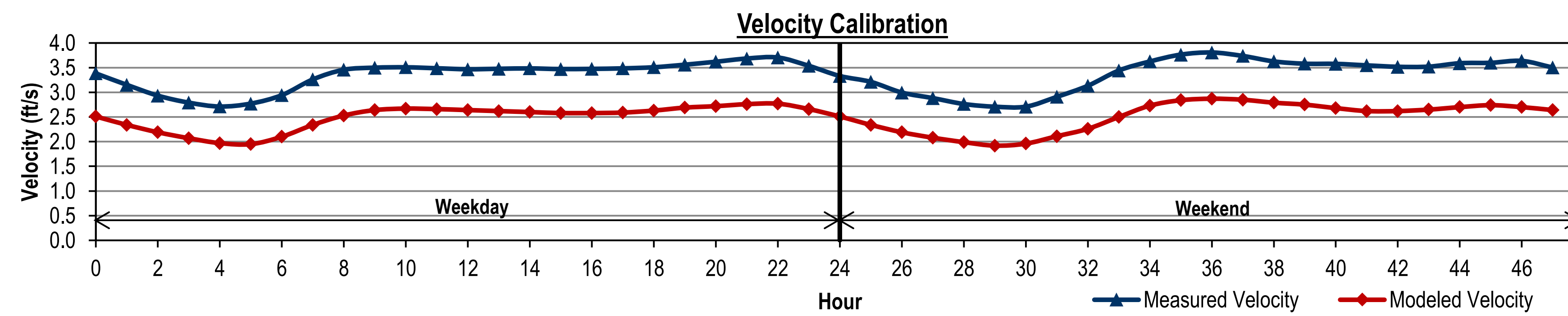
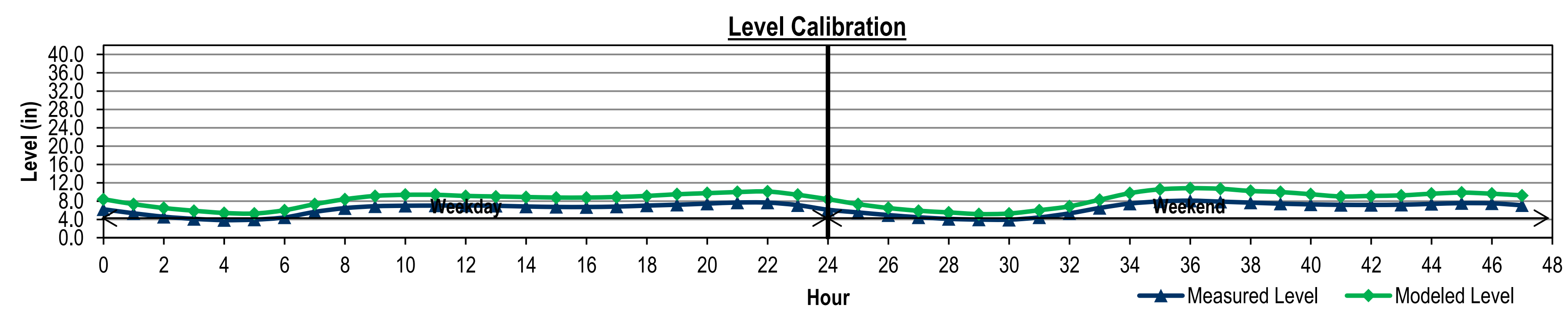
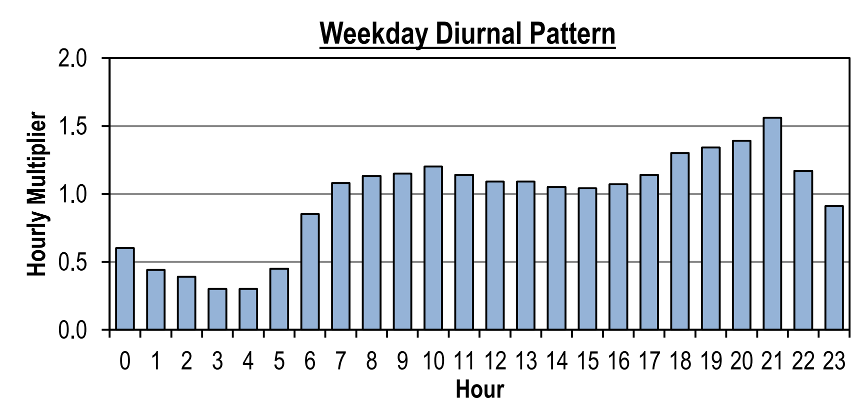
	Hour	Measured Data Flow (mgd)	Measured Data Level (in)	Measured Data Velocity (ft/s)	Modeled Data Flow (mgd)	Modeled Data Level (in)	Modeled Data Velocity (ft/s)	Diurnal Initial Curve	Diurnal Modified Curve	Diurnal Calibrated Diurnal
Weekday	0	1.938	6.2	3.38	2.141	8.4	2.51	0.71	0.60	0.60
	1	1.446	5.3	3.15	1.640	7.3	2.34	0.53	0.44	0.44
	2	1.078	4.6	2.93	1.272	6.5	2.19	0.43	0.39	0.39
	3	0.876	4.1	2.79	1.029	5.9	2.07	0.38	0.30	0.30
	4	0.770	3.8	2.71	0.863	5.4	1.97	0.40	0.30	0.30
	5	0.820	3.9	2.77	0.828	5.3	1.95	0.50	0.45	0.45
	6	1.031	4.4	2.94	1.085	6.0	2.10	0.80	0.85	0.85
	7	1.630	5.6	3.26	1.626	7.3	2.34	1.03	1.08	1.08
	8	2.098	6.5	3.46	2.176	8.4	2.53	1.14	1.13	1.13
	9	2.322	6.9	3.50	2.556	9.1	2.64	1.17	1.15	1.15
	10	2.381	7.0	3.51	2.667	9.4	2.67	1.17	1.20	1.20
	11	2.382	7.0	3.49	2.657	9.4	2.66	1.16	1.14	1.14
	12	2.377	7.0	3.47	2.564	9.1	2.64	1.15	1.09	1.09
	13	2.352	7.0	3.48	2.485	9.0	2.62	1.12	1.09	1.09
	14	2.284	6.8	3.48	2.432	8.9	2.60	1.09	1.05	1.05
	15	2.226	6.7	3.47	2.372	8.8	2.58	1.09	1.04	1.04
	16	2.224	6.7	3.48	2.356	8.8	2.58	1.11	1.07	1.07
	17	2.273	6.8	3.49	2.401	8.9	2.59	1.17	1.14	1.14
	18	2.395	7.0	3.51	2.542	9.1	2.63	1.24	1.30	1.30
	19	2.525	7.2	3.56	2.760	9.5	2.69	1.32	1.34	1.34
	20	2.696	7.4	3.62	2.893	9.7	2.72	1.40	1.39	1.39
	21	2.869	7.7	3.69	3.050	10.0	2.76	1.41	1.56	1.56
	22	2.876	7.7	3.71	3.096	10.1	2.77	1.21	1.17	1.17
	23	2.466	7.1	3.54	2.649	9.4	2.66	0.95	0.91	0.91
Weekend	24	1.861	6.1	3.33	2.144	8.4	2.51	0.76	0.60	0.60
	25	1.548	5.5	3.21	1.641	7.3	2.34	0.60	0.44	0.44
	26	1.231	4.9	3.00	1.273	6.5	2.19	0.50	0.39	0.39
	27	1.019	4.5	2.88	1.049	5.9	2.08	0.42	0.38	0.38
	28	0.866	4.1	2.76	0.897	5.5	1.99	0.39	0.22	0.22
	29	0.803	4.0	2.71	0.782	5.2	1.92	0.39	0.30	0.30
	30	0.798	3.9	2.71	0.841	5.3	1.96	0.50	0.50	0.50
	31	1.016	4.4	2.91	1.098	6.0	2.11	0.70	0.65	0.65
	32	1.433	5.3	3.13	1.440	6.8	2.26	1.03	1.00	1.00
	33	2.106	6.5	3.44	2.082	8.3	2.50	1.32	1.45	1.45
	34	2.703	7.4	3.63	2.925	9.7	2.73	1.50	1.65	1.65
	35	3.062	7.9	3.76	3.394	10.6	2.84	1.56	1.70	1.70
	36	3.188	8.1	3.81	3.518	10.8	2.87	1.48	1.70	1.70
	37	3.020	7.9	3.74	3.429	10.7	2.85	1.37	1.50	1.50
	38	2.807	7.7	3.63	3.181	10.2	2.79	1.30	1.45	1.45
	39	2.658	7.4	3.58	2.993	10.0	2.75	1.26	1.30	1.30
	40	2.578	7.3	3.58	2.720	9.5	2.68	1.23	1.07	1.07
	41	2.502	7.2	3.55	2.489	9.0	2.62	1.21	1.14	1.14
	42	2.472	7.2	3.52	2.515	9.1	2.62	1.22	1.18	1.18
	43	2.499	7.2	3.52	2.619	9.2	2.65	1.29	1.26	1.26
	44	2.642	7.4	3.59	2.814	9.6	2.70	1.34	1.45	1.45
	45	2.734	7.5	3.60	2.971	9.8	2.74	1.34	1.25	1.25
	46	2.736	7.5	3.64	2.812	9.6	2.70	1.19	1.17	1.17
	47	2.426	7.1	3.50	2.588	9.2	2.64	0.91	0.91	0.91
Average										
Weekday		2.014	6.3	3.35	2.172	8.3	2.49	0.99	0.97	0.97
Weekend		2.113	6.4	3.36	2.259	8.4	2.50	1.03	1.03	1.03
ADWF[(1)]		2.042	6.3	3.35	2.197	8.3	2.49	1.00	0.98	0.98
% Error										
Weekday					7.9%	32.5%	-25.6%			
Weekend					6.9%	31.3%	-25.6%			

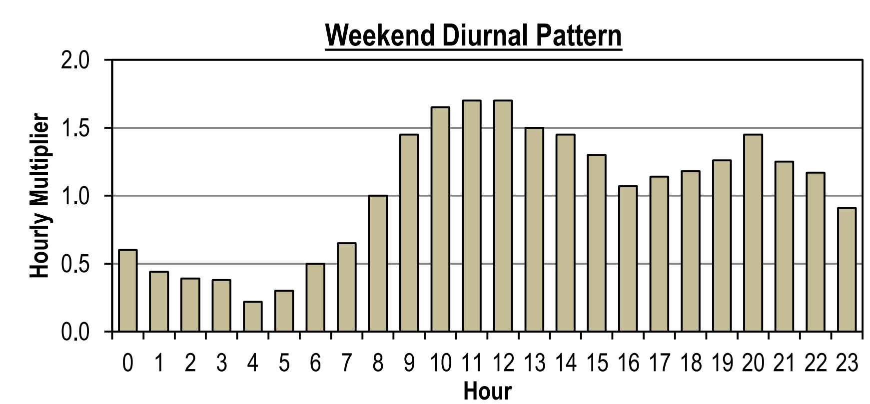
Note:
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7











City of Oxnard

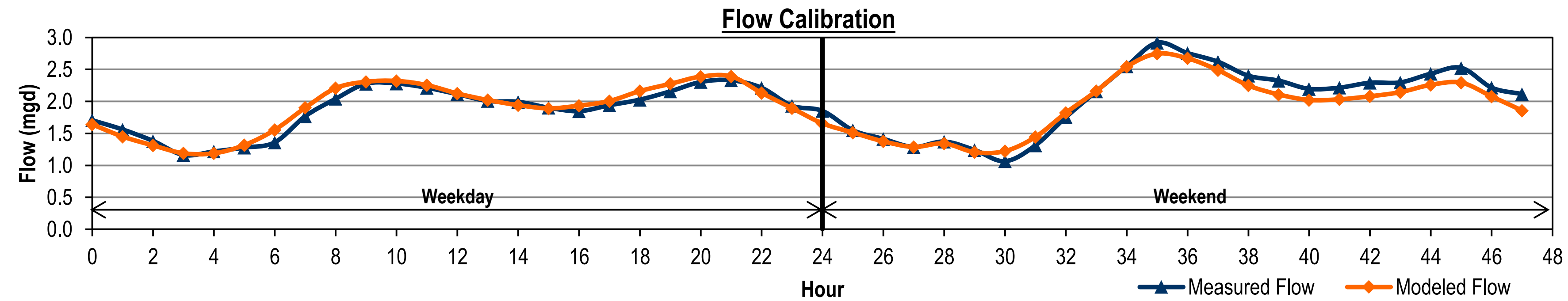
Public Works Integrated Master Plan

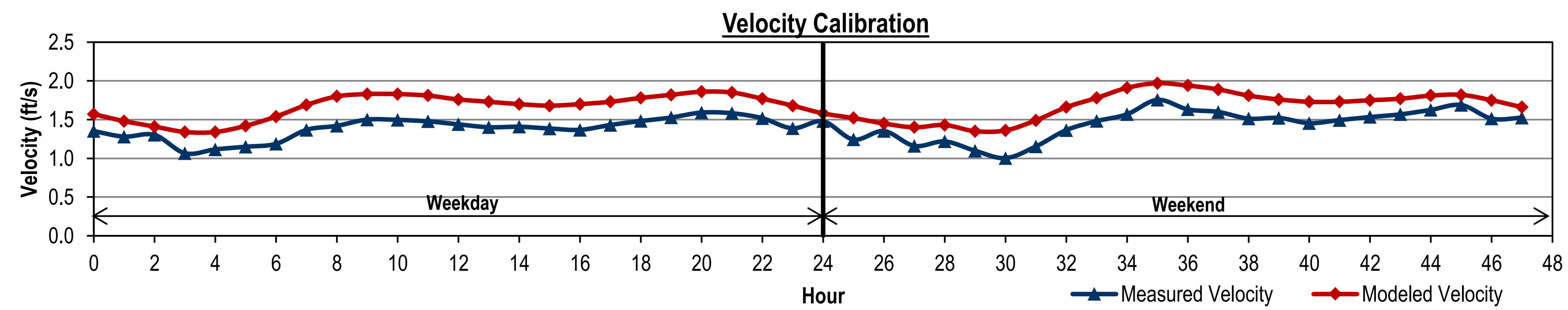
FLOW MONITORING SITE 10 DRY WEATHER FLOW CALIBRATION

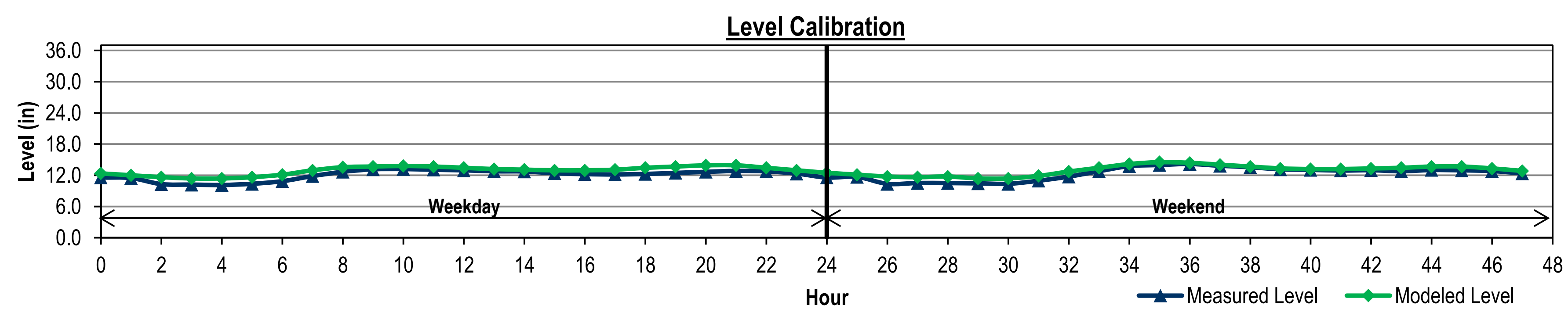
	Hour	Measured Data Flow (mgd)	Measured Data Level (in)	Measured Data Velocity (ft/s)	Modeled Data Flow (mgd)	Modeled Data Level (in)	Modeled Data Velocity (ft/s)	Diurnal Initial Curve	Diurnal Modified Curve	Diurnal Calibrated Diurnal
Weekday	0	1.706	11.6	1.35	1.639	12.4	1.57	0.81	0.71	0.71
	1	1.561	11.5	1.28	1.450	12.0	1.48	0.72	0.64	0.64
	2	1.382	10.3	1.30	1.312	11.6	1.41	0.61	0.55	0.55
	3	1.163	10.2	1.07	1.189	11.4	1.34	0.63	0.65	0.65
	4	1.218	10.1	1.12	1.188	11.4	1.34	0.67	0.84	0.84
	5	1.278	10.4	1.15	1.318	11.6	1.42	0.71	0.89	0.89
	6	1.360	10.9	1.19	1.556	12.1	1.54	0.92	0.99	0.99
	7	1.768	11.9	1.37	1.901	13.0	1.69	1.06	1.29	1.29
	8	2.041	12.7	1.42	2.207	13.6	1.80	1.19	1.24	1.24
	9	2.277	13.2	1.50	2.308	13.7	1.83	1.19	1.14	1.14
	10	2.281	13.2	1.50	2.320	13.8	1.83	1.15	1.14	1.14
	11	2.214	13.1	1.48	2.256	13.7	1.81	1.10	1.04	1.04
	12	2.115	13.0	1.44	2.124	13.4	1.76	1.04	0.99	0.99
	13	2.007	12.8	1.40	2.022	13.2	1.73	1.04	0.96	0.96
	14	1.994	12.7	1.41	1.942	13.1	1.70	0.99	0.94	0.94
	15	1.901	12.4	1.39	1.892	13.0	1.68	0.96	1.04	1.04
	16	1.848	12.2	1.37	1.934	13.0	1.70	1.01	1.04	1.04
	17	1.940	12.2	1.43	2.007	13.1	1.73	1.06	1.18	1.18
	18	2.028	12.3	1.48	2.162	13.4	1.78	1.12	1.22	1.22
	19	2.157	12.5	1.53	2.275	13.7	1.82	1.20	1.25	1.25
	20	2.304	12.7	1.59	2.388	13.9	1.86	1.21	1.29	1.29
	21	2.332	12.8	1.58	2.391	13.9	1.85	1.15	0.90	0.90
	22	2.213	12.8	1.52	2.133	13.4	1.77	1.01	0.85	0.85
	23	1.932	12.3	1.39	1.895	13.0	1.68	0.89	0.80	0.80
Weekend	24	1.852	11.6	1.48	1.657	12.5	1.58	0.81	0.80	0.80
	25	1.549	11.7	1.24	1.513	12.1	1.52	0.74	0.70	0.70
	26	1.415	10.4	1.35	1.375	11.8	1.45	0.67	0.60	0.60
	27	1.288	10.5	1.16	1.289	11.6	1.40	0.71	0.85	0.85
	28	1.372	10.5	1.22	1.342	11.8	1.43	0.65	0.57	0.57
	29	1.241	10.4	1.10	1.206	11.4	1.35	0.55	0.43	0.43
	30	1.065	10.4	1.00	1.223	11.4	1.36	0.68	0.72	0.72
	31	1.312	11.0	1.15	1.443	11.9	1.49	0.91	1.21	1.21
	32	1.753	11.7	1.36	1.821	12.7	1.66	1.12	1.27	1.27
	33	2.157	12.8	1.48	2.161	13.4	1.78	1.33	1.41	1.41
	34	2.550	13.8	1.57	2.542	14.2	1.91	1.52	1.61	1.61
	35	2.917	14.0	1.76	2.748	14.5	1.97	1.43	1.33	1.33
	36	2.756	14.2	1.63	2.674	14.4	1.94	1.36	1.23	1.23
	37	2.621	13.8	1.60	2.490	14.0	1.89	1.25	1.05	1.05
	38	2.402	13.6	1.51	2.249	13.7	1.81	1.21	1.04	1.04
	39	2.325	13.1	1.52	2.109	13.3	1.76	1.14	1.03	1.03
	40	2.196	13.1	1.45	2.023	13.2	1.73	1.15	1.04	1.04
	41	2.216	12.9	1.49	2.033	13.2	1.73	1.19	1.08	1.08
	42	2.293	13.0	1.53	2.080	13.3	1.75	1.20	1.10	1.10
	43	2.298	12.8	1.57	2.145	13.4	1.77	1.27	1.20	1.20
	44	2.434	13.0	1.63	2.260	13.7	1.81	1.31	1.25	1.25
	45	2.525	13.0	1.69	2.293	13.7	1.82	1.15	0.88	0.88
	46	2.215	12.8	1.51	2.077	13.3	1.75	1.10	0.83	0.83
	47	2.114	12.4	1.52	1.858	12.8	1.66	0.96	0.83	0.83
Average										
Weekday		**1.876**	**12.1**	**1.38**	**1.909**	**12.9**	**1.67**	**0.98**	**0.98**	**0.98**
Weekend		**2.036**	**12.3**	**1.44**	**1.942**	**13.0**	**1.68**	**1.06**	**1.00**	**1.00**
ADWF[1]		**1.922**	**12.1**	**1.40**	**1.918**	**12.9**	**1.67**	**1.00**	**0.99**	**0.99**
% Error										
Weekday					1.7%	7.2%	20.7%			
Weekend					-4.6%	5.1%	16.7%			

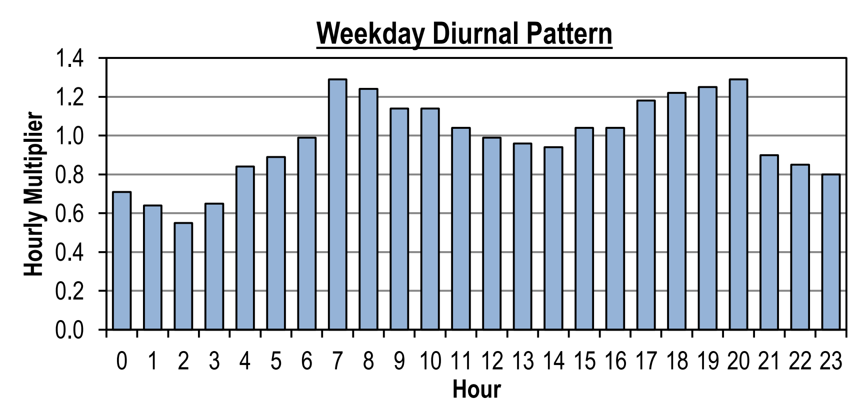
Note:

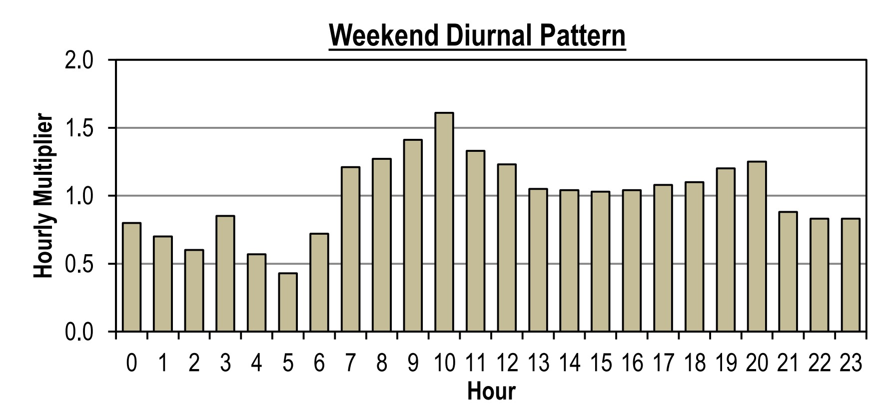
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7











APPENDIX B – WET WEATHER FLOW CALIBRATION PLOTS AND RAIN GAUGE LOCATIONS

Table 1 Wet Weather Flow Calibration Results
Public Works Integrated Master Plan
City of Oxnard

Meter Number	Pipe Diameter (in)	Storm 1 (12/11/2014-12/12/2014)											
		Measured Data[1]				Modeled Data[2]				Percent Error[3]			
		Avg. Flow (mgd)	Peak Flow (mgd)	Avg. Velocity (ft/s)	Avg. Level (in)	Avg. Flow (mgd)	Peak Flow (mgd)	Avg. Velocity (ft/s)	Avg. Level (in)	Avg. Flow (%)	Peak Flow (%)	Avg. Velocity (%)	Avg. Level (%)
SITE 1	41.5	5.284	6.808	2.62	16.6	5.506	7.395	2.78	15.6	4.2%	8.6%	5.9%	-6.0%
SITE 2	36	3.063	5.780	1.78	14.4	2.744	6.086	1.87	13.5	***-10.4%***	5.3%	4.6%	-6.0%
SITE 3	60	7.739	10.727	2.32	18.3	7.185	10.352	2.31	19.2	-7.2%	-3.5%	-0.6%	5.0%
SITE 4A	33	3.298	4.818	1.67	18.1	3.779	5.413	1.95	17.3	14.6%	12.3%	16.8%	-4.3%
SITE 5	36	1.634	2.663	1.42	10.6	1.475	2.739	1.38	11.8	-9.7%	2.8%	-2.9%	11.0%
SITE 6	24	1.350	1.921	2.10	8.3	1.517	2.078	2.37	8.3	12.4%	8.2%	13.2%	-0.2%
SITE 7	24	0.331	0.503	1.25	4.4	0.328	0.481	1.33	4.5	-0.8%	-4.5%	6.5%	2.4%
SITE 8	27	2.292	4.191	2.61	9.9	2.305	4.260	2.76	9.8	0.6%	1.6%	5.5%	-1.2%
SITE 9	42	2.301	3.231	3.43	6.8	2.380	3.421	2.56	8.7	3.4%	5.9%	***-25.3%***	***27.9%***
SITE 10	37	2.297	3.533	1.76	11.5	2.169	3.279	2.03	11.4	-5.6%	-7.2%	15.6%	-1.2%

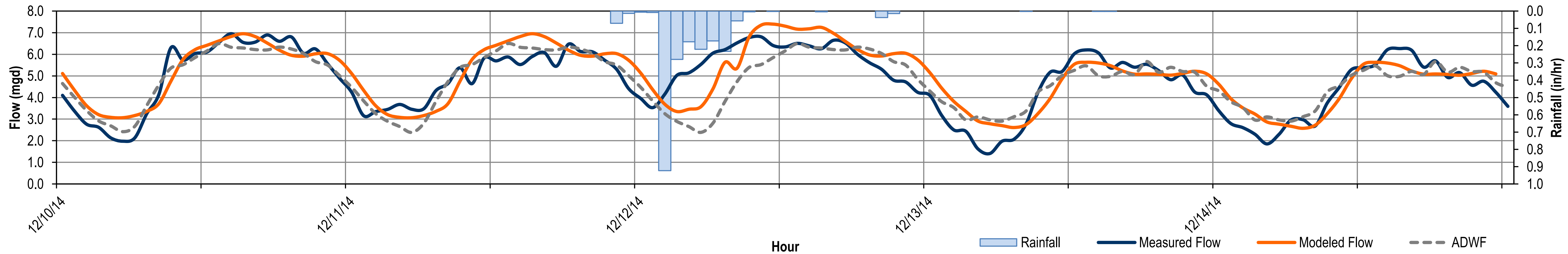
Notes:
1. Temporary Flow Monitoring Program, V&A Consulting Engineers
2. Average flows are calculated from flow monitoring data. Maximum flow values are hourly peaks.
3. Percent Difference = (Modeled - Measured)/Measured*100.

City of Oxnard

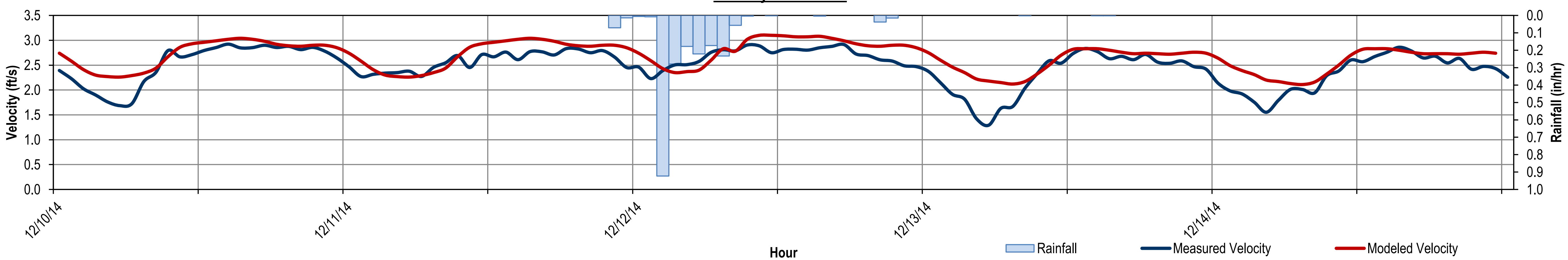
Public Works Integrated Master Plan

FLOW MONITORING SITE 1 WET WEATHER FLOW CALIBRATION (12/10/14-12/15/14)

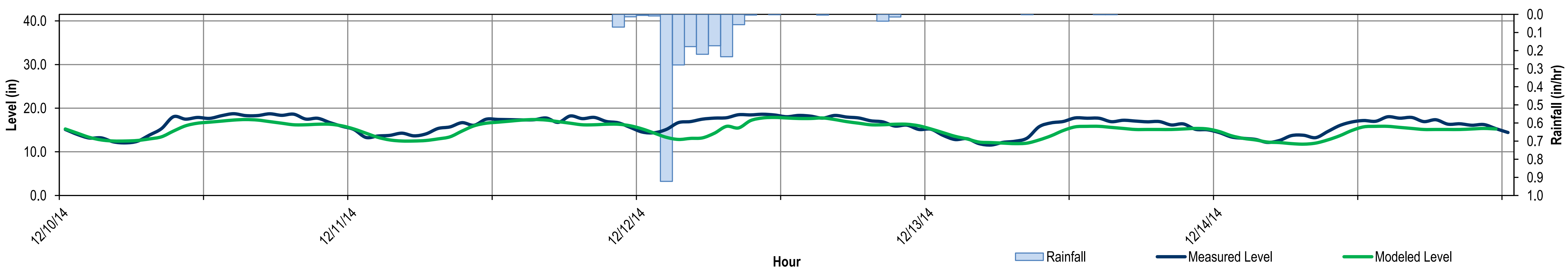
Flow Calibration



Velocity Calibration



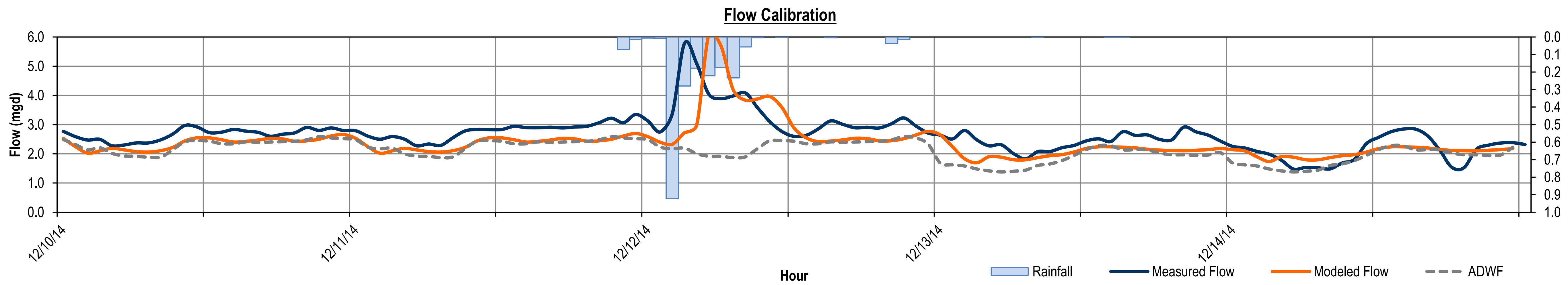
Level Calibration

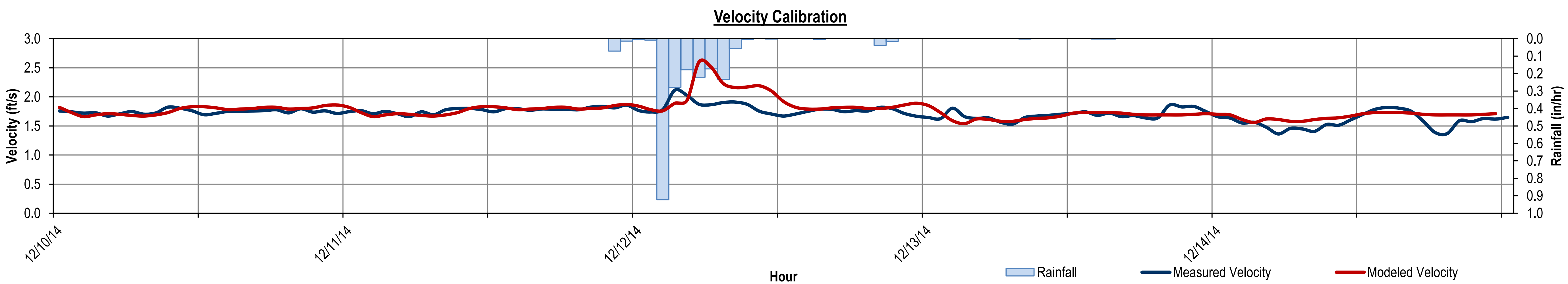


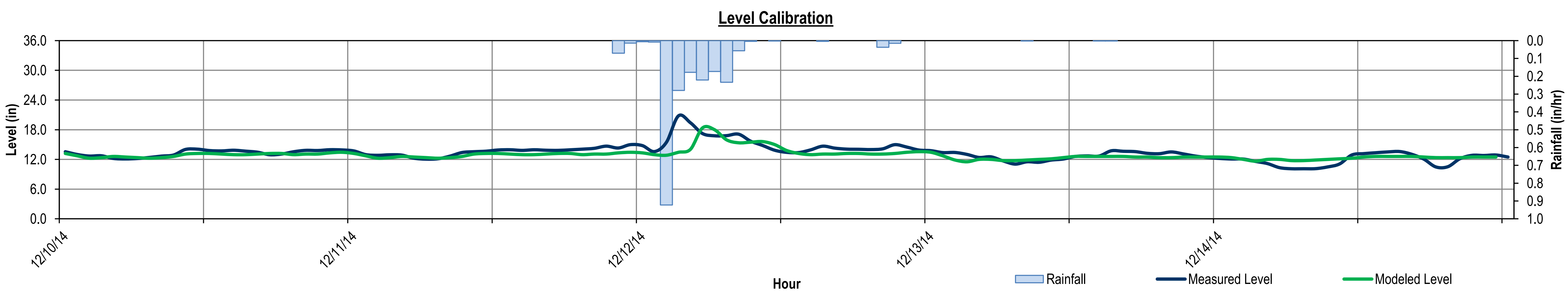
City of Oxnard

Public Works Integrated Master Plan

FLOW MONITORING SITE 2 WET WEATHER FLOW CALIBRATION (12/10/14-12/15/14)



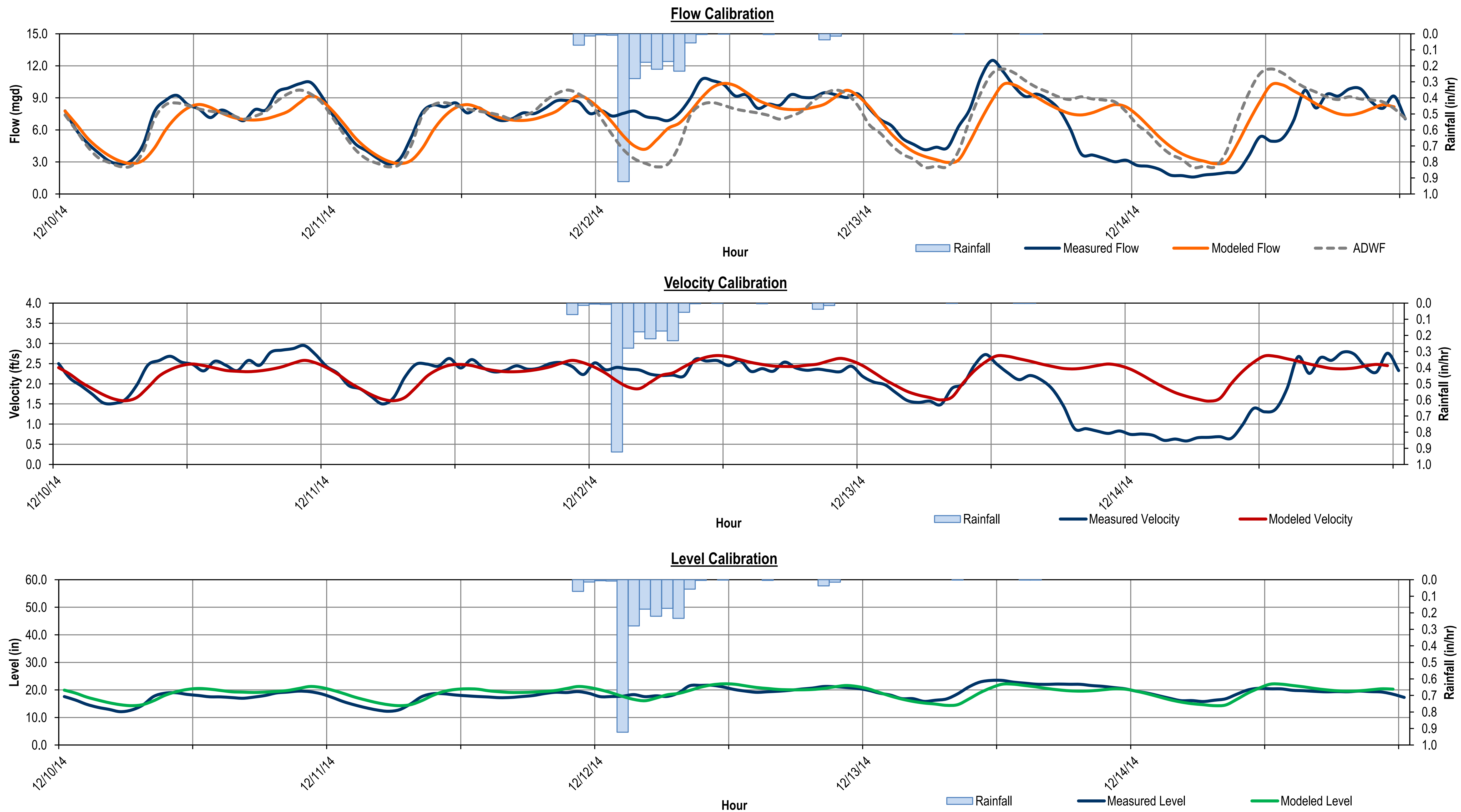




City of Oxnard

Public Works Integrated Master Plan

FLOW MONITORING SITE 3 WET WEATHER FLOW CALIBRATION (12/10/14-12/15/14)



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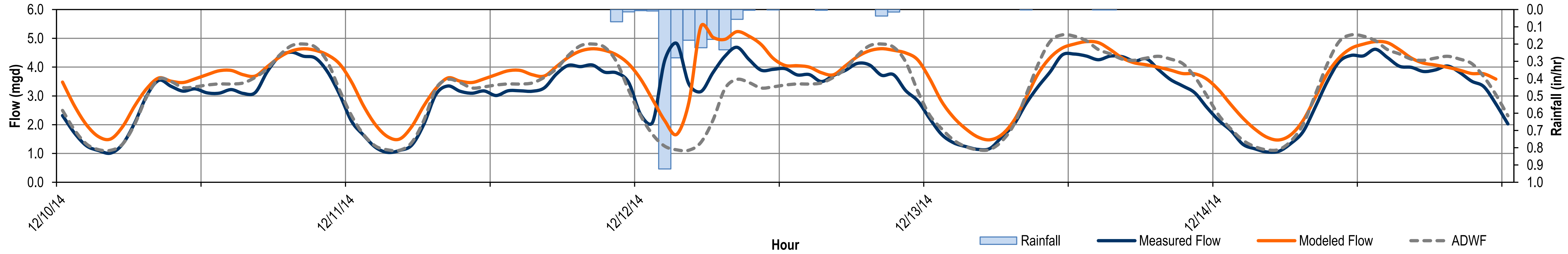
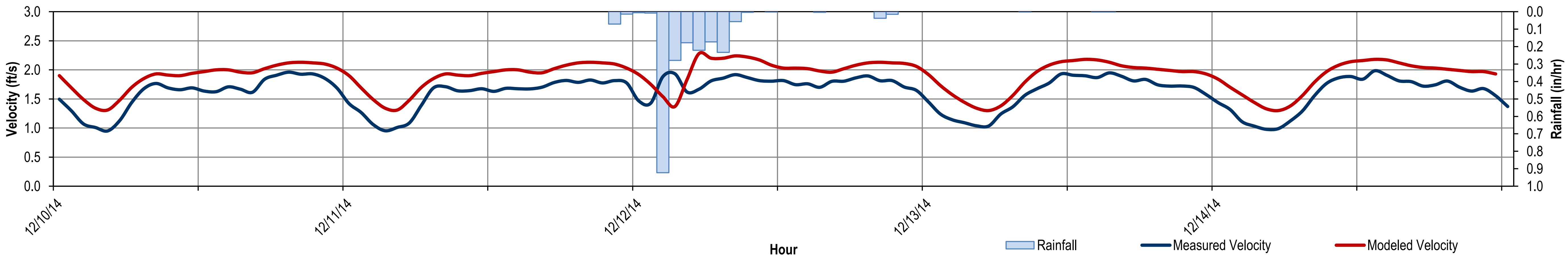
Public Works Integrated Master Plan

FLOW MONITORING SITE 4A WET WEATHER FLOW CALIBRATION (12/10/14-12/15/14)

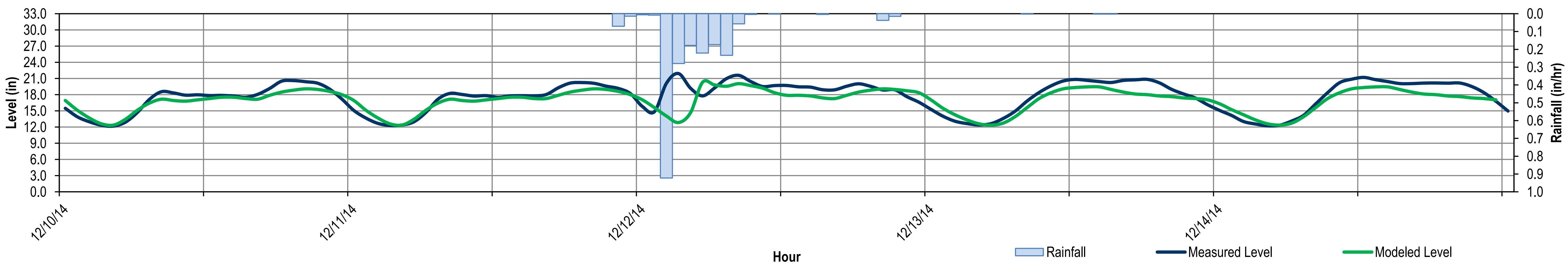
Flow Calibration



Velocity Calibration



Level Calibration

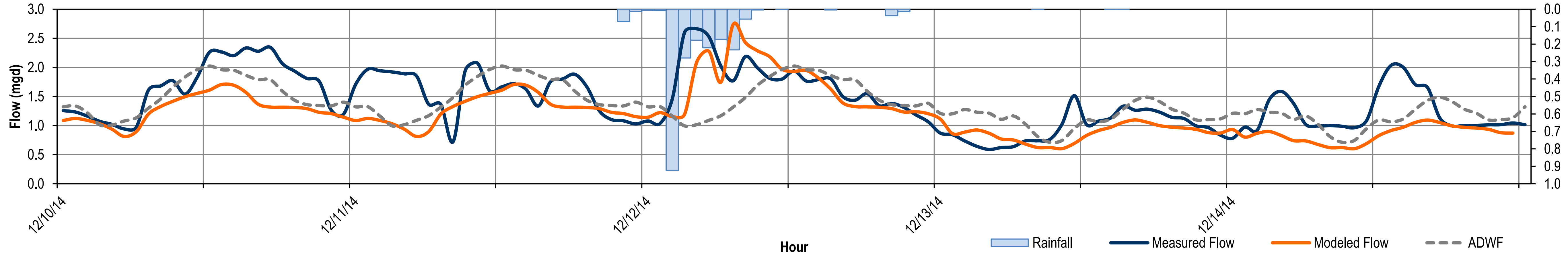


City of Oxnard

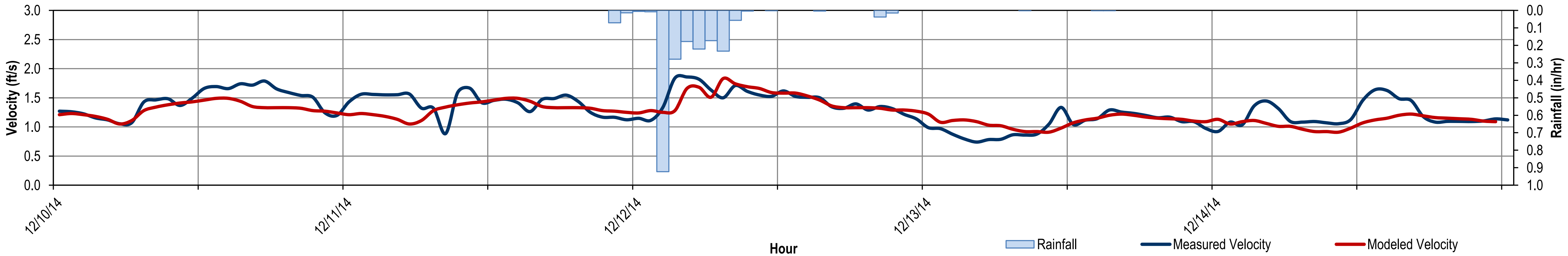
Public Works Integrated Master Plan

FLOW MONITORING SITE 5 WET WEATHER FLOW CALIBRATION (12/10/14-12/15/14)

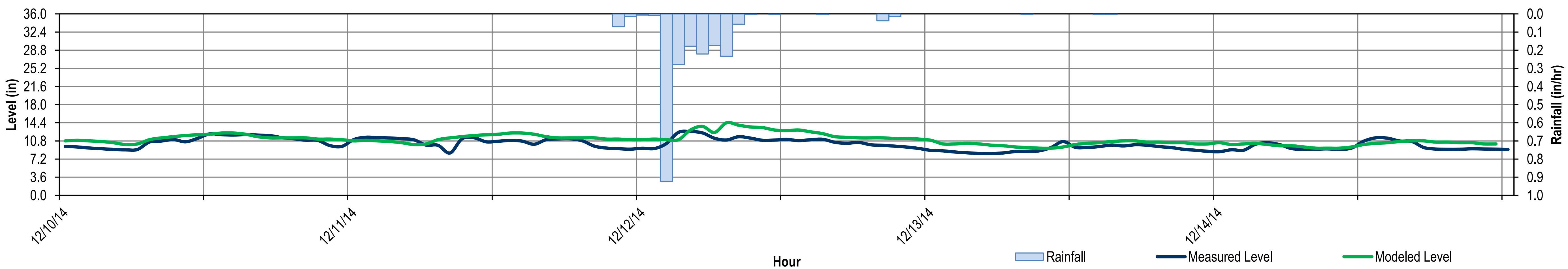
Flow Calibration



Velocity Calibration

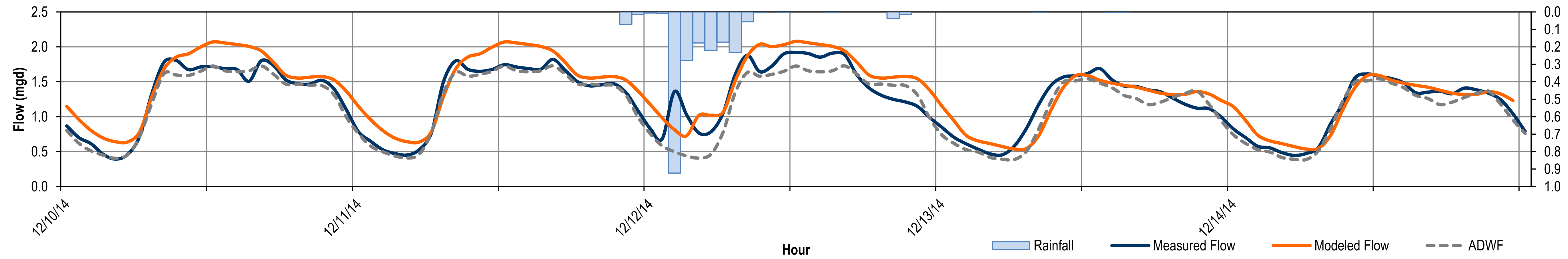


Level Calibration

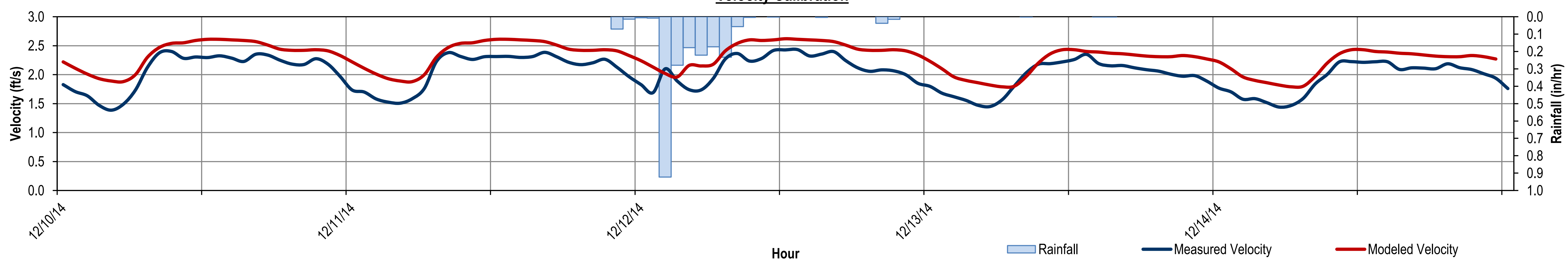


City of Oxnard
Public Works Integrated Master Plan
FLOW MONITORING SITE 6 WET WEATHER FLOW CALIBRATION (12/10/14-12/15/14)

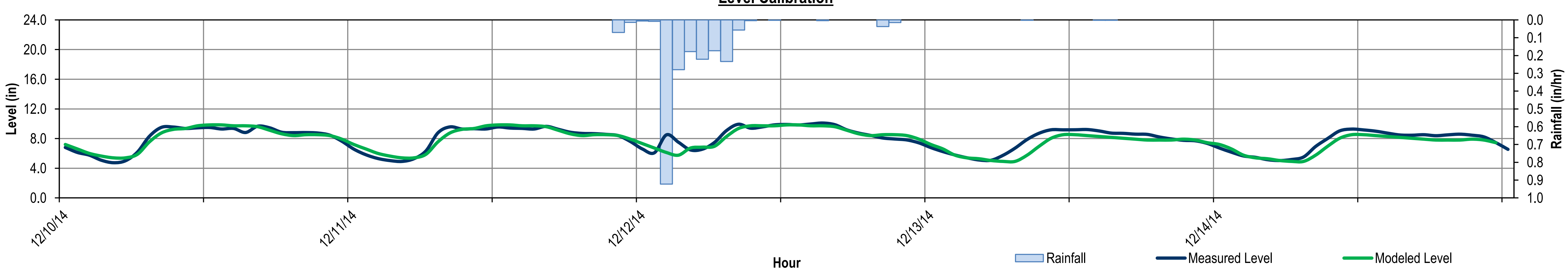
Flow Calibration



Velocity Calibration



Level Calibration

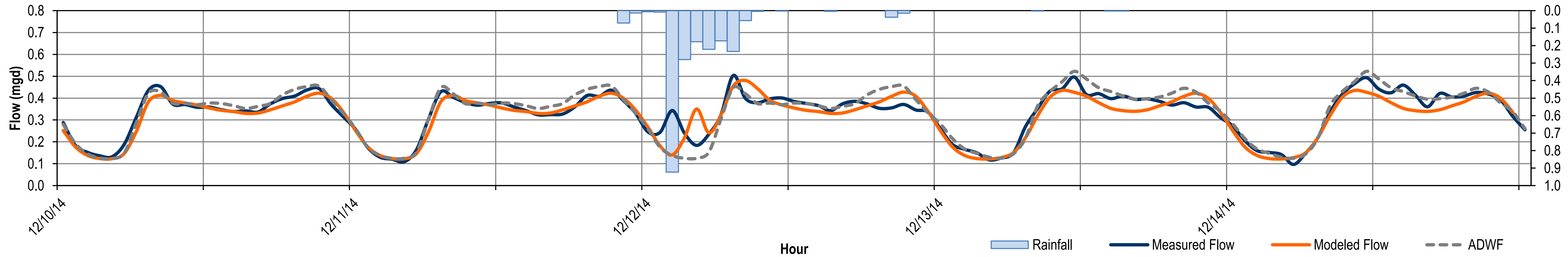


City of Oxnard

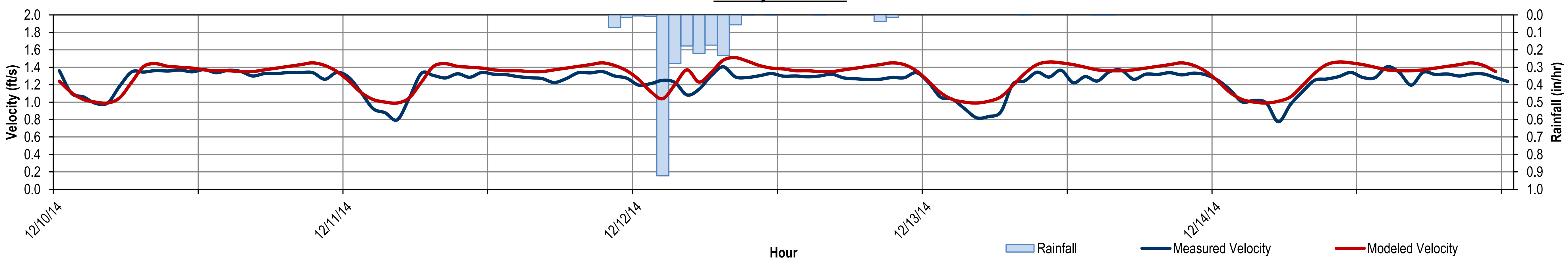
Public Works Integrated Master Plan

FLOW MONITORING SITE 7 WET WEATHER FLOW CALIBRATION (12/10/14-12/15/14)

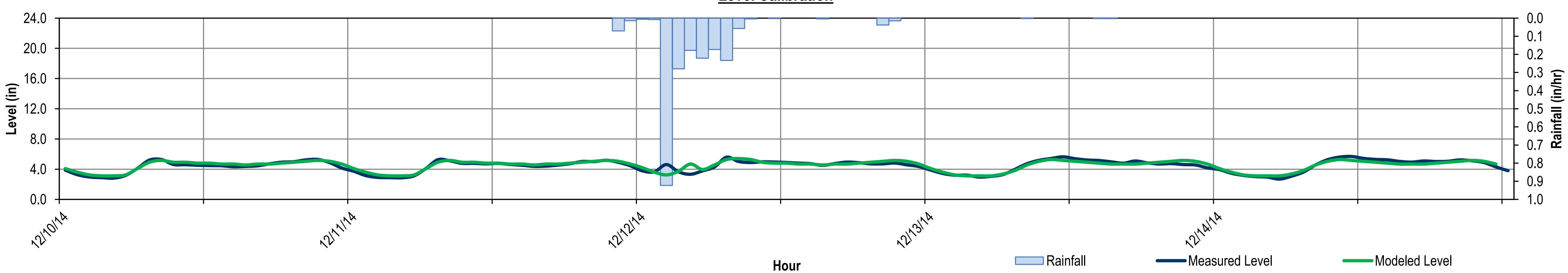
Flow Calibration



Velocity Calibration



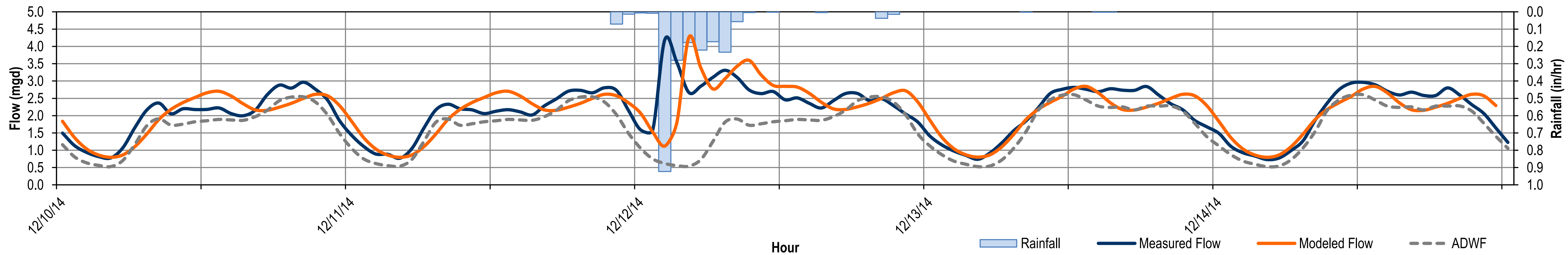
Level Calibration



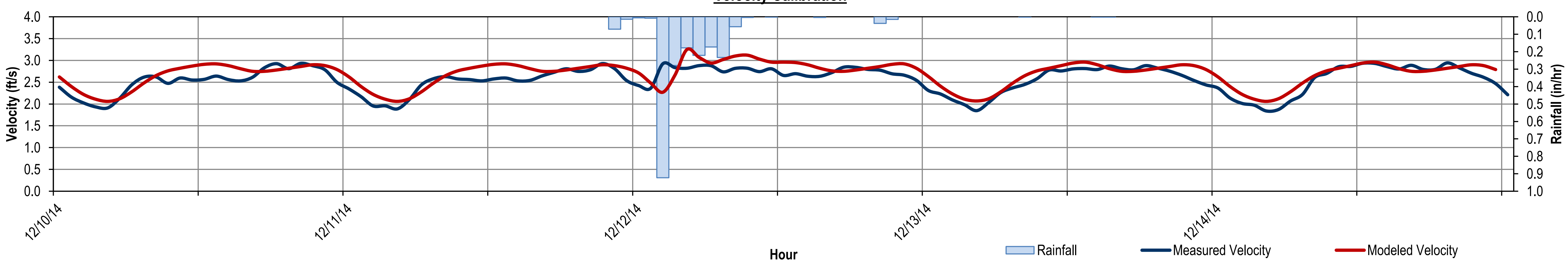
City of Oxnard
Public Works Integrated Master Plan
FLOW MONITORING SITE 8 WET WEATHER FLOW CALIBRATION (12/10/14-12/15/14)

carollo

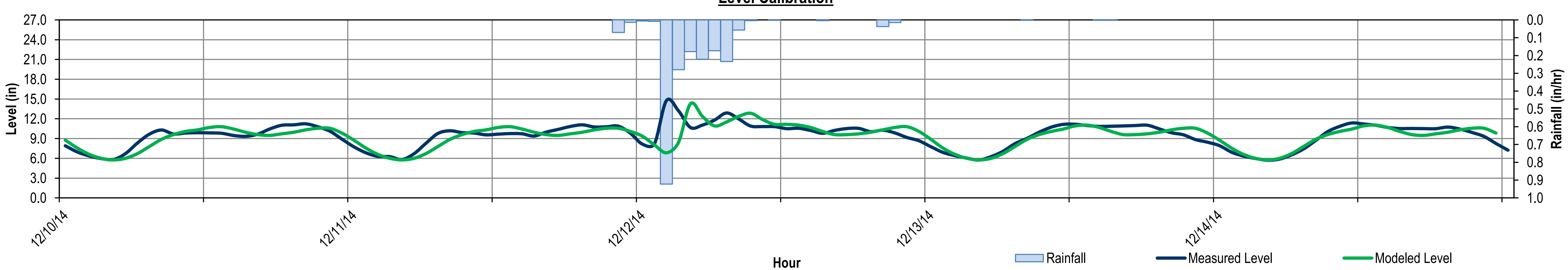
Flow Calibration



Velocity Calibration



Level Calibration

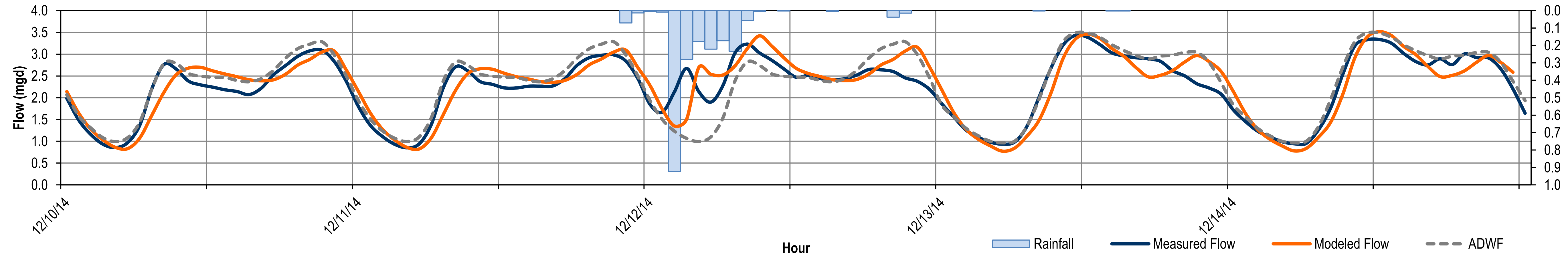


City of Oxnard

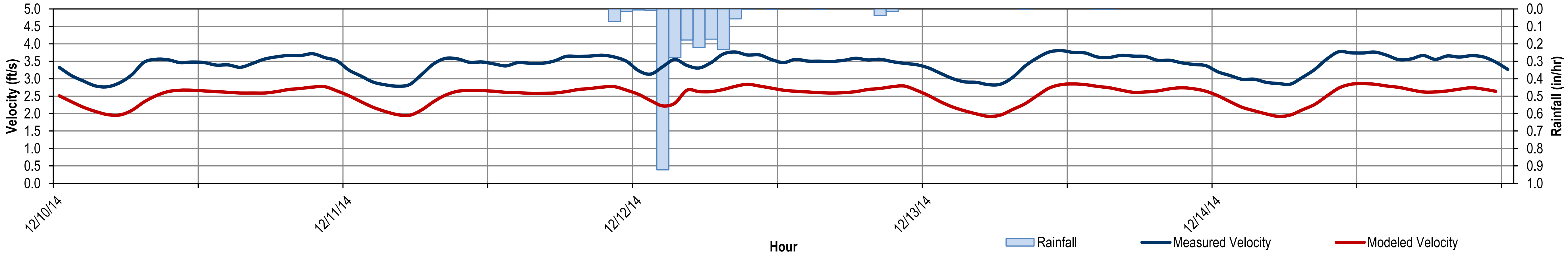
Public Works Integrated Master Plan

FLOW MONITORING SITE 9 WET WEATHER FLOW CALIBRATION (12/10/14-12/15/14)

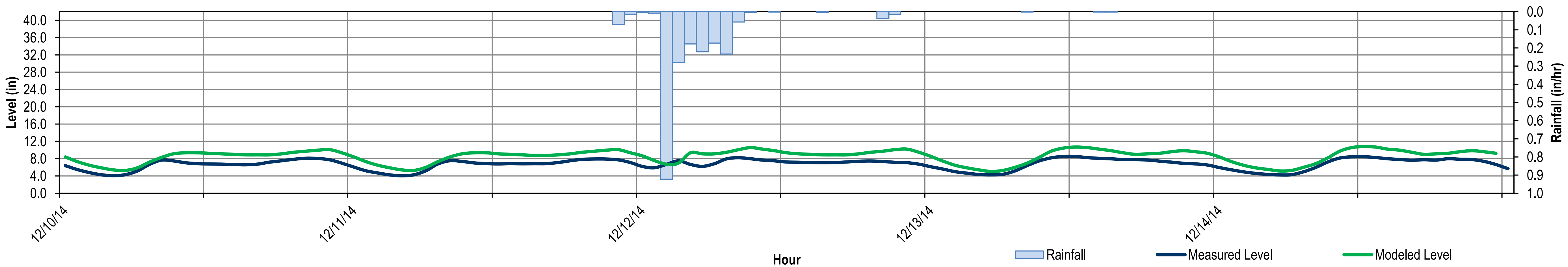
Flow Calibration



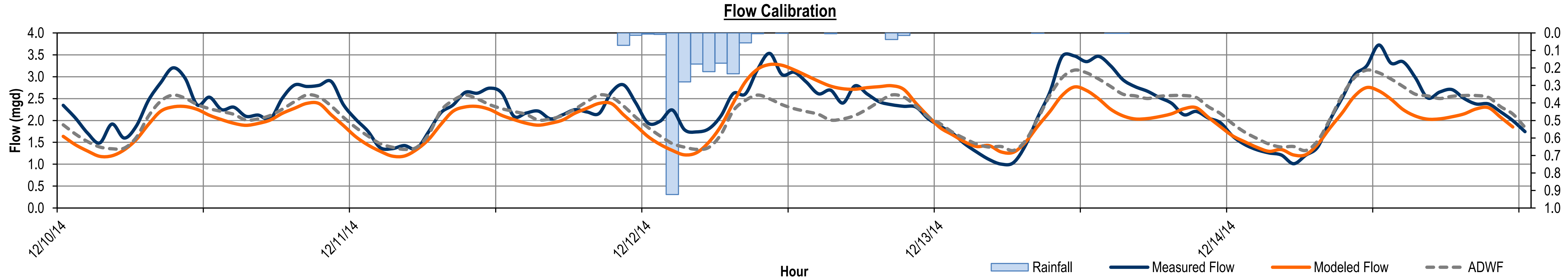
Velocity Calibration

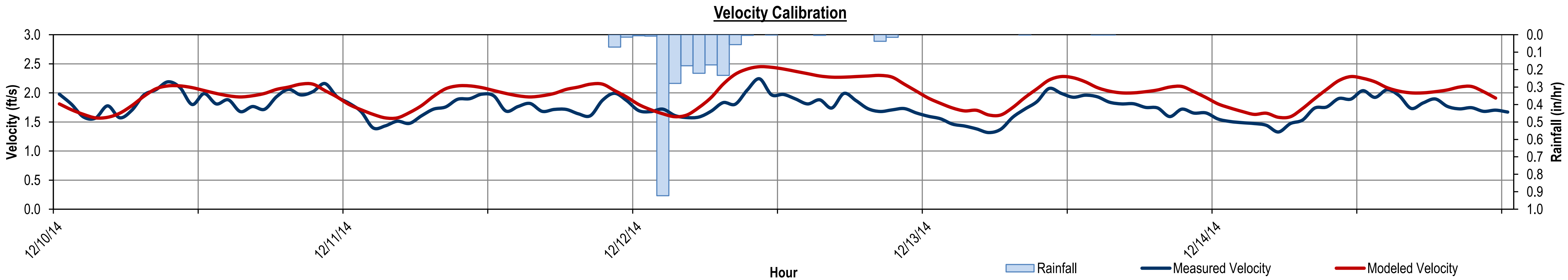


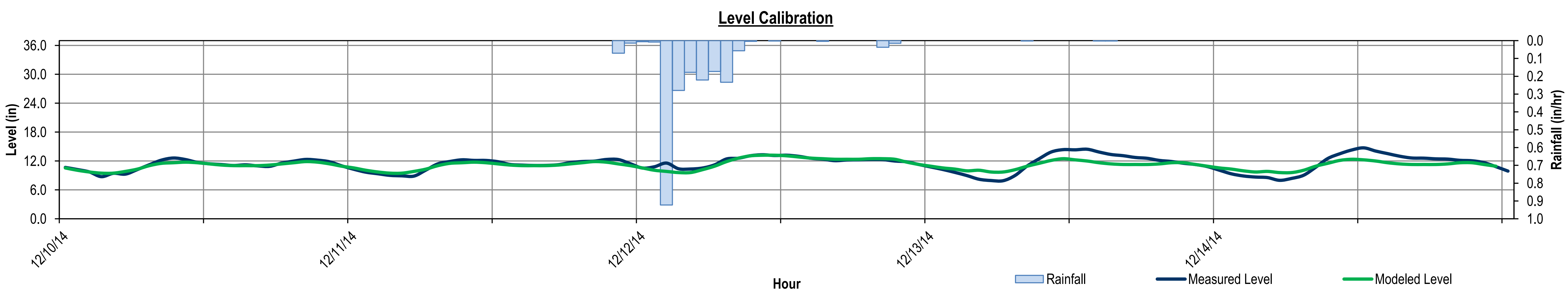
Level Calibration

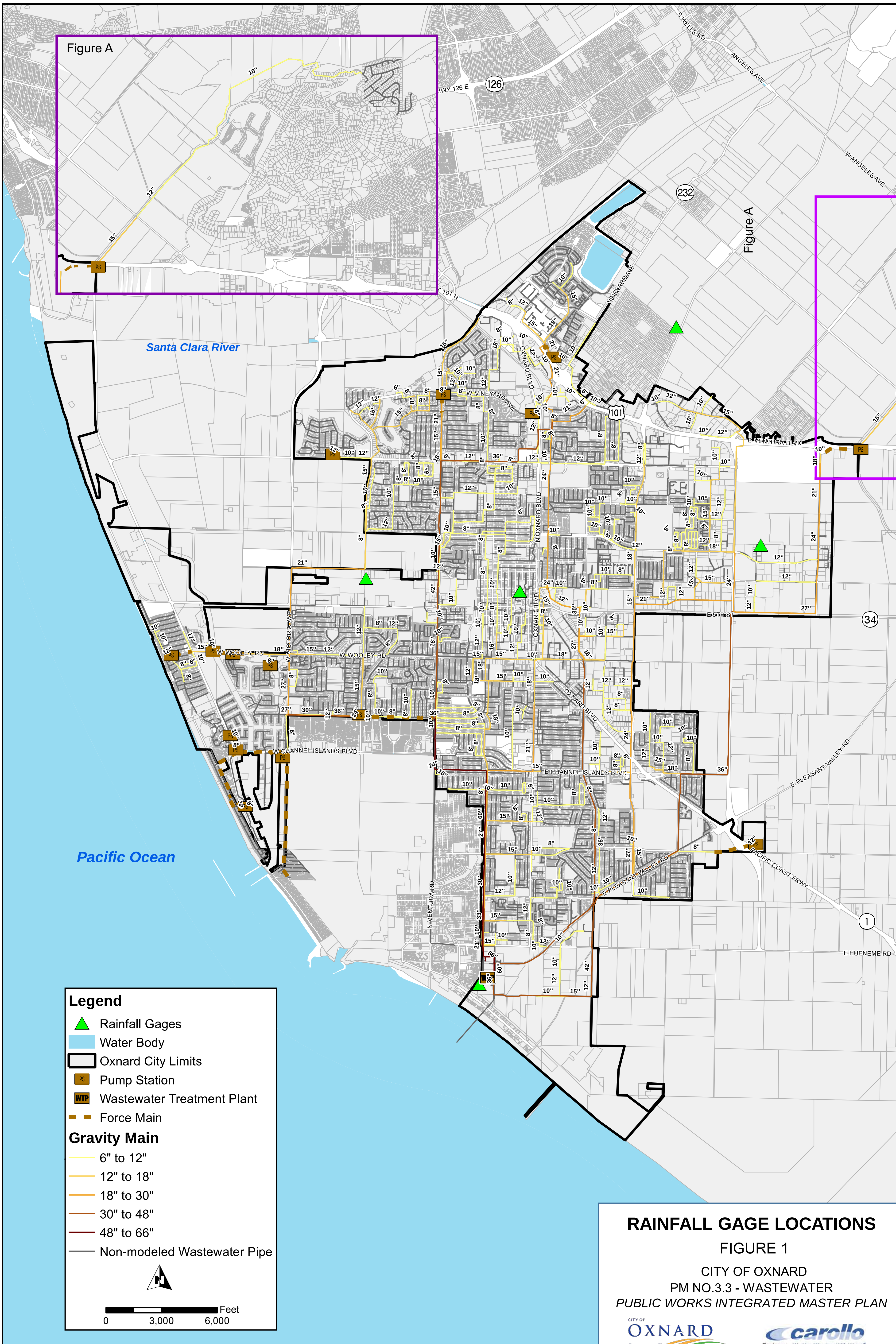


City of Oxnard
Public Works Integrated Master Plan
FLOW MONITORING SITE 10 WET WEATHER FLOW CALIBRATION (12/10/14-12/15/14)









RAINFALL GAGE LOCATIONS

FIGURE 1

CITY OF OXNARD
PM NO.3.3 - WASTEWATER
PUBLIC WORKS INTEGRATED MASTER PLAN

CITY OF OXNARD CALIFORNIA

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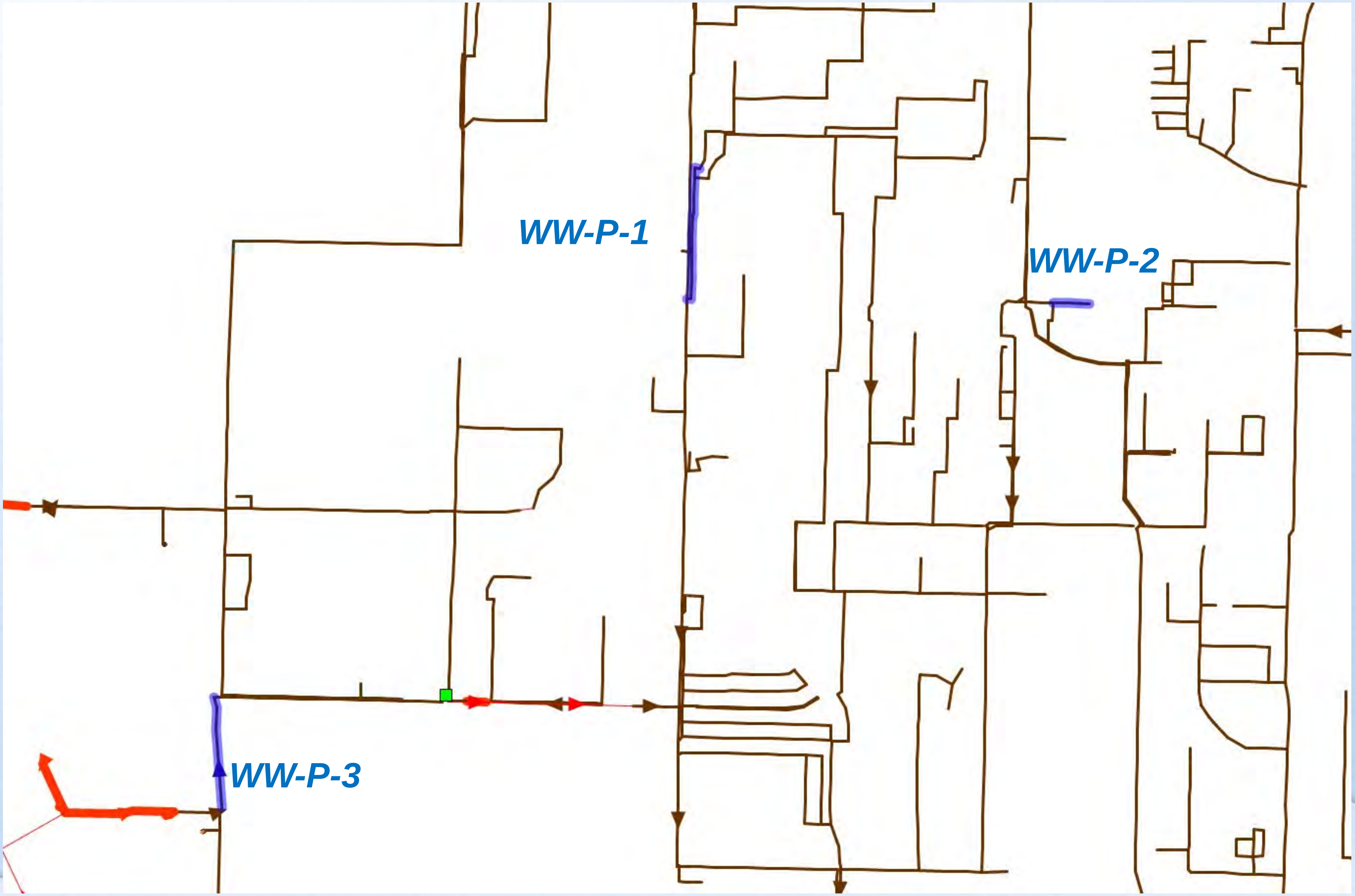
APPENDIX C – WASTEWATER COLLECTION SYSTEM IMPROVEMENTS

Waste Water Collection System Improvements

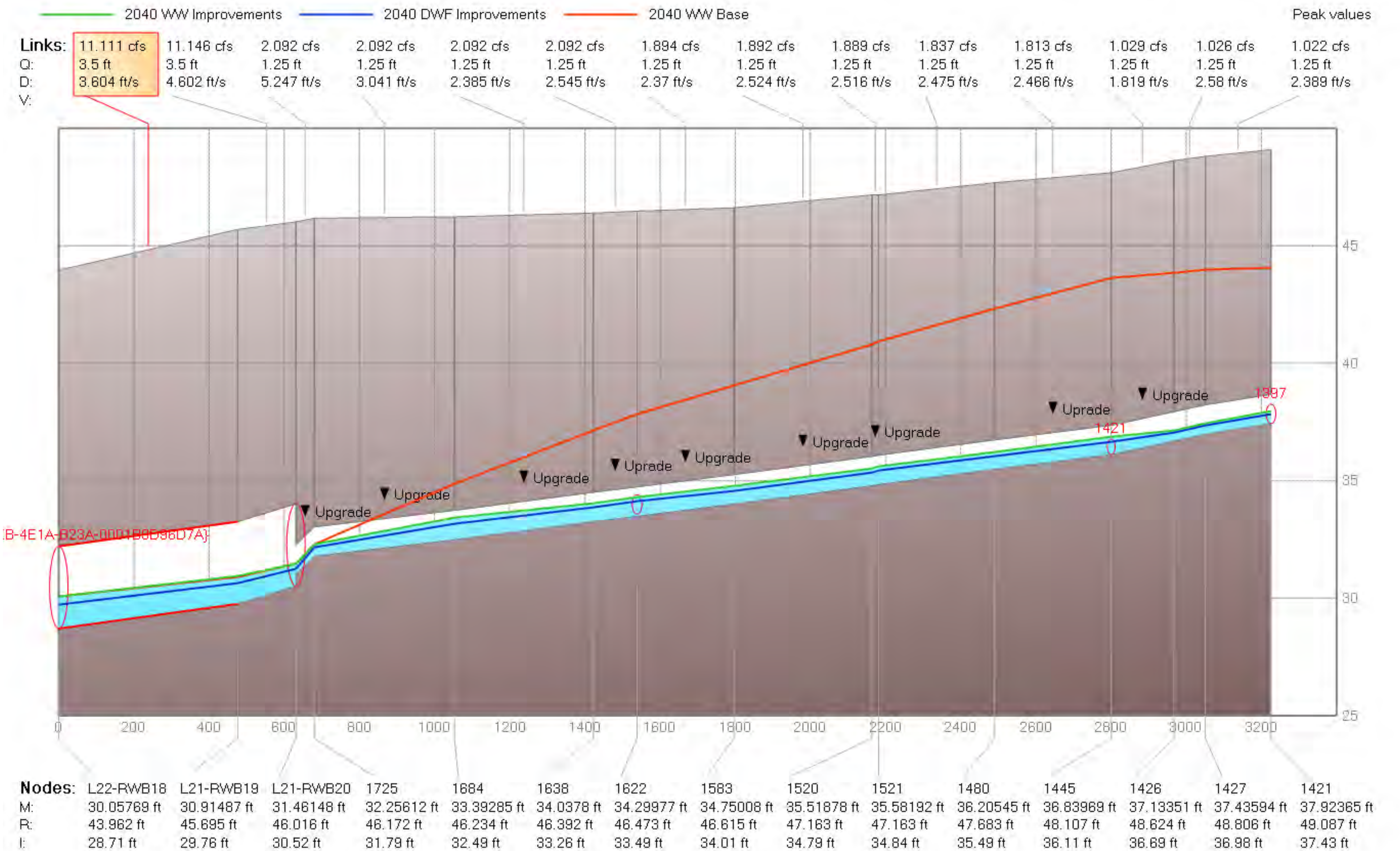
Oxnard, CA

08/09/2015

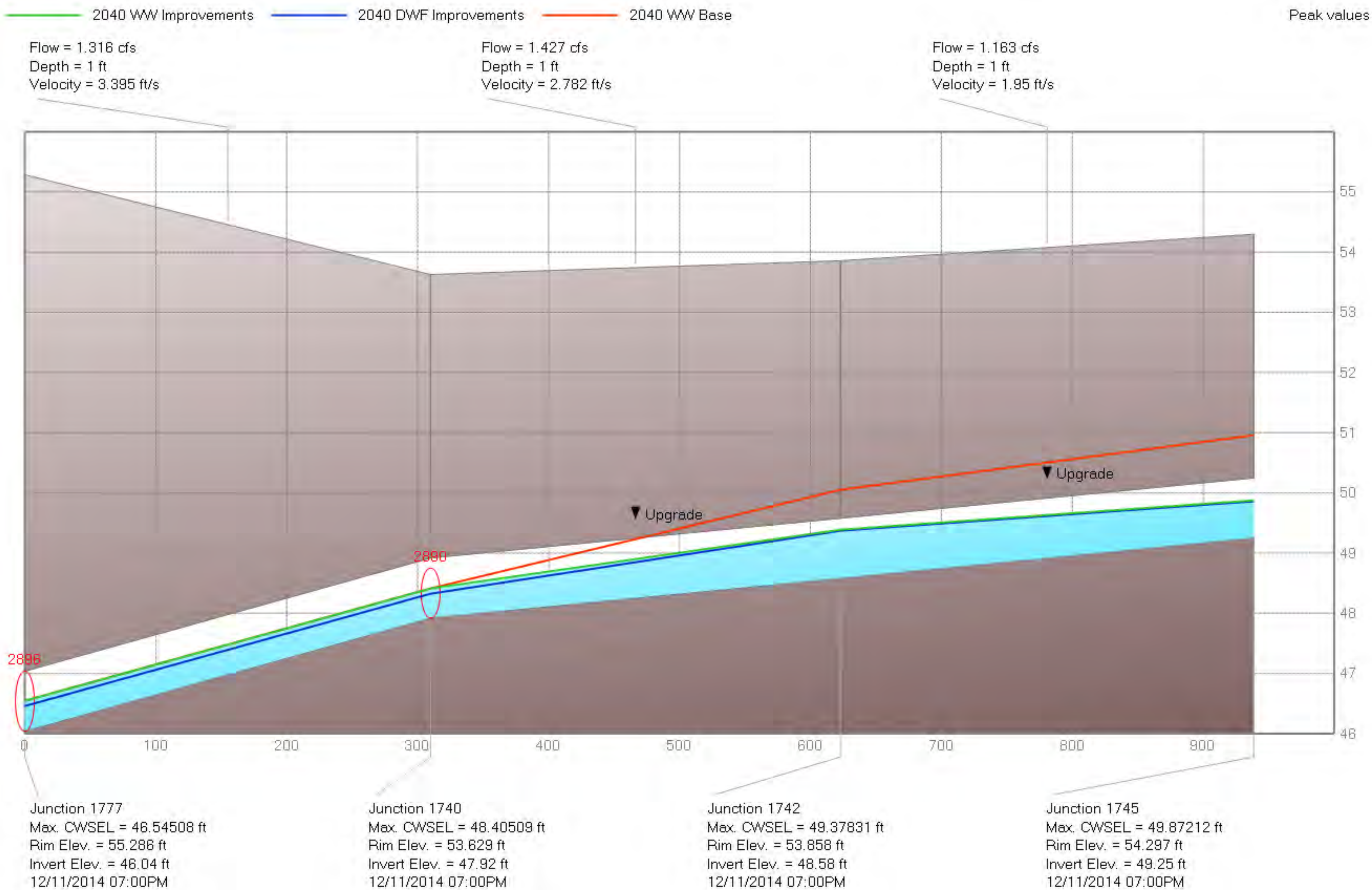
Upgrade Locations



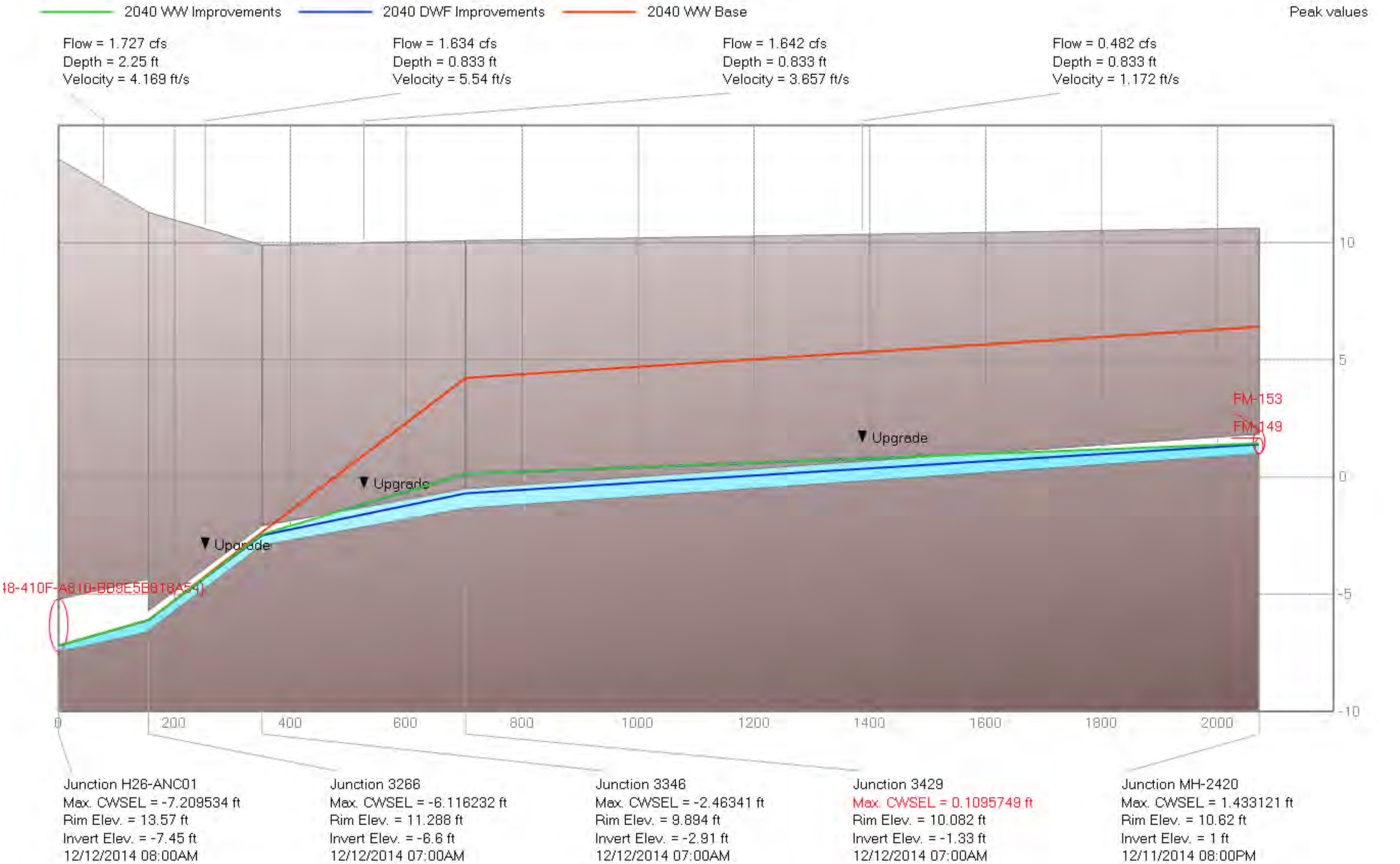
WW-P-1


2040 WW Improvements
2040 DWF Improvements
2040 WW Base
Peak values
Links:
Q:
D:
V:
11.111 cfs 3.5 ft 3.604 ft/s
11.146 cfs 3.5 ft 4.602 ft/s
2.092 cfs 1.25 ft 5.247 ft/s
2.092 cfs 1.25 ft 3.041 ft/s
2.092 cfs 1.25 ft 2.385 ft/s
2.092 cfs 1.25 ft 2.545 ft/s
1.894 cfs 1.25 ft 2.37 ft/s
1.892 cfs 1.25 ft 2.524 ft/s
1.889 cfs 1.25 ft 2.516 ft/s
1.837 cfs 1.25 ft 2.475 ft/s
1.813 cfs 1.25 ft 2.466 ft/s
1.029 cfs 1.25 ft 1.819 ft/s
1.026 cfs 1.25 ft 2.58 ft/s
1.022 cfs 1.25 ft 2.389 ft/s
Upgrade
Upgrade
Upgrade
Uprade
Upgrade
Upgrade
Upgrade
Uprade
Upgrade
1397
1421
45
40
35
30
25
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
3200
Nodes:
M:
R:
I:
L22-RWB18 30.05769 ft 43.962 ft 28.71 ft
L21-RWB19 30.91487 ft 45.695 ft 29.76 ft
L21-RWB20 31.46148 ft 46.016 ft 30.52 ft
1725 32.25612 ft 46.172 ft 31.79 ft
1684 33.39285 ft 46.234 ft 32.49 ft
1638 34.0378 ft 46.392 ft 33.26 ft
1622 34.29977 ft 46.473 ft 33.49 ft
1583 34.75008 ft 46.615 ft 34.01 ft
1520 35.51878 ft 47.163 ft 34.79 ft
1521 35.58192 ft 47.163 ft 34.84 ft
1480 36.20545 ft 47.683 ft 35.49 ft
1445 36.83969 ft 48.107 ft 36.11 ft
1426 37.13351 ft 48.624 ft 36.69 ft
1427 37.43594 ft 48.806 ft 36.98 ft
1421 37.92365 ft 49.087 ft 37.43 ft

WW-P-2


2040 WW Improvements
2040 DWF Improvements
2040 WW Base
Peak values
Flow = 1.316 cfs
Depth = 1 ft
Velocity = 3.395 ft/s
Flow = 1.427 cfs
Depth = 1 ft
Velocity = 2.782 ft/s
Flow = 1.163 cfs
Depth = 1 ft
Velocity = 1.95 ft/s
2896
2890
Upgrade
Upgrade
Junction 1777
Max. CWSEL = 46.54508 ft
Rim Elev. = 55.286 ft
Invert Elev. = 46.04 ft
12/11/2014 07:00PM
Junction 1740
Max. CWSEL = 48.40509 ft
Rim Elev. = 53.629 ft
Invert Elev. = 47.92 ft
12/11/2014 07:00PM
Junction 1742
Max. CWSEL = 49.37831 ft
Rim Elev. = 53.858 ft
Invert Elev. = 48.58 ft
12/11/2014 07:00PM
Junction 1745
Max. CWSEL = 49.87212 ft
Rim Elev. = 54.297 ft
Invert Elev. = 49.25 ft
12/11/2014 07:00PM

WW-P-3



2040 WW Improvements
2040 DWF Improvements
2040 WW Base
Peak values
Flow = 1.727 cfs
Depth = 2.25 ft
Velocity = 4.169 ft/s
Flow = 1.634 cfs
Depth = 0.833 ft
Velocity = 5.54 ft/s
Flow = 1.642 cfs
Depth = 0.833 ft
Velocity = 3.657 ft/s
Flow = 0.482 cfs
Depth = 0.833 ft
Velocity = 1.172 ft/s
Upgrade
Upgrade
Upgrade
FM-153
FM-149
10
5
0
-5
-10
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Junction H26-ANC01
Max. CWSEL = -7.209534 ft
Rim Elev. = 13.57 ft
Invert Elev. = -7.45 ft
12/12/2014 08:00AM
Junction 3266
Max. CWSEL = -6.116232 ft
Rim Elev. = 11.288 ft
Invert Elev. = -6.6 ft
12/12/2014 07:00AM
Junction 3346
Max. CWSEL = -2.46341 ft
Rim Elev. = 9.894 ft
Invert Elev. = -2.91 ft
12/12/2014 07:00AM
Junction 3429
Max. CWSEL = 0.1095749 ft
Rim Elev. = 10.082 ft
Invert Elev. = -1.33 ft
12/12/2014 07:00AM
Junction MH-2420
Max. CWSEL = 1.433121 ft
Rim Elev. = 10.62 ft
Invert Elev. = 1 ft
12/11/2014 08:00PM

This document is released for the purpose of information exchange review and planning only under the authority of Tracy Anne Clinton, September 2017, State of California, PE No. 48199 and Elizabeth Abigail Charbonnet, September 2017, State of California, PE No. 84612

City of Oxnard

Public Works Integrated Master Plan

WASTEWATER

PROJECT MEMORANDUM 3.4
TREATMENT PLANT PERFORMANCE AND CAPACITY

REVISED FINAL DRAFT
September 2017

Engineers...Working Wonders With Water™

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PREFACE

The analysis and evaluations contained in these Project Memorandum (PM) are based on data and information available at the time of the original date of publication, December 2015. After development of the December 2015 Final Draft PMs, the City continued to move forward on two concurrent aspects: 1) advancing the facilities planning for the water, wastewater, recycled water, and stormwater facilities; and 2) developing Updated Cost of Service (COS) Studies (Carollo, 2017) for the wastewater/collection system and the water/distribution system. The updated 2017 COS studies contain the most recent near-term Capital Improvement Projects (CIP). **The complete updated CIP based on the near-term and long-term projects is contained in the Brief History and Overview of the City of Oxnard Public Works Department's Integrated Planning Efforts: May 2014 – August 2017 section.**

At the time of this Revised PWIMP, minor edits were also incorporated into the PMs. Minor edits included items such as table title changes and updating reports that were completed after the December 2015 original publication date.

City of Oxnard

Public Works Integrated Master Plan

WASTEWATER

PROJECT MEMORANDUM 3.4
TREATMENT PLANT PERFORMANCE AND CAPACITY

TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

TREATMENT PLANT PERFORMANCE AND CAPACITY

1.0 INTRODUCTION

This Project Memorandum (PM) summarizes the existing Oxnard Wastewater Treatment Plant (OWTP) performance and determines a capacity rating for each unit process at the plant. This analysis is integral to determining required future capital improvement projects.

1.1 PMs Used for Reference

The findings outlined in this PM are made in concert with recommendations and analyses from other related PMs:

- PM 3.1 - Wastewater System - Background Summary.
- PM 3.2 - Wastewater System - Flow and Load Projections.
- PM 3.3 - Wastewater System - Infrastructure Modeling and Alternatives.
- PM 3.11 - Wastewater System - Flow Monitoring.

1.2 Other Reports Used for Reference

In analyzing the OWTP's performance and capacity in this PWIMP, findings from other reports were incorporated to ensure a well-rounded and holistic look at the wastewater system. The following reports are used in this PWIMP analysis:

- Oxnard Wastewater Treatment Plant National Pollutant Discharge Elimination System (NPDES) Permit, Order No. R4-2013-0094, NPDES No. CA0054097. (NPDES Permit, 2013).
- Oxnard Wastewater Treatment Plant Operations and Maintenance Manual Volume 1-6, April 1980 (Brown and Caldwell, 1980).
- Oxnard Wastewater Treatment Plant Operations and Maintenance Manual Phase 1 Expansion Volumes 1-4, September 1991 (Camp Dresser McKee Inc., 1991).
- Design of Municipal Wastewater Treatment Plants Fifth Edition, Water Environment Federation/America Society of Civil Engineers, (WEF/ASCE, 2010).
- Wastewater Engineering Treatment and Resource Recovery, Fifth Edition, (Metcalf and Eddy, 2014).

2.0 PLANT PERFORMANCE AND CRITERIA REVIEW

This section summarizes the performance of the OWTP treatment processes. The existing performance provided a benchmark for the planning of new facilities. The plant performance review was used to calibrate a process model and establish sizing criteria for use in the capacity analysis. The review period over which performance has been evaluated is from January 2010 through December 2013. Historical process loadings and criteria presented are based on reported data provided by the OWTP staff.

The performance assessment discussed in the sections below is comprised of two main sections:

- Overall treatment performance of the OWTP, with respect to meeting discharge limits and other effluent requirements.
- Historical loading and performance of each of the unit processes.

An understanding of the OWTP's current treatment performance is critical in determining the treatment capacity of the OWTP. Based on historical loading and performance, recommended criteria for assessing capacity were developed for each major treatment process. The recommended criteria serve as the basis for the process capacity assessment.

2.1 Overall Treatment Plant Performance

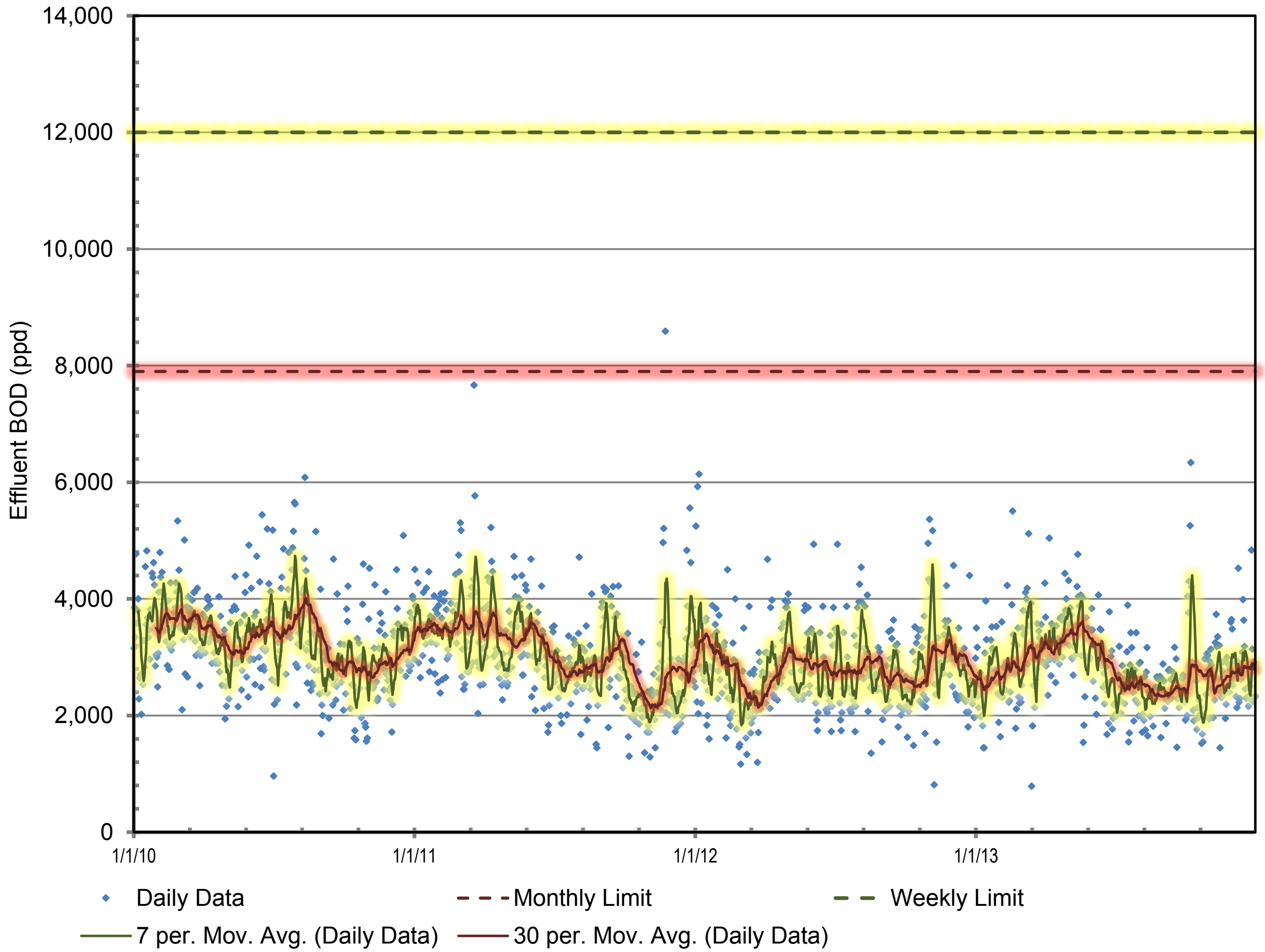
This section summarizes the overall treatment plant performance of the OWTP. The overall treatment performance is based on historical compliance with conventional pollutant requirements in the OWTP's NPDES permit.

2.1.1 NPDES Conventional Pollutants

Conventional pollutants regulated in the NPDES permit include biochemical oxygen demand (BOD_5), total suspended solids (TSS), pH, oil and grease, settleable solids, and turbidity. During the review period, the OWTP achieved compliance with all of the regulated conventional pollutants.

The OWTP met all the limits for conventional pollutants. There were some instances where performance goals were exceeded. The instances were minor and usually associated with reported detection limits for some of the priority pollutants being above the effluent limit. It is not known if the effluent concentration would be less than the effluent limit if the analysis method had a lower detection limit.

Figures 1 and 2 show the daily effluent BOD_5 and TSS concentrations, respectively, along with the 7-day and 30-day running averages. The 7-day and 30-day running averages represent the weekly and monthly averages of the data, and correspond to the effluent weekly and monthly NPDES limits. As shown in the figures, the running averages are well below the weekly and monthly effluent limits for both of these constituents.



HISTORICAL FINAL EFFLUENT BOD_5 LOADING

FIGURE 1

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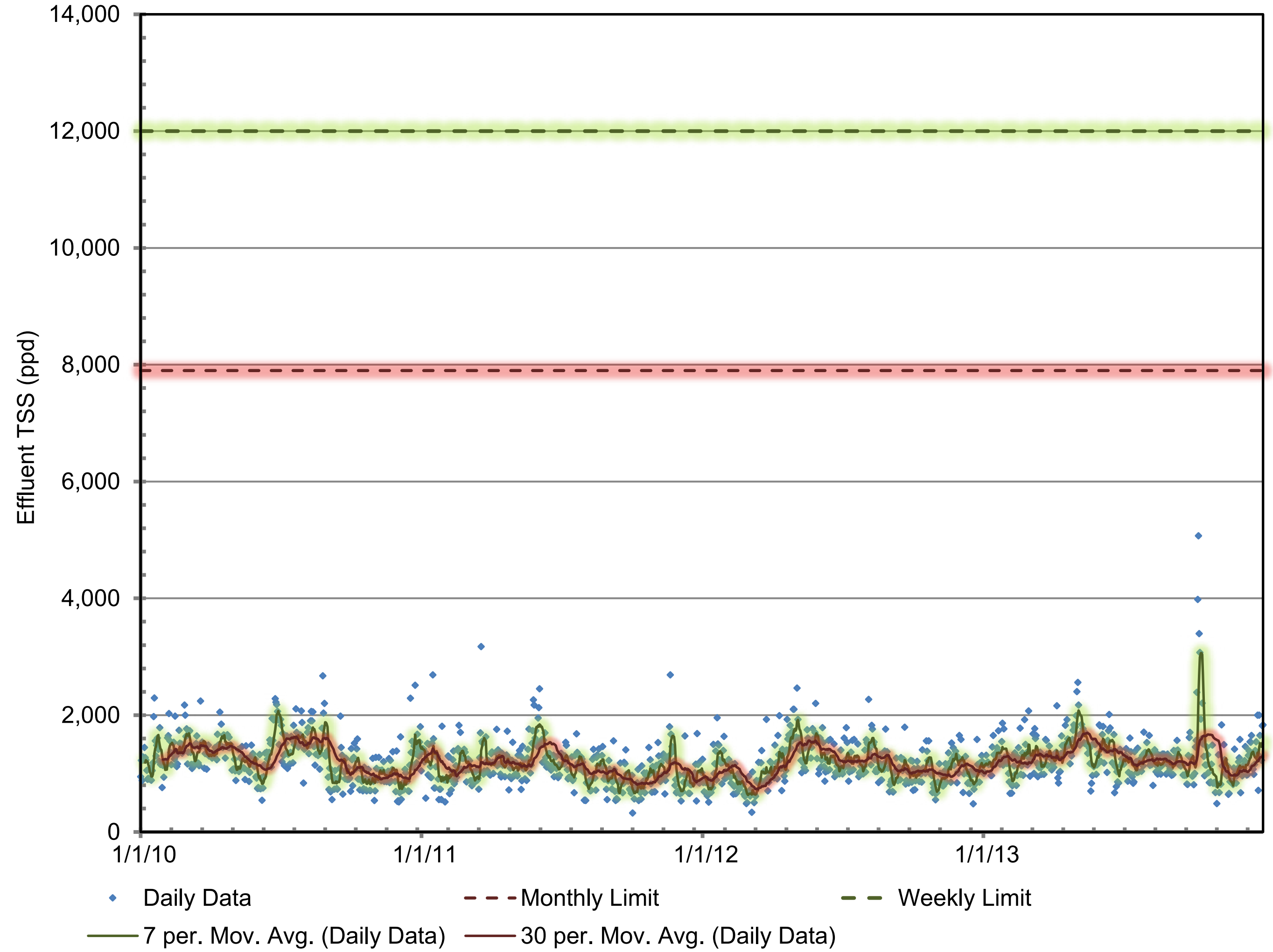
ox0715f24-9587(PM3-4 FIG1).ai



HISTORICAL FINAL EFFLUENT TSS LOADING

FIGURE 2

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Table 1 summarizes the overall performance of the OWTP with respect to conventional pollutants in the NPDES permit.

Table 1 Overall OWTP Performance for Conventional Pollutants
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Effluent Water Quality Parameter	Units	Limit[1]	2010 - 2013 Performance	Number of Exceedances
BOD_5	mg/L	Average Monthly = 30	13 - 22	0
		Average Weekly = 45	11 - 28	0
	ppd	Average Monthly = 7,960	2126 - 4009	0
		Average Weekly = 11,900	1834 - 4737	0
TSS	mg/L	Average Monthly = 30	4 - 10	0
		Average Weekly = 45	4 - 19	0
	ppd	Average Monthly = 7,960	731 - 1696	0
		Average Weekly = 11,900	633 - 3063	0
pH	Standard Units	6.0 - 9.0	7 - 8	0
Oil and Grease	mg/L	Average Monthly = 25	5 - 7	0
		Average Weekly = 40	5 - 9	0
	ppd	Average Monthly = 6,630	754 - 1393	0
		Average Weekly = 10,600	693 - 1694	0
Settleable Solids	ml/L	Average Monthly = 1.0	0.01 - 0.016	0
		Average Weekly = 1.5	0.01 - 0.036	0
Turbidity	NTU	Average Monthly = 75	3 - 7	0
		Average Weekly = 100	2 - 13	0

Note:
(1) Per NPDES Waste Discharge Requirements Order No. R4-2013-0094, NPDES No. CA0054097.

2.2 Unit Process Loading and Performance

This section summarizes the assessment of the OWTP performance and unit process performance. This is important as it provides a benchmark for the planning of new facilities and assessing capacity. In some cases, historical performance confirms that original design criteria are appropriate for assessing unit process capacity. In others, above or below average performance warrants using criteria different from the original design for assessing capacity. For each unit process, recommended criteria should be developed for use in the capacity assessment. Table 2 summarizes the key load and performance data as well as the recommended criteria for the OWTP processes. Approximately 1 to 3 years of daily operating data were reviewed to characterize the historical performance.

Table 2 OWTP Process Performance and Criteria Summary
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City of Oxnard

Process/Design Parameter	Design Parameter	Units	Original Design[1]	Historical Performance (2010 – 2013)	MOP-8[2] or Typical Values[3]	Recommended Criteria for Capacity Analysis
Grit Chambers	Overflow Rate at PWWF	gpd/sf	42,315	23,056	20,000 - 50,000	42,315
	Detention Time at PWWF	min	2.8	5.1	2 to 5[4]	2.8
Primary Sedimentation Tanks	Overflow Rate:	gpd/sf				
	ADWF		1,270	809[5]	800 - 1,200[2]	1,270
	PWWF		2,200	1,598[5]	2,000 - 3,000[2]	2,200
	% BOD Removal	%	35	46	25 - 40[2]	35
	% TSS Removal	%	65	70	50 - 70[2]	65
Biofiltration Units	Hydraulic Load:					
	Average	gpm/sf	0.50	--	0.9[2]	1.00
	Peak		1.50	--	2.9[2]	1.50
	Volumetric Load at ADMML	lb BOD_5/ 1,000 ft^3/d	47[6]	55	100-220[2]	100
	% BOD Removal	%	--	23	40-70[2]	24
	% Soluble BOD Removal	%	--	63	40-70[2]	69
Aeration Basins	Solids Retention Time (SRT)	days	--	2.0 [7]	Variable	2.5
	Hydraulic Detention Time (HRT)	hrs	--	4.3 [7]	Variable	Variable
	MLSS	mg/L	--	1002	2,000 - 4,000[2]	Depends on Peak Week Load, SVI, and Sec Sed Basin Capacity
	Sludge Volume Index (SVI)	mL/g	--			
	90 Percentile			177	150[3]	150
	Temperature	°C	--	19 - 27	Variable	20 - 27

Table 2 OWTP Process Performance and Criteria Summary
Public Works Integrated Master Plan
City of Oxnard

Process/Design Parameter	Design Parameter	Units	Original Design[1]	Historical Performance (2010 – 2013)	MOP-8[2] or Typical Values[3]	Recommended Criteria for Capacity Analysis
Secondary Sedimentation Tanks	Peak Solids Loading	lb/sf/day	--	28.7[8]	40 - 50[2]	28.7[9]
	Overflow Rate at ADWF	gpd/sf	600	341[10]	400 - 700[2]	Depends on SVI and MLSS concentration
	Overflow Rate at PWWF	gpd/sf	1,100	699[10]	1,000 - 1,600[3]	Depends on SVI and selected MLSS concentration
Chlorine Contact Basins	Detention Time:					
	ADWF	min	20	46	30 - 60[2]	30
	PWWF		--	23	15 - 30[2]	15
Dissolved Air Floatation Thickeners (DAFTs)	Solids Load (Peak 14-day Average)	lb/sf/hr	--	1.78[11]	0.4 - 1[2]	1.6
	Hydraulic Load (Peak 14-day Average)	gpm/sf	--	1.06[11]	0.5 - 2[2]	1.0
	TWAS Concentration	% TS	--	5.5	3.5 - 4[2]	--
Gravity Thickeners	Solids Load (Peak 14-day Average)	lb/sf/hr	1.0	1.5 [11]	1.2	1.2
	Hydraulic Load (Peak 14-day Average)	gpd/sf	700	842 [11]	700	700
	Percent Solids Capture	%	--	--	85 - 90	--
	Thickened Sludge Concentration	% TS	--	--	3.5 - 4.0	--

Table 2 OWTP Process Performance and Criteria Summary
Public Works Integrated Master Plan
City of Oxnard

Process/Design Parameter	Design Parameter	Units	Original Design[1]	Historical Performance (2010 – 2013)	MOP-8[2] or Typical Values[3]	Recommended Criteria for Capacity Analysis
Anaerobic Digesters	Volatile Solids Load at ADMML	lbs VS/ CF/ day	0.1	0.10 [12]	0.1 - 0.4[2]	0.15
	HRT	days	25	25.4[12]	10 - 20[2]	15
	VS Reduction	%	55	55	50 - 65%[2]	55
	Volatile Acids	mg/L	50 - 500	194	< 300	< 300
	Alkalinity	mg/L as $CaCO_3$	2,000 - 4,000	3,378	> 1,000	> 1,000
	Volatile Acids / Alkalinity	--	0.03 - 0.13	0.06	< 0.10	< 0.10
	pH	-	6.8 - 7.4	--	6.8 - 7.4	6.8 - 7.4
Belt Filter Press	Solids Feed Rate per unit	lb/hr	820	984[13]	700 - 900	820
	Dewatered Sludge % Solids	%	18 - 22	19.6	15 - 25	20

Notes:
(1) From OWTP O&M Manuals (Brown and Caldwell, 1980) (Camp Dresser McKee Inc., 1991).
(2) (WEF/ASCE, 2010).
(3) Typical values based on Carollo experience.
(4) (Metcalf and Eddy, 2014).
(5) Calculated assuming 3 of 4 in service.
(6) Based on 1.73 lb BOD_5/d/sf media. 604 kcf of media at 27 sf/cf results in max BOD5 load of 28,213 lb/d.
(7) Based on 1 of 2 in service.
(8) Peak flow rate of 74.5 mgd, RAS flow rate of 29.0 mgd, all secondary clarifiers in service, and an SVI of 150 mL/g.
(9) Given the shallow surface water depth of the OWTP primary clarifiers, a higher solids loading rate is not recommended.
(10) Assume all in service.
(11) Based on 1 of 2 in service.
(12) Digester 1 and 3 in service only.
(13) Based on all four in service for 16 hours per day.

In general, the unit processes at the OWTP have been operating at loading rates that are well within their original design values or typical operating ranges. In addition, performance has been adequate and some of the unit processes are not even operating with all units in service, which means there is capacity for additional flow or load. The following sections review key findings for each unit process.

2.2.1 Aerated Grit Chambers

Key design parameters for grit removal include surface overflow rate and hydraulic detention time. During both dry and wet weather periods, the grit chambers are typically operated well within their design capacity with both units in service. During the review period, the average overflow rate at peak wet weather flow was around 23,000 gallons per day per square foot (gpd/sf) and the average detention time was 5.1 minutes. Given that the grit chambers have been performing satisfactorily, it is recommended the original design criteria be used for the capacity analysis.

2.2.2 Primary Clarifiers

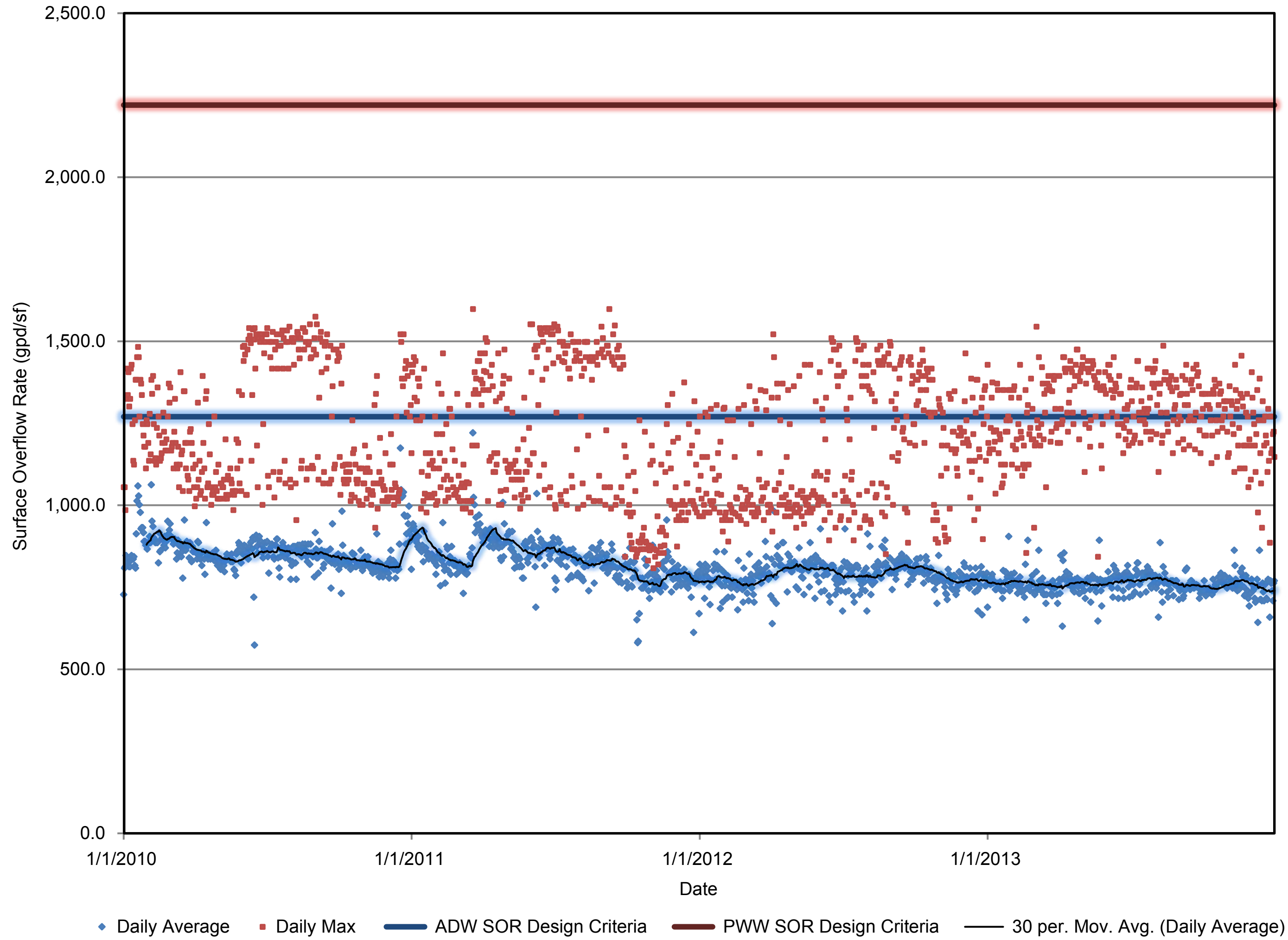
Surface overflow rate is the key parameter used to design primary clarifiers. Over the review period, the primary clarifiers were generally operated below the original design overflow rate and within the typical range for primary clarifiers. Figure 3 presents the daily and 30-day average overflow rates for the review period and shows that the design wet weather overflow rate and the design average dry weather (ADW) overflow rate was never exceeded during the review period.

During the review period, the plant operated with only three of the four primary clarifiers in service. Even with only three of four in service, the primary clarifiers have performed well within the range for typical primary clarifiers. Their performance with respect to BOD and TSS removal has been quite good, with an average BOD removal of 46 percent and TSS removal of 70 percent. Both of these removal rates are better than design. The likely reason for the better performance is that the facility operates with chemical addition to enhance performance. The recommended criteria for capacity analysis are shown in Table 2.

2.2.3 Biotowers

Key parameters used to design biotowers include hydraulic load rate and BOD_5 load rate. Over the review period, the volumetric BOD_5 load to the biotowers has been well below typical biotower design criteria, but slightly higher than the original design criteria.

The biotowers are designed to reduce the organic load to the downstream secondary system. Over the review period, the biotowers achieved approximately 23 percent BOD_5 removal and 63 percent soluble BOD removal. Over this period, the maximum month BOD_5 load to the biotowers was 55 lbs BOD_5/ 1000 CF of media/ day. The BOD_5 removal rate is quite low especially given the relatively low loading rate. It is likely that a portion of the flow



PRIMARY CLARIFIER OVERFLOW RATE

FIGURE 3

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is short-circuiting the biotowers by flowing down the central column, and thus is short-circuiting treatment.

2.2.4 Activated Sludge Tanks

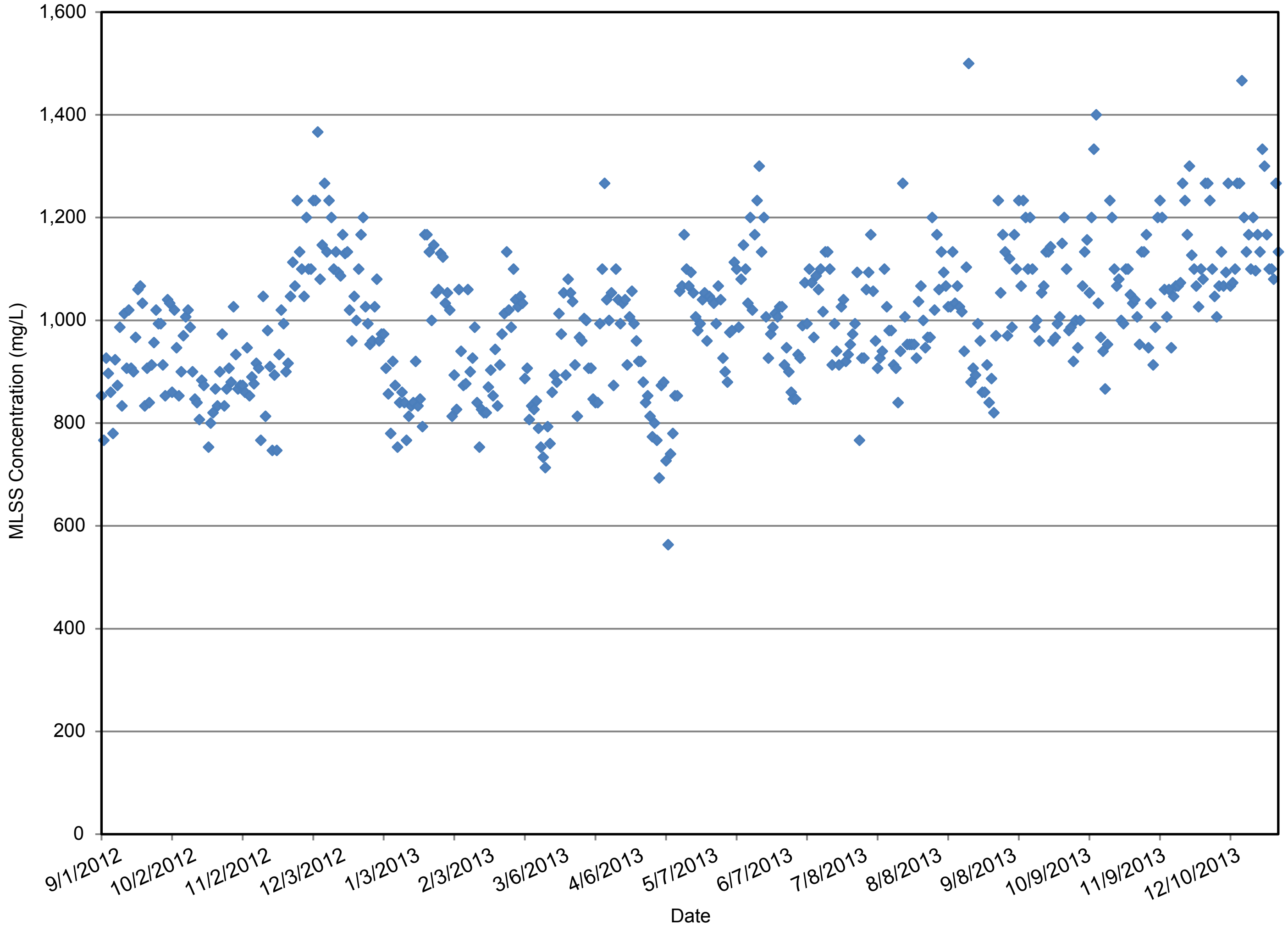
The aeration tanks can be configured as 6 parallel basins or as 2 three-pass basins with a serpentine flow pattern. During the period of operations and performance data reviewed, a single three-pass basin was used.

The aeration basins remove BOD_5 by converting soluble organics into settleable biomass (floc). The aeration basins were designed for BOD_5 removal only. Because the current NPDES permit does not have effluent ammonia requirements, they have never been operated to fully oxidize ammonia (nitrify). The key parameters used in the design and operation of an activated sludge process include: Mixed Liquor Suspended Solids (MLSS) concentration, Solids Retention Time (SRT), and Sludge Volume Index (SVI).

Figure 4 shows that the aeration basins have typically been operated at an MLSS concentration of around 1,000 milligrams per liter (mg/L), which is lower than typical design values. The MLSS concentration is important as it directly affects the mass of solids in the aeration tanks, which affects the operating SRT and treatment capacity. The MLSS concentration calculated in assessing capacity will depend on the peak flow through the activated sludge process. Peak flow to the activated sludge process is critical because it is desirable to use the maximum MLSS concentration that does not cause failure of the downstream secondary clarifiers from solids overload during peak flows. Based on historic operation, a MLSS concentration of 1,530 mg/L at ADMM was used for assessing activated sludge system capacity.

The SRT is one of the most important operating parameters for an activated sludge system and is defined as the total mass of solids in the aeration tanks divided by the total mass of the solids leaving the system in the Waste Activated Sludge (WAS) and secondary effluent. The SRT needed to achieve good performance depends on the treatment objectives (e.g., BOD_5 removal only, nitrification, denitrification, biological phosphorus removal) and the wastewater temperature. Because there are currently no controlling effluent ammonia limits, the treatment objective of the aeration basins is for BOD_5 removal only. Figure 5 shows the SRT over the study period. As shown in the graph, the SRT has stayed relatively constant at 2 days. An SRT of 2.5 days at ADMM will be used for assessing aeration basin capacity.

In addition to removing BOD_5 and other desired constituents, the aeration basin should generate well-settling sludge, which is measured by the SVI. The SVI represents the volume the solids in a mixed liquor sample with a given concentration will compress to after 30 minutes. In general, the lower the SVI, the faster the solids settle.



MIXED LIQUOR SUSPENDED SOLIDS CONCENTRATION

FIGURE 4

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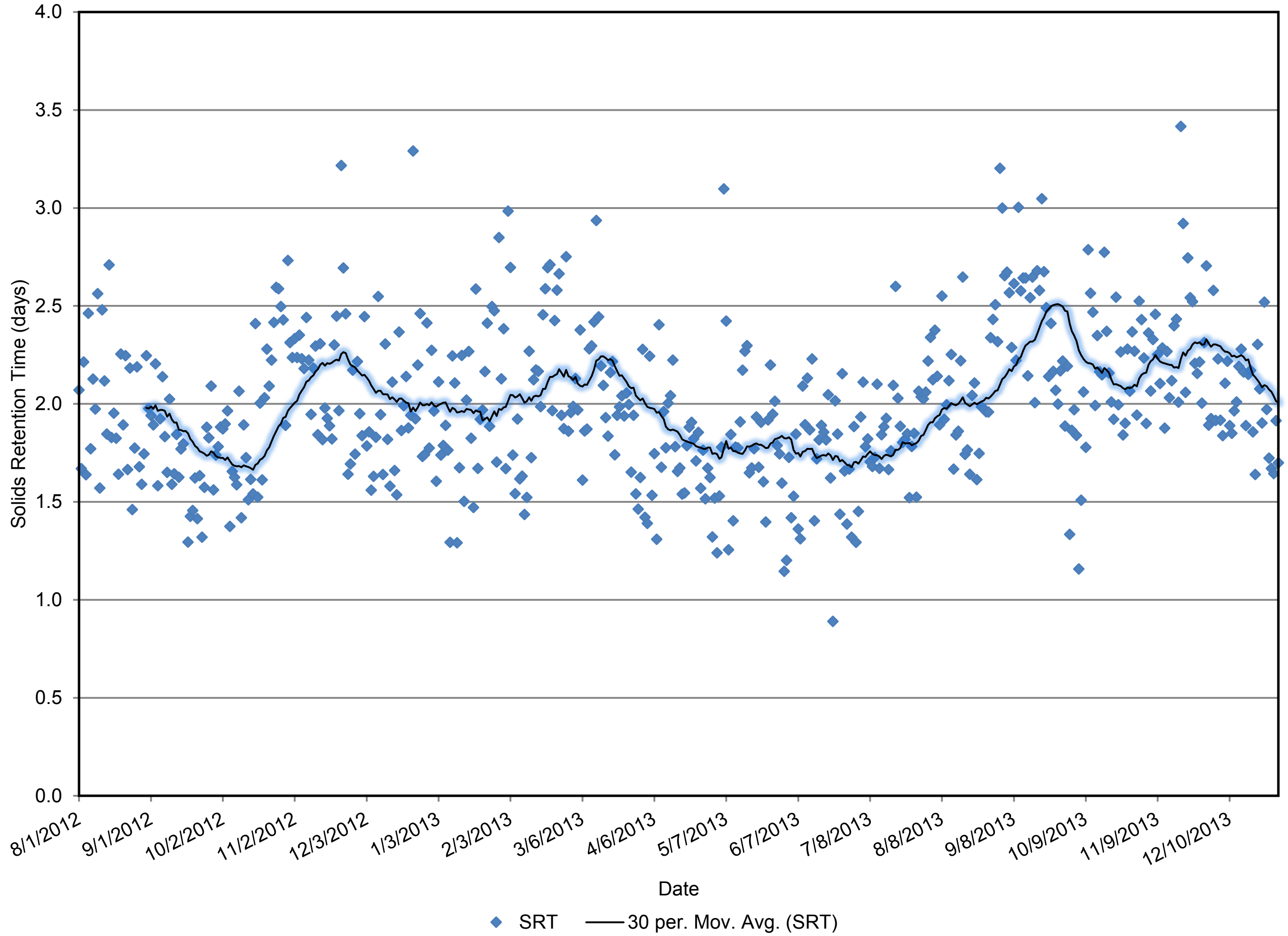

SOLIDS RETENTION TIME

FIGURE 5

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ox0715f28-9587(PM3-4 FIG5).ai

The SVI is important as it directly affects the capacity of the downstream clarifiers and overall secondary process. Figure 6 shows how the SVI has varied historically. Over the past four years, the 90^{th} percentile SVI value was about 177 mL/g. The 90^{th} percentile SVI for a typical, properly functioning activated sludge process is generally closer to 150 mL/g. A SVI less than 150 mL/g represents a well-settling sludge and an SVI greater than 150 represents a poor-settling sludge. Since the observed 90th percentile SVI is higher than design, the City should continue to monitor this and consider modifications to improve settleability, such as a biological selector, if this becomes an issue in the future. Additionally, the City should have an alternate means of improving settleability, such as polymer addition or RAS chlorination, in the event that a peak flow event occurs during the approximately 30 days per year that the SVI is greater than 150 mL/g.

For planning purposes, a 90^{th} percentile SVI of 150 mL/g was used for assessing the PWWF capacity.

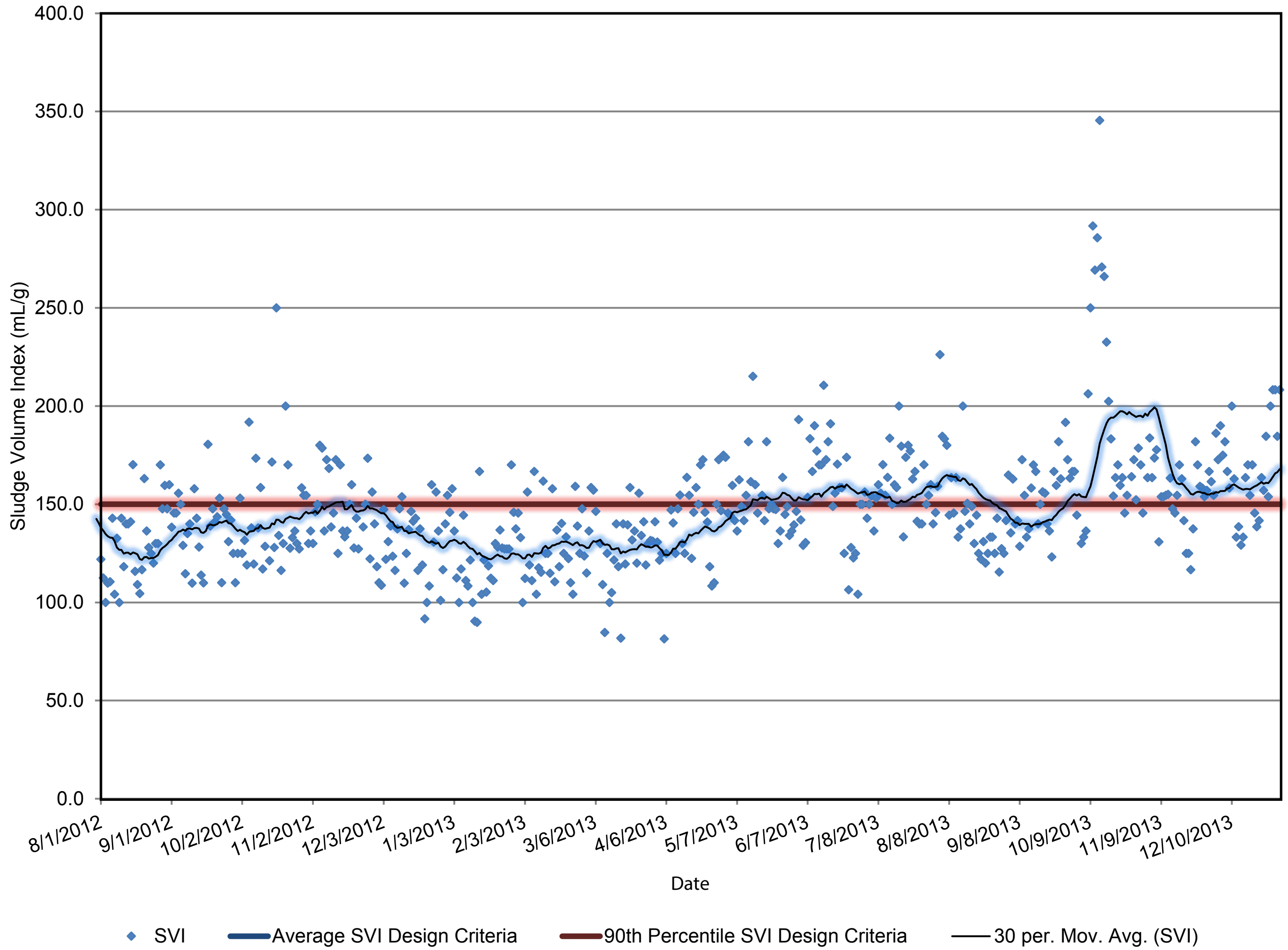
2.2.5 Secondary Sedimentation Tanks

The OWTP has 18 rectangular secondary sedimentation tanks (SSTs), each with a surface water depth of 9.9 feet. Typically, 12 of 18 are in service.

The secondary sedimentation basins separate the settleable biomass and floc (activated sludge) generated in the aeration basins from the effluent. In general, the sedimentation basins have performed well given the OWTP met the BOD_5 and TSS effluent requirements during the entire review period. Figure 7 shows the secondary sedimentation basin overflow rate over the review period. The figure shows that the sedimentation basins were generally operated at well below their design overflow rates, with all units in service. As part of the capacity assessment, a process model was developed to identify the maximum capacity for the sedimentation basins. The 90^{th} percentile SVI of 150 mL/g was used to assess the capacity of the secondary sedimentation basins for a range of MLSS concentrations. As discussed in further detail in the capacity assessment, modeling results indicate that the sedimentation basins can operate at a surface overflow rate of 1,200 gallons per day per square foot (gpd/sf) during the projected 2040 peak flow of 50.5 mgd.

2.2.6 Chlorine Contact Tanks

The OWTP has two 3-pass chlorine contact tanks. In 2013, the 30-day geometric mean total coliform in OWTP effluent was around 80,800 MPN/L. While this is quite high, given their allowable dilution of 98:1, the OWTP was able to meet the recommended Ocean Plan receiving water total coliform limit of 1,000 MPN/L.



SLUDGE VOLUME INDEX

FIGURE 6

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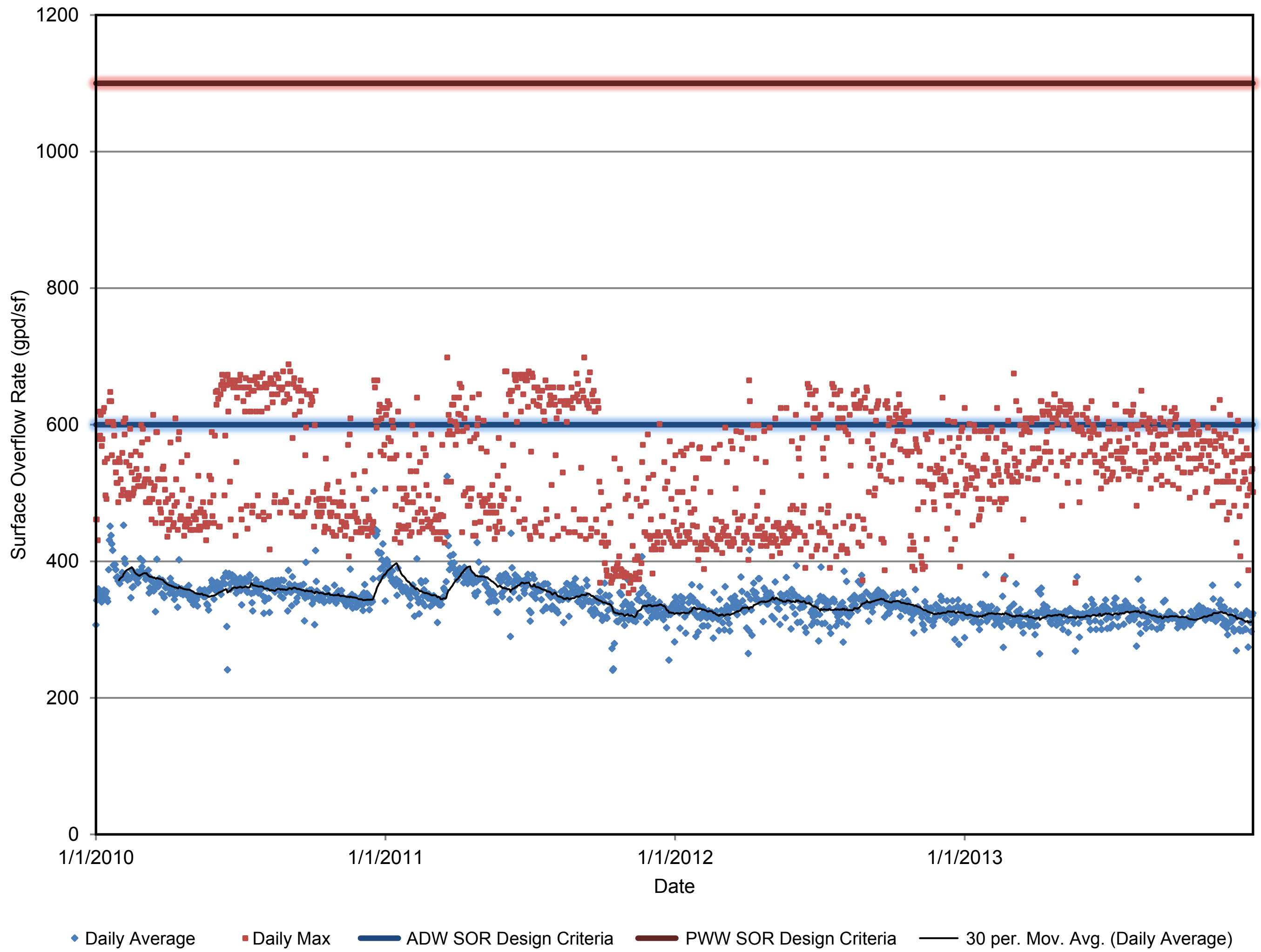

SECONDARY CLARIFIER OVERFLOW RATE

FIGURE 7

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ox0715f30-9587(PM3-4 FIG7).ai

Key parameters used to design and operate chlorine disinfection processes include chlorine dose and contact time. Over the review period, the contact time was about 46 minutes and 23 minutes at average dry weather flow (ADWF) and peak wet weather flow (PWWF), respectively. The contact time at ADWF was well above the original design criteria of 20 minutes. In addition, chlorine contact basins are routinely operated at 15 to 30 minute contact times during peak flows. Given this, it is recommended that a revised contact time of 30 minutes be used to assess the ADWF capacity of the disinfection process and a revised contact time of 15 minutes be used to assess the PWWF capacity.

2.2.7 Gravity Thickeners

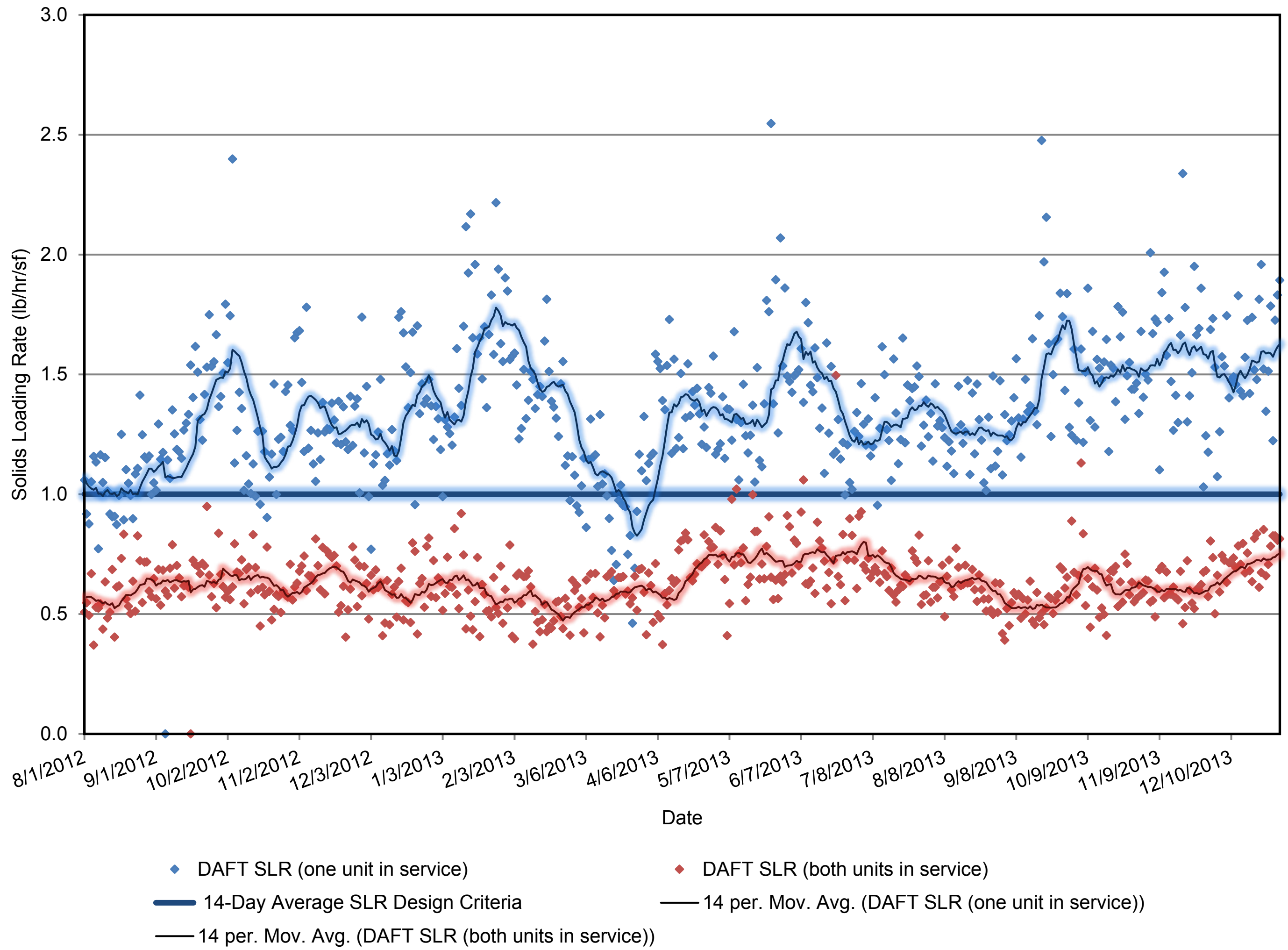
Historically, the gravity thickeners thicken primary sludge from the primary clarifiers before the primary sludge is mixed with thickened waste activated sludge (TWAS) and sent to the digesters. Key parameters used to design and operate the gravity thickeners include solids loading and hydraulic loading. During the review period, the gravity thickeners have been over-loaded both on a hydraulic and solids basis when one unit is out of service. The 14-day average solids loading to the gravity thickeners was 1.5 pounds per hour per square foot (lb/sf/hr) and the 14-day average hydraulic loading was 842 gallons per day per square foot (gpd/sf). Both of these loading rates assume one gravity thickener is out of service. A solids loading rate of 1.2 lb/sf/hr and a hydraulic loading rate of 700 gpd/sf are recommended for the capacity analysis.

2.2.8 DAFTs

Solids loading rate is the primary parameter used for DAFT design and operation. Figure 8 shows the DAFT solids loading rates based on operating one and two DAFTs for 24 hours per day. As shown in the figure, when only one unit is in operation, the DAFT is overloaded. Hydraulic loading rate is often also considered. Figure 9 shows the DAFT hydraulic loading rate based on operating one and two DAFTs for 24 hours per day.

OWTP typically operates with only one DAFT in service. Under this operating condition, typical peak 14-day solids and hydraulic loading are 1.78 pounds per square foot per hour (lb/sf/hr) and 1.06 gallons per minute per square foot (gpm/sf), respectively. Under this operating condition, the DAFTs are overloaded. However, with both units in service the loading rates are within recommended values. Even with hydraulic and solids loading rates exceeding original design criteria, the DAF thickeners have performed well, achieving an average percent total solids (TS) concentration of 5.5 percent.

While typical design criteria for peak 14-day solids and hydraulic loading is 1.0 lb/sf/hr and 1.0 gpm/sf respectively, based on successful operating experience, a solids load criterion of 1.6 lb/sf/hr and a hydraulic load rate criterion of 1.0 gpm/sf will be used for peak 14-day to conduct the capacity assessment. This peak 14-day solids loading rate corresponds to 40 pounds per day per square foot (ppd/sf).



DAFT SOLIDS LOADING RATE

FIGURE 8

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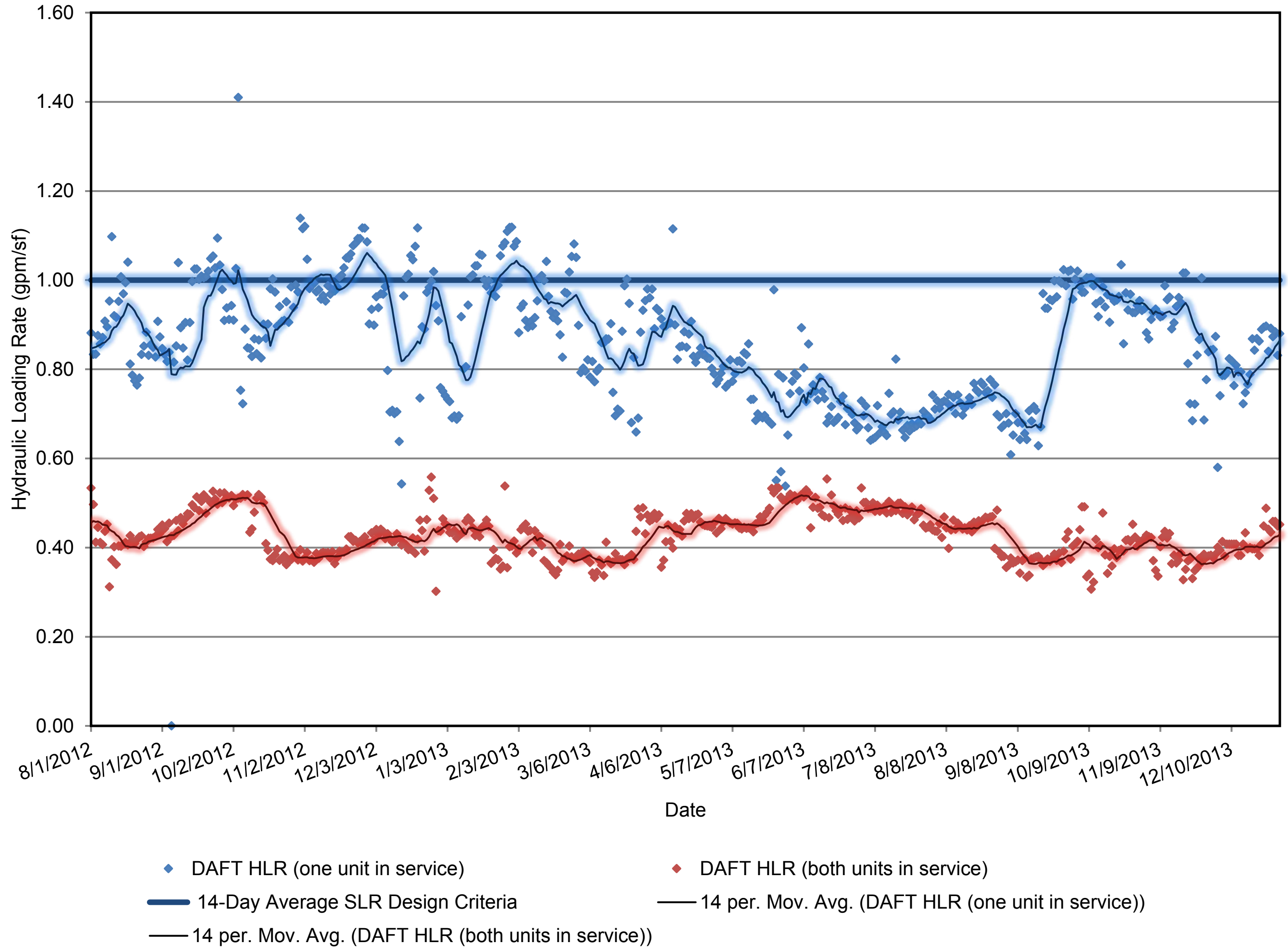

DAFT HYDRAULIC LOADING RATE

FIGURE 9

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2.2.9 Digesters

The anaerobic digesters have performed adequately with both Digesters 1 and 3 in service, achieving an average volatile solids reduction (VSR) of 55 percent, which is equal to the original design VSR.

Volatile solids loading rate (VSLR) and the hydraulic residence time (HRT) are key parameters used for digester design and operation. The VSLR has been right around the original design criteria, which is on the low end of typical design values. In addition, as shown in Figure 10 the average HRT has almost always been higher than the original design criteria. It is recommended that a minimum HRT of 15 days and a maximum VSLR of 0.15 lb/cf/d be used to conduct the capacity assessment.

While the digester performance has been adequate with both Digesters 1 and 3 in service, neither Digester 1 nor Digester 3 can be taken offline for cleaning without putting Digester 2 back in service. Currently, Digester 2 is not operational due to the condition of its roof.

2.2.10 Dewatering

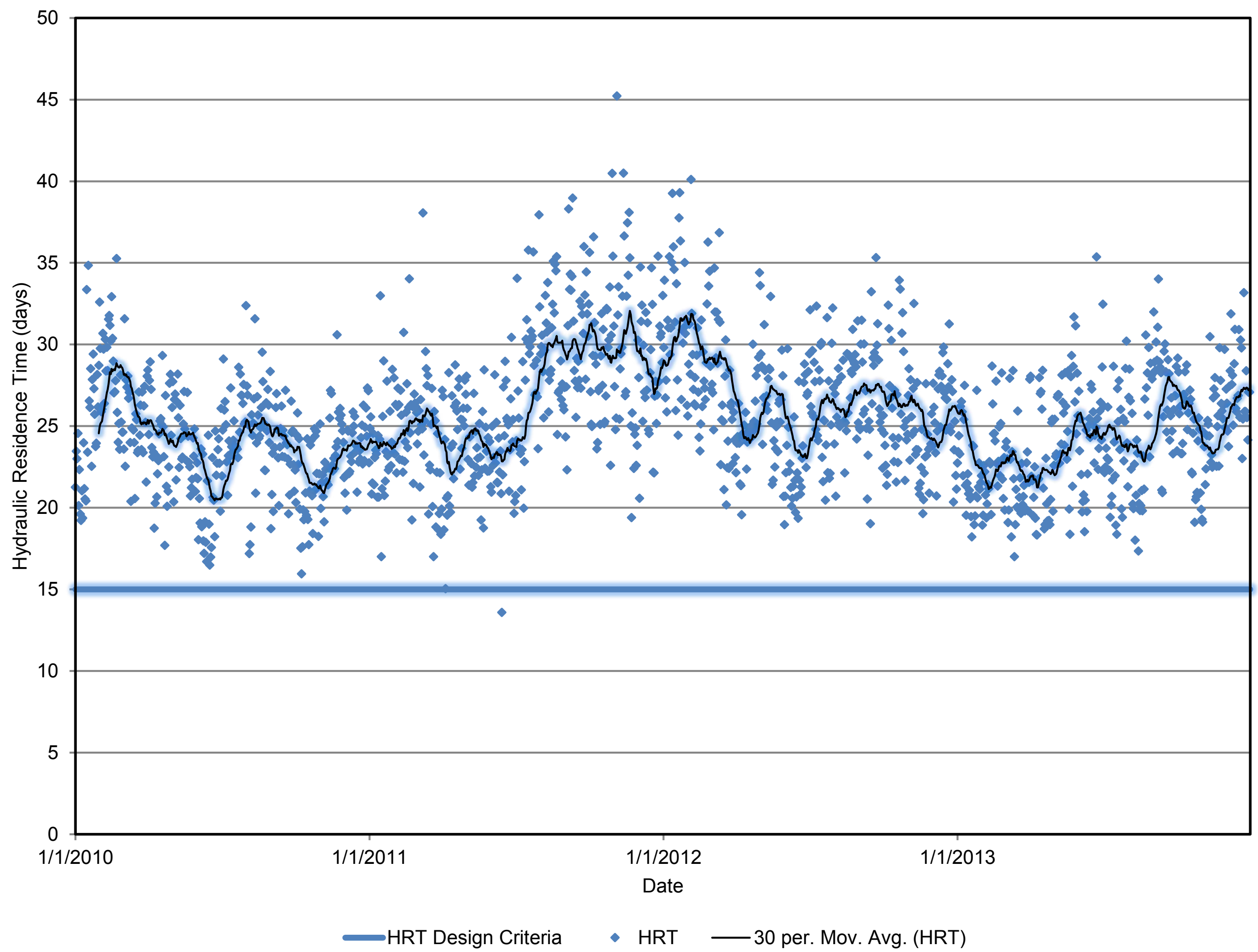
Typically, all four BFP units are in operation for 16 hours each day, Monday through Saturday. On Sunday, typically only two BFP units are in operation for 16 hours. The average dried sludge percent solids are 19.6, which is within the original design value range. However, the historical solids feed rate, assuming all four units are in service for 16 hours each day, is higher than the original design criteria, indicating that the BFPs are likely overloaded. The original design solids loading rate of 820 pounds per hour (pph) was used for the capacity analysis.

3.0 CAPACITY ANALYSIS

This section summarizes the results of the capacity analysis. Process capacities were estimated for each unit process and are dependent on a range of parameters, including: flow, influent wastewater characteristics, treatment objectives, process configurations and limitations, and desired redundancy. Capacities were estimated for each of these processes based on the recommended criteria in Table 2.

3.1 Peak Hour Wet Weather Flow Capacity

The Peak Hour Wet Weather Flow (PHWWF) capacity was estimated for facilities where sizing is established by the peak flow. These facilities include the headworks, influent pumping, primary clarifiers, biotowers, and interstage pumping. Peak capacities for process units are based on all units being in service, while pumping capacities are based on the large unit being out of service. Table 3 summarizes the PHWWF capacity for each of these processes. Figure 11 illustrates this same information.



DIGESTER HYDRAULIC RESIDENCE TIME ASSUMING DIGESTER 2 IS OUT OF SERVICE

FIGURE 10

CITY OF OXNARD

PM NO. 3.4 – TREATMENT PLANT PERFORMANCE AND CAPACITY

PUBLIC WORKS INTEGRATED MASTER PLAN

ox0715f33-9587(PM3-4 FIG10).ai

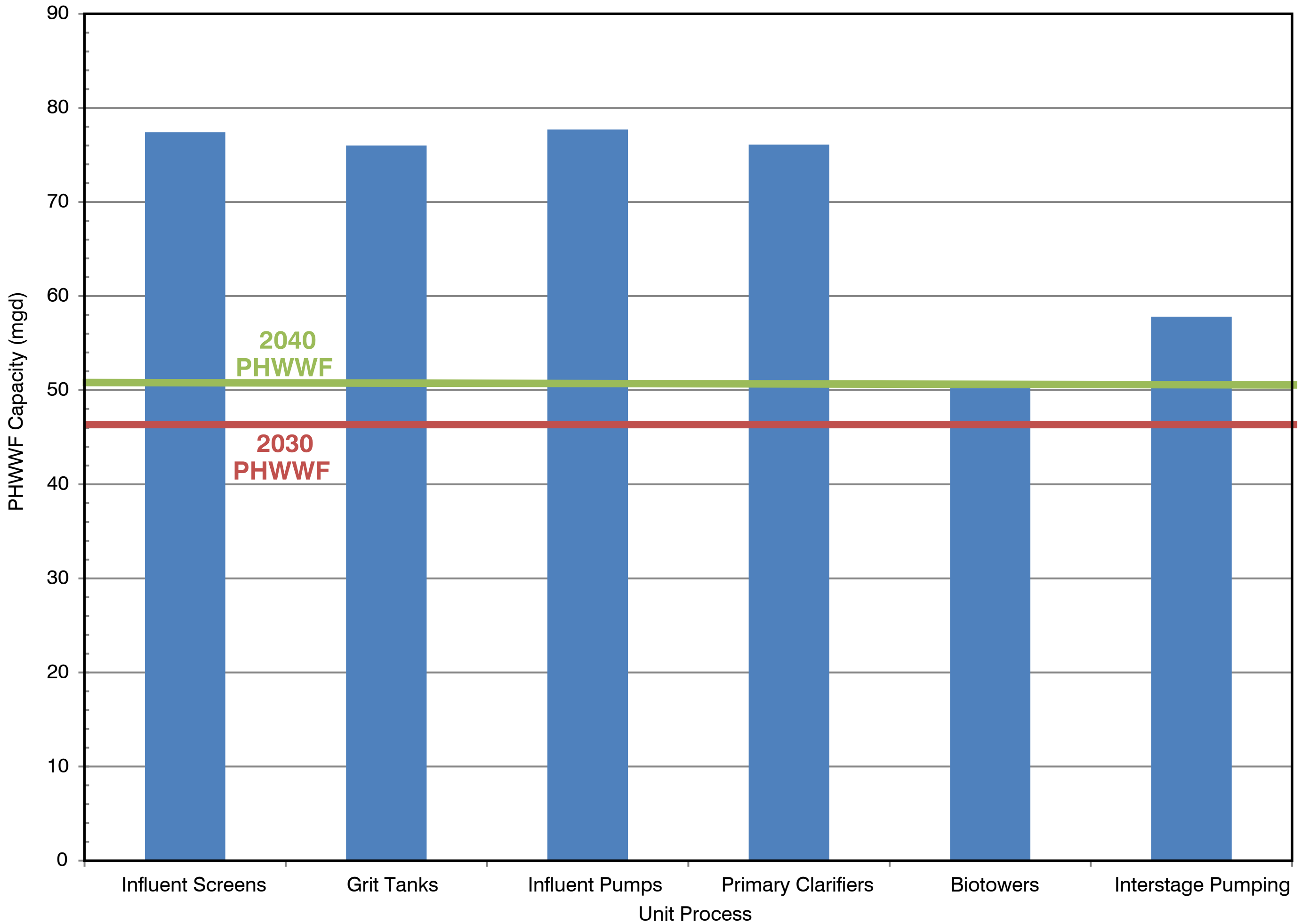
Table 3 Peak Hour Wet Weather Flow Capacity Public Works Integrated Master Plan City of Oxnard	
Process	**PHWWF Capacity (mgd)**
Influent Screens	77.4(1)
Grit Tanks	76(2)
Influent Pumps	77.7(3)
Primary Clarifiers	76.1(4)
Biotowers	50.2(5)
Interstage Pumping	57.8(6)

Notes:
(1) Based on 2 of 4 automatic screens in service or 1 of 2 manual bar screens in service.
(2) Based on both units in service and a peak overflow rate of 42,315 gpd/sf, as originally designed.
(3) Based on 3 of 6 pumps being out of service, as originally designed.
(4) Assumes all 4 units are in service and the peak overflow rate is 2,200 gpd/sf, as originally designed.
(5) Based on both units in service and a peak overflow rate of 1.5 gpm/sf, as originally designed.
(6) Assumes 2 of 3 units are in service.

3.2 Wet Weather Flow Equalization Capacity

Design influent flow hydrographs were developed for the current 10-year and future 10-year design storms to determine if the existing headworks and equalization facilities have sufficient capacity to accommodate wet weather flows. The hydrographs, which are shown in Figure 12, were developed as part of PM 3.3 - *Wastewater System - Infrastructure Modeling and Alternatives*. The 10-year design storm was selected to be consistent with the collection system analysis and because it is believed to be a sufficiently conservative basis for evaluating the OWTP headworks and equalization (EQ) basin capacity. The rated maximum capacity of the OWTP outfall is 50 mgd, so flow equalization is necessary when the plant flow rate exceeds this value.

The hydrographs summarize the peak wet weather flow expected at the OWTP for each hour of each design storm. The current 10-year design storm hydrograph approximates expected OWTP influent flows given current collection system flows. The design storm hydrographs approximate what OWTP influent flows are expected to be when flows increase in the future. The peak flow of the current 10-year storm is about 38.5 mgd and occurs around the 13th hour of the storm; and the peak flow of the future 10-year storm is about 49.6 mgd and also occurs around the 13th hour of the storm.



OWTP PEAK HOUR WET WEATHER FLOW CAPACITY BAR GRAPH

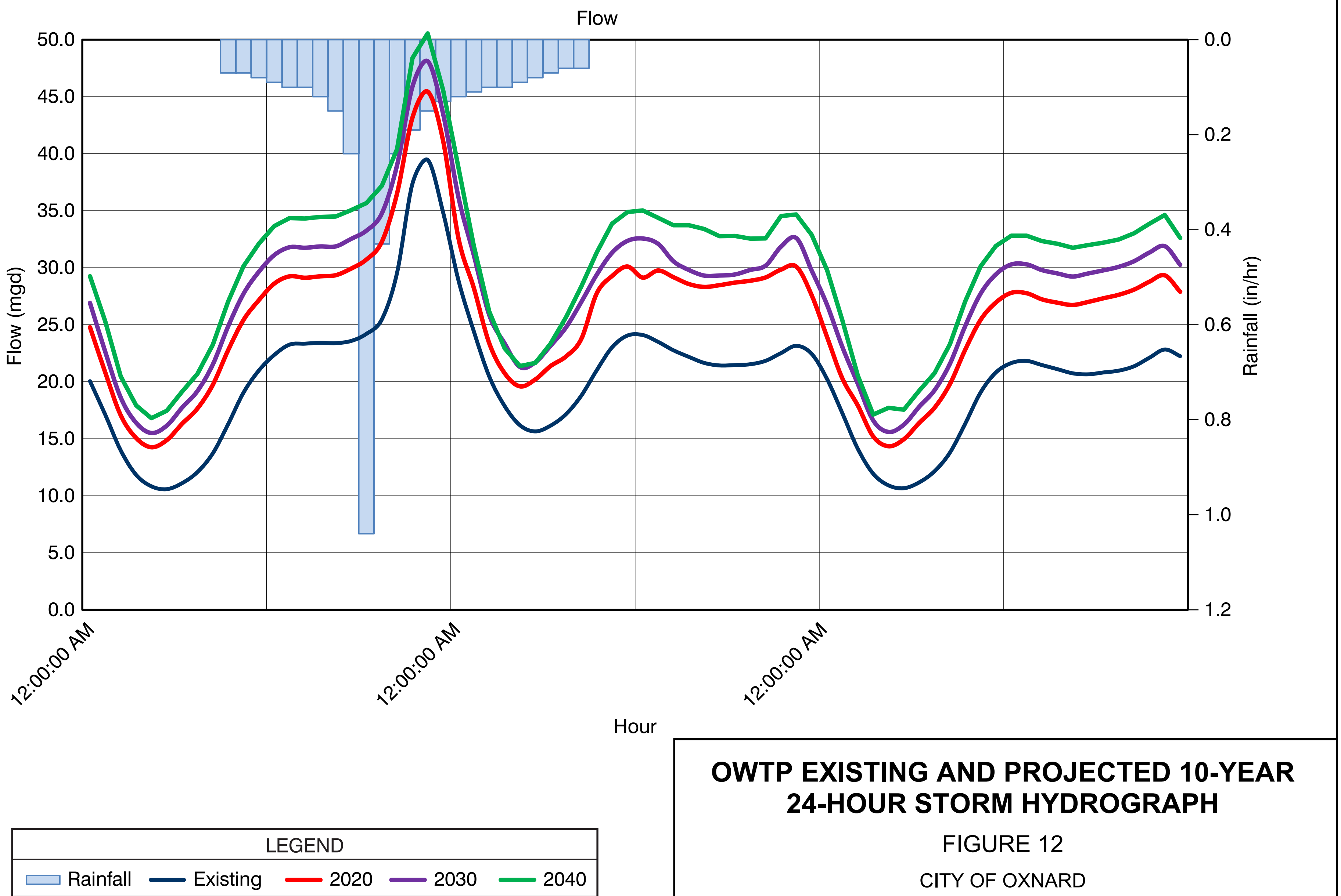
FIGURE 11

CITY OF OXNARD

PM NO. 3.4 – TREATMENT PLANT PERFORMANCE AND CAPACITY

PUBLIC WORKS INTEGRATED MASTER PLAN

ox0715f34-9587(PM3-4 FIG11).ai



OWTP EXISTING AND PROJECTED 10-YEAR 24-HOUR STORM HYDROGRAPH

FIGURE 12

CITY OF OXNARD

PM NO. 3.4 – TREATMENT PLANT PERFORMANCE AND CAPACITY

PUBLIC WORKS INTEGRATED MASTER PLAN

ox1115f3-9587(PM3-4FIG12).ai

In comparing the hydrographs to the capacity of the existing headworks and equalization facilities, it was determined the OWTP has sufficient capacity to accommodate peak wet weather flows over the planning horizon. As shown in Figure 11, the capacity of the headworks facilities are greater than the peak wet weather flows expected at the OWTP during the design storm. Figure 13 illustrates the required EQ basin volume needed for the design storm as a function of flow rate being treated at the OWTP. At the permitted capacity of 31.7 mgd, approximately 4.95 million gallons of storage is needed in 2040, which is just under the available storage capacity. Historically, the EQ basins have never been filled to capacity. While in 2040, EQ basin capacity will be nearing its limit, determining if additional capacity is needed will depend on how the EQ basins are operated. Both the Advanced Water Purification Facility (AWPF) and outfall needs should be considered to see if there is additional EQ basin capacity needed.

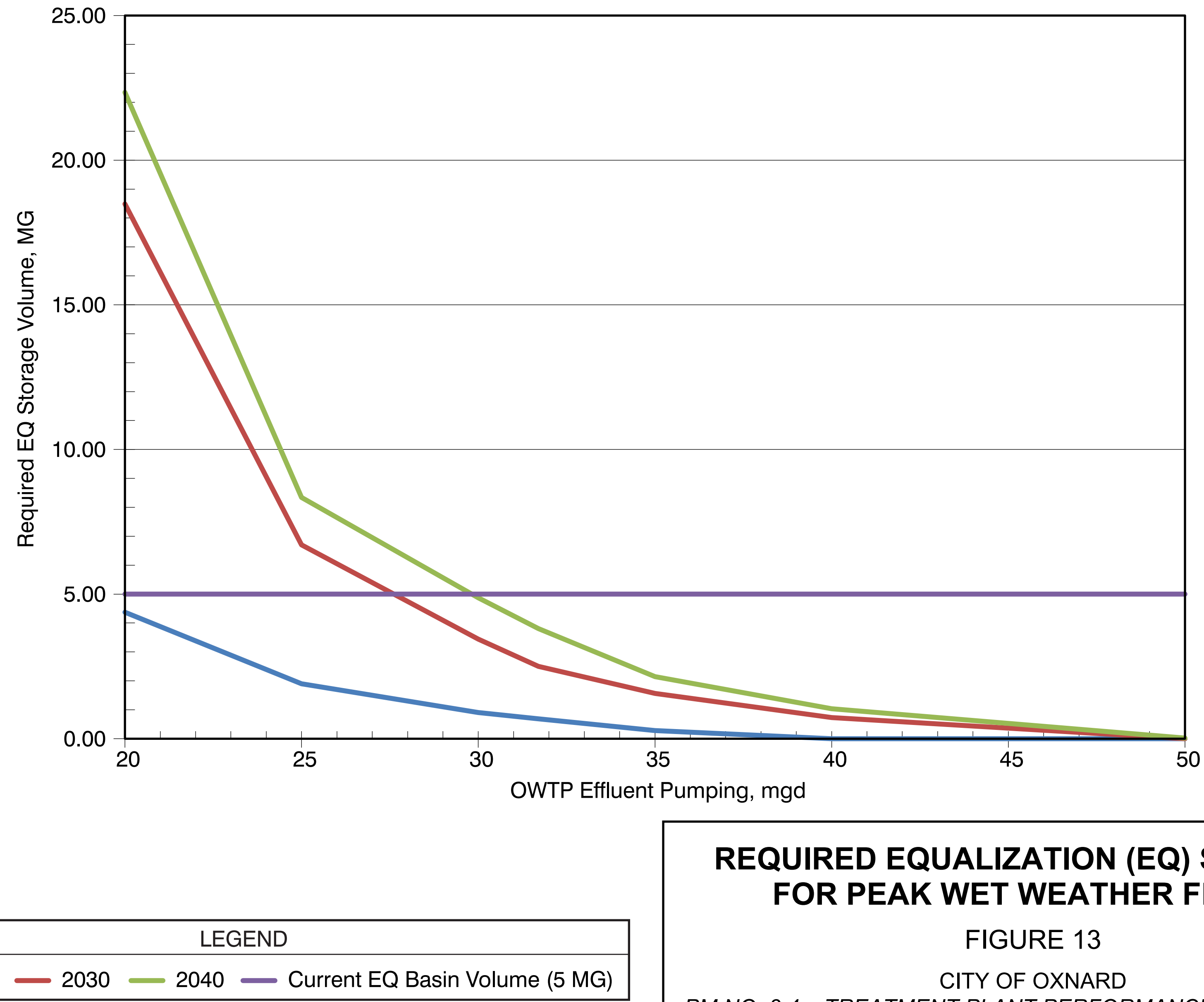
3.3 ADWF Capacity

The ADWF capacity was estimated for facilities where sizing is established by average flows, or influent BOD and TSS loading to the plant. These facilities include the primary clarifiers, aeration basins, secondary clarifiers, gravity thickeners, DAF thickeners, anaerobic digesters, and dewatering. To determine the capacity for these facilities, a plant process model was developed and calibrated to historical operating data from 2013. This process model was used to simulate maximum month, peak 14-day, and peak day conditions for the plant. Each unit process was evaluated using one of these flow conditions. Using the process model to simulate the flow condition of interest for each unit process, the influent flow was increased until the operating limits (as established in Table 2) were exceeded for each particular unit. This influent flow was taken as the capacity limit for that particular unit. The capacity limit was converted to an equivalent ADWF based on the historical peaking factors observed (see flow and load analysis). Table 4 summarizes the capacity for each process. Figure 14 shows the ADWF capacities of each process. Appendix A includes a summary of the model outputs and operational data for the calibration period.

3.3.1 Liquid Treatment Process Capacity

As shown in Table 4, all of the liquid treatment processes have sufficient capacity for projected flows through 2040. The limiting liquid treatment process is the secondary capacity.

The average dry weather capacity rating of the aeration basins is dependent on their ability to remove organic material at the anticipated peak flow and load conditions associated with a given ADW flow rate. The aeration basin performance is dependent on several factors, including but not limited to treatment goals, solids retention time (SRT), MLSS concentration, influent alkalinity, and temperature. To determine the ADWF capacity of the aeration basins, dynamic and steady state process models were used to simulate process



REQUIRED EQUALIZATION (EQ) STORAGE FOR PEAK WET WEATHER FLOWS

FIGURE 13

CITY OF OXNARD

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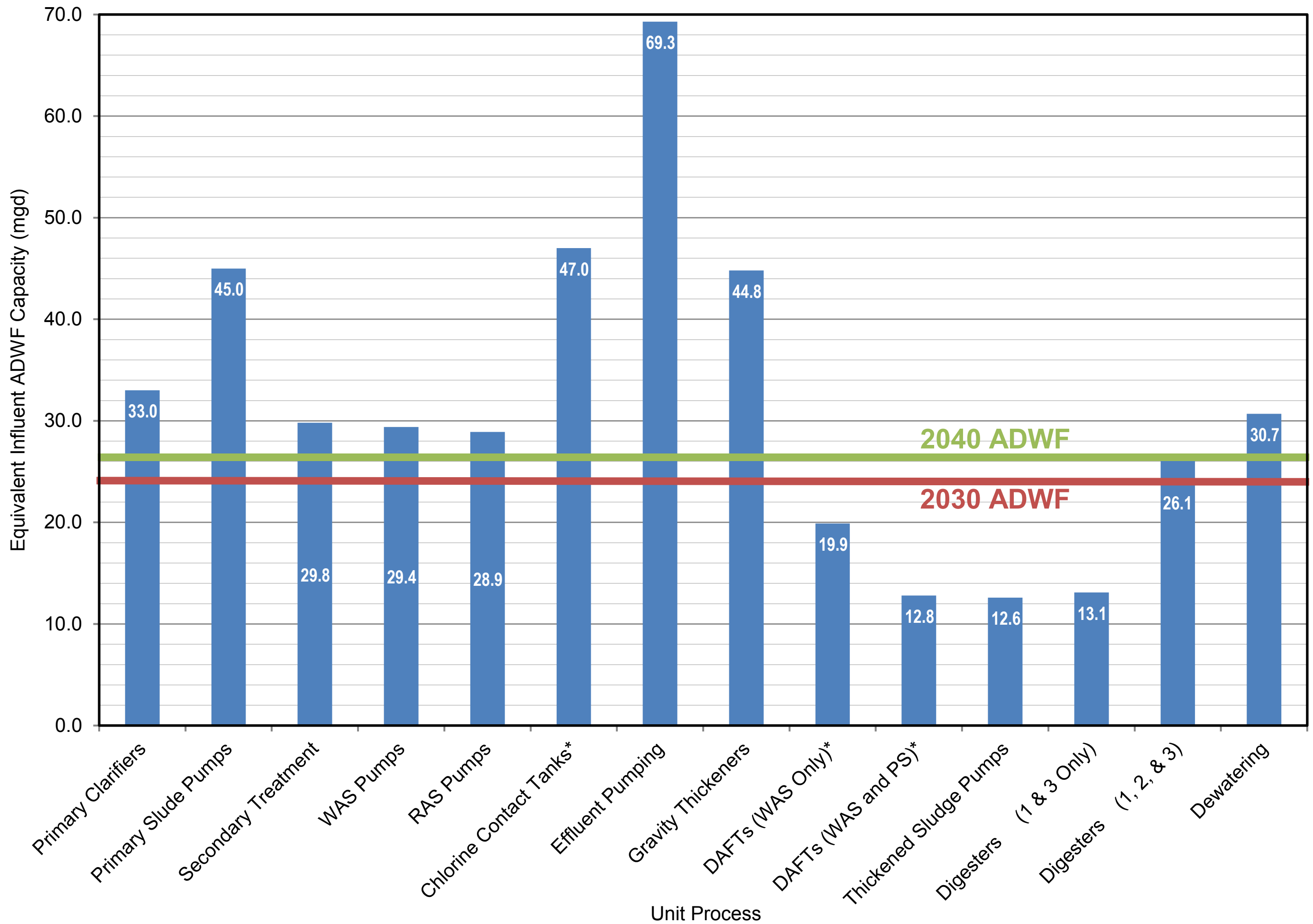
PUBLIC WORKS INTEGRATED MASTER PLAN



* *All unit processes assume the largest unit is out of service except for those starred.*

OWTP AVERAGE DRY WEATHER FLOW CAPACITY BAR GRAPH

FIGURE 14

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Table 4 ADWF Capacity
Public Works Integrated Master Plan
City of Oxnard

Process	Averaging Period	Design Criteria	Equivalent Influent ADWF Capacity (mgd)(1)
Primary Clarifiers	Average Annual	1270 gpd/sf	**33.0(2)**
	Peak Day	2200 gpd/sf	56.4(3)
Primary Sludge Pumps	Average Annual	2 mgd	45.5(2)
	Peak Day	3 mgd	**45.0(3)**
Secondary Treatment	Average Annual	--(4)	--
	Maximum Month	--(4)	**29.8**
WAS Pumps	Average Annual	1.4 mgd	**29.4(2)**
	Peak 14-day	2.1 mgd	44.1(3)
RAS Pumps	Average Annual	--(5)	**28.9(2)**
Chlorine Contact Tanks	Average Annual	20 min	47.6(3)
	Peak Day	15 min	**47.0(3)**
Effluent Pumping	Average Annual	69.2 mgd	**69.3(2)**
	Peak Day	94.2 mgd	69.9(3)
Gravity Thickeners	Average Annual	29 ppd/sf	**44.8(2)**
	Peak 14-day	29 ppd/sf	59.7(3)
DAFTs - WAS Only	Average Annual	30 ppd/sf	21.7(3)
	Peak 14-day	40 ppd/sf	**19.9(3)**
DAFTs - WAS and Primary Sludge	Average Annual	60 ppd/sf	18.9(3)
	Peak 14-day	60 ppd/sf	**12.8(3)**
Thickened Sludge Pumps	Average Annual	0.1 mgd	**12.6(2)**
	Peak 14-day	0.2 mgd	17.0(3)
Digesters - Digester 1 and 3	Average Annual	15 days	15.0(2) (6)
		0.15 lb VSS/d/cuft	**13.1(2) (7)**
	Maximum Month	15 days	27.9(3)
		0.15 lb VSS/d/cuft	25.8(3)
Digesters - Digester 1, 2, & 3	Average Annual	15 days	30(2)
		0.15 lb VSS/d/cuft	**26.1(2)**
	Maximum Month	15 days	39.1(3)
		0.15 lb VSS/d/cuft	36.1(3)
Digested Sludge Pumps	Average Annual	0.7 mgd	**101(2)**
	Peak 14-day	1.1 mgd	103(3)
Dewatering	Average Annual	820 lb/hr	31.7(2) (8)
	Maximum Month	820 lb/hr	**30.7(3) (8)**

Notes:
(1) The limiting ADWF capacity is shown in bold and underlined.
(2) Assumes largest unit is out of service.
(3) Assumes all units are in service.
(4) Depends on SVI and selected MLSS concentration.
(5) RAS pumps' capacity is rated to handle average influent dry weather flow.
(6) If both Digesters 1 and 3 were in service the equivalent ADWF capacity would be 37.4 mgd.
(7) If both Digesters 1 and 3 were in service the equivalent ADWF capacity would be 25.8 mgd. This would then be the limiting capacity.
(8) Assumes continuous operation.

conditions at the facility's operating limits. Secondary treatment capacity was evaluated for two scenarios:

- BOD Removal Only. The City's existing NPDES permit is based on meeting a monthly limit of 30 mg/L for BOD and TSS. For this scenario, the recommended operating limit is a 2.5-day SRT and a 150 mL/g 90th percentile SVI under maximum month load conditions.

- Nitrification / Denitrification. While it is not anticipated that the City's existing NPDES permit will change in the near future, increased recycled water production by the AWPF will increase constituent concentrations, particularly ammonia, above those in the secondary effluent. A detailed discussion of these effects can be found in PM 4.3. One way potentially to address this concern is to nitrify and denitrify in the secondary treatment process. For this scenario, an operating SRT limit of 5 days and a 90th percentile SVI of 150 mL/g were used under maximum month load conditions. Recirculation within the aeration basins and the creation of an initial anoxic zone was modeled as part of this denitrification scenario.

While the existing secondary treatment process has sufficient treatment capacity to meet the City's NPDES BOD limits through the planning horizon, the secondary treatment process does not have sufficient capacity to nitrify and denitrify. Thus, it is recommended that the OWTP consider a secondary treatment capacity expansion or switch to an alternative process configuration, such as membrane bioreactors, in order to handle the higher MLSS concentrations associated with the higher SRT needed for nitrification/denitrification should this be necessary with the expansion of the AWPF.

3.3.2 Solids Handling Process Capacity

The simulated primary sludge, thickened primary sludge, WAS, TWAS, and digested sludge production were used to determine the capacity of the gravity thickeners, DAFTs, anaerobic digesters, and centrifuges from the rating criteria presented in Table 4. Based on the BioWin Model's projected sludge production through 2030, the DAFTs, thickened sludge pumps, digesters, and dewatering units need additional capacity.

While the influent solids load and organic load are expected to increase by around 30 percent, the modeled sludge production is expected to increase by more than 30 percent. This increase in sludge production is in part due to the removal of the biotowers and addition of an anaerobic selector in the ASTs. This change will increase the amount of WAS produced which will affect the capacity of the DAFTs, digesters, and dewatering equipment. An increase in modeled sludge production is also likely due to the efficiency chosen in the primaries. As a conservative approach, a BOD and TSS percent removal of 35 and 65, respectively, was used in the modeling effort. However, historically the OWTP has operated with a 46 percent BOD removal efficiency and a 70 percent TSS removal efficiency. This change in efficiency will also affect the amount of WAS produced downstream. Because of these anticipated changes to sludge production, additional DAFT units, digesters, and dewatering units are needed.

Two scenarios were considered for loading of the DAFTs. The first scenario assumed that primary sludge would be thickened separately in either the existing gravity thickeners or, if the primary clarifiers are rebuilt, in new primary clarifiers. Results of this capacity analysis can be found in Table 4 under ‘DAFTs – WAS Only’. The second scenario assumed that the DAFTs would be used to thicken both primary sludge and WAS. The results of this capacity analysis can also be found in Table 4 under ‘DAFTs – WAS and Primary Sludge’. Based on our process model, in both instances, the DAFTs need additional units. The associated thickened sludge pumps will also need to be upsized.

Two scenarios were also considered for the digesters. The first scenario is consistent with current operation, which assumes that Digester 2 is out of service. Under this configuration, neither Digester 3 nor Digester 1 can be taken offline for maintenance given current digester loading. The second scenario assumes that Digester 2 is repaired and put back online. Under this scenario, a digester can be taken offline during average annual flows and loadings for maintenance and repair through 2030. However, the three digesters will need additional capacity by 2040, given the projected changes to sludge production at the plant and projected flows and loads in this PWIMP.

Dewatering capacity was also considered as part of this capacity analysis. If continuous operation is assumed, then the dewatering units have sufficient capacity through 2040. However, additional capacity would allow the units to come offline at night and make operation logistically easier.

APPENDIX A – BIOWIN CALIBRATION REPORT

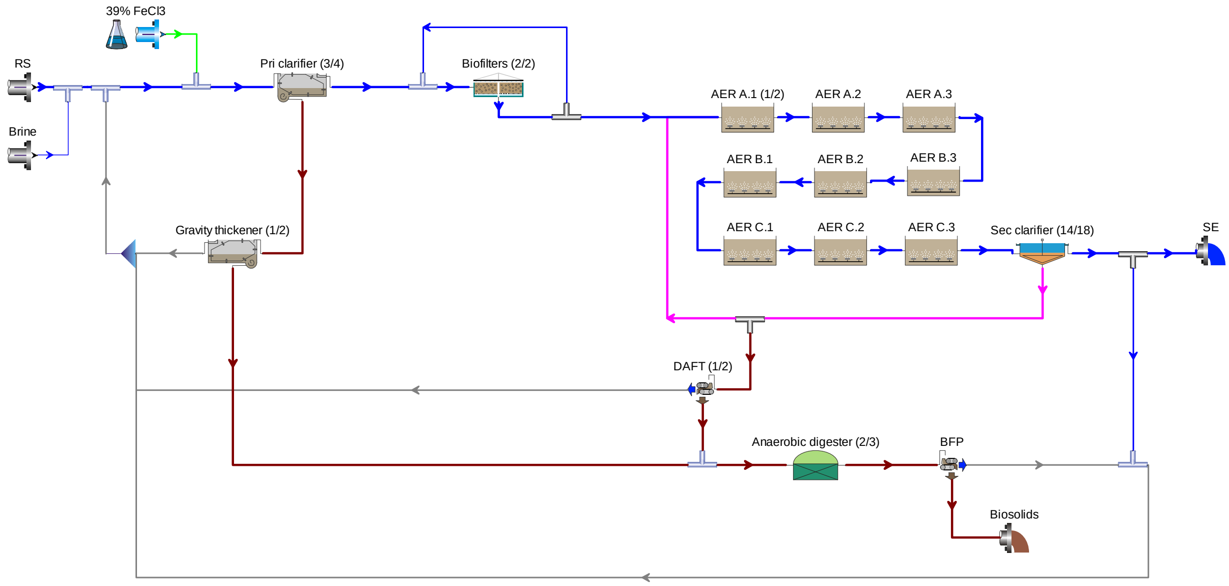
BioWin user and configuration data

Project details
Project name: Oxnard Master PlanProject ref.: 9587A.00
Plant name: Oxnard WWTPUser name: Ron Appleton

Created: 5/22/2014Saved: 5/29/2015

Steady state solution
SRT (total): 2.21112 days
Temperature: 26.0°C

Flowsheet



Configuration information for all Ideal primary settling tank units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]
Gravity thickener (1/2)	0.3272	2734.0000	16.000

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Gravity thickener (1/2)	Fraction	0.09

Element name	Percent removal	Blanket fraction

Gravity thickener (1/2)	95.00000	0.50000

Configuration information for all Anaerobic Digester units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]	Head space volume
Anaerobic digester (2/3)	3.9750	1.586E+4	33.500	1.0

Operating data Average (flow/time weighted as required)

Element name	Pressure [psi]	pH
Anaerobic digester (2/3)	14.9	7.0

Element name	Average Temperature
Anaerobic digester (2/3)	35.0

Configuration information for all Bioreactor units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]	# of diffusers
AER A.1 (1/2)	0.4960	3900.0000	17.000	2626
AER A.2	0.4960	3900.0000	17.000	2626
AER A.3	0.4960	3900.0000	17.000	2626
AER B.3	0.4960	3900.0000	17.000	2626
AER B.2	0.4960	3900.0000	17.000	2626
AER B.1	0.4960	3900.0000	17.000	2626
AER C.3	0.4960	3900.0000	17.000	2626
AER C.2	0.4960	3900.0000	17.000	2626
AER C.1	0.4960	3900.0000	17.000	2626

Operating data Average (flow/time weighted as required)

Element name	Average DO Setpoint [mg/L]
AER B.3	0.3
AER B.2	0.4
AER B.1	0.5
AER C.3	1.0
AER C.2	0.8
AER C.1	0.7

Element name	Average Air flow rate [ft3/min (20C, 1 atm)]
AER A.1 (1/2)	325.0
AER A.2	325.0
AER A.3	325.0

Aeration equipment parameters

Element name	k1 in C = k1(PC)^0.25 + k2	k2 in C = k1(PC)^0.25 + k2	Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)]	Area of one diffuser	% of tank area covered by diffusers [%]
AER A.1 (1/2)	2.5656	0.0432	0.8200	0.2673	18.0000
AER A.2	2.5656	0.0432	0.8200	0.2673	18.0000
AER A.3	2.5656	0.0432	0.8200	0.2673	18.0000
AER B.3	2.5656	0.0432	0.8200	0.2673	18.0000
AER B.2	2.5656	0.0432	0.8200	0.2673	18.0000
AER B.1	2.5656	0.0432	0.8200	0.2673	18.0000
AER C.3	2.5656	0.0432	0.8200	0.2673	18.0000
AER C.2	2.5656	0.0432	0.8200	0.2673	18.0000
AER C.1	2.5656	0.0432	0.8200	0.2673	18.0000

Configuration information for all Effluent units

Configuration information for all Ideal clarifier units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]
Sec clarifier (14/18)	3.3972	4.620E+4	9.830

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Sec clarifier (14/18)	Ratio	0.54

Element name	Average Temperature	Reactive	Percent removal	Blanket fraction
Sec clarifier (14/18)	Uses global setting	No	99.55000	0.05000

Configuration information for all COD Influent units

Operating data Average (flow/time weighted as required)

Element name	RS	Brine
Time	0	0
Flow	17.9998901044325	1.65
TCOD mgCOD/L	685.00000	0
TKN mgN/L	53.00000	0
TP mgP/L	10.00000	0
NO3-N mgN/L	0	0
pH	7.60000	7.30000
Alk mmol/L	6.00000	6.00000
ISSinf mgISS/L	45.00000	0
SCa mg/L	80.00000	80.00000
SMg mg/L	15.00000	15.00000
DO mg/L	0	0

Element name	RS	Brine
Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD]	0.1600	0.1600
Fac - Acetate [gCOD/g of readily biodegradable COD]	0.1500	0.1500

Fxsp - Non-colloidal slowly biodegradable	[gCOD/g of slowly degradable COD]	0.8500	0.7500
Fus - Unbiodegradable soluble	[gCOD/g of total COD]	0.0500	0.0500
Fup - Unbiodegradable particulate	[gCOD/g of total COD]	0.1300	0.1300
Fna - Ammonia	[gNH3-N/gTKN]	0.6600	0.6600
Fnox - Particulate organic nitrogen	[gN/g Organic N]	0.5000	0.5000
Fnus - Soluble unbiodegradable TKN	[gN/gTKN]	0.0200	0.0200
FupN - N:COD ratio for unbiodegradable part. COD	[gN/gCOD]	0.0350	0.0350
Fpo4 - Phosphate	[gPO4-P/gTP]	0.5000	0.5000
FupP - P:COD ratio for unbiodegradable part. COD	[gP/gCOD]	0.0110	0.0110
FZbh - OHO COD fraction	[gCOD/g of total COD]	0.0200	0.0200
FZbm - Methylotroph COD fraction	[gCOD/g of total COD]	1.000E-4	1.000E-4
FZaob - AOB COD fraction	[gCOD/g of total COD]	1.000E-4	1.000E-4
FZnob - NOB COD fraction	[gCOD/g of total COD]	1.000E-4	1.000E-4
FZaao - AAO COD fraction	[gCOD/g of total COD]	1.000E-4	1.000E-4
FZbp - PAO COD fraction	[gCOD/g of total COD]	1.000E-4	1.000E-4
FZbpa - Propionic acetogens COD fraction	[gCOD/g of total COD]	1.000E-4	1.000E-4
FZbam - Acetoclastic methanogens COD fraction	[gCOD/g of total COD]	1.000E-4	1.000E-4
FZbhm - H2-utilizing methanogens COD fraction	[gCOD/g of total COD]	1.000E-4	1.000E-4
FZe - Endogenous products COD fraction	[gCOD/g of total COD]	0	0

Configuration information for all Metal addition units

Operating data Average (flow/time weighted as required)

Element name	39% FeCl3
Zbh mgCOD/L	0
Zbmeth mgCOD/L	0
Zaob mgCOD/L	0
Znob mgCOD/L	0
Zaao mgCOD/L	0
Zbp mgCOD/L	0
Zbpa mgCOD/L	0
Zbam mgCOD/L	0
Zbhm mgCOD/L	0
Ze mgCOD/L	0
Xsp mgCOD/L	0
Xsc mgCOD/L	0
Xi mgCOD/L	0
Xon mgN/L	0
Xop mgP/L	0
Xin mgN/L	0
Xip mgP/L	0
Spha mgCOD/L	0
PP-lo mgP/L	0
PP-hi mgP/L	0
Sbsc mgCOD/L	0
Sbsa mgCOD/L	0
Sbsp mgCOD/L	0
Sbmeth mgCOD/L	0
SbH2 mgCOD/L	0
CH4 mg/L	0
NH3-N mgN/L	0
Nos mgN/L	0
N2O-N mgN/L	0
NO2-N mgN/L	0
NO3-N mgN/L	0
N2 mgN/L	0
PO4-P (incl. MeP) mgP/L	0
Sus mgCOD/L	0
Nus mgN/L	0
ISSinf mgISS/L	0
XStru mgISS/L	0
XHDP mgISS/L	0
XHAP mgISS/L	0
SMg mg/L	0

SCa mg/L	0
Me mg/L	190500.00000
SCat meq/L	5.00000
SAn meq/L	10252.71160
SCO2 mmol/L	7.00000
UD1 mg/L	0
UD2 mg/L	0
UD3 mgVSS/L	0
UD4 mgISS/L	0
DO mg/L	0
Flow	0.0009

Configuration information for all Ideal primary settling tank (old) units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]
Pri clarifier (3/4)	1.9434	2.598E+4	10.000

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Pri clarifier (3/4)	Fraction	0.05

Element name	Percent removal	Blanket fraction
Pri clarifier (3/4)	74.00000	0.10000

Configuration information for all Dewatering unit units

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
DAFT (1/2)	Fraction	0.05
BFP	Fraction	0.14

Element name	Percent removal
DAFT (1/2)	95.00000
BFP	95.00000

Configuration information for all Sludge units

Configuration information for all Splitter units

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification

TFE recycle splitter	Flowrate [Side]	11.6
WAS splitter	Flowrate [Side]	0.7188
BFP spray water splitter	Flowrate [Side]	1.5

Configuration information for all Trickling filter units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]	Media area [ft2]
Biofilters (2/2)	3.0089	2.325E+4	17.300	1.086E+7

Element name	Specific area [ft2/ft3]	Specific volume [ft3/ft3]
Biofilters (2/2)	27	0.05

Operating data Average (flow/time weighted as required)

Element name	Average DO Setpoint
Biofilters (2/2)	2.0

Aeration equipment parameters

Element name	Alpha (surf) OR Alpha F (diff) [-]	Beta [-]	Surface pressure [kPa]	Fractional effective saturation depth (Fed) [-]
Biofilters (2/2)	0.8500	0.9500	101.3250	0.3250

Element name	Supply gas CO2 content [vol. %]	Supply gas O2 [vol. %]	Off-gas CO2 [vol. %]	Off-gas O2 [vol. %]	Off-gas H2 [vol. %]	Off-gas NH3 [vol. %]	Off-gas CH4 [vol. %]	Surface turbulence factor [-]
Biofilters (2/2)	0.0350	20.9500	2.0000	18.8000	0	0	0	2.0000

BioWin Album

Album page - Page 1

Elements	Flow [mgd]	TSS [mgTSS/L]	VSS [mgVSS/L]	TCBOD [mg/L]	SCBOD [mg/L]	TKN [mgN/L]	NH3-N [mgN/L]	NOx [mgN/L]	TP [mgP/L]	PO4-P (incl. MeP) [mgP/L]	pH []	Alk [mmol/L]	Temp. [deg. C]
RS	17.99989	344.19243	298.29893	328.96570	124.28132	53.00000	34.98000	0	10.00000	5.00000	7.59997	6.00006	26.00000
RS mixer	19.64989	315.29061	273.25079	301.34247	113.84543	48.54959	32.04273	0	9.16030	4.58015	7.56228	5.99938	26.00000
Plant influent	22.93119	296.02930	253.44681	273.72505	102.21638	53.17057	37.43361	0.00195	11.19908	6.85819	7.39185	6.28903	26.00000
Pri clarifi	21.84969	86.50419	69.15784	149.01181	102.21237	46.32965	37.43214	0.00195	5.95599	4.77149	7.20048	6.03163	26.00000

er (3/4)													
TFE recycle splitter	21.84969	118.90456	100.25312	117.04596	45.81488	46.19281	38.89614	0.01560	5.95599	4.26925	7.00186	6.14256	26.00000
SE	19.63089	7.54448	5.95360	4.71338	1.14003	38.60772	35.86977	0.02050	2.90267	2.72969	7.05231	5.93529	26.00000

Album page - Page 1

Elements	TSS [lb TSS/d]	VSS [lb VSS/d]	ISSinf [lb ISS/d]	ISScell [lb ISS/d]	ISSprec [lb ISS/d]	ISStot [lb ISS/d]
RS	51703.33419	44809.37962	6759.73627	134.21830	0	6893.95457
	-	-	-	-	-	-
Pri clarifier (3/4) (U)	44895.04120	35891.57137	5539.77610	171.04538	3292.64836	9003.46983
Gravity thickener (1/2) (U)	41728.91977	33375.14665	5262.78729	147.18903	2943.79680	8353.77311
	-	-	-	-	-	-
WAS splitter (U)	18550.40367	14630.87884	1816.08766	1025.61475	1077.82241	3919.52483
DAFT (1/2) (U)	17622.90668	13899.33490	1725.28328	974.33402	1023.95449	3723.57178
	-	-	-	-	-	-
Digester feed mixer	59350.71592	47274.48155	6988.07057	1121.52304	3966.64076	12076.23437
Anaerobic digester (2/3)	33032.74056	21300.86550	6988.07057	592.60031	4151.20418	11731.87506
	-	-	-	-	-	-
Biosolids	31381.32400	20235.82222	6638.66704	562.97030	3943.86444	11145.50178

Album page - Page 1

Elements	TSS [lb TSS/d]	VSS [lb VSS/d]	TCBOD [lb /d]	TKN [lb N/d]	NH3-N [lb N/d]	TP [lb P/d]	SPO4 [lb P/d]
DAFT (1/2)	927.52140	731.54394	445.53848	282.79684	203.44435	43.08102	15.17513
BFP filtrate mixer	1745.64554	1139.57113	492.98051	1506.23788	1396.50586	514.22803	461.11340
	-	-	-	-	-	-	-
Total	2673.16695	1871.11507	938.51899	1789.03472	1599.95020	557.30905	476.28853
	-	-	-	-	-	-	-
RS	51703.33419	44809.37962	49416.03002	7961.46717	5254.56833	1502.16362	751.08181

Album page - Page 2

Elements	DO [mg/L]	OUR - Total [mgO/L/hr]	OUR - Nitrification [mgO/L/hr]	OTR [lb/hr]	Air flow rate [ft3/min (20C, 1 atm)]
AER A.1 (1/2)	0.02699	20.51424	0.01763	66.30016	325.00000
AER A.2	0.02850	16.01141	0.01860	66.28792	325.00000
AER A.3	0.07364	15.80373	0.04604	65.92197	325.00000
AER B.1	0.50000	17.47218	0.22661	73.44844	395.97710
AER B.2	0.40000	17.67317	0.19321	74.28032	395.18891
AER B.3	0.30000	18.03627	0.15542	77.21305	407.91526
AER C.1	0.70000	17.33566	0.28225	74.01496	412.73377
AER C.2	0.80000	16.75587	0.30737	70.48364	395.26051
AER C.3	1.00000	16.18817	0.34991	69.26551	400.08558
	-	-	-	-	-
Total	3.82914	155.79070	1.59704	637.21598	3382.16112

Album page - Page 2

Elements	Flow [mgd]	Flow [mgd]	TSS [mgTSS/L]	TSS [lb TSS/d]
RS	17.99989	-----	344.19243	51703.33419
SE	19.63089	-----	7.54448	1235.99490
	-	-	-	
Pri clarifier (3/4) (U)	1.08239	-----	4970.10329	44895.04120
Gravity thickener (1/2) (U)	0.10175	-----	49144.65935	41728.91977
	-	-	-	
WAS splitter (U)	0.71880	-----	3092.41600	18550.40367
DAFT (1/2) (U)	0.03917	-----	53904.56995	17622.90668
	-	-	-	
Digester feed mixer	0.14092	-----	50466.93399	59350.71592
	-	-	-	
Anaerobic digester (2/3)	0.14092	-----	28088.30714	33032.74056
	-	-	-	
Biosolids	0.01990	-----	188980.73122	31381.32400

Album page - Page 2

Elements	MeP (s) [mol/d]	MeOH3 (s) [mol/d]	MeH2PO4++ [mol/d]	Me+++ [mol/d]	PO4-P (incl. MeP) [lb P/d]
	-	-	-	-	-
Pri clarifier (3/4) (U)	5950.98887	0	0.27429	0.00000	442.39626
	-	-	-	-	-
WAS splitter (U)	1948.00917	0	0.37788	0.00000	149.07354
DAFT (1/2) (U)	1850.65063	0	0.01675	0.00000	127.24722
	-	-	-	-	-
Anaerobic digester (2/3)	7502.70517	0	2.30446	0.00000	1010.21248
	-	-	-	-	-
Biosolids	7127.96838	0	0.26730	0.00000	557.03566

Album page - Page 3

Elements	TSS [mgTSS/L]	VSS [mgVSS/L]
AER A.1 (1/2)	1105.77111	877.97160
AER A.2	1109.56961	881.38781
AER A.3	1109.07340	880.57377
AER B.1	1099.24707	869.81333
AER B.2	1102.69046	873.54688
AER B.3	1106.08177	877.24784
AER C.1	1095.82738	866.12342
AER C.2	1092.49317	862.55102
AER C.3	1089.25267	859.10597

Album page - Page 3

Elements	VSS destruction [%]	Off gas flow rate (dry) [ft3/min]	Off gas Methane [%]	Off gas Carbon dioxide [%]
Anaerobic digester (2/3)	54.94215	279.90329	64.03812	35.85033

Album page - Page 3

Elements	TSS [mgTSS/L]	VSS [mgVSS/L]	TCBOD [mg/L]	TKN [mgN/L]	NH3-N [mgN/L]	SPO4 [mgP/L]	VFA [mg/L]	pH []	Alk [mmol/L]
Pri clarifier (3/4) (U)	4970.10329	3973.37462	2791.01389	191.22031	37.43214	3.98874	15.87836	7.20048	9.22581
Gravity thickener (1/2) (U)	49144.65935	39306.31854	27078.96010	1534.02206	55.10152	42.86919	914.90795	5.09621	21.58204
WAS splitter (U)	-3092.41600	-2439.01775	-1465.03802	-261.15282	-35.86977	-2.67607	-0.03363	-7.05231	-7.61875
DAFT (1/2) (U)	53904.56995	42514.98823	25518.62797	3926.78191	35.86977	2.67556	0.03363	7.09029	19.01306
Anaerobic digester (2/3)	-28088.30714	-18112.49210	-6122.36273	-2199.19101	-938.12542	-423.36179	-105.70785	-6.81758	-110.36574
BFP (U)	188980.82091	121861.66780	40746.06119	9414.77042	938.12542	423.33579	105.70785	6.88711	205.39913
Gravity thickener (1/2)	-277.83045	-222.58645	-247.83011	-51.90087	-37.77552	-3.89970	-56.43157	-6.95332	-6.15795
DAFT (1/2)	163.53358	128.98031	78.55399	49.86061	35.86977	2.67556	0.03363	7.09029	6.07234
BFP	1635.33522	1054.52329	429.69130	1012.83818	938.12542	423.33579	105.70785	6.88711	60.11605
Recycle stream mixer	-180.64488	-134.85166	-108.33944	-80.84310	-69.71660	-18.55936	-20.78625	-6.98744	-8.02279

Global Parameters

Common

Name	Default	Value	
Hydrolysis rate [1/d]	2.1000	2.1000	1.0290
Hydrolysis half sat. [-]	0.0600	0.0600	1.0000
Anoxic hydrolysis factor [-]	0.2800	0.2800	1.0000
Anaerobic hydrolysis factor (AS) [-]	0.0400	0.0400	1.0000
Anaerobic hydrolysis factor (AD) [-]	0.5000	0.1800	1.0000
Adsorption rate of colloids [L/(mgCOD d)]	0.1500	0.1500	1.0290
Ammonification rate [L/(mgN d)]	0.0400	0.0400	1.0290
Assimilative nitrate/nitrite reduction rate [1/d]	0.5000	0.5000	1.0000
Endogenous products decay rate [1/d]	0	0	1.0000

AOB

Name	Default	Value	
Max. spec. growth rate [1/d]	0.9000	0.9000	1.0720
Substrate (NH4) half sat. [mgN/L]	0.7000	0.7000	1.0000
Byproduct NH4 logistic slope [-]	50.0000	50.0000	1.0000
Byproduct NH4 inflection point [mgN/L]	1.4000	1.4000	1.0000
AOB denite DO half sat. [mg/L]	0.1000	0.1000	1.0000
AOB denite HNO2 half sat. [mgN/L]	5.000E-6	5.000E-6	1.0000
Aerobic decay rate [1/d]	0.1700	0.1700	1.0290
Anoxic/anaerobic decay rate [1/d]	0.0800	0.0800	1.0290
KiHNO2 [mmol/L]	0.0050	0.0050	1.0000

NOB

Name	Default	Value	
Max. spec. growth rate [1/d]	0.7000	0.7000	1.0600
Substrate (NO2) half sat. [mgN/L]	0.1000	0.1000	1.0000
Aerobic decay rate [1/d]	0.1700	0.1700	1.0290
Anoxic/anaerobic decay rate [1/d]	0.0800	0.0800	1.0290
KiNH3 [mmol/L]	0.0750	0.0750	1.0000

AAO

Name	Default	Value	
Max. spec. growth rate [1/d]	0.2000	0.1000	1.1000
Substrate (NH4) half sat. [mgN/L]	2.0000	2.0000	1.0000
Substrate (NO2) half sat. [mgN/L]	1.0000	1.0000	1.0000
Aerobic decay rate [1/d]	0.0190	0.0190	1.0290
Anoxic/anaerobic decay rate [1/d]	0.0095	0.0095	1.0290
Ki Nitrite [mgN/L]	1000.0000	1000.0000	1.0000
Nitrite sensitivity constant [L / (d mgN)]	0.0160	0.0160	1.0000

OHO

Name	Default	Value	
Max. spec. growth rate [1/d]	3.2000	3.2000	1.0290
Substrate half sat. [mgCOD/L]	5.0000	5.0000	1.0000
Anoxic growth factor [-]	0.5000	0.5000	1.0000
Denite N2 producers (NO3 or NO2) [-]	0.5000	0.5000	1.0000
Aerobic decay rate [1/d]	0.6200	0.6200	1.0290
Anoxic decay rate [1/d]	0.2330	0.2330	1.0290
Anaerobic decay rate [1/d]	0.1310	0.1310	1.0290
Fermentation rate [1/d]	1.6000	1.6000	1.0290
Fermentation half sat. [mgCOD/L]	5.0000	5.0000	1.0000
Fermentation growth factor (AS) [-]	0.2500	0.2500	1.0000
Free nitrous acid inhibition [mmol/L]	1.000E-7	1.000E-7	1.0000

Methylotrophs

Name	Default	Value	
Max. spec. growth rate [1/d]	1.3000	1.3000	1.0720
Methanol half sat. [mgCOD/L]	0.5000	0.5000	1.0000
Denite N2 producers (NO3 or NO2) [-]	0.5000	0.5000	1.0000
Aerobic decay rate [1/d]	0.0400	0.0400	1.0290
Anoxic/anaerobic decay rate [1/d]	0.0300	0.0300	1.0000
Free nitrous acid inhibition [mmol/L]	1.000E-7	1.000E-7	1.0000

PAO

Name	Default	Value	
Max. spec. growth rate [1/d]	0.9500	0.9500	1.0000
Max. spec. growth rate, P-limited [1/d]	0.4200	0.4200	1.0000
Substrate half sat. [mgCOD(PHB)/mgCOD(Zbp)]	0.1000	0.1000	1.0000
Substrate half sat., P-limited [mgCOD(PHB)/mgCOD(Zbp)]	0.0500	0.0500	1.0000
Magnesium half sat. [mgMg/L]	0.1000	0.1000	1.0000
Cation half sat. [mmol/L]	0.1000	0.1000	1.0000
Calcium half sat. [mgCa/L]	0.1000	0.1000	1.0000

Aerobic/anoxic decay rate [1/d]	0.1000	0.1000	1.0000
Aerobic/anoxic maintenance rate [1/d]	0	0	1.0000
Anaerobic decay rate [1/d]	0.0400	0.0400	1.0000
Anaerobic maintenance rate [1/d]	0	0	1.0000
Sequestration rate [1/d]	4.5000	4.5000	1.0000
Anoxic growth factor [-]	0.3300	0.3300	1.0000

Acetogens

Name	Default	Value	
Max. spec. growth rate [1/d]	0.2500	0.2500	1.0290
Substrate half sat. [mgCOD/L]	10.0000	10.0000	1.0000
Acetate inhibition [mgCOD/L]	10000.0000	10000.0000	1.0000
Anaerobic decay rate [1/d]	0.0500	0.0500	1.0290
Aerobic/anoxic decay rate [1/d]	0.5200	0.5200	1.0290

Methanogens

Name	Default	Value	
Acetoclastic max. spec. growth rate [1/d]	0.3000	0.3000	1.0290
H2-utilizing max. spec. growth rate [1/d]	1.4000	1.4000	1.0290
Acetoclastic substrate half sat. [mgCOD/L]	100.0000	100.0000	1.0000
Acetoclastic methanol half sat. [mgCOD/L]	0.5000	0.5000	1.0000
H2-utilizing CO2 half sat. [mmol/L]	0.1000	0.1000	1.0000
H2-utilizing substrate half sat. [mgCOD/L]	0.1000	0.1000	1.0000
H2-utilizing methanol half sat. [mgCOD/L]	0.5000	0.5000	1.0000
Acetoclastic propionic inhibition [mgCOD/L]	10000.0000	10000.0000	1.0000
Acetoclastic anaerobic decay rate [1/d]	0.1300	0.1300	1.0290
Acetoclastic aerobic/anoxic decay rate [1/d]	0.6000	0.6000	1.0290
H2-utilizing anaerobic decay rate [1/d]	0.1300	0.1300	1.0290
H2-utilizing aerobic/anoxic decay rate [1/d]	2.8000	2.8000	1.0290

pH

Name	Default	Value
OHO low pH limit [-]	4.0000	4.0000
OHO high pH limit [-]	10.0000	10.0000
Methylotrophs low pH limit [-]	4.0000	4.0000
Methylotrophs high pH limit [-]	10.0000	10.0000
Autotrophs low pH limit [-]	5.5000	5.5000
Autotrophs high pH limit [-]	9.5000	9.5000
PAO low pH limit [-]	4.0000	4.0000
PAO high pH limit [-]	10.0000	10.0000
OHO low pH limit (anaerobic) [-]	5.5000	5.5000
OHO high pH limit (anaerobic) [-]	8.5000	8.5000
Propionic acetogens low pH limit [-]	4.0000	4.0000
Propionic acetogens high pH limit [-]	10.0000	10.0000
Acetoclastic methanogens low pH limit [-]	5.0000	5.0000
Acetoclastic methanogens high pH limit [-]	9.0000	9.0000
H2-utilizing methanogens low pH limit [-]	5.0000	5.0000
H2-utilizing methanogens high pH limit [-]	9.0000	9.0000

Switches

Name	Default	Value
Aerobic/anoxic DO half sat. [mgO2/L]	0.0500	0.0500
Anoxic/anaerobic NOx half sat. [mgN/L]	0.1500	0.1500

AOB DO half sat. [mgO2/L]	0.2500	1.0000
NOB DO half sat. [mgO2/L]	0.5000	0.5000
AAO DO half sat. [mgO2/L]	0.0100	0.0100
Anoxic NO3(->NO2) half sat. [mgN/L]	0.1000	0.1000
Anoxic NO3(->N2) half sat. [mgN/L]	0.0500	0.0500
Anoxic NO2(->N2) half sat. (mgN/L)	0.0100	0.0100
NH3 nutrient half sat. [mgN/L]	0.0050	0.0050
PolyP half sat. [mgP/mgCOD]	0.0100	0.0100
VFA sequestration half sat. [mgCOD/L]	5.0000	5.0000
P uptake half sat. [mgP/L]	0.1500	0.1500
P nutrient half sat. [mgP/L]	0.0010	0.0010
Autotroph CO2 half sat. [mmol/L]	0.1000	0.1000
H2 low/high half sat. [mgCOD/L]	1.0000	1.0000
Propionic acetogens H2 inhibition [mgCOD/L]	5.0000	5.0000
Synthesis anion/cation half sat. [meq/L]	0.0100	0.0100

Common

Name	Default	Value
Biomass volatile fraction (VSS/TSS)	0.9200	0.9200
Endogenous residue volatile fraction (VSS/TSS)	0.9200	0.9200
N in endogenous residue [mgN/mgCOD]	0.0700	0.0700
P in endogenous residue [mgP/mgCOD]	0.0220	0.0220
Endogenous residue COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
Particulate substrate COD:VSS ratio [mgCOD/mgVSS]	1.6000	1.6000
Particulate inert COD:VSS ratio [mgCOD/mgVSS]	1.6000	1.6000

AOB

Name	Default	Value
Yield [mgCOD/mgN]	0.1500	0.1500
AOB denite NO2 fraction as TEA [-]	0.5000	0.5000
Byproduct NH4 fraction to N2O [-]	0.0025	0.0025
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

NOB

Name	Default	Value
Yield [mgCOD/mgN]	0.0900	0.0900
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

AAO

Name	Default	Value
Yield [mgCOD/mgN]	0.1140	0.1140
Nitrate production [mgN/mgBiomassCOD]	2.2800	2.2800
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

OHO

Name	Default	Value
Yield (aerobic) [-]	0.6660	0.6660
Yield (fermentation, low H2) [-]	0.1000	0.1000
Yield (fermentation, high H2) [-]	0.1000	0.1000
H2 yield (fermentation low H2) [-]	0.3500	0.3500
H2 yield (fermentation high H2) [-]	0	0
Propionate yield (fermentation, low H2) [-]	0	0
Propionate yield (fermentation, high H2) [-]	0.7000	0.7000
CO2 yield (fermentation, low H2) [-]	0.7000	0.7000
CO2 yield (fermentation, high H2) [-]	0	0
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Endogenous fraction - aerobic [-]	0.0800	0.0800
Endogenous fraction - anoxic [-]	0.1030	0.1030
Endogenous fraction - anaerobic [-]	0.1840	0.1840
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
Yield (anoxic) [-]	0.5400	0.5400
Yield propionic (aerobic) [-]	0.6400	0.6400
Yield propionic (anoxic) [-]	0.4600	0.4600
Yield acetic (aerobic) [-]	0.6000	0.6000
Yield acetic (anoxic) [-]	0.4300	0.4300
Yield methanol (aerobic) [-]	0.5000	0.5000
Adsorp. max. [-]	1.0000	1.0000
Max fraction to N2O at high FNA over nitrate [-]	0.0500	0.0500
Max fraction to N2O at high FNA over nitrite [-]	0.1000	0.1000

Methylotrophs

Name	Default	Value
Yield (anoxic) [-]	0.4000	0.4000
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
Max fraction to N2O at high FNA over nitrate [-]	0.1000	0.1000
Max fraction to N2O at high FNA over nitrite [-]	0.1500	0.1500

PAO

Name	Default	Value
Yield (aerobic) [-]	0.6390	0.6390
Yield (anoxic) [-]	0.5200	0.5200
Aerobic P/PHA uptake [mgP/mgCOD]	0.9300	0.9300
Anoxic P/PHA uptake [mgP/mgCOD]	0.3500	0.3500
Yield of PHA on sequestration [-]	0.8890	0.8890
N in biomass [mgN/mgCOD]	0.0700	0.0700
N in sol. inert [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous part. [-]	0.2500	0.2500
Inert fraction of endogenous sol. [-]	0.2000	0.2000
P/Ac release ratio [mgP/mgCOD]	0.5100	0.5100
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
Yield of low PP [-]	0.9400	0.9400

Acetogens

Name	Default	Value
Yield [-]	0.1000	0.1000
H2 yield [-]	0.4000	0.4000
CO2 yield [-]	1.0000	1.0000
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Methanogens

Name	Default	Value
Acetoclastic yield [-]	0.1000	0.1000
Methanol acetoclastic yield [-]	0.1000	0.1000
H2-utilizing yield [-]	0.1000	0.1000
Methanol H2-utilizing yield [-]	0.1000	0.1000
N in acetoclastic biomass [mgN/mgCOD]	0.0700	0.0700
N in H2-utilizing biomass [mgN/mgCOD]	0.0700	0.0700
P in acetoclastic biomass [mgP/mgCOD]	0.0220	0.0220
P in H2-utilizing biomass [mgP/mgCOD]	0.0220	0.0220
Acetoclastic fraction to endog. residue [-]	0.0800	0.0800
H2-utilizing fraction to endog. residue [-]	0.0800	0.0800
Acetoclastic COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
H2-utilizing COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

General

Name	Default	Value
Molecular weight of other anions [mg/mmol]	35.5000	35.5000
Molecular weight of other cations [mg/mmol]	39.1000	39.1000
Mg to P mole ratio in polyphosphate [mmolMg/mmolP]	0.3000	0.3000
Cation to P mole ratio in polyphosphate [meq/mmolP]	0.1500	0.1500
Ca to P mole ratio in polyphosphate [mmolCa/mmolP]	0.0500	0.0500
Cation to P mole ratio in organic phosphate [meq/mmolP]	0.0100	0.0100
Bubble rise velocity (anaerobic digester) [cm/s]	23.9000	23.9000
Bubble Sauter mean diameter (anaerobic digester) [cm]	0.3500	0.3500
Anaerobic digester gas hold-up factor []	1.0000	1.0000
Tank head loss per metre of length (from flow) [m/m]	0.0025	0.0025

Mass transfer

Name	Default	Value	
Kl for H2 [m/d]	17.0000	17.0000	1.0240
Kl for CO2 [m/d]	10.0000	10.0000	1.0240
Kl for NH3 [m/d]	1.0000	1.0000	1.0240
Kl for CH4 [m/d]	8.0000	8.0000	1.0240
Kl for N2 [m/d]	15.0000	15.0000	1.0240
Kl for N2O [m/d]	8.0000	8.0000	1.0240
Kl for O2 [m/d]	13.0000	13.0000	1.0240

Henry's law constants

Name	Default	Value	
CO2 [M/atm]	3.4000E-2	3.4000E-2	2400.0000
O2 [M/atm]	1.3000E-3	1.3000E-3	1500.0000
N2 [M/atm]	6.5000E-4	6.5000E-4	1300.0000
N2O [M/atm]	2.5000E-2	2.5000E-2	2600.0000

NH3 [M/atm]	5.8000E+1	5.8000E+1	4100.0000
CH4 [M/atm]	1.4000E-3	1.4000E-3	1600.0000
H2 [M/atm]	7.8000E-4	7.8000E-4	500.0000

Physico-chemical rates

Name	Default	Value	
Struvite precipitation rate [1/d]	3.000E+10	3.000E+10	1.0240
Struvite redissolution rate [1/d]	3.000E+11	3.000E+11	1.0240
Struvite half sat. [mgTSS/L]	1.0000	1.0000	1.0000
HDP precipitation rate [L/(molP d)]	1.000E+8	1.000E+8	1.0000
HDP redissolution rate [L/(mol P d)]	1.000E+8	1.000E+8	1.0000
HAP precipitation rate [molHDP/(L d)]	5.000E-4	5.000E-4	1.0000

Physico-chemical constants

Name	Default	Value
Struvite solubility constant [mol/L]	6.918E-14	6.918E-14
HDP solubility product [mol/L]	2.750E-22	2.750E-22
HDP half sat. [mgTSS/L]	1.0000	1.0000
Equilibrium soluble PO4 with Al dosing at pH 7 [mgP/L]	0.0100	0.0100
Al to P ratio [molAl/molP]	0.8000	0.8000
Al(OH)3 solubility product [mol/L]	1.259E+9	1.259E+9
AlHPO4+ dissociation constant [mol/L]	7.943E-13	7.943E-13
Equilibrium soluble PO4 with Fe dosing at pH 7 [mgP/L]	0.0100	0.0100
Fe to P ratio [molFe/molP]	1.6000	1.6000
Fe(OH)3 solubility product [mol/L]	0.0500	0.0500
FeH2PO4++ dissociation constant [mol/L]	5.012E-22	5.012E-22

Aeration

Name	Default	Value
Alpha (surf) OR Alpha F (diff) [-]	0.5000	0.4000
Beta [-]	0.9500	0.9500
Surface pressure [kPa]	101.3250	101.3250
Fractional effective saturation depth (Fed) [-]	0.3250	0.3250
Supply gas CO2 content [vol. %]	0.0350	0.0350
Supply gas O2 [vol. %]	20.9500	20.9500
Off-gas CO2 [vol. %]	2.0000	2.0000
Off-gas O2 [vol. %]	18.8000	18.8000
Off-gas H2 [vol. %]	0	0
Off-gas NH3 [vol. %]	0	0
Off-gas CH4 [vol. %]	0	0
Surface turbulence factor [-]	2.0000	2.0000
Set point controller gain []	1.0000	1.0000

Modified Vesilind

Name	Default	Value
Maximum Vesilind settling velocity (Vo) [ft/min]	0.387	0.387
Vesilind hindered zone settling parameter (K) [L/g]	0.370	0.370
Clarification switching function [mg/L]	100.000	100.000
Specified TSS conc.for height calc. [mg/L]	2500.000	2500.000
Maximum compactability constant [mg/L]	15000.000	15000.000

Double exponential

Name	Default	Value
Maximum Vesilind settling velocity (Vo) [ft/min]	0.934	0.934
Maximum (practical) settling velocity (Vo') [ft/min]	0.615	0.615
Hindered zone settling parameter (Kh) [L/g]	0.400	0.400
Flocculent zone settling parameter (Kf) [L/g]	2.500	2.500
Maximum non-settleable TSS [mg/L]	20.0000	20.0000
Non-settleable fraction [-]	0.0010	0.0010
Specified TSS conc. for height calc. [mg/L]	2500.0000	2500.0000

Emission factors

Name	Default	Value
Carbon dioxide equivalence of nitrous oxide	296.0000	296.0000
Carbon dioxide equivalence of methane	23.0000	23.0000

Biofilm general

Name	Default	Value	
Attachment rate [g / (m2 d)]	80.0000	80.0000	1.0000
Attachment TSS half sat. [mg/L]	100.0000	100.0000	1.0000
Detachment rate [g/(m3 d)]	8.000E+4	8.000E+4	1.0000
Solids movement factor []	10.0000	10.0000	1.0000
Diffusion neta []	0.8000	0.8000	1.0000
Thin film limit [mm]	0.5000	0.5000	1.0000
Thick film limit [mm]	3.0000	3.0000	1.0000
Assumed Film thickness for tank volume correction (temp independent) [mm]	0.7500	0.7500	1.0000
Film surface area to media area ratio - Max.[ ]	1.0000	1.0000	1.0000
Minimum biofilm conc. for streamer formation [gTSS/m2]	4.0000	4.0000	1.0000

Maximum biofilm concentrations [mg/L]

Name	Default	Value	
Zbh	5.000E+4	5.000E+4	1.0000
Zbmeth	5.000E+4	5.000E+4	1.0000
Zaob	1.000E+5	1.000E+5	1.0000
Znob	1.000E+5	1.000E+5	1.0000
Zaao	5.000E+4	5.000E+4	1.0000
Zbp	5.000E+4	5.000E+4	1.0000
Zbpa	5.000E+4	5.000E+4	1.0000
Zbam	5.000E+4	5.000E+4	1.0000
Zbhm	5.000E+4	5.000E+4	1.0000
Ze	3.000E+4	3.000E+4	1.0000
Xsp	5000.0000	5000.0000	1.0000
Xsc	4000.0000	4000.0000	1.0000
Xi	5000.0000	5000.0000	1.0000
Xon	0	0	1.0000
Xop	0	0	1.0000
Xin	0	0	1.0000
Xip	0	0	1.0000
Spha	5000.0000	5000.0000	1.0000
PP-lo	1.150E+6	1.150E+6	1.0000
PP-hi	1.150E+6	1.150E+6	1.0000
Sbsc	0	0	1.0000
Sbsa	0	0	1.0000
Sbsp	0	0	1.0000
Sbmeth	0	0	1.0000
SbH2	0	0	1.0000
CH4	0	0	1.0000

NH3-N	0	0	1.0000
Nos	0	0	1.0000
N2O-N	0	0	1.0000
NO2-N	0	0	1.0000
NO3-N	0	0	1.0000
N2	0	0	1.0000
PO4-P (incl. MeP)	1.000E+10	1.000E+10	1.0000
Sus	0	0	1.0000
Nus	0	0	1.0000
ISSinf	1.300E+6	1.300E+6	1.0000
XStru	8.500E+5	8.500E+5	1.0000
XHDP	1.150E+6	1.150E+6	1.0000
XHAP	1.600E+6	1.600E+6	1.0000
SMg	0	0	1.0000
SCa	0	0	1.0000
Me	1.000E+10	1.000E+10	1.0000
SCat	0	0	1.0000
SAn	0	0	1.0000
SCO2	0	0	1.0000
UD1	0	0	1.0000
UD2	0	0	1.0000
UD3	5.000E+4	5.000E+4	1.0000
UD4	5.000E+4	5.000E+4	1.0000
DO	0	0	1.0000

Effective diffusivities [m2/s]

Name	Default	Value	
Zbh	5.000E-14	5.000E-14	1.0290
Zbmeth	5.000E-14	5.000E-14	1.0290
Zaob	5.000E-14	5.000E-14	1.0290
Znob	5.000E-14	5.000E-14	1.0290
Zaao	5.000E-14	5.000E-14	1.0290
Zbp	5.000E-14	5.000E-14	1.0290
Zbpa	5.000E-14	5.000E-14	1.0290
Zbam	5.000E-14	5.000E-14	1.0290
Zbhm	5.000E-14	5.000E-14	1.0290
Ze	5.000E-14	5.000E-14	1.0290
Xsp	5.000E-14	5.000E-14	1.0290
Xsc	5.000E-12	5.000E-12	1.0290
Xi	5.000E-14	5.000E-14	1.0290
Xon	5.000E-14	5.000E-14	1.0290
Xop	5.000E-14	5.000E-14	1.0290
Xin	5.000E-14	5.000E-14	1.0290
Xip	5.000E-14	5.000E-14	1.0290
Spha	5.000E-14	5.000E-14	1.0290
PP-lo	5.000E-14	5.000E-14	1.0290
PP-hi	5.000E-14	5.000E-14	1.0290
Sbsc	6.900E-10	6.900E-10	1.0290
Sbsa	1.240E-9	1.240E-9	1.0290
Sbsp	8.300E-10	8.300E-10	1.0290
Sbmeth	1.600E-9	1.600E-9	1.0290
SbH2	5.850E-9	5.850E-9	1.0290
CH4	1.963E-9	1.963E-9	1.0290
NH3-N	2.000E-9	2.000E-9	1.0290
Nos	1.370E-9	1.370E-9	1.0290
N2O-N	1.607E-9	1.607E-9	1.0290
NO2-N	2.980E-9	2.980E-9	1.0290
NO3-N	2.980E-9	2.980E-9	1.0290
N2	1.900E-9	1.900E-9	1.0290
PO4-P (incl. MeP)	2.000E-9	2.000E-9	1.0290
Sus	6.900E-10	6.900E-10	1.0290
Nus	6.850E-10	6.850E-10	1.0290
ISSinf	5.000E-14	5.000E-14	1.0290
XStru	5.000E-14	5.000E-14	1.0290
XHDP	5.000E-14	5.000E-14	1.0290
XHAP	5.000E-14	5.000E-14	1.0290

SMg	7.200E-10	7.200E-10	1.0290
SCa	7.200E-10	7.200E-10	1.0290
Me	4.800E-10	4.800E-10	1.0290
SCat	1.440E-9	1.440E-9	1.0290
SAn	1.440E-9	1.440E-9	1.0290
SCO2	1.960E-9	1.960E-9	1.0290
UD1	6.900E-10	6.900E-10	1.0290
UD2	6.900E-10	6.900E-10	1.0290
UD3	5.000E-14	5.000E-14	1.0290
UD4	5.000E-14	5.000E-14	1.0290
DO	2.500E-9	2.500E-9	1.0290

EPS Strength coefficients [ ]

Name	Default	Value	
Zbh	1.0000	1.0000	1.0000
Zbmeth	1.0000	1.0000	1.0000
Zaob	5.0000	5.0000	1.0000
Znob	25.0000	25.0000	1.0000
Zaao	10.0000	10.0000	1.0000
Zbp	1.0000	1.0000	1.0000
Zbpa	1.0000	1.0000	1.0000
Zbam	1.0000	1.0000	1.0000
Zbhm	1.0000	1.0000	1.0000
Ze	1.0000	1.0000	1.0000
Xsp	1.0000	1.0000	1.0000
Xsc	1.0000	1.0000	1.0000
Xi	1.0000	1.0000	1.0000
Xon	1.0000	1.0000	1.0000
Xop	1.0000	1.0000	1.0000
Xin	1.0000	1.0000	1.0000
Xip	1.0000	1.0000	1.0000
Spha	1.0000	1.0000	1.0000
PP-lo	1.0000	1.0000	1.0000
PP-hi	1.0000	1.0000	1.0000
Sbsc	0	0	1.0000
Sbsa	0	0	1.0000
Sbsp	0	0	1.0000
Sbmeth	0	0	1.0000
SbH2	0	0	1.0000
CH4	0	0	1.0000
NH3-N	0	0	1.0000
Nos	0	0	1.0000
N2O-N	0	0	1.0000
NO2-N	0	0	1.0000
NO3-N	0	0	1.0000
N2	0	0	1.0000
PO4-P (incl. MeP)	1.0000	1.0000	1.0000
Sus	0	0	1.0000
Nus	0	0	1.0000
ISSinf	0.3300	0.3300	1.0000
XStru	1.0000	1.0000	1.0000
XHDP	1.0000	1.0000	1.0000
XHAP	1.0000	1.0000	1.0000
SMg	0	0	1.0000
SCa	0	0	1.0000
Me	1.0000	1.0000	1.0000
SCat	0	0	1.0000
SAn	0	0	1.0000
SCO2	0	0	1.0000
UD1	0	0	1.0000
UD2	0	0	1.0000
UD3	1.0000	1.0000	1.0000
UD4	1.0000	1.0000	1.0000
DO	0	0	1.0000

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City of Oxnard

Public Works Integrated Master Plan

WASTEWATER

PROJECT MEMORANDUM 3.5
CONDITION ASSESSMENT

REVISED FINAL DRAFT
September 2017

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pw:\\Carollo\Documents\Client\CA\Oxnard\9587A00\Deliverables\Updated PM Deliverables\PM 03 Wastewater System\PM 3.5

PREFACE

The analysis and evaluations contained in these Project Memorandum (PM) are based on data and information available at the time of the original date of publication, December 2015. After development of the December 2015 Final Draft PMs, the City continued to move forward on two concurrent aspects: 1) advancing the facilities planning for the water, wastewater, recycled water, and stormwater facilities; and 2) developing Updated Cost of Service (COS) Studies (Carollo, 2017) for the wastewater/collection system and the water/distribution system. The updated 2017 COS studies contain the most recent near-term Capital Improvement Projects (CIP). **The complete updated CIP based on the near-term and long-term projects is contained in the Brief History and Overview of the City of Oxnard Public Works Department's Integrated Planning Efforts: May 2014 – August 2017 section.**

At the time of this Revised PWIMP, minor edits were also incorporated into the PMs. Minor edits included items such as table title changes and updating reports that were completed after the December 2015 original publication date.

City of Oxnard

Public Works Integrated Master Plan

WASTEWATER

PROJECT MEMORANDUM 3.5
CONDITION ASSESSMENT

TABLE OF CONTENTS

Page No.

LIST OF TABLES

LIST OF FIGURES

CONDITION ASSESSMENT

1.0 INTRODUCTION

This purpose of this report is to present and summarize the condition assessment of wastewater assets conducted for the City of Oxnard (City) by Carollo Engineers (Carollo) as part of the Public Works Integrated Master Plan. This assessment was conducted to identify rehabilitation and replacement (R&R, or renewal) needs. The effort included using asset management methodology to identify the existing wastewater assets and to conduct a visual condition assessment of above-ground assets, a seismic evaluation of structures, a desktop evaluation of below-ground assets, and a cathodic protection system evaluation.

To prioritize the R&R needs, a risk assessment was conducted that examined the vulnerability, or likelihood of failure, and criticality, or consequence of failure for each asset. Consistent risk scoring methodology was applied to both above- and below-ground assets to allow for prioritization across these varied asset types.

The findings from this report will be incorporated into a detailed and comprehensive capital improvement program (CIP) that summarizes all Public Works Integrated Master Plan recommendations. The CIP will reflect the combined planning considerations of the R&R needs identified here, as well as regulatory-driven needs, growth-driven needs, and other enhancements.

2.0 APPROACH

2.1 Asset Registry

Using multiple references provided by the City, Carollo compiled an inventory of above- and below-ground assets with the appropriate level of detail for a visual condition assessment and system-wide capital planning projects. An asset was defined as a functional component valued at $10,000 or more, or one critical to plant performance. Equipment such as smaller valves, sump pumps, and local control panels were not included as individual assets, rather were addressed as ancillary items. Assets were classified by facility type, unit process, and discipline. Assets at the lift stations were classified by facility type, site location, and discipline.

Carollo reviewed the history of replacements and major rehabilitations with City staff and identified data gaps or areas of uncertainty for focus during the field assessment. Where possible, existing references were used to identify design and sizing criteria, age, capacity, and other information prior to the assessment.

2.2 Asset Risk

Risk of an asset is a measure of the impact of asset failure on the overall system. By quantifying and assessing the risk of failure or inability of an asset to meet its intended function, R&R projects can be selected and implemented to mitigate the risk. The following sections detail the calculation used to estimate risk for both above- and below-ground assets.

2.2.1 Vulnerability

The vulnerability metric reflects the "likelihood of asset failure." Failure can occur from physical failure, performance failure, or technological obsolescence. The vulnerability of an asset is inversely proportional to the Evaluated Remaining Useful Life (EvRUL), which is determined as part of the condition assessment. The vulnerability expresses the likelihood of failure of an asset in the next year. Because the vulnerability was calculated with a slightly different approach for above- and below-ground assets, the details on this methodology are presented in the respective sections for these different asset types.

2.2.2 Criticality

The criticality scoring system divides probable "consequences of failure" into four categories:

- Public Health and Safety.
- Financial Impact.
- Effect on Customers/Public Confidence.
- Cost of Repairs.

The criticality scoring scale used in the assessment of each facility is shown in Table 1. This scale is adapted from the *International Infrastructure Management Manual, New Zealand National Asset Management Steering Group, and the Institute of Public Works Engineering of Australia* (2011). The criticality of an asset is the sum of the score from each of the four categories multiplied by the category weighting factor. Because the approach for below-ground assets included pipe size and geospatial factors, additional details on the criticality methodology for below-ground assets can be found in Section 4.3.

Table 1 Criticality Scoring Matrix for Assets
Public Works Integrated Master Plan
City of Oxnard

Criticality Category	Weight	Negligible = 1	Low = 4	Moderate = 7	Severe = 10
Public and Employee Health and Safety	30%	No injuries or adverse health effects	Minor injury with no lost-time or medical attention	Lost-time injury or medical attention	Multiple persons' lost-time injury or medical attention
Financial Impact	20%	Absorbed within current budget and under GM signature authority < $25,000	Requires Council approval $25,000 to $150,000	Requires Council approval $150,000 to $250,000	Requires Council approval > $250,000
Environment or Regulatory Compliance	30%	Overall compliance with permits	Sustained odor issue Loss of expected efficiency	Bypass or overflow event Solids not meeting 503 regulations Hazardous material release	Single permit violation
Customer Service (Ability to Respond)	20%	Function restored within 8 hours	Function restored in 8 to 24 hours	Function restored in more than 24 hours but less than 3 days	Function restored in more than 3 days

2.2.3 Risk

Just as risk is expressed as the economic cost or as the product of cost and chance, risk is calculated in this analysis as the product of the consequence of the failure and the likelihood of failure, or:

Risk = Criticality x Vulnerability

At a minimum, assets with higher risk ratings must be closely monitored and targeted for corrective or preventative action, including maintenance, rehabilitation, or replacement.

3.0 ABOVE-GROUND ASSET ASSESSMENT

3.1 Above-ground Overview

Above-ground assets included structures and equipment owned and operated by the City. A consistent approach was used for assessing and valuing all above-ground assets, regardless of whether they were within the treatment or collection system. The above-ground asset inventory included approximately 26 structures, 160 pumps, 15 wet wells, and a variety of other assets across the Oxnard Wastewater Treatment Plant (OWTP) and collection system. The recorded age of each asset varied from 1955 to the present.

3.2 Above-ground Vulnerability

The above-ground vulnerability is addressed based on visual condition assessment findings, as well as the seismic evaluation summarized in Section 3.2.2 and the cathodic protection system evaluation summarized in Section 3.2.3.

The condition of each asset was evaluated on a one-through-five ranking scale, based on the International Infrastructure Management Manual (IIMM). In the IIMM, condition is expressed in terms of the amount of repair needed to bring an asset to "like new" condition. The definitions for the one-through-five condition ranking system from the IIMM are presented in Table 2. The assessment included inquiries into maintenance and performance history as well as design criteria, installation date, and typical condition parameters that could be used to standardize the procedure for future assessments. These inquiries helped inform condition scores for each asset. It should be noted that the assessment was visual only and did not include testing such as concrete core sampling.

3.2.1 OWTP Visual Condition Assessment Findings

The OWTP is designed to currently treat an average dry weather flow (ADWF) of 31.7 million gallons per day (mgd) and a peak wet weather flow (PWWF) of 68.2 mgd. The OWTP began operation in 1955, with major expansions in 1975 and 1985. Figure 1 presents the site map for the OWTP.

Table 2	Asset Condition Ranking Public Works Integrated Master Plan City of Oxnard	
Score(1)	**Description**(1)	**Required Rehabilitation Percentage**(1,2)
1	Very Good	0%
2	Good	1-10%
3	Fair	11-20%
4	Poor	21-50%
5	Very Poor	>50%

Notes:
(1) Adapted from the International Infrastructure Management Manual.
(2) Percentage of asset requiring rehabilitation: The percentage of the asset value needed to return the asset to a condition ranking of one.

Significant findings are summarized below for the OWTP in order of process flow. Findings for the visual condition assessment of the lift stations are summarized following the OWTP sections.

3.2.2 Headworks

3.2.2.1 Structural

No issues were noted with the structural assets at the Headworks during the condition assessment evaluation. However, in 2013-2014 plant staff identified significant concrete and coating deterioration below the Vortex Drop Structure No. 1 cover when this asset was taken out of service for cleaning. Additionally, plant staff noted in 2013-2014 that there is moderate deterioration of concrete and coating below and above the inlet junction structure covers, influent screens channels, grit chamber, and influent pump station. These conditions were identified via opening of cover hatches and visual inspections.

3.2.2.2 Mechanical/Process

Light corrosion of the screening compactors and mechanical bar screens was observed. The sodium hypochlorite pumps were found to be nearing the end of their useful life.

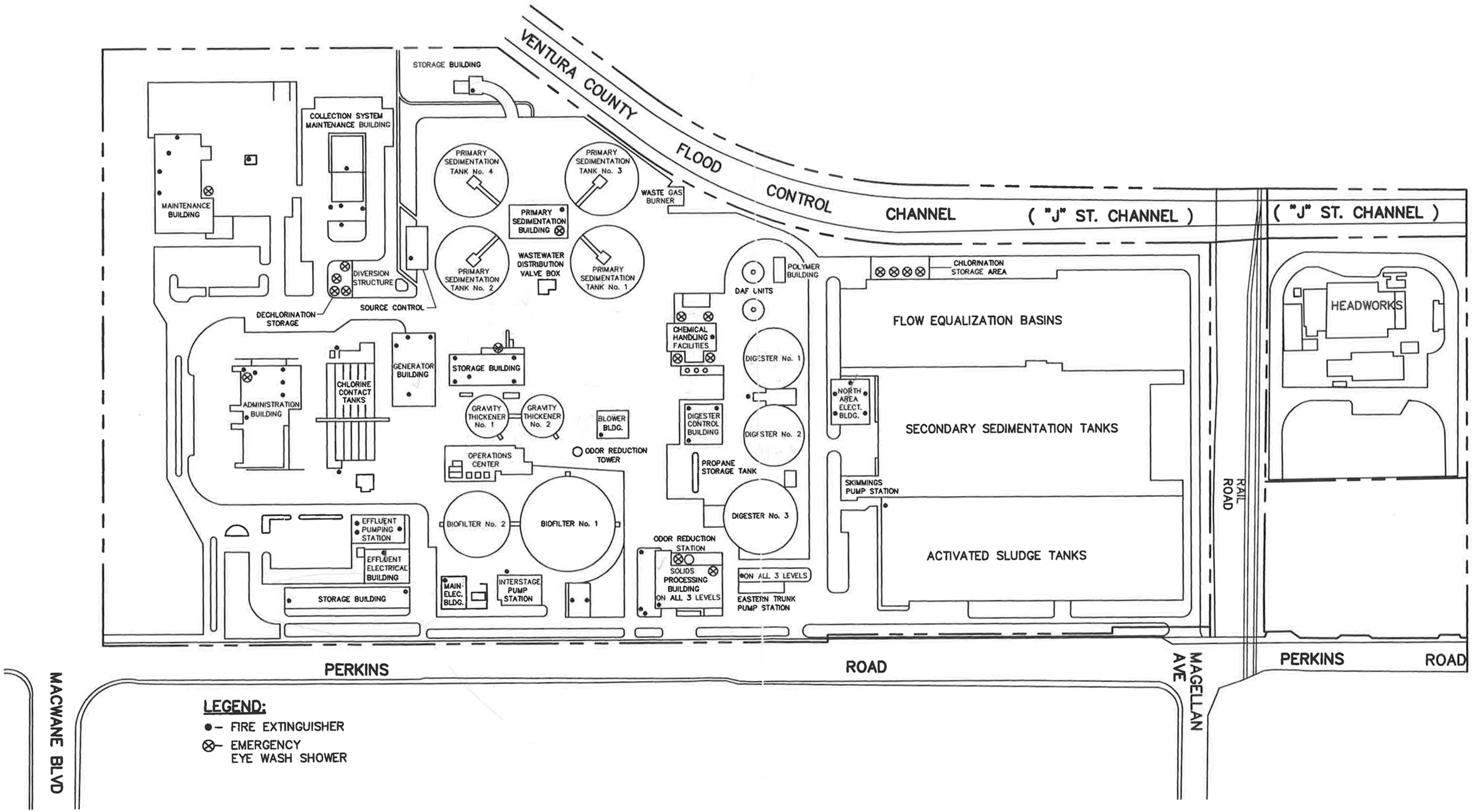
3.2.2.3 Electrical and Instrumentation/Controls

No Electrical and Instrumentation/Controls (E&IC) issues were noted at the Headworks.

3.2.3 Primary Clarification

3.2.3.1 Structural

Structural assets at the primary clarifiers, including the clarifier basins and the Primary Sedimentation Building were found to be in fair to poor condition. Concrete core samples were not taken for subsequent physical or chemical testing.



OWTP SITE MAP

FIGURE 1

CITY OF OXNARD

PM NO. 3.5 – CONDITION ASSESSMENT

PUBLIC WORKS INTEGRATED MASTER PLAN

ox0715f38-9587(PM3-5 FIG1).ai

3.2.3.2 Mechanical/Process

Mechanical assets at the primary clarification tanks were found to be in poor or very poor condition and were found to be nearing the end of their useful life. The clarifier mechanism walkways, especially the walkway on Clarifier 4, were observed to present a significant safety hazard to operators. Furthermore, the sludge pump tanks and scum ejectors were in very poor condition. The scum ejector in Primary Clarifier 1 was converted to an electrical float ejector. It is recommended that the remaining scum ejectors also be converted to electrical float ejectors or that new scum injectors be installed.

3.2.3.3 Electrical and Instrumentation/Controls

E&IC assets in the primary clarification process were found to be nearing the end of their useful life and in very poor condition. Replacement is recommended for motor control center (MCC) MCC-DPIA and MCC-DPIB.

3.2.4 Biofilters (Trickling Filters)

3.2.4.1 Structural

The biofilters were found to be in very poor condition. The condition has been discussed in further detail in the Biotower 1 Structural Analysis Report, prepared by Penfield and Smith Engineers, January 2014.

3.2.4.2 Mechanical/Process

Severe issues were noted at the biofilters. There include concerns about the mechanical distributor mechanism, namely the failed distributor seal. The distributor tube seal has failed in each biofilter, resulting in significant short-circuiting of primary effluent through the biofilter and poor observed treatment efficiency. In addition, the trickling filter media was installed in the late 1970s and portions of the media were replaced in 1985. The media is in poor condition.

3.2.4.3 Electrical and Instrumentation/Controls

No E&IC issues were noted at this location at the time of the condition assessment. City noted in November of 2015 that the E&IC assets are nearing the end of their useful life.

3.2.5 Interstage Pumping Station

3.2.5.1 Structural

The Interstage Pumping Station is in acceptable condition, with no significant issues noted at the time of the condition assessment. City noted in November of 2015 that the wet well is in poor condition.

3.2.5.2 Mechanical/Process

The pumps at this location were found to be in poor to fair condition based on observed corrosion, vibration, and noise.

3.2.5.3 Electrical and Instrumentation/Controls

No significant E&IC issues were present here at the time of the condition assessment. City noted in November of 2015 that the E&IC assets are nearing the end of their useful life.

3.2.6 <u>Secondary Treatment</u>

3.2.6.1 Structural

The secondary treatment structures including aeration basins, secondary sedimentation tanks, and flow equalization were found to be in medium to poor condition. Additional information can be found in the Seismic Assessment Report prepared by Carollo Engineers in October 2014, summarized below.

3.2.6.2 Mechanical/Process

Aeration basin diffusers and piping were found to be in very poor condition. Cracking is visible in multiple areas.

Secondary sedimentation collectors, skimmers, and drives in basin 17 and 18 were found to be in very poor condition and requiring significant rehabilitation. The return activated sludge (RAS), waste activated sludge (WAS), and high pressure 3 water pumps (3WHP) were found to be in poor condition and require rehabilitation. Select pumps at the secondary treatment facilities require new impellers due to their age and O&M staff conversations. Motorized skimmers in the secondary sedimentation basins 1 through 16 were found to be in poor condition, and non-functional. While these skimmers were not directly observed during the condition assessment, their condition assessment was based on their age and conversations with operating staff. City noted in November of 2015 that the 3 WHP strainers need to be replaced as well.

3.2.6.3 Electrical and Instrumentation/Controls

The secondary treatment processes are powered by electrical equipment discussed elsewhere in this report.

3.2.7 <u>Disinfection Facilities</u>

3.2.7.1 Structural

Concrete repairs are needed at the disinfection facilities. A replacement of the handrails and grating is also recommended.

3.2.7.2 Mechanical/Process

No significant mechanical issues noted here. The mechanical assets were found to be in fair condition and showing regular wear and tear for their age. There are six pumps that were assessed as being in medium condition but are no longer in use. The dechlorination storage area was also included in the assessment but was rated a low criticality because they are no longer in use.

3.2.7.3 Electrical and Instrumentation/Controls

No significant E&IC issues were observed at this location.

3.2.8 Effluent Pumping

3.2.8.1 Structural

The effluent pumping station is in poor condition and in need of replacement or rehabilitation. Additional information can be found in the Seismic Assessment Report prepared by Carollo Engineers in October 2014, summarized below.

3.2.8.2 Mechanical/Process

Mechanical assets were observed to be mostly in fair condition. However, pump number 2 was recently replaced, and because of this has a condition score of good. Also, Pump 5 known as “Big-Red,” was found to be in poor condition. The engine drive at this location was rebuilt more than 10 years ago, and appeared to be in fair condition.

3.2.8.3 Electrical and Instrumentation/Controls

The electrical assets at the effluent were observed to be in very poor condition with both MCCs showing significant need for replacement.

3.2.9 Thickening

3.2.9.1 Structural

The gravity thickeners and dissolved air flotation thickeners (DAFTs) were all found to be in poor condition. Additional information can be found in the Seismic Assessment Report prepared by Carollo Engineers in October 2014, summarized below.

The mechanical assets at the DAFT tanks were found to be in fair condition. Vibration and noise were observed in the collectors and drives.

3.2.9.2 Mechanical/Process

The fans/louvers at gravity thickener 1 were found to be in poor condition. The fans/louvers at gravity thickener 2 were replaced five years ago and are in good condition. The fans/louvers at both gravity thickeners need to be serviced every other month. A majority of the mechanical assets including the collectors, drives, launders, pumps, and walkways were found to be in poor or very poor condition as they are reaching the end of their useful life.

The odor reduction tower at this location was also assessed, and is in poor condition.

3.2.9.3 Electrical and Instrumentation/Controls

The MCCs at the gravity thickener location were observed to be in very poor condition, replacement of MCC-DP3C and MCC-DP3D is recommended.

3.2.10 <u>Digestion</u>

3.2.10.1 Structural

Digesters 1 and 2 were built in 1975 and originally both had floating covers. The cover on Digester 1 was subsequently replaced with a fixed cover when the original cover tilted. However, Digester 2 still has the original floating cover. Due to the cover age and corrosion under the cover, Digester 2 is out of service with its roof in need of replacement. Digester 1 has a crack running up the side of the tank. Additional information can be found in the Seismic Assessment Report prepared by Carollo Engineers in October 2014, summarized below.

3.2.10.2 Mechanical/Process

The digester gas piping has temporary seals in multiple places. The digester gas compressors, heat exchangers, and mixing tubes were found to be in poor condition and in need of replacement. Heat Exchanger 2 was out of service during the site visit. Operations staff noted that the heat exchangers do not appear to remove sufficient excess heat during the summer months for flexible operation within the mesophilic range. However, the heat exchanger water pump at the chlorine contact tank was recently replaced.

3.2.10.3 Electrical and Instrumentation/Controls

MCCs located at the digester control building were observed to be in poor condition, this includes MCC-DP2C, MCC-GH, MCC-GF, and MCC-EDPIC. For all electrical assets in poor condition, replacement is recommended.

3.2.11 <u>Dewatering</u>

3.2.11.1 Structural

Per the seismic evaluation, the Solids Processing Building is in need of further Tier 2 Evaluation.

3.2.11.2 Mechanical/Process

The sludge dewatering belt filter presses and conveyers were found to be corroded and in need of rehabilitation or replacement.

3.2.11.3 Electrical and Instrumentation/Controls

The eastern trunk dewatering building contains both old and new electrical equipment. The older switchboard is in fair condition and may require replacement in the near future.

3.2.12 Cogeneration

3.2.12.1 Structural

The Cogeneration Building was observed to be in fair condition, with some deterioration observed on wood members and masonry units. Additional information can be found in the Seismic Assessment Report prepared by Carollo Engineers in October 2014, summarized below.

3.2.12.2 Mechanical/Process

The cogeneration units are more than twenty years old but are rebuilt regularly. They were observed to be in fair condition. The cogen blowers were observed to be in poor condition based on age and deterioration.

3.2.12.3 Electrical and Instrumentation/Controls

The MCCs in the Cogeneration Building were observed to be in poor to very poor condition due in part to weathering in the building. City noted in November of 2015 that the HVAC also should be replaced.

3.2.13 Main Electrical Building

3.2.13.1 Structural

The Main Electrical Building was observed to be in very poor condition. Additional information can be found in the Seismic Assessment Report prepared by Carollo Engineers in October 2014, summarized below.

3.2.13.2 Mechanical/Process

No mechanical assets were observed at this location.

3.2.13.3 Electrical and Instrumentation/Controls

The electrical assets at this location including MCC-GB, MCC-DP4B, MCC-DP4, MCC-CG, and MCC-GD, were all observed at poor condition. All of these assets were built by Federal Pacific in 1978 and thus are the oldest MCC assets onsite. Because of their age and poor condition, they are in need of replacement.

3.2.14 North Area Electrical Building

3.2.14.1 Structural

The North Area Electrical Building was observed to be in fair condition. Additional information can be found in the Seismic Assessment Report prepared by Carollo Engineers in October 2014, summarized below.

3.2.14.2 Mechanical/Process

No mechanical assets were observed at this location.

3.2.14.3 Electrical and Instrumentation/Controls

The electrical assets at this location were found to be in fair condition and mostly likely will not require rehab in the near future.

3.2.15 All Other Electrical

Switchgear located in the Effluent Electrical Building was observed to be in good condition.

The condition of MCCs is not only based on the age of the equipment, but also the weathering from the conditions of the rooms in which the MCCs reside. MCCs from the same install year may have different condition assessment scores. This is due to lack of air condition in many rooms and/or direct exposure to outside weather from doors left open. Specifically, the MCCs in each of the following buildings have clearly been influenced by weathering, some to a greater degree than others: Cogen Building, Digester Control Building Eastern Trunk Pump Station (Sampling Station), Old Blower Building, Old Headworks Building, Plant Control Center, Effluent Pump Station, and the DAF Building. Many of these MCCs have been discussed in other sections; however, MCCs in the Old Headworks Building and Old Blower Building are discussed here. The Old Headworks Building contains MCC-HC and MCC-EDPIB, both of these were observed to be in fair condition. The Old Blower Building contains MCC-DP2B, which was observed to be in poor condition, requiring replacement.

In addition to MCCs affected by weathering conditions, the Admin Building contains MCC-EDPIE, MCC-DP3A, and MCC-DP2D. All three of these MCCs were observed to in poor to fair condition, eventually requiring replacement. MCCs located at the generator building were also observed to be in poor to fair condition depending on the manufacturer and age. For all electrical assets in poor condition, replacement is recommended.

For master planning perspective, an issue noted is the lack of emergency power. There is only one power feed to the plant. While the generators have adequate capacity, these cannot be brought on line quickly enough to serve as emergency power. In the event of power loss, influent is directed to a primary clarifier. This allows for a half hour detention time until power can be brought online. Reserving clarifier capacity for emergency use, however, means that many maintenance and rehabilitation activities cannot be conducted routinely. The Master Plan will therefore include recommendations for replacement of the generators or addition of emergency power equipment.

3.2.16 OWTP Seismic Evaluation

A concurrent seismic evaluation was conducted on the OWTP structures and is presented in a separate report titled Seismic Assessment of OWTP Structures, dated October 2014. A summary of the findings is shown in Table 3.

Table 3 Seismic Findings Summary for OWTP Structures
Public Works Integrated Master Plan
City of Oxnard

Structure/Component	Recommendation
Headworks Building	Further Evaluation Not Required
Grit Screening Building	Further Tier 2 Evaluation(1)
Primary/DAFT Building	Further Tier 2 Evaluation(1)
Main Switchgear Building	Replace/Retrofit(2)
Blower Building	Replace/Retrofit(2)
North Area Electrical Building	Further Tier 2 Evaluation(1)
Digester Control Building	Replace/Retrofit(2)
Solids Processing Building	Further Tier 2 Evaluation(1)
Plant Control Center Building	Replace/Retrofit(2)
Effluent Pumping Station	Replace/Retrofit(2)
Co-Generation Building	Replace/Retrofit(2)
Maintenance Building	Further Tier 2 Evaluation(1)
Collection System Maintenance Building	Further Tier 2 Evaluation(1)
Chemical Handling Building	Further Tier 2 Evaluation(1)
Vacuum Filter Building	Replace/Retrofit(2)
Butler Building	Replace/Retrofit(2)
16 KW Switchgear Building/Effluent Pump Station VFD Building	Replace/Retrofit(2)
Administration Building	Further Tier 2 Evaluation(1)
Aeration Basin/Activated Sludge	Concrete Testing(3)
Secondary Sedimentation Basin	Concrete Testing(3)
Flow Equalization Basin	Concrete Testing(3)
Primary Clarifier Tanks	Concrete Testing(3)
Gravity Thickener Tanks	Concrete Testing(3)
Digester Tanks	Concrete Testing(3)
DAFT Tanks	Concrete Testing(3)
Chlorine Contact Tank	Concrete Testing(3)

Notes:
(1) Further Tier 2 Evaluation will be completed by December 1, 2014.
(2) Retrofit versus replacement decisions will be made in conjunction with the Integrated Water Management Plan alternatives analysis.
(3) Testing of the concrete in the basins and tanks will follow next. This task effort was approved on Nov 25, 2014 with Amendment 1 to the PWIMP. A separate report will be developed that will document those conclusions.

3.2.17 OWTP Cathodic Protection System Evaluation

A cathodic protection system evaluation of the OWTP was conducted and is presented in a separate report titled Asset Corrosion Assessment and CP Evaluation Survey, dated September 2014. Corrosion protection of below grade pipes, valves, and fittings included protective coatings, double polyethylene wrapping, and petroleum wax tape wrapping. The design life for the galvanic (sacrificial anode) cathodic protection systems at the OWTP failed and require immediate replacement. The cathodic protection system at most locations is now exceeded, and the overall condition of the cathodic protection systems is unsatisfactory for protection of the subject structures. A few systems were found to be operational and are providing an adequate level of protection, but most were either non-operational or totally depleted and in need of complete overhaul.

3.2.18 Lift Station Visual Condition Assessment Findings

The collection system includes fifteen (15) lift stations, all of which were visually assessed. Each lift station was found to have two submersible pumps except for Lift Station 29, which had four submersible pumps. When a pump fails, it is typically switched out with a replacement from the storage facility building back at the OWTP facility. Because these are replaced with spares as needed, the submersible pumps were not considered capital assets in this study. Assets found at the lift stations and included in the registry were:

- Wet Well Structure.
- Valve Vault.
- Electrical Panel.
- Generator (if present).

Tables 4 and 5 summarize the condition of the valve vault and wet well structure for all of the lift stations. The lift stations were assessed for the condition of concrete, anchorage, and coating. Details from the visual condition assessment of the lift stations can be found in Appendix A.

3.2.19 Remaining Useful Life Calculations

The following sections detail the approach for calculating remaining useful life for above-ground assets, which in turn is used to calculate vulnerability. The values calculated for each asset can be found in Appendix A for the OWTP and lift stations.

3.2.20 Original Useful Life

Original Useful Life is the number of years an asset is expected to be in service as a function of asset type (i.e., mechanical, structural, electrical, instrumentation and control). Original Useful Life is used to develop different estimates of remaining useful life, described below. The Original Useful Life estimates for different types of assets are presented in Table 6. These estimates were based on industry standard guidelines (e.g., American

Water Work Association (AWWA), Water Environment Federation (WEF), American Society of Civil Engineers (ASCE), and the International Infrastructure Management Manual (IIMM)).

Table 4 Lift Stations: Condition Assessment: Valve Vault
Public Works Integrated Master Plan
City of Oxnard

Lift Station: Location	Condition Rating			
	Concrete	Anchorage	Coating	Overall
Lift Station 1: Colony	4	3	3	3
Lift Station 2: Harbor	3	1	2	2
Lift Station 4: Mandalay & Wooley	4	4	5	4
Lift Station 6: Canal	2	2	2	2
Lift Station 7	3	3	2	2
Lift Station 8	1	1	1	1
Lift Station 9: Merion Way	2	2	2	2
Lift Station 15: Cascade	3	2	3	3
Lift Station 20: Beardsley	3	4	3	3
Lift Station 23: Wagon Wheel	1	2	1	1
Lift Station 24: Handyman	5	4	5	5
Lift Station 27: Launch Ramp	3	3	3	3
Lift Station 28: Hueneme	2	2	2	2
Lift Station 29: Patterson & Hemlock	2	2	3	2
Lift Station 30: Colony	4	4	4	4

Table 5 Lift Stations: Condition Assessment: Wet Well Structure
Public Works Integrated Master Plan
City of Oxnard

Lift Station: Location	Condition Rating			
	Concrete	Anchorage	Coating	Overall
Lift Station 1: Colony	3	3	4	3
Lift Station 2: Harbor	2	2	3	2
Lift Station 4: Mandalay & Wooley	2	3	2	2
Lift Station 6: Canal	4	3	4	4
Lift Station 7	3	3	2	2
Lift Station 8	1	1	1	1
Lift Station 9: Merion Way	3	3	3	3
Lift Station 15: Cascade	3	2	3	3
Lift Station 20: Beardsley	3	4	4	4
Lift Station 23: Wagon Wheel	1	2	1	1
Lift Station 24: Handyman	5	4	5	5
Lift Station 27: Launch Ramp	2	3	2	2
Lift Station 28: Hueneme	2	2	3	2
Lift Station 29: Patterson & Hemlock	2	2	3	2
Lift Station 30: Colony	3	3	3	3

Table 6 Original Useful Life Based on Asset Category Public Works Integrated Master Plan City of Oxnard	
Asset Category	**Original Useful Life[(1)]**
Civil/Sitework	50
Structural	
General	50
Concrete	50
Fiberglass	25
Steel	25
Plastic	10
Mechanical	
General/Other	20
Valves	35
Pumps – Water	20
Pumps – Wastewater	20
Chemical Feed Pumps	10
Coolers/ACs/Fans	15
Electrical	
General	20
VFDs	15
Instrumentation	
General	10
RTUs	15

Note:
(1) These defaults are based on values from the International Infrastructure Management Manual, Edition 2006, USEPA guides, other industry references, and Carollo project experience.

3.2.21 Evaluated Remaining Useful Life

The EvRUL is based on the current condition of the asset and is the estimated remaining number of years until the physical failure of the asset. EvRUL does not take into account the actual age of the asset; rather it reflects an estimate of remaining useful life based on the observed condition alone. EvRUL was calculated as:

$$(1 - \text{Condition Fraction}) \times \text{Original Useful Life}$$

Condition fractions are shown in Table 7. The relationship between condition ranking and condition fraction reflects the logic that once an asset deteriorates to a below-average condition, its probability of failure increases and its remaining years in service decline more rapidly than for assets that are maintained in good condition. The rehabilitation percentages associated with each condition ranking were used to estimate the condition fractions.

Table 7 Condition Fraction Public Works Integrated Master Plan City of Oxnard	
Condition as Defined in Table 2	**Condition Fraction**
1 (Very Good)	0
2 (Good)	0.10
3 (Fair)	0.20
4 (Poor)	0.40
5 (Very Poor)	0.90

3.2.22 Economic Remaining Useful Life

The Economic Remaining Useful Life (EcRUL) aims to indicate the cost-based optimum time to rehabilitate an asset. EcRUL is an estimate of the point in an asset's service life before the maintenance costs and the likelihood of failure substantially increase, when the asset could still be restored to like-new condition with reasonable reinvestment or be replaced with a newer model offering improved efficiency. For example, a pump that has been overhauled at the right time with new bearings, gear shaft, and impeller may have a fully renewed service life. If the rehabilitation were postponed too late, however, the pump may no longer be serviceable with routine restoration methods. Likewise, a concrete structure in average condition can often be rehabilitated with crack sealing and coating, but if the structure is allowed to deteriorate too far, corrosion may extend to its members and require a rehabilitation effort with costs similar to that of a new building.

Based on Carollo observation of utilities and the management/reinvestments in assets, this period of time often occurs after the asset value reaches approximately half of its original value, when the cost for maintenance or rehabilitation of the asset begins to increase considerably. EcRUL is therefore calculated in from the following equation, which begins with half of the original useful life:

(Original Useful Life / 2) - (Original Useful Life * Condition Fraction)

The precise optimum time for reinvestment or asset renewal cannot be predicted for any asset. Nevertheless, rehabilitation activities that extend beyond typical maintenance activities incur a cost, and this cost is usually less than the cost to replace the asset entirely. Therefore, a utility that wants to ideally optimize expenditures needs to examine rehabilitation opportunities prior to incurring the capital expenditures. EcRUL provides the City with a “trigger point” to conduct rehabilitation versus replacement analysis. EcRUL values are presented in Appendix A.

3.2.23 Vulnerability Summary

The highest vulnerability assets at both the OWTP and lift stations were those that have a poor condition and shorter original useful life. Vulnerability scores can be found in Appendix A for the OWTP and lift station assets.

3.3 Above-ground Criticality

As noted in Section 2.2.2, a criticality matrix was developed for scoring the consequence of failure of assets. Criticality scores are detailed in Appendix A for the OWTP and lift station assets. In general, assets with the highest criticality scores were structural or electrical assets. These have a high criticality score in all categories, and electrical assets in particular have a have a high health and safety factor due to hazards associated with troubleshooting these assets.

3.4 Above-ground Risk

Risk scores can be found in Appendix A for the OWTP and lift station assets. Assets were sorted by risk, and the data set was examined for logical break points. The assets with risk greater than 0.5 are either highly critical or have condition concerns. Assets with risk below 0.46 were grouped in large numbers and were found to be less of concern. Therefore everything above 0.46 is high risk and shown in these tables.

A summary of the highest risk assets at the OWTP is presented by unit process in Table 8. A summary of the highest risk assets among the lift stations is presented by lift station in Table 9.

4.0 BELOW-GROUND ASSET ASSESSMENT

4.1 Below-ground Overview

Figures 2, 3, and 4 show the collection system by diameter, material, and age respectively.

Table 8 High Risk Assets at the OWTP
Public Works Integrated Master Plan
City of Oxnard

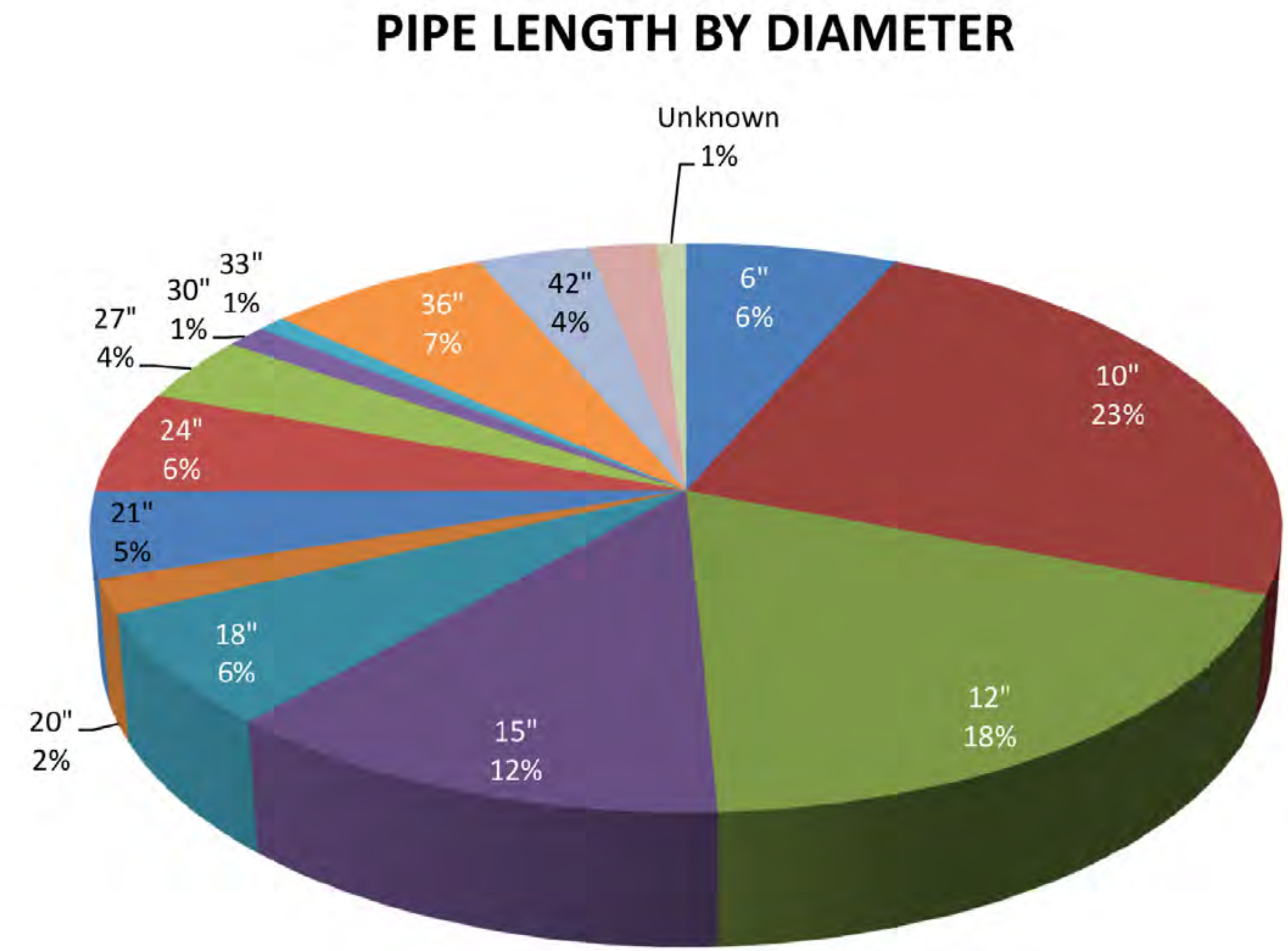
Process/Asset	Risk
Primary Treatment	
Primary Clarifiers (1-4) Collector Drive, Walkways, and Launders	4.48
Sludge Pump Tanks (1-4)	3.85
MCCs-DPIA, DPIB, DP2B, EDPIA	3.85
Scum Ejectors	3.22
Primary Clarifiers (2 & 4)	1.7
Large Isolation Valves	1.04

Table 8 High Risk Assets at the OWTP Public Works Integrated Master Plan City of Oxnard	
Process/Asset	**Risk**
Biofilters	
Recirculation Pumps Mag Drive 1 and 2	3.4
Distributors and Drives	2.17
Biofilter Tanks 1 and 2	1.7
Biofilter Media Tanks (1 & 2)	0.8
Secondary Treatment	
Collector, Skimmer, and Drives (17-18)	1.54
Effluent Pump Station	
MCCs	3.85
Gravity Thickening	
MCCs-DP3C, DP3D	3.85
Thickened Sludge Pumps (1-3)	0.51
Digestion	
Digester Head Exchanger No. 2	3.22
Digester No. 2 Tank	1.52
Digested Sludge Pumps (1-3)	0.51
Digester Control Building	1.46
Digester Hot Water Pump 1	0.51
Digester Mixing Equipment and Draft Tubes Nos. 1-3	0.51
MCCs (DP2C, EDPIC, GF)	0.46
Dewatering	
Conveyors	2.8
Belt Filter Press 1-4	2.8
Dewatering Feed Pump 5	0.51
Washwater Booster Pumps (1-4)	0.51
Electrical	
Effluent Electrical Building Switchgear	5.11
Main Electrical Building Large Standby Generators	4.69
Effluent Electrical Building (DP2A, EBPIB)	3.85
Main Electrical 500 kW Generator	0.7
Older Transformers (1 & 2)	0.51
Main Electrical Building MCCs (DP4, DP4B, GB, GC, GD)	
Administration Building MCCs (DP2D, DP3A, EDPIE, HG)	
Buildings	
Main Switchgear Building	(1.46) Seismic(1)
Plant Control Center Building	(1.46) Seismic(1)
Vacuum Filter	(1.46) Seismic(1)
Blower Building	(1.1) Seismic(1)

Note:
(1) Indicates a seismic deficiency that requires concrete testing, further Tier 2 evaluation, or replacement. Refer to Table 3.

Table 9 High Risk Assets at Lift Stations
Public Works Integrated Master Plan
City of Oxnard

Site/Asset	Risk
Lift Station 23 Wagon Wheel	
Submersible Pumps (1-2)	4.27
MCC	3.85
Wet Well Structure	2.56
SCADA Panel	2.25
Valve Vault	0.68
Lift Station 6 Canal	
Submersible Pumps (1-2)	0.51
MCC	0.46
Lift Station 04 Mandalay & Wooley	
SCADA Panel	0.51
MCC	0.46



COLLECTION SYSTEM DIAMETER

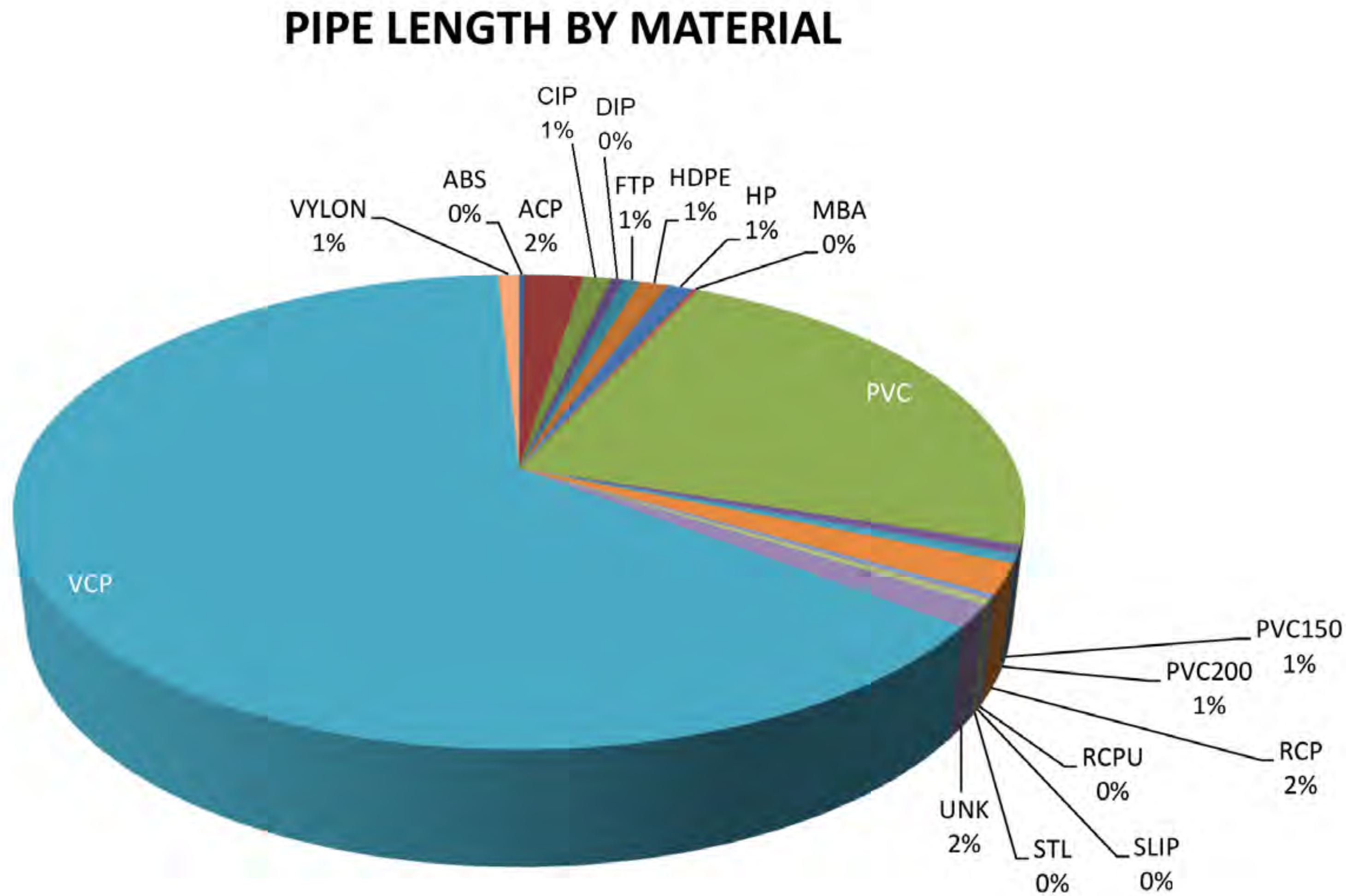
FIGURE 2

CITY OF OXNARD

PM NO. 3.5 – CONDITION ASSESSMENT

PUBLIC WORKS INTEGRATED MASTER PLAN

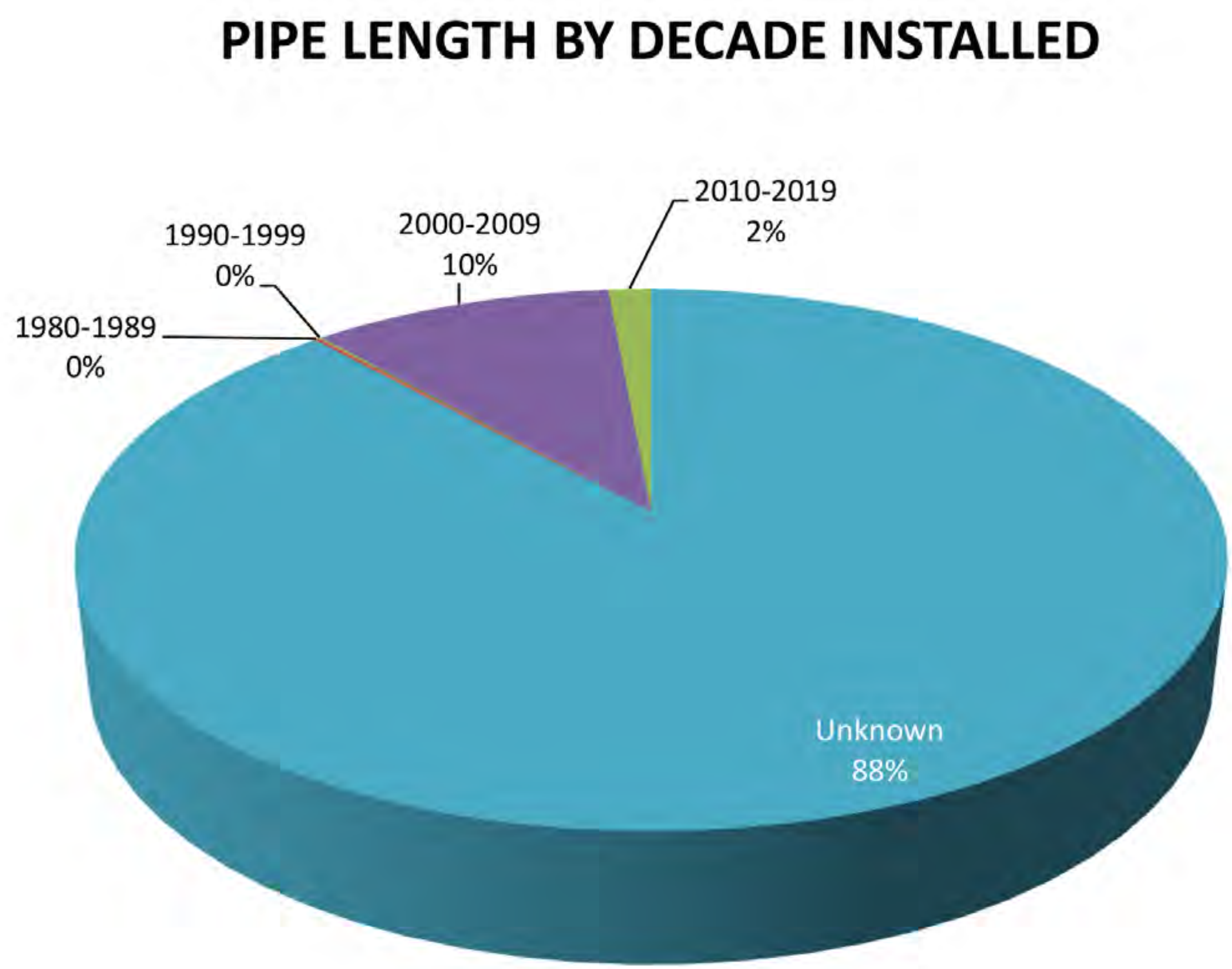
ox0715f39-9587(PM3-5 FIG2).ai



COLLECTION SYSTEM MATERIAL

FIGURE 3

CITY OF OXNARD
PM NO. 3.5 – CONDITION ASSESSMENT
PUBLIC WORKS INTEGRATED MASTER PLAN



COLLECTION SYSTEM AGE

FIGURE 4

CITY OF OXNARD
PM NO. 3.5 – CONDITION ASSESSMENT
PUBLIC WORKS INTEGRATED MASTER PLAN

CITY OF OXNARD CALIFORNIA

carollo Engineers...Working Wonders With Water®

4.2 Below-ground Vulnerability

The useful life of pipes varies based on several factors other than pipe age and material, but these other factors are often difficult to quantify. Other factors affecting pipe failures include:

- Pipe bedding that is substandard.
- Loading from traffic above pipes in the street.
- High groundwater levels.
- Freeze and thaw action of surrounding soils.
- Soil conditions and corrosivity.
- Construction methods, primarily poor quality work.
- Pipe lining issues.
- Level of and need for cathodic protection.
- Operating beyond recommended limitations of material.

Given the complexity of pipe failure prediction, age is typically used as an indicator of condition and therefore remaining useful life. Table 10 shows the reported original useful life expectancies of different pipe materials and the value chosen for input into the desktop evaluation model.

4.2.1 <u>Desktop Evaluation</u>

The desktop evaluation relied on GIS data of the Oxnard collection system. Installation year was not available for 206 of the 263 segments for sewer force mains and 7123 of the 8686 segments for sewer gravity mains. Thus collectively only 18 percent of the collection system piping had a known installation year. Figure 5 shows a map of the collection system assets for which installation year was not indicated.

For the purpose of the analysis, an installation year of 1965 was assumed for these pipes, based on data conservative estimate of development in the area. Figure 6 shows the estimated vulnerability within the collection system based on this assumption.

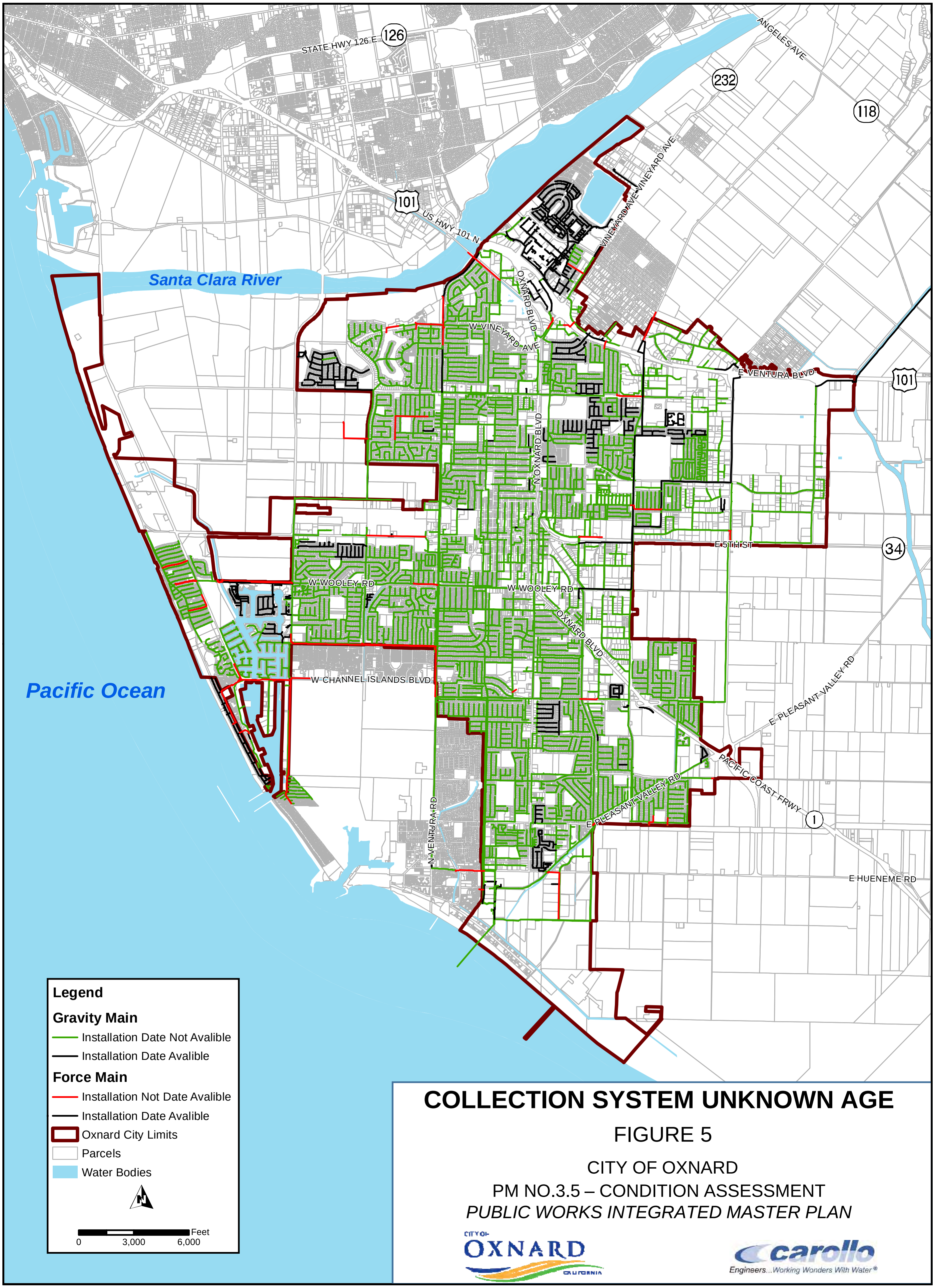
4.2.2 <u>Collection System Cathodic Protection Findings</u>

As noted in Section 3.2.3, a cathodic protection system evaluation was conducted and is presented in a separate report titled Asset Corrosion Assessment and CP Evaluation Survey, dated September 2014. This study includes findings on soil corrosivity applicable to the collection system evaluation. The soil corrosivity study included in situ conductivity measurements at multiple locations throughout the City, as well as twelve soil samples collected and analyzed in a certified laboratory. The findings of the corrosivity study were that the soil conditions range from “Corrosive” to “Severely Corrosive.” These conditions place a stronger emphasis on the need for working cathodic protection systems as well as protective coatings.

Table 10 Original Useful Life Expectancies for Below-Ground Assets
Public Works Integrated Master Plan
City of Oxnard

Material	Pipe Code	Generally (years)	Life Expectancy Range (years)			Chosen Value
			100%	50%	10%	
Unlined Cast Iron	CIU	20 to 150	20 to 90	30 to 115	50 to 150	70
Lined Cast Iron (original)	CIP	30 to 175	30 to 80	50 to 180	70 to 175	115
Lined Ductile Iron (original)	DIP	30 to 200	30 to 100	50 to 150	90 to 200	100
Steel	SCP	20 to 125	20 to 75	40 to 100	60 to 125	70
Asbestos Cement	ACP	20 to 135	25 to 80	35 to 100	50 to 135	65
Concrete	CONC	30 to 200	30 to 100	40 to 150	60 to 200	95
AWWA C900 PVC	C900	30 to 110	40 to 60	60 to 90	90 to 110	75
PVC	PVC	30 to 150	30 to 100	40 to 130	50 to 150	85
Vitrified Clay Pipe	VCP	100	N/A	N/A	N/A	100
Polyethylene	PE	50	N/A	N/A	N/A	50
Manholes	MAN	30 to 100	N/A	N/A	N/A	70

References:
1. AWWARF Report, *Quantifying Future Rehabilitation and Replacement Needs of Water Mains* (1998).
2. *AWWARF Report 91167, Installation, Condition Assessment and Reliability of Service Lines (2007).*



COLLECTION SYSTEM UNKNOWN AGE

FIGURE 5

CITY OF OXNARD

PM NO.3.5 – CONDITION ASSESSMENT

PUBLIC WORKS INTEGRATED MASTER PLAN

CITY OF OXNARD CALIFORNIA

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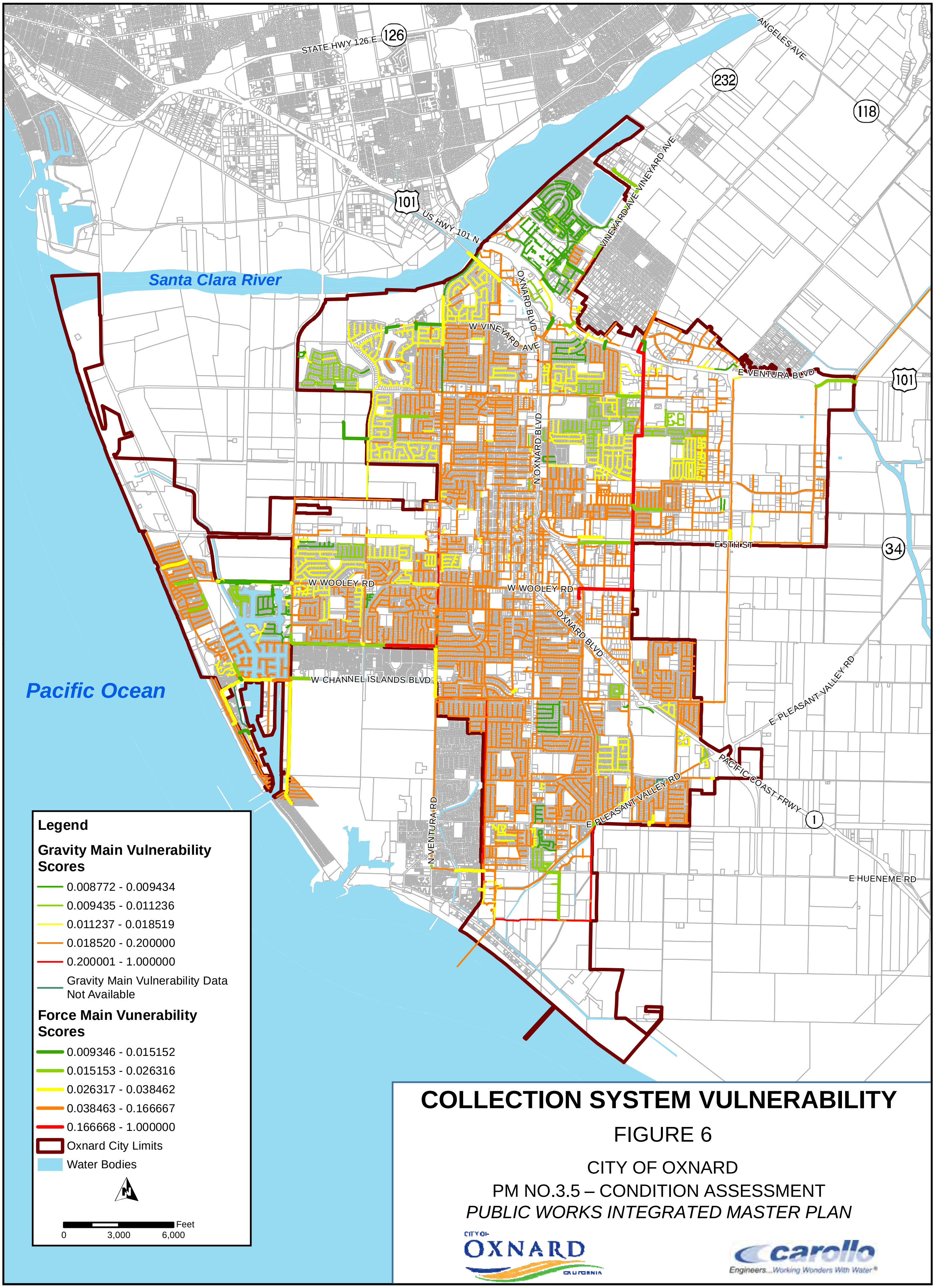

COLLECTION SYSTEM VULNERABILITY

FIGURE 6

CITY OF OXNARD

PM NO.3.5 – CONDITION ASSESSMENT

PUBLIC WORKS INTEGRATED MASTER PLAN

CITY OF OXNARD CALIFORNIA

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4.3 Below-ground Criticality

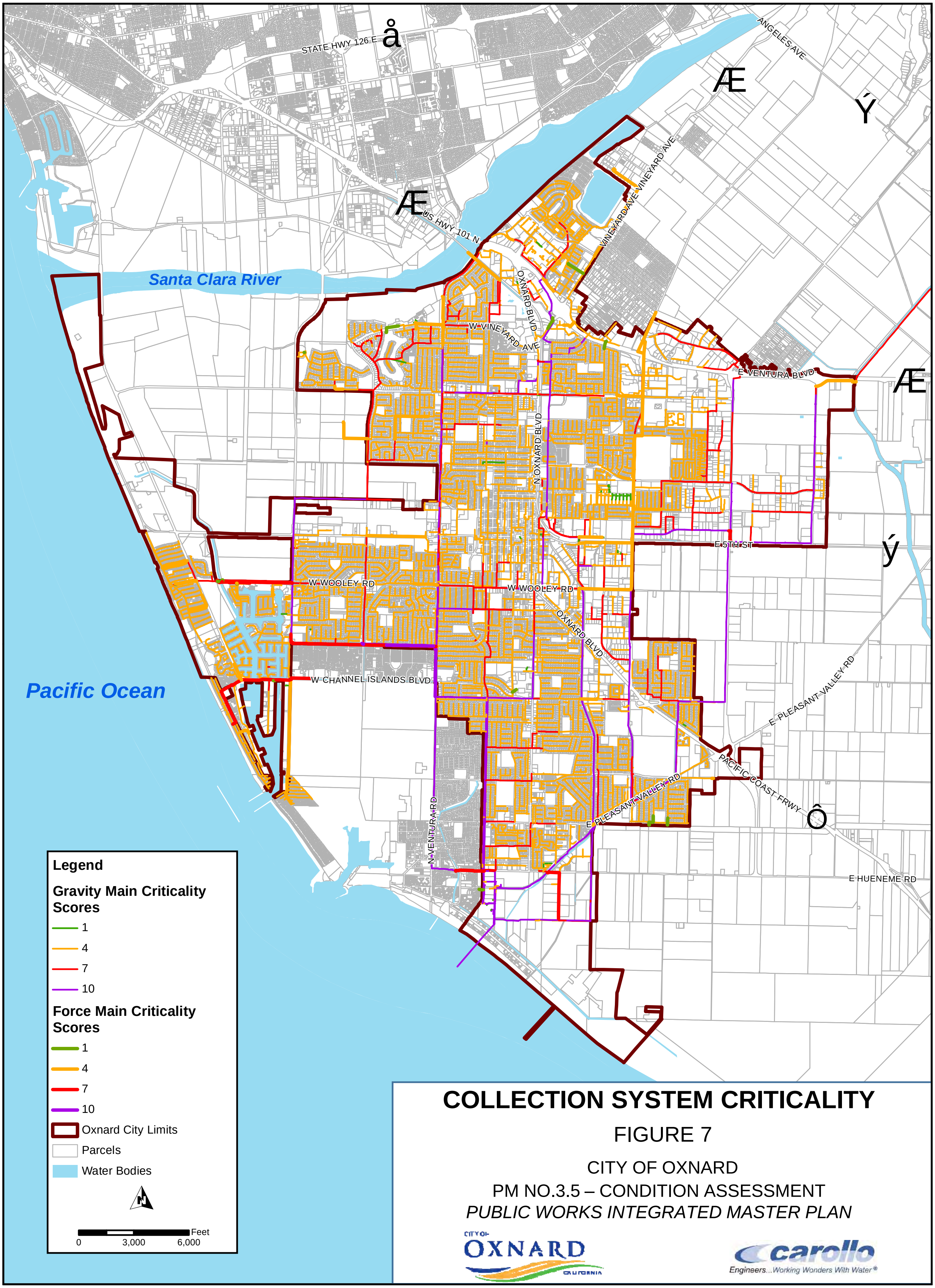
While the criticality scoring system for below-ground assets was structured similar to that used for above-ground assets, specific criteria were developed for each of the below-ground asset systems. These criteria are shown in Table 11. Several of the parameters in the criticality scoring matrix rely on data that is currently being developed in the Public Works Integrated Master Plans modeling efforts. Where data was not available, such as for the number of equivalent dwelling units (EDUs) served by a given segment of pipe, pipe diameter was used as a proxy for criticality. Figure 7 shows a map of the draft criticality scores of the Oxnard collection system, which will be updated when more information is available and following workshops with the City.

4.4 Below-ground Risk

Figure 8 shows a map of the City with the pipes color-coded to show the assets with the greatest potential risk of failure. These assets with the highest risk should be targeted for further inspection, repair, or replacement. As noted above, this figure will be updated when more information is available and following workshops with the City.

Table 11 Below-ground Criticality Ranking Scale
Public Works Integrated Master Plan
City of Oxnard

Criticality Category	Weight	Negligible = 1	Low = 4	Moderate = 7	Severe = 10
Public and Employee Health and Safety	30%	Pipes serving < 100 EDUs	Pipes serving 100-500 EDUs	Pipes serving 500-1,000 EDUs	Pipes serving > 1,000 EDUs or within 500 feet of critical facility
Financial Impact	20%	6” pipes	8” pipes	10” pipes	12” pipes and larger
Environmental or Regulatory Compliance	30%	No pipes	Pipes not within protected habitat or 250 feet of waterway	Uphill from waterway within 250 feet	Pipes in protected natural habitat
Customer Service (Ability to Respond)	20%	Pipes within 2 miles of maintenance headquarters	Pipes greater than 2 miles of maintenance headquarters	Pipes defined as hard to access	Pipes > 12’ deep or > 12” diameter



COLLECTION SYSTEM CRITICALITY

FIGURE 7

CITY OF OXNARD

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CITY OF OXNARD CALIFORNIA

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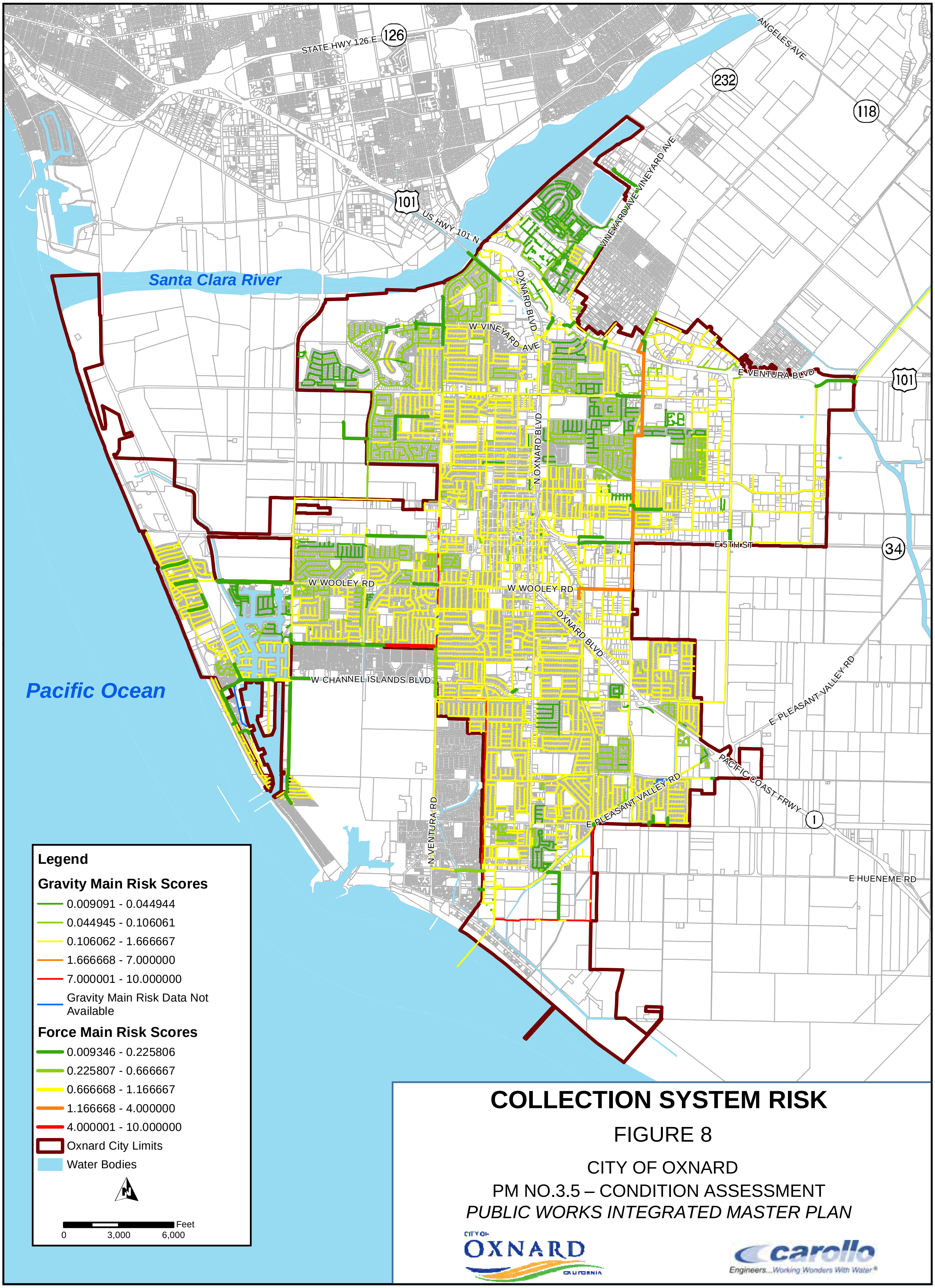

COLLECTION SYSTEM RISK

FIGURE 8

CITY OF OXNARD

PM NO.3.5 – CONDITION ASSESSMENT

PUBLIC WORKS INTEGRATED MASTER PLAN

CITY OF OXNARD CALIFORNIA

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APPENDIX A – OWTP AND LIFT STATIONS CONDITION ASSESSMENT FINDINGS AND RISK SCORES

Condition Assessment Findings and Risk Scores

OWTP

Headworks

Component	Year	Condition	Comments	OUL	EvRUL	EcRUL	Vuln	Criticality	Risk
Bar Screen 1 (Mechanical)	2006.1	3	Light Corrosion on drive. Not in service.	23.2	18.6	7	0.0538	4	0.22
Bar Screen 2 (Mechanical)	2008	2		20	18	8	0.0556	4	0.22
Bar Screen 3 (Mechanical)	2008	3	Not in service.	20	16	6	0.0625	4	0.25
Bar Screen 4 (Mechanical)	2008	3	Light corrosion on drive belt, makes noise.	20	16	6	0.0625	4	0.25
Bar Screen 5 (Manual)	2008	2		20	18	8	0.0556	1.9	0.11
Bar Screen 6 (Manual)	2008	2		20	18	8	0.0556	1.9	0.11
Flowmeter	2008	2		10	9	4	0.1111	2.5	0.28
Grit Blower 1	2008	2		20	18	8	0.0556	2.5	0.14
Grit Blower 2	2008	2		20	18	8	0.0556	2.5	0.14
Grit Blower 3	2008	2		20	18	8	0.0556	2.5	0.14
Grit Blower 4	2008	2		20	18	8	0.0556	2.5	0.14
Grit Pump 1 (West)	2008	2		20	18	8	0.0556	2.5	0.14
Grit Pump 2 (West)	2008	2		20	18	8	0.0556	2.5	0.14
Grit Pump 3 (West)	2008	2		20	18	8	0.0556	2.5	0.14
Grit Pump 4 (West)	2008	2		20	18	8	0.0556	2.5	0.14

1. Original Useful Life.
2. Evaluated Remaining Useful Life.
3. Economic Remaining Useful Life.
4. Vulnerability.

Component	Year	Condition	Comments	OUL	EvRUL	EcRUL	Vuln	Criticality	Risk
Grit Pump 5 (East)	2008	2		20	18	8	0.0556	2.5	0.14
Grit Pump 6 (East)	2008	2		20	18	8	0.0556	2.5	0.14
Grit Pump 7 (East)	2008	2		20	18	8	0.0556	2.5	0.14
Grit Pump 8 (East)	2008	2		20	18	8	0.0556	2.5	0.14
Grit Separator/Classifier 1	2008	2		20	18	8	0.0556	2.5	0.14
Grit Separator/Classifier 2	2008	2		20	18	8	0.0556	2.5	0.14
Headworks Building	2008	2	100' x 20'.	50	45	20	0.0222	10	0.22
Headworks Grit Screens Building	2008	2	40' x 100'.	50	45	20	0.0222	5.2	0.12
Hypo Chemical Feed Pump (Sodium Hypo Pump 2)	2008	2		10	9	4	0.1111	4	0.44
Influent Check Valve 1	2008	2		35	31.5	14	0.0317	1.6	0.05
Influent Check Valve 2	2008	2		35	31.5	14	0.0317	1.6	0.05
Influent Check Valve 3	2008	2		35	31.5	14	0.0317	1.6	0.05
Influent Check Valve 4	2008	2		35	31.5	14	0.0317	1.6	0.05
Influent Check Valve 5	2008	2		35	31.5	14	0.0317	1.6	0.05
Influent Check Valve 6	2008	2		35	31.5	14	0.0317	1.6	0.05
Influent Pump 1	2008	2		20	18	8	0.0556	2.8	0.16
Influent Pump 2	2008	2		20	18	8	0.0556	2.8	0.16
Influent Pump 3	2008	2		20	18	8	0.0556	2.8	0.16
Influent Pump 4	2008	2		20	18	8	0.0556	2.8	0.16
Influent Pump 5	2008	2		20	18	8	0.0556	2.8	0.16

1. Original Useful Life.
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Component	Year	Condition	Comments	OUL	EvRUL	EcRUL	Vuln	Criticality	Risk
Influent Pump 6	2008	2		20	18	8	0.0556	2.8	0.16
MCC- HW	2008	2	AB Centerline. Age assumed by manufacturer.	20	18	8	0.0556	10	0.56
Odor Control Ductworks & Vessels	1994	2		20	18	8	0.0556	5.8	0.32
Remote Telemetry Unit (RTU)	2008	2		15	13.5	6	0.0741	1.6	0.12
Screening Compactor 1	2008	3	Light corrosion. With replacement range.	20	16	6	0.0625	2.5	0.16
Screening Compactor 2	2008	3	Light corrosion. With replacement range.	20	16	6	0.0625	2.5	0.16
Sodium Hydroxide Pump 1	2008	3	Within replacement range.	10	8	3	0.125	4	0.5
Sodium Hydroxide Pump 2	2008	3	Within replacement range.	10	8	3	0.125	4	0.5
Sodium Hydroxide Storage Tank	2008	3	Within replacement range.	30	24	9	0.0417	5.8	0.24
Sodium Hypochlorite Pump 1	2008	3	Within replacement range.	10	8	3	0.125	4	0.5
Sodium Hypochlorite Storage Tank	2008	3	Within replacement range.	30	24	9	0.0417	4	0.17
Standby Generator	2008	2		20	18	8	0.0556	10	0.56
VFDs	2008	2		15	13.5	6	0.0741	4.9	0.36
Primary Treatment									
Clarifier 1 Collector Drive, Walkways, & Launders	1994	5		20	2	-8	0.7	6.4	4.48
Clarifier 2 Collector Drive, Walkways, & Launders	1994	5		20	2	-8	0.7	6.4	4.48
Clarifier 3 Collector Drive, Walkways, & Launders	1994	5		20	2	-8	0.7	6.4	4.48

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Component	Year	Condition	Comments	OUL	EvRUL	EcRUL	Vuln	Criticality	Risk
Clarifier 4 Collector Drive, Walkways, & Launders	1994	5		20	2	-8	0.7	6.4	4.48
Large Isolation Valve 1	1979	5		35	3.5	-14	0.2	5.2	1.04
Large Isolation Valve 2	1979	5		35	3.5	-14	0.2	5.2	1.04
MCC-DP2B	1994	5	Federal Pacific. Age assumed by manufacturer.	20	2	-8	0.7	5.5	3.85
MCC-DPIA	1994	5	Federal Pacific. Age assumed by manufacturer.	20	2	-8	0.7	5.5	3.85
MCC-DPIB	1994	5	Federal Pacific. Age assumed by manufacturer.	20	2	-8	0.7	5.5	3.85
MCC-EDPIA	1994	5	Federal Pacific. 1988 Drawings. Age assumed by manufacturer.	20	2	-8	0.7	5.5	3.85
Primary Clarification Tank 1	1972	4	Penfield and Smith reported cracking, abrasion at the effluent box, comprimised ladder anchorage, and corrosion of catwalk supports. Carollo recommends concrete testing to determine remaining useful life and rehabilitation strategy.	50	30	5	0.0333	8.5	0.28
Primary Clarification Tank 2	1972	5	Penfield and Smith reported cracking, abrasion at the effluent box, comprimised ladder anchorage, and severe corrosion of catwalk supports. Catwalk needs to be replaced. Carollo recommends concrete testing to determine remaining useful life and rehabilitation strategy. Nearing end of useful life.	50	5	-20	0.2	8.5	1.7

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Component	Year	Condition	Comments	OUL	EvRUL	EcRUL	Vuln	Criticality	Risk
Primary Clarification Tank 3	1972	4	Penfield and Smith reported cracking, abrasion at the effluent box, comprimised ladder anchorage, and corrosion of catwalk supports. Carollo recommends concrete testing to determine remaining useful life and rehabilitation strategy.	50	30	5	0.0333	8.5	0.28
Primary Clarification Tank 4	1972	5	Penfield and Smith reported cracking, abrasion at the effluent box, comprimised ladder anchorage, and severe corrosion of catwalk supports. Catwalk needs to be replaced. Carollo recommends concrete testing to determine remaining useful life and rehabilitation strategy. Nearing end of useful life.	50	5	-20	0.2	8.5	1.7
Primary Sedimentation Building	1972	4	Significant sign of decay, shrinkage, and other damage to the wood members, deteriation of masonry units and mortar. 75' x 35'.	50	30	5	0.0333	6.4	0.21
Scum Ejector 1	1994	5		20	2	-8	0.7	4.6	3.22
Scum Ejector 2	1994	5		20	2	-8	0.7	4.6	3.22
Scum Ejector 3	1994	5		20	2	-8	0.7	4.6	3.22
Scum Ejector 4	1994	5		20	2	-8	0.7	4.6	3.22
Sludge Pump Tank 1	1994	5	Nearing end of useful life.	20	2	-8	0.7	5.5	3.85
Sludge Pump Tank 2	1994	5	Nearing end of useful life.	20	2	-8	0.7	5.5	3.85
Sludge Pump Tank 3	1994	5	Nearing end of useful life.	20	2	-8	0.7	5.5	3.85

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Component	Year	Condition	Comments	OUL	EvRUL	EcRUL	Vuln	Criticality	Risk
Sludge Pump Tank 4	1994	5	Nearing end of useful life.	20	2	-8	0.7	5.5	3.85
Bio Filters									
Bio Filter Distributor & Drives Tank 1	1994	5	Distribution tube seal broken.	20	2	-8	0.7	3.1	2.17
Bio Filter Distributor & Drives Tank 2	1994	5		20	2	-8	0.7	3.1	2.17
Bio Filter Tank 1 Media	2014	5	Media falling apart. Concrete in bad condition.	50	5	-20	0.2	4	0.8
Bio Filter Tank 2 Media	2014	5	Center shaft shield broken.	50	5	-20	0.2	4	0.8
Bio Filter Ventilation Blower 1	1994	4		20	12	2	0.0833	4.9	0.41
Bio Filter Ventilation Blower 2	1994	4		20	12	2	0.0833	4.9	0.41
Bio Filter Ventilation Blower 3	1994	4		20	12	2	0.0833	4.9	0.41
Bio Filter Ventilation Blower 4	1994	4		20	12	2	0.0833	4.9	0.41
Biological Trickling Tank 1 Structure	2014	5	Approx. 643,398 sq. ft. (r=64' x 50').	50	5	-20	0.2	8.5	1.7
Biological Trickling Tank 2 Structure	2014	5	Approx. 392,699 sq. ft. (r=64' x 50').	50	5	-20	0.2	8.5	1.7
Recirculation Pump Mag Drive 1	2014	5		20	2	-8	0.7	4.9	3.43
Recirculation Pump Mag Drive 2	2014	5		20	2	-8	0.7	4.9	3.43
Recirculation Tank 1 Pump 1	1994	3	Noise vibration.	20	16	6	0.0625	6.1	0.38
Recirculation Tank 1 Pump 2	1994	3		20	16	6	0.0625	6.1	0.38
Interstage Pump Station									
Interstage Pump 1	1994	3		20	16	6	0.0625	4.3	0.27

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Component	Year	Condition	Comments	OUL	EvRUL	EcRUL	Vuln	Criticality	Risk
Interstage Pump 2	1994	4	Corrosion, noise, vibration.	20	12	2	0.0833	4.3	0.36
Interstage Pump 3	1994	4	Corrosion, noise, vibration.	20	12	2	0.0833	4.3	0.36
Interstage Well Structure	1977	3		50	40	15	0.025	8.2	0.21
Large isolation Valve 1	1979	3		35	28	10.5	0.0357	3.4	0.12
Large Isolation Valve 2	1979	3		35	28	10.5	0.0357	3.4	0.12
Large Isolation Valve 3	1979	3		35	28	10.5	0.0357	3.4	0.12
VFDs	1999	2		15	13.5	6	0.0741	4.3	0.32
Aerated Activated Sludge									
Aeration Basin 1 Structure	1990	3		50	40	15	0.025	3.7	0.09
Aeration Basin 2 Structure	1990	3		50	40	15	0.025	3.7	0.09
Aeration Basin 3 Structure	1990	3		50	40	15	0.025	3.7	0.09
Aeration Basin 4 Structure	1990	3		50	40	15	0.025	3.7	0.09
Aeration Basin 5 Structure	1990	3		50	40	15	0.025	3.7	0.09
Aeration Basin 6 Structure	1990	3		50	40	15	0.025	3.7	0.09
Blower 1	1994	2	6000 scfm, 9.6 psi, Single stage, Turblex blowers.	20	18	8	0.0556	2.8	0.16
Blower 2	1994	2	6000 scfm, 9.6 psi, Single stage, Turblex blowers.	20	18	8	0.0556	2.8	0.16
Blower 3	1994	2	6000 scfm, 9.6 psi, Single stage, Turblex blowers.	20	18	8	0.0556	2.8	0.16
Blower 4	1994	2	6000 scfm, 9.6 psi, Single stage, Turblex blowers.	20	18	8	0.0556	2.8	0.16

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Component	Year	Condition	Comments	OUL	EvRUL	EcRUL	Vuln	Criticality	Risk
Blower 5	1994	2	6000 scfm, 9.6 psi, Single stage, Turblex blowers.	20	18	8	0.0556	2.8	0.16
Diffusers & Piping Basin 1	1994	4		20	12	2	0.0833	3.7	0.31
Diffusers & Piping Basin 2	1994	4		20	12	2	0.0833	3.7	0.31
Diffusers & Piping Basin 3	1994	4		20	12	2	0.0833	3.7	0.31
Diffusers & Piping Basin 4	1994	4	Cracked air piping in some places. Pipe is very brittle.	20	12	2	0.0833	3.7	0.31
Diffusers & Piping Basin 5	1994	4		20	12	2	0.0833	3.7	0.31
Diffusers & Piping Basin 6	1994	4		20	12	2	0.0833	3.7	0.31
Sed/RAS/WAS/Flow Equal									
3WHP Facilities Pump 1	1994	4		20	12	2	0.0833	2.5	0.21
3WHP Facilities Pump 2	1994	4		20	12	2	0.0833	2.5	0.21
3WHP Facilities Pump 3	1994	4		20	12	2	0.0833	2.5	0.21
AST Drain Pump	1994	4		20	12	2	0.0833	1.6	0.13
Blowers (18)	1994	2		20	18	8	0.0556	1.6	0.09
Flow Equalization Basin Structure	1990	4	Penfield and Smith reported exposed rebar, cracking, and spalling.	50	30	5	0.0333	6.1	0.2
Flow Equalization Gates & Drives	1994	3		20	16	6	0.0625	1.6	0.1
Flow Equalization Pump 1	1994	3		20	16	6	0.0625	3.1	0.19
Flow Equalization Pump 2	1994	3		20	16	6	0.0625	3.1	0.19
Flow Equalization Pump 3	1994	3	Wobbling.	20	16	6	0.0625	3.1	0.19
RAS Pump 1	1994	4		20	12	2	0.0833	2.2	0.18

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Component	Year	Condition	Comments	OUL	EvRUL	EcRUL	Vuln	Criticality	Risk
RAS Pump 2	1994	4		20	12	2	0.0833	2.2	0.18
RAS Pump 3	1994	4		20	12	2	0.0833	2.2	0.18
RAS Pump 4	1994	4		20	12	2	0.0833	2.2	0.18
RAS Pump Galley Ventilation Fan 1	1994	3		20	16	6	0.0625	6.1	0.38
RAS Pump Galley Ventilation Fan 2	1994	3		20	16	6	0.0625	6.1	0.38
Secondary Sed. Collector, Skimmer & Drives (1-16)	1994	3	Basin 13-16 have manual skimmers that work well. 1-12 have motorized skimmers that don't work.	20	16	6	0.0625	2.2	0.14
Secondary Sed. Collector, Skimmer & Drives (17-18)	1994	5	Mechanisms need to be completely rehabbed.	20	2	-8	0.7	2.2	1.54
Secondary Sed. Sludge Magnetic Flow Meters (18)	2004	3	Magnetic flow meter placed on every secondary sludge line (dwgs).	10	8	3	0.125	2.5	0.31
Secondary Sedimentation Skimmings Pumps (18)	1994	3	Change impeller on one pump.	20	16	6	0.0625	1.6	0.1
Secondary Sedimentation Tanks (18)	1990	3	Carollo recommends concrete testing to determine concrete condition and seismic strengthening opions.	50	40	15	0.025	2.8	0.07
VFDs	1999	3		15	12	4.5	0.0833	1.6	0.13
WAS Pump 1	1994	4		20	12	2	0.0833	3.7	0.31
WAS Pump 2	1994	4		20	12	2	0.0833	3.7	0.31
WAS Pump 3	1994	4		20	12	2	0.0833	3.7	0.31
Disinfection Facilities									
Chlorine Contact Gates, Supports & Operators	1994	4		20	12	2	0.0833	1.6	0.13

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Component	Year	Condition	Comments	OUL	EvRUL	EcRUL	Vuln	Criticality	Risk
Chlorine Contact Tank Structure	1972	3	Penfield & Smith reported minor cracks, staining, and spalling. Carollo advises concrete testing to confirm condition and determine long-term needs.	50	40	15	0.025	5.2	0.13
Hypo Pump 1	2004	3	Not in use.	10	8	3	0.125	1	0.13
Hypo Pump 2	2004	3	Not in use.	10	8	3	0.125	1	0.13
Hypo Pump 3	2004	3	Not in use.	10	8	3	0.125	1	0.13
Hypo Pump 4	2004	3	Not in use.	10	8	3	0.125	1	0.13
Hypo Pump 5	2004	3	Not in use.	10	8	3	0.125	1	0.13
Hypo Pump 6	2004	3	Not in use.	10	8	3	0.125	1	0.13
Hypo Tank 1	2000	3	Not in use.	30	24	9	0.0417	6.7	0.28
Hypo Tank 2	1990	3	In use for disinfecting 3WHP.	30	24	9	0.0417	6.7	0.28
Effluent - Pump Station (EPS)									
Effluent Pump Station Building	1972	3	Penfield and Smith reported minor cracking and shallow spalling in places, as well as timber joist checking. Building size is 25' x 25'.	50	40	15	0.025	7.3	0.18
Effluent - Pump Station (EPS)									
Engine Drive 2	2004	3	500 KW. Manifold replaced rebuilt more than 10 year ago.	20	16	6	0.0625	4	0.25
Effluent - Pump Station (EPS)									
Large isolation Valves (4)	1979	3		35	28	10.5	0.0357	3.4	0.12
Effluent - Pump Station (EPS)									

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Component	Year	Condition	Comments	OUL	EvRUL	EcRUL	Vuln	Criticality	Risk
MCC-DP4A	1994	5	Federal Pacific. Age assumed by manufacturer.	20	2	-8	0.7	5.5	3.85
Effluent - Pump Station (EPS)									
MCC-EDPID	1994	5	Federal Pacific. Age assumed by manufacturer.	20	2	-8	0.7	5.5	3.85
Effluent - Pump Station (EPS)									
Pump 1	1994	3		20	16	6	0.0625	6.1	0.38
Effluent - Pump Station (EPS)									
Pump 2	2006	2	Brand new.	20	18	8	0.0556	6.1	0.34
Effluent - Pump Station (EPS)									
Pump 3	1994	3		20	16	6	0.0625	6.1	0.38
Effluent - Pump Station (EPS)									
Pump 4	1994	3		20	16	6	0.0625	6.1	0.38
Effluent - Pump Station (EPS)									
Pump 5 - Big Red	1994	4		20	12	2	0.0833	1	0.08
Effluent - Pump Station (EPS)									
VFDs	1999	2		15	13.5	6	0.0741	3.4	0.25
Gravity Thickeners & Blower Building									
Blower Building	2008	5	36' x 18'.	50	5	-20	0.2	5.5	1.1
Gravity Thickeners & Blower Building									
Blower Building Remote Telemetry Unit (RTU)	1999	3		15	12	4.5	0.0833	3.4	0.28
Gravity Thickeners & Blower Building									
Fans/ Louvers Tank 1	1994	4	Needs service every other month.	20	12	2	0.0833	4.9	0.41

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Component	Year	Condition	Comments	OUL	EvRUL	EcRUL	Vuln	Criticality	Risk
Gravity Thickeners & Blower Building									
Fans/ Louvers Tank 2	2009	4	New service every other month.	20	12	2	0.0833	4.9	0.41
Gravity Thickeners & Blower Building									
Collector Drive, Walkways, Launders Tank 1	1994	4		20	12	2	0.0833	5.2	0.43
Gravity Thickeners & Blower Building									
Collector Drive, Walkways, Launders Tank 2	1994	4		20	12	2	0.0833	5.2	0.43
Gravity Thickeners & Blower Building									
Gravity Thickening Tank 1	1964	4	Approx. 47,557 sq. ft. (r=29, h=18).	50	30	5	0.0333	8.5	0.28
Gravity Thickeners & Blower Building									
Gravity Thickening Tank 2	1964	4	Approx. 47,557 sq. ft. (r=29, h=18).	50	30	5	0.0333	8.5	0.28
Gravity Thickeners & Blower Building									
MCC -DP3C	1994	5	Federal Pacific. Should move to own building- sludge dew. Age assumed by manufacturer.	20	2	-8	0.7	5.5	3.85
Gravity Thickeners & Blower Building									
MCC -DP3D	1994	5	Federal Pacific. Age assumed by manufacturer.	20	2	-8	0.7	5.5	3.85
Gravity Thickeners & Blower Building									
MCC-NG	1994	4	Westinghouse. Age assumed by manufacturer.	20	12	2	0.0833	5.5	0.46
Gravity Thickeners & Blower Building									
Odor Reduction Tower	1977	4	25' x 25'.	50	30	5	0.0333	7.3	0.24
Gravity Thickeners & Blower Building									

1. Original Useful Life.
2. Evaluated Remaining Useful Life.
3. Economic Remaining Useful Life.
4. Vulnerability.

Component	Year	Condition	Comments	OUL	EvRUL	EcRUL	Vuln	Criticality	Risk
Thickened Sludge Pump 1	1994	4		20	12	2	0.0833	6.1	0.51
Gravity Thickeners & Blower Building									
Thickened Sludge Pump 2	1994	4		20	12	2	0.0833	6.1	0.51
Gravity Thickeners & Blower Building									
Thickened Sludge Pump 3	1994	4		20	12	2	0.0833	6.1	0.51
DAF									
DAF Air Saturation Tank #1	2014	3		20	16	6	0.0625	6.7	0.42
DAF Air Saturation Tank #2	2014	3		20	16	6	0.0625	6.7	0.42
DAF Collectors Drives Tank 1	1994	3	Vibration and noise present.	20	16	6	0.0625	3.7	0.23
DAF Collectors Drives Tank 2	1994	3	Rebuilt inside baffle of piping 7 years ago.	20	16	6	0.0625	3.7	0.23
DAF Compressor 1	1999	3		15	12	4.5	0.0833	1.9	0.16
DAF Compressor 2	1999	3		15	12	4.5	0.0833	1.9	0.16
DAF Compressor 3	1999	3		15	12	4.5	0.0833	1.9	0.16
DAF Compressor 4	1999	3		15	12	4.5	0.0833	1.9	0.16
DAF Starter Rack	1994	3		20	16	6	0.0625	4	0.25
DAF Tank 1	1990	4	Penfield & Smith reported cracks, and delaminated and spalled concrete. Carollo recommends concrete testing to determine condition and long-term needs. Approx. 115,812 sq. ft. (r=48', h=18').	50	30	5	0.0333	8.5	0.28

1. Original Useful Life.
2. Evaluated Remaining Useful Life.
3. Economic Remaining Useful Life.
4. Vulnerability.

Component	Year	Condition	Comments	OUL	EvRUL	EcRUL	Vuln	Criticality	Risk
DAF Tank 2	1990	3	Penfield & Smith reported cracks, and delaminated and spalled concrete. Carollo recommends concrete testing to determine condition and long-term needs. Approx. 115,812 sq. ft. (r=48', h=18'). Rebuilt interiors.	50	40	15	0.025	8.5	0.21
DAF TWAS Sludge Pump 1	1994	3		20	16	6	0.0625	6.1	0.38
DAF TWAS Sludge Pump 2	1994	3	Replaced parts once.	20	16	6	0.0625	6.1	0.38
DAF Underflow Recirculation Pump 1	1994	3		20	16	6	0.0625	6.1	0.38
DAF Underflow Recirculation Pump 2	2014	3		20	16	6	0.0625	6.1	0.38
DAF VFDs	1999	3		15	12	4.5	0.0833	3.4	0.28
Polymer Blending Unit 1	1994	3		20	16	6	0.0625	4	0.25
Polymer Blending Unit 2	1994	3		20	16	6	0.0625	4	0.25
Polymer Building	2014	3	25' x 20'.	50	40	15	0.025	7.3	0.18
Polymer Bulk Building Storage Tank	1990	3		30	24	9	0.0417	7.3	0.3
Polymer Solution Pump 1	1994	3		20	16	6	0.0625	6.1	0.38
Polymer Solution Pump 2	1994	3		20	16	6	0.0625	6.1	0.38
Polymer Solution Pump 3	1994	3		20	16	6	0.0625	6.1	0.38
Polymer Transfer Pump	1994	3		20	16	6	0.0625	6.1	0.38
Digestion									
Digested Sludge Pump 1	2014	4	Progressive Cavity Pump.	20	12	2	0.0833	6.1	0.51

1. Original Useful Life.
2. Evaluated Remaining Useful Life.
3. Economic Remaining Useful Life.
4. Vulnerability.

Component	Year	Condition	Comments	OUL	EvRUL	EcRUL	Vuln	Criticality	Risk
Digested Sludge Pump 2	2014	4		20	12	2	0.0833	6.1	0.51
Digested Sludge Pump 3	2014	4		20	12	2	0.0833	6.1	0.51
Digestor Blower 1	1994	4		20	12	2	0.0833	4.9	0.41
Digestor Blower 2	1994	4		20	12	2	0.0833	4.9	0.41
Digestor Blower 3	1994	4		20	12	2	0.0833	4.9	0.41
Digestor Blower 4	1994	4		20	12	2	0.0833	4.9	0.41
Digestor Blower 5	1994	4		20	12	2	0.0833	4.9	0.41
Digestor Blower 6	1994	3	Big.	20	16	6	0.0625	4.9	0.31
Digestor Blower 7	1994	3	Big.	20	16	6	0.0625	4.9	0.31
Digestor Control Building	1977	5	Significant signs of decay, shrinkage, and other damage to the wood members, deterioation of the masonry units. 35' x 50 '.	50	5	-20	0.2	7.3	1.46
Digestor Flares	1984	3	Used only when cogen is out of service. Installed new igniters 2 months old.	30	24	9	0.0417	3.4	0.14
Digestor Heat Exchanger 1	1994	4	Corrosion and noise present.	20	12	2	0.0833	4.6	0.38
Digestor Heat Exchanger 2	1994	5	Out of service.	20	2	-8	0.7	4.6	3.22
Digestor Heat Exchanger 3	1994	4		20	12	2	0.0833	4.6	0.38
Digestor No. 1 Hot Water Pump 4	1994	4		20	12	2	0.0833	6.1	0.51
Digestor No. 1 Mixing Equipment & Draft Tubes	1999	4	Gas piping. Installed temporary seals at multiple places.	15	9	1.5	0.1111	4.6	0.51

1. Original Useful Life.
2. Evaluated Remaining Useful Life.
3. Economic Remaining Useful Life.
4. Vulnerability.

Component	Year	Condition	Comments	OUL	EvRUL	EcRUL	Vuln	Criticality	Risk
Digestor No. 1 Tank	1977	4	Diameter = 45, height 50'. Roof was redone to a fixed roof. Digestor has a crack on the side all the way to the top.	50	30	5	0.0333	7.6	0.25
Digestor No. 2 Mixing Equipment & Draft Tubes	1999	4		15	9	1.5	0.1111	4.6	0.51
Digestor No. 2 Tank	1977	5	Diameter = 45, height 50'. Not in service. Roof in bad condition. Out of service.	50	5	-20	0.2	7.6	1.52
Digestor No. 3 Mixing Equipment & Draft Tubes	1999	4	Piping corrosion, sediment trap is corroding.	15	9	1.5	0.1111	4.6	0.51
Digestor No. 3 Tank	1990	4	Diameter = 55, height 50'.	50	30	5	0.0333	7.6	0.25
MCC-DP2C	1994	5	Federal Pacific. Age assumed by manufacturer.	20	2	-8	0.7	5.5	3.85
MCC-EDPIC	1994	5	Federal Pacific. Age assumed by manufacturer.	20	2	-8	0.7	5.5	3.85
MCC-GF	1994	5	Federal Pacific. Age assumed by manufacturer.	20	2	-8	0.7	5.5	3.85
Petroleum Gas Tank	1984	3		30	24	9	0.0417	7.3	0.3
Remote Telemetry Unit (RTU)	1999	3		15	12	4.5	0.0833	3.4	0.28
SCADA System Terminal	2004	3		10	8	3	0.125	2.5	0.31
Dewatering									
Air Handling Unit and Odord Control	2014	4		20	12	2	0.0833	1	0.08
Belt Filter Press 1	1994	5	Corroded. Have not rebuilt in a long time.	20	2	-8	0.7	4	2.8
Belt Filter Press 2	2014	5		20	2	-8	0.7	4	2.8

1. Original Useful Life.
2. Evaluated Remaining Useful Life.
3. Economic Remaining Useful Life.
4. Vulnerability.

Component	Year	Condition	Comments	OUL	EvRUL	EcRUL	Vuln	Criticality	Risk
Belt Filter Press 3	2014	5		20	2	-8	0.7	4	2.8
Belt Filter Press 4	2014	5		20	2	-8	0.7	4	2.8
Conveyers	1994	5	System is corroded, needs replacement. Drive noise and vibration.	20	2	-8	0.7	4	2.8
Dewatering Feed Pump 1	1994	3		20	16	6	0.0625	6.1	0.38
Dewatering Feed Pump 2	1994	3		20	16	6	0.0625	6.1	0.38
Dewatering Feed Pump 3	1994	3		20	16	6	0.0625	6.1	0.38
Dewatering Feed Pump 4	1994	3		20	16	6	0.0625	6.1	0.38
Dewatering Feed Pump 5	1994	4		20	12	2	0.0833	6.1	0.51
Dewatering Feed Sludge Grinder	1994	4		20	12	2	0.0833	4	0.33
Eastern Trunk Pump Station	1990	4	Westinghouse.	50	30	5	0.0333	7.3	0.24
Fans/ Louvers	1994	3		20	16	6	0.0625	4.9	0.31
Gravity Thickener Scrubber	1999	4		15	9	1.5	0.1111	4	0.44
MCC-SH	1994	4	Westinghouse. Age assumed by manufacturer.	20	12	2	0.0833	5.5	0.46
Odor Control Ductworks & Vessels	1994	3		20	16	6	0.0625	4.9	0.31
Polyblend Unit 1	2014	4		20	12	2	0.0833	4	0.33
Polyblend Unit 2	2014	4		20	12	2	0.0833	4	0.33
Polyblend Unit 3	2014	4		20	12	2	0.0833	4	0.33
Polyblend Unit 4	2014	4		20	12	2	0.0833	4	0.33

1. Original Useful Life.
2. Evaluated Remaining Useful Life.
3. Economic Remaining Useful Life.
4. Vulnerability.

Component	Year	Condition	Comments	OUL	EvRUL	EcRUL	Vuln	Criticality	Risk
Solids Processing Building	1990	3	Penfield and Smith reported cracks, spalling, and corrosion to struts. 60' x 75'.	50	40	15	0.025	7.3	0.18
Solids Processing Polmer Storage Addition Tank	1990	3		30	24	9	0.0417	7.3	0.3
Solids Processing Polymer Chemical Storage eq	1994	3		20	16	6	0.0625	4	0.25
VFDs	1999	3		15	12	4.5	0.0833	3.4	0.28
Washwater Booster Pump 1	2014	4		20	12	2	0.0833	6.1	0.51
Washwater Booster Pump 2	2014	4		20	12	2	0.0833	6.1	0.51
Washwater Booster Pump 3	2014	4		20	12	2	0.0833	6.1	0.51
Washwater Booster Pump 4	2014	4		20	12	2	0.0833	6.1	0.51
Cogen/Generator Building									
Cogen Air Handling Unit	2010	4	15 hp. Vibration and noise present. Ducting replaced 4 years ago.	20	12	2	0.0833	4	0.33
Cogen Blended Gas Blower	1994	4		20	12	2	0.0833	4.9	0.41
Cogen Blower 1 DG	1994	4		20	12	2	0.0833	4.9	0.41
Cogen Blower 1 NG	1994	4		20	12	2	0.0833	4.9	0.41
Cogen Blower 2 DG	1994	4		20	12	2	0.0833	4.9	0.41
Cogen Blower 2 NG	1994	4		20	12	2	0.0833	4.9	0.41
Cogen Engine Generator 1	1994	3	500 KW. Rebuilt regularly. Some corrosion on roof, paint peeling.	20	16	6	0.0625	6.7	0.42
Cogen Engine Generator 2	1994	3	500 KW. Rebuilt regularly. Some corrosion on roof, paint peeling.	20	16	6	0.0625	6.7	0.42

1. Original Useful Life.
2. Evaluated Remaining Useful Life.
3. Economic Remaining Useful Life.
4. Vulnerability.

Component	Year	Condition	Comments	OUL	EvRUL	EcRUL	Vuln	Criticality	Risk
Cogen Engine Generator 3	1994	3	500 KW. Rebuilt regularly. Some corrosion on roof, paint peeling.	20	16	6	0.0625	6.7	0.42
Cogen Switchgear	1994	3		20	16	6	0.0625	4	0.25
Cogen/Generator Building	1977	3	Significant decay, shrinkage, damage to wood members, deterioration of masonry units. Building size approx. 1500 sq.ft.	50	40	15	0.025	7.3	0.18
MCC-DP3B	1994	5	Federal Pacific. Age assumed by manufacturer.	20	2	-8	0.7	5.5	3.85
MCC-GA	1994	4	Westinghouse. Age assumed by manufacturer.	20	12	2	0.0833	5.5	0.46

Electrical - Main Electrical Building

Component	Year	Condition	Comments	OUL	EvRUL	EcRUL	Vuln	Criticality	Risk
Large Standby Generator 1	1994	5	1.5 MW. Tested 20 minutes a month. Burns 75 gallons per hour. Parts Available. Condition 5 based on inability to bring emergency power on line in short time. Overall emergency power system needs to be improved.	20	2	-8	0.7	6.7	4.69

Electrical - Main Electrical Building

Component	Year	Condition	Comments	OUL	EvRUL	EcRUL	Vuln	Criticality	Risk
Large Standby Generator 2	1994	5	1.5 MW. Tested 20 minutes a month. Burns 75 gallons per hour. Parts Available. Condition 5 based on inability to bring emergency power on line in short time. Overall emergency power system needs to be improved.	20	2	-8	0.7	6.7	4.69

Electrical - Main Electrical Building

1. Original Useful Life.
2. Evaluated Remaining Useful Life.
3. Economic Remaining Useful Life.
4. Vulnerability.

Component	Year	Condition	Comments	OUL	EvRUL	EcRUL	Vuln	Criticality	Risk
500 kW Generator	2006	5	Caterpillar 500 kW generator, located at Old Headworks. Diesel. Condition 5 based on inability to bring emergency power on line in short time. Overall emergency power system needs to be improved.	20	2	-8	0.7	1	0.7
Electrical - Main Electrical Building									
Main Electrical/Switchgear Building	1977	5	Significant sign of decay, shrinkage, and other damage to wood members noted. 31' x 47'.	50	5	-20	0.2	7.3	1.46
Electrical - Main Electrical Building									
MCC-DP4	1994	5	Federal Pacific. Age assumed by manufacturer.	20	2	-8	0.7	5.5	3.85
Electrical - Main Electrical Building									
MCC-DP4B	1994	5	Federal Pacific. Age assumed by manufacturer.	20	2	-8	0.7	5.5	3.85
Electrical - Main Electrical Building									
MCC-GB	1994	5	Federal Pacific. Age assumed by manufacturer.	20	2	-8	0.7	5.5	3.85
Electrical - Main Electrical Building									
MCC-GC	1994	5	Federal Pacific. Age assumed by manufacturer.	20	2	-8	0.7	5.5	3.85
Electrical - Main Electrical Building									
MCC-GD	1994	5	Federal Pacific. Age assumed by manufacturer.	20	2	-8	0.7	5.5	3.85
Electrical - Main Electrical Building									
Older Transformer 1	1994	4	This one is older.	20	12	2	0.0833	6.1	0.51
Electrical - Main Electrical Building									

1. Original Useful Life.
2. Evaluated Remaining Useful Life.
3. Economic Remaining Useful Life.
4. Vulnerability.

Component	Year	Condition	Comments	OUL	EvRUL	EcRUL	Vuln	Criticality	Risk
Older Transformer 2	1994	4		20	12	2	0.0833	6.1	0.51
Electrical - Main Electrical Building									
Switchboard MA-MB	1994	3		20	16	6	0.0625	4	0.25
Electrical - Main Electrical Building									
Switchgear 1	1994	3		20	16	6	0.0625	4	0.25
Electrical - Main Electrical Building									
Switchgear 2	2014	4		20	12	2	0.0833	4	0.33
Electrical - Main Electrical Building									
Switchgear HW	1994	3		20	16	6	0.0625	4	0.25
Electrical - Main Electrical Building									
Transformer A	1994	1	2000 KVA.	20	20	10	0.05	6.1	0.31
Electrical - Main Electrical Building									
Transformer B	1994	1	2500 KVA.	20	20	10	0.05	6.1	0.31
Electrical - North Area Electrical Building									
MCC-NA	1994	4	Westinghouse Series 2100. Activated sludge blower motor control center.	20	12	2	0.0833	5.5	0.46
Electrical - North Area Electrical Building									
MCC-NC	1994	4	Westinghouse Series 2100. VFD motor control center.	20	12	2	0.0833	5.5	0.46
Electrical - North Area Electrical Building									
MCC-ND	1994	4	Westinghouse Series 2100. Age assumed by manufacturer.	20	12	2	0.0833	5.5	0.46
Electrical - North Area Electrical Building									

1. Original Useful Life.
2. Evaluated Remaining Useful Life.
3. Economic Remaining Useful Life.
4. Vulnerability.

Component	Year	Condition	Comments	OUL	EvRUL	EcRUL	Vuln	Criticality	Risk
MCC-NE	1994	4	Westinghouse Series 2100. Age assumed by manufacturer.	20	12	2	0.0833	5.5	0.46
Electrical - North Area Electrical Building									
MCC-NF	1994	4	Westinghouse Series 2100. Age assumed by manufacturer.	20	12	2	0.0833	5.5	0.46
Electrical - North Area Electrical Building									
North Area Electrical Building Structure	1990	2	No signficant signs of deterioration. 50' x 40'.	50	45	20	0.0222	7.3	0.16
Electrical - North Area Electrical Building									
Remote Telemetry Unit (RTU)	1999	3		15	12	4.5	0.0833	3.4	0.28
Electrical - North Area Electrical Building									
Switchboard-NB	1994	2		20	18	8	0.0556	4	0.22
Electrical - North Area Electrical Building									
Switchgear	1994	3		20	16	6	0.0625	4	0.25
Electrical - North Area Electrical Building									
Swithcboards Large	1990	2		30	27	12	0.037	4	0.15
Electrical - North Area Electrical Building									
Transformer TC	1994	3	1000KVA, 2300/480V.	20	16	6	0.0625	6.1	0.38
Electrical - North Area Electrical Building									
Transformer TD	1994	2	1000KVA, 2300/480V.	20	18	8	0.0556	6.1	0.34
Electrical - North Area Electrical Building									
VFDs (13)	1999	2		15	13.5	6	0.0741	3.4	0.25
General - Administration Building									
Administration Building	1977	3	100' x 150'.	50	40	15	0.025	7.3	0.18

1. Original Useful Life.
2. Evaluated Remaining Useful Life.
3. Economic Remaining Useful Life.
4. Vulnerability.

Component	Year	Condition	Comments	OUL	EvRUL	EcRUL	Vuln	Criticality	Risk
MCC- DP2D	1994	5	Federal Pacific. Age assumed by manufacturer.	20	2	-8	0.7	5.5	3.85
MCC-DP3A	1994	5	Federal Pacific. Age assumed by manufacturer.	20	2	-8	0.7	5.5	3.85
MCC-EDPIE	1994	5	Federal Pacific. Age assumed by manufacturer.	20	2	-8	0.7	5.5	3.85
Remote Telemetry Unit (RTU)	1999	3		15	12	4.5	0.0833	3.4	0.28
General - Plant Control Center									
Operations/Plant Control Center Building	1977	5	Significant sign of decay, shrinkage, and other damage to wood members and deterioation to masonry units was noted. Building size is 50' x 90'.	50	5	-20	0.2	7.3	1.46
Remote Telemetry Unit (RTU)	1999	3		15	12	4.5	0.0833	3.4	0.28
General - Collection System Maintenance									
Collection System Maintenance Building	1990	4		50	30	5	0.0333	7.3	0.24
General - Maintenance Building									
Maintenance Building	1990	3	Deterioration of wood members noted.	50	40	15	0.025	7.3	0.18
Truck Scale	1994	3		20	16	6	0.0625	4	0.25

1. Original Useful Life.
2. Evaluated Remaining Useful Life.
3. Economic Remaining Useful Life.
4. Vulnerability.

Component	Year	Condition	Comments	OUL	EvRUL	EcRUL	Vuln	Criticality	Risk
General - Vacuum Filtration									
Vacuum Filtration Building	1964	5	Signicant sign of decay, shrinkage, and other damage to the wood members, deterioration of masonry masonry units and morotor, and significant wall cracks were noted. Buidling size is approx. 1000 sq. ft. Used as storage.	50	5	-20	0.2	7.3	1.46
General - Butler Storage Building									
Butler Building 1	1977	4	Significant corrosion noted on steel. Building size approx. 1500 sq.ft.	50	30	5	0.0333	7.3	0.24
Butler Building 2	2014	4		50	30	5	0.0333	1	0.03
MCC-HC	1994	4	Westignhouse. Age assumed by manufacturer.	20	12	2	0.0833	5.5	0.46
MCC-HG	1994	5	Federal Pacific. Age assumed by manufacturer.	20	2	-8	0.7	5.5	3.85
General - Chemical Handling Facilities									
Chemical Handling Facilities Building	2014	4	25' x 50'. Used as electrical shop.	50	30	5	0.0333	7.3	0.24
Ferric Chloride Pump 1	2014	3		20	16	6	0.0625	1	0.06
Ferric Chloride Pump 2	2014	3		20	16	6	0.0625	1	0.06
General - Effluent Electrical Building									
Effluent Electrical/16 kW Switchgear Building	2014	4	35' x 25'.	50	30	5	0.0333	7.3	0.24
Gym Switchgear	2014	5	Westinghouse.	20	2	-8	0.7	7.3	5.11
MCC- DP2A	2014	5	Federal Pacific.	20	2	-8	0.7	5.5	3.85

1. Original Useful Life.
2. Evaluated Remaining Useful Life.
3. Economic Remaining Useful Life.
4. Vulnerability.

Component	Year	Condition	Comments	OUL	EvRUL	EcRUL	Vuln	Criticality	Risk
MCC- EBPIB	2014	5	Federal Pacific.	20	2	-8	0.7	5.5	3.85

WW Lift Stations

Lift Station 01 Cabezone

Component	Year	Condition	Comments	OUL	EvRUL	EcRUL	Vuln	Criticality	Risk
Flow Meter	2004	3	4" diameter.	10	8	3	0.125	2.5	0.31
MCC	1994	4		20	12	2	0.0833	5.5	0.46
SCADA Panel	2004	3		10	8	3	0.125	2.5	0.31
Submersible Pump 1	1994	3		20	16	6	0.0625	6.1	0.38
Submersible Pump 2	1994	3		20	16	6	0.0625	6.1	0.38
Valve Vault	1979	3		35	28	10.5	0.0357	3.4	0.12
Wet Well Structure	1984	3		30	24	9	0.0417	6.4	0.27

Lift Station 02 Harbor

Component	Year	Condition	Comments	OUL	EvRUL	EcRUL	Vuln	Criticality	Risk
MCC	1994	4		20	12	2	0.0833	5.5	0.46
Paving/Fencing	1986	3	12' x 20'. Some cracking on slab.	50	40	15	0.025	1.6	0.04
SCADA Panel	2004	3		10	8	3	0.125	2.5	0.31
Submersible Pump 1	2013	3	25 Amps - 240 V. Valve recently replaced. Medium corrosion in in lift station. Mild corrosion in valve box.	20	16	6	0.0625	6.1	0.38
Submersible Pump 2	1994	3	25 Amps - 240 V. Medium corrosion in in lift station. Mild corrosion in valve box.	20	16	6	0.0625	6.1	0.38
Valve Vault	1986	2		35	31.5	14	0.0317	3.4	0.11
Wet Well Structure	1986	4		30	18	3	0.0556	6.4	0.36

1. Original Useful Life.
2. Evaluated Remaining Useful Life.
3. Economic Remaining Useful Life.
4. Vulnerability.

Component	Year	Condition	Comments	OUL	EvRUL	EcRUL	Vuln	Criticality	Risk
Lift Station 04 Mandalay & Wooley									
MCC	1994	4	Shows significant corrosion on inside.	20	12	2	0.0833	5.5	0.46
SCADA Panel	2004	4		10	6	1	0.1667	2.5	0.42
Submersible Pump 1	1994	4	Operating at 35 Amps - 480 Volts. Medium corrosion in lift station. Mild corrosion in valve box.	20	12	2	0.0833	6.1	0.51
Submersible Pump 2	1994	4	Medium corrosion in lift station. Mild corrosion in valve box.	20	12	2	0.0833	6.1	0.51
Valve Vault	1986	4	Door is stuck shut.	35	21	3.5	0.0476	3.4	0.16
Wet Well Structure	1986	2		30	27	12	0.037	6.4	0.24
Lift Station 06 Canal									
MCC	1994	4		20	12	2	0.0833	5.5	0.46
SCADA Panel	2004	4		10	6	1	0.1667	2.5	0.42
Submersible Pump 1	1994	4	240 Volts, 15 hp. Medium corrosion in lift station, mild corrosion in valve box.	20	12	2	0.0833	6.1	0.51
Submersible Pump 2	1994	4	Medium corrosion in lift station, mild corrosion in valve box.	20	12	2	0.0833	6.1	0.51
Valve Vault	1984	2	Significant corrosion on valves.	35	31.5	14	0.0317	3.4	0.11
Wet Well Structure	1984	3		30	24	9	0.0417	6.4	0.27
Lift Station 07									
Generator	2002	2	CAT Generator, diesel.	20	18	8	0.0556	6.7	0.37
MCC	2002	2		20	18	8	0.0556	5.5	0.31
Paving/Fencing	2002	2	30' x 40' x 5' tall.	50	45	20	0.0222	1.6	0.04

1. Original Useful Life.
2. Evaluated Remaining Useful Life.
3. Economic Remaining Useful Life.
4. Vulnerability.

Component	Year	Condition	Comments	OUL	EvRUL	EcRUL	Vuln	Criticality	Risk
SCADA Panel	2004	2		10	9	4	0.1111	2.5	0.28
Submersible Pump 1	2002	2	12.2 amps.	20	18	8	0.0556	6.1	0.34
Submersible Pump 2	2002	2	8.2 amps.	20	18	8	0.0556	6.1	0.34
Valve Vault	2002	2		35	31.5	14	0.0317	3.4	0.11
Wet Well Structure	2002	2	8' diameter.	30	27	12	0.037	6.4	0.24
Lift Station 08									
Generator	2002	1	40 kW valley power systems.	20	20	10	0.05	6.7	0.34
MCC	2002	1		20	20	10	0.05	5.5	0.28
Paving/Fencing	2002	1	30' x 40' x 6'.	50	50	25	0.02	1.6	0.03
SCADA Panel	2004	1		10	10	5	0.1	2.5	0.25
Submersible Pump 1	2002	1	17.2.	20	20	10	0.05	6.1	0.31
Submersible Pump 2	2002	1		20	20	10	0.05	6.1	0.31
Valve Vault	2002	1		35	35	17.5	0.0286	3.4	0.1
Wet Well Structure	2002	1	15' deep.	30	30	15	0.0333	6.4	0.21
Lift Station 09 Merion Way									
Generator	2002	2	16 kW.	20	18	8	0.0556	6.7	0.37
MCC	2002	2		20	18	8	0.0556	5.5	0.31
Paving/Fencing	2002	2	30' x 30' x 6' tall.	50	45	20	0.0222	1.6	0.04
SCADA Panel	2004	2		10	9	4	0.1111	2.5	0.28
Submersible Pump 1	2002	2		20	18	8	0.0556	6.1	0.34
Submersible Pump 2	2002	2		20	18	8	0.0556	6.1	0.34

1. Original Useful Life.
2. Evaluated Remaining Useful Life.
3. Economic Remaining Useful Life.
4. Vulnerability.

Component	Year	Condition	Comments	OUL	EvRUL	EcRUL	Vuln	Criticality	Risk
Valve Vault	2002	2		35	31.5	14	0.0317	3.4	0.11
Wet Well	2002	3	8' diameter x 25' deep.	30	24	9	0.0417	6.4	0.27
Lift Station 15 Cascade									
MCC	1994	4	Fairly old but in good condition.	20	12	2	0.0833	5.5	0.46
SCADA Panel	2004	3		10	8	3	0.125	2.5	0.31
Submersible Pump 1	1994	3	240 Volts, 13.5 Amps.	20	16	6	0.0625	6.1	0.38
Submersible Pump 2	1994	3	240 Volts, 13.5 Amps.	20	16	6	0.0625	6.1	0.38
Valve Vault	1979	3		35	28	10.5	0.0357	3.4	0.12
Wet Well Structure	1984	3		30	24	9	0.0417	6.4	0.27
Lift Station 20 Beardsley									
Generator	1997	3	CAT.	20	16	6	0.0625	6.7	0.42
MCC	1997	4		20	12	2	0.0833	5.5	0.46
Paving/Fencing	1997	3	40' x 30'.	50	40	15	0.025	1.6	0.04
SCADA Panel	2004	3		10	8	3	0.125	2.5	0.31
Submerisble Pump 1	1997	3	6" Discharge.	20	16	6	0.0625	6.1	0.38
Submersible Pump 2	1997	3	6" Discharge.	20	16	6	0.0625	6.1	0.38
Valve Vault	1997	3	Vault fills with water from adjacent irrigation, pipes and valves very corroded. Check valves tend to plug.	35	28	10.5	0.0357	3.4	0.12
Wet Well Structure	1997	4	10' diameter.	30	18	3	0.0556	6.4	0.36
Lift Station 23 Wagon Wheel									
MCC	1994	5	Old, some corrosion inside.	20	2	-8	0.7	5.5	3.85

1. Original Useful Life.
2. Evaluated Remaining Useful Life.
3. Economic Remaining Useful Life.
4. Vulnerability.

Component	Year	Condition	Comments	OUL	EvRUL	EcRUL	Vuln	Criticality	Risk
SCADA Panel	2004	5		10	1	-4	0.9	2.5	2.25
Submersible Pump 1	1994	5	29 Amps - 480V, 8" discharge. Corrosion on lift pump station and valve box.	20	2	-8	0.7	6.1	4.27
Submersible Pump 2	1994	5	8" discharge. Corrosion on lift pump station and valve box.	20	2	-8	0.7	6.1	4.27
Valve Vault	1984	5	Corrosion on valve casing and valve vault.	35	3.5	-14	0.2	3.4	0.68
Wet Well Structure	1984	5		30	3	-12	0.4	6.4	2.56
Lift Station 24 Handyman									
MCC Box	1994	4	Has been hit by a vehicle in the past.	20	12	2	0.0833	5.5	0.46
SCADA Panel	2004	3		10	8	3	0.125	2.5	0.31
Submersible Pump 1	1994	3	Operating at 20 Amps - 480V. Some corrosion in lift station and valve box.	20	16	6	0.0625	6.1	0.38
Submersible Pump 2	2013	3	Operating at 20 Amps - 480V. Replaced recently.	20	16	6	0.0625	6.1	0.38
Valve Vault	1986	3	Significant corrosion on valves and hardware. Vault doors in good condition.	35	28	10.5	0.0357	3.4	0.12
Wet Well Structure	1986	3		30	24	9	0.0417	6.4	0.27
Lift Station 27 Launch Ramp									
MCC	1994	2	Old, some corrosion inside and out around bottom of hinges.	20	18	8	0.0556	5.5	0.31
Paving/Fencing	1977	2	15' x 20'.	50	45	20	0.0222	1.6	0.04
SCADA Panel	2004	2		10	9	4	0.1111	2.5	0.28

1. Original Useful Life.
2. Evaluated Remaining Useful Life.
3. Economic Remaining Useful Life.
4. Vulnerability.

Component	Year	Condition	Comments	OUL	EvRUL	EcRUL	Vuln	Criticality	Risk
Submersible Pump 1	1994	2		20	18	8	0.0556	6.1	0.34
Submersible Pump 2	1994	2		20	18	8	0.0556	6.1	0.34
Valve Vault	1979	2	Some corrosion on valves, significant corrosion on steel pipes.	35	31.5	14	0.0317	3.4	0.11
Wet Well Structure	1984	2	Doors hard to open.	30	27	12	0.037	6.4	0.24
Lift Station 28 Hueneme									
Generator	1994	2	80 kW Diesel. Kholer power systems.	20	18	8	0.0556	6.7	0.37
MCC	1994	2		20	18	8	0.0556	5.5	0.31
Paving/Fencing	1977	2	35' x 35' CMU Walls 8' high.	50	45	20	0.0222	1.6	0.04
SCADA Panel	2004	2		10	9	4	0.1111	2.5	0.28
Submersible Pump 1	1994	2	3100 gpm.	20	18	8	0.0556	6.1	0.34
Submersible Pump 2	1994	2	3100 gpm.	20	18	8	0.0556	6.1	0.34
Submersible Pump 3	1994	2	3100 gpm.	20	18	8	0.0556	6.1	0.34
Valve Vault	1979	2	8' x 16' x 6' deep. Good condition.	35	31.5	14	0.0317	3.4	0.11
Wet Well Structure	1984	2		30	27	12	0.037	6.4	0.24
Lift Station 29 Patterson & Hemlock (Large)									
Generator	1994	2	Cummins 275 hp, good condition.	20	18	8	0.0556	6.7	0.37
Generator Room Structure	1977	2	12' deep x 25'.	50	45	20	0.0222	7.3	0.16
MCC	1994	2	7 Sections.	20	18	8	0.0556	5.5	0.31
SCADA Cabinet	2004	2	3 Sections.	10	9	4	0.1111	2.5	0.28
Submersible Pump 1	1994	2	3500 gpm.	20	18	8	0.0556	6.1	0.34

1. Original Useful Life.
2. Evaluated Remaining Useful Life.
3. Economic Remaining Useful Life.
4. Vulnerability.

Component	Year	Condition	Comments	OUL	EvRUL	EcRUL	Vuln	Criticality	Risk
Submersible Pump 2	1994	2	3500 gpm.	20	18	8	0.0556	6.1	0.34
Submersible Pump 3	1994	2	3500 gpm.	20	18	8	0.0556	6.1	0.34
Submersible Pump 4	1994	2	3500 gpm.	20	18	8	0.0556	6.1	0.34
Switchboard	1994	2		20	18	8	0.0556	4	0.22
Valve Vault	1979	2	12' x 25' x 8'. Very large	35	31.5	14	0.0317	3.4	0.11
Wet Well Structure	1984	2	Very large 12' x 25' x 40 ' deep.	30	27	12	0.037	6.4	0.24
Lift Station 30 Colony									
MCC	1994	2		20	18	8	0.0556	5.5	0.31
SCADA Panel	2004	2		10	9	4	0.1111	2.5	0.28
Submersible Pump 1	1994	3	27.9 A, 480 V.	20	16	6	0.0625	6.1	0.38
Submersible Pump 2	1994	3	27.9 A, 480 V.	20	16	6	0.0625	6.1	0.38
Valve Vault	1984	3		35	28	10.5	0.0357	3.4	0.12
Wet Well Structure	1984	4	Piping corroded.	30	18	3	0.0556	6.4	0.36

1. Original Useful Life.
2. Evaluated Remaining Useful Life.
3. Economic Remaining Useful Life.
4. Vulnerability.

APPENDIX B – OWTP AND LIFT STATIONS CRITICALITY SCORES

Crticality Scores

Component	Public and Employee Health and Safety	Financial Impact	Environmental or Regulatory Compliance	Customer Service	Total Criticality

OWTP

Headworks

Component	Public and Employee Health and Safety	Financial Impact	Environmental or Regulatory Compliance	Customer Service	Total Criticality
Bar Screen 1 (Mechanical)	No lost-time injuries or medical attention	Between $150,000 and $250,000	Minor	No impacts	4
Bar Screen 2 (Mechanical)	No lost-time injuries or medical attention	Between $150,000 and $250,000	Minor	No impacts	4
Bar Screen 3 (Mechanical)	No lost-time injuries or medical attention	Between $150,000 and $250,000	Minor	No impacts	4
Bar Screen 4 (Mechanical)	No lost-time injuries or medical attention	Between $150,000 and $250,000	Minor	No impacts	4
Bar Screen 5 (Manual)	No lost-time injuries or medical attention	Less than $25,000	No effect	No impacts	1.9
Bar Screen 6 (Manual)	No lost-time injuries or medical attention	Less than $25,000	No effect	No impacts	1.9
Flowmeter	No effect	Between $25,000 and $150,000	Minor	No impacts	2.5
Grit Blower 1	No lost-time injuries or medical attention	Between $25,000 and $150,000	No effect	No impacts	2.5
Grit Blower 2	No lost-time injuries or medical attention	Between $25,000 and $150,000	No effect	No impacts	2.5
Grit Blower 3	No lost-time injuries or medical attention	Between $25,000 and $150,000	No effect	No impacts	2.5

Component	Public and Employee Health and Safety	Financial Impact	Environmental or Regulatory Compliance	Customer Service	Total Criticality
Grit Blower 4	No lost-time injuries or medical attention	Between $25,000 and $150,000	No effect	No impacts	2.5
Grit Pump 1 (West)	No lost-time injuries or medical attention	Between $25,000 and $150,000	No effect	No impacts	2.5
Grit Pump 2 (West)	No lost-time injuries or medical attention	Between $25,000 and $150,000	No effect	No impacts	2.5
Grit Pump 3 (West)	No lost-time injuries or medical attention	Between $25,000 and $150,000	No effect	No impacts	2.5
Grit Pump 4 (West)	No lost-time injuries or medical attention	Between $25,000 and $150,000	No effect	No impacts	2.5
Grit Pump 5 (East)	No lost-time injuries or medical attention	Between $25,000 and $150,000	No effect	No impacts	2.5
Grit Pump 6 (East)	No lost-time injuries or medical attention	Between $25,000 and $150,000	No effect	No impacts	2.5
Grit Pump 7 (East)	No lost-time injuries or medical attention	Between $25,000 and $150,000	No effect	No impacts	2.5
Grit Pump 8 (East)	No lost-time injuries or medical attention	Between $25,000 and $150,000	No effect	No impacts	2.5
Grit Separator/Classifier 1	No lost-time injuries or medical attention	Between $25,000 and $150,000	No effect	No impacts	2.5
Grit Separator/Classifier 2	No lost-time injuries or medical attention	Between $25,000 and $150,000	No effect	No impacts	2.5
Headworks Building	Potential for loss of life	More than $250,000	Major impact	Long-term impact	10
Headworks Grit Screens Building	No lost-time injuries or medical attention	More than $250,000	Minor	Minor disruption	5.2

Component	Public and Employee Health and Safety	Financial Impact	Environmental or Regulatory Compliance	Customer Service	Total Criticality
Hypo Chemical Feed Pump (Sodium Hypo Pump 2)	No lost-time injuries or medical attention	Less than $25,000	Minor	Short-term impact	4
Influent Check Valve 1	No effect	Between $25,000 and $150,000	No effect	No impacts	1.6
Influent Check Valve 2	No effect	Between $25,000 and $150,000	No effect	No impacts	1.6
Influent Check Valve 3	No effect	Between $25,000 and $150,000	No effect	No impacts	1.6
Influent Check Valve 4	No effect	Between $25,000 and $150,000	No effect	No impacts	1.6
Influent Check Valve 5	No effect	Between $25,000 and $150,000	No effect	No impacts	1.6
Influent Check Valve 6	No effect	Between $25,000 and $150,000	No effect	No impacts	1.6
Influent Pump 1	No effect	More than $250,000	No effect	No impacts	2.8
Influent Pump 2	No effect	More than $250,000	No effect	No impacts	2.8
Influent Pump 3	No effect	More than $250,000	No effect	No impacts	2.8
Influent Pump 4	No effect	More than $250,000	No effect	No impacts	2.8
Influent Pump 5	No effect	More than $250,000	No effect	No impacts	2.8

Component	Public and Employee Health and Safety	Financial Impact	Environmental or Regulatory Compliance	Customer Service	Total Criticality
Influent Pump 6	No effect	More than $250,000	No effect	No impacts	2.8
MCC- HW	Potential for loss of life	More than $250,000	Major impact	Long-term impact	10
Odor Control Ductworks & Vessels	No effect	More than $250,000	Major	Short-term impact	5.8
Remote Telemetry Unit (RTU)	No effect	Between $25,000 and $150,000	No effect	No impacts	1.6
Screening Compactor 1	No lost-time injuries or medical attention	Between $25,000 and $150,000	No effect	No impacts	2.5
Screening Compactor 2	No lost-time injuries or medical attention	Between $25,000 and $150,000	No effect	No impacts	2.5
Sodium Hydroxide Pump 1	No lost-time injuries or medical attention	Less than $25,000	Minor	Short-term impact	4
Sodium Hydroxide Pump 2	No lost-time injuries or medical attention	Less than $25,000	Minor	Short-term impact	4
Sodium Hydroxide Storage Tank	Potential for loss of life	Less than $25,000	Minor	Short-term impact	5.8
Sodium Hypochlorite Pump 1	No lost-time injuries or medical attention	Less than $25,000	Minor	Short-term impact	4
Sodium Hypochlorite Storage Tank	No lost-time injuries or medical attention	Less than $25,000	Minor	Short-term impact	4
Standby Generator	Potential for loss of life	More than $250,000	Major impact	Long-term impact	10
VFDs	No lost-time injuries or medical attention	Between $150,000 and $250,000	Major	No impacts	4.9

Component	Public and Employee Health and Safety	Financial Impact	Environmental or Regulatory Compliance	Customer Service	Total Criticality
Primary Treatment					
Clarifier 1 Collector Drive, Walkways, & Launders	No effect	More than $250,000	Major	Long-term impact	6.4
Clarifier 2 Collector Drive, Walkways, & Launders	No effect	More than $250,000	Major	Long-term impact	6.4
Clarifier 3 Collector Drive, Walkways, & Launders	No effect	More than $250,000	Major	Long-term impact	6.4
Clarifier 4 Collector Drive, Walkways, & Launders	No effect	More than $250,000	Major	Long-term impact	6.4
Large Isolation Valve 1	No lost-time injuries or medical attention	Between $25,000 and $150,000	Minor	Long-term impact	5.2
Large Isolation Valve 2	No lost-time injuries or medical attention	Between $25,000 and $150,000	Minor	Long-term impact	5.2
MCC-DP2B	No lost-time injuries or medical attention	Between $150,000 and $250,000	Major	Minor disruption	5.5
MCC-DPIA	No lost-time injuries or medical attention	Between $150,000 and $250,000	Major	Minor disruption	5.5
MCC-DPIB	No lost-time injuries or medical attention	Between $150,000 and $250,000	Major	Minor disruption	5.5
MCC-EDPIA	No lost-time injuries or medical attention	Between $150,000 and $250,000	Major	Minor disruption	5.5
Primary Clarification Tank 1	Potential for loss of life	More than $250,000	Major	Short-term impact	8.5

Component	Public and Employee Health and Safety	Financial Impact	Environmental or Regulatory Compliance	Customer Service	Total Criticality
Primary Clarification Tank 2	Potential for loss of life	More than $250,000	Major	Short-term impact	8.5
Primary Clarification Tank 3	Potential for loss of life	More than $250,000	Major	Short-term impact	8.5
Primary Clarification Tank 4	Potential for loss of life	More than $250,000	Major	Short-term impact	8.5
Primary Sedimentation Building	Potential for loss of life	More than $250,000	Minor	No impacts	6.4
Scum Ejector 1	No lost-time injuries or medical attention	Between $25,000 and $150,000	Minor	Short-term impact	4.6
Scum Ejector 2	No lost-time injuries or medical attention	Between $25,000 and $150,000	Minor	Short-term impact	4.6
Scum Ejector 3	No lost-time injuries or medical attention	Between $25,000 and $150,000	Minor	Short-term impact	4.6
Scum Ejector 4	No lost-time injuries or medical attention	Between $25,000 and $150,000	Minor	Short-term impact	4.6
Sludge Pump Tank 1	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Short-term impact	5.5
Sludge Pump Tank 2	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Short-term impact	5.5
Sludge Pump Tank 3	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Short-term impact	5.5
Sludge Pump Tank 4	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Short-term impact	5.5

Component	Public and Employee Health and Safety	Financial Impact	Environmental or Regulatory Compliance	Customer Service	Total Criticality
Bio Filters					
Bio Filter Distributor & Drives Tank 1	No effect	Between $25,000 and $150,000	Minor	Minor disruption	3.1
Bio Filter Distributor & Drives Tank 2	No effect	Between $25,000 and $150,000	Minor	Minor disruption	3.1
Bio Filter Tank 1 Media	No lost-time injuries or medical attention	Between $25,000 and $150,000	Minor	Minor disruption	4
Bio Filter Tank 2 Media	No lost-time injuries or medical attention	Between $25,000 and $150,000	Minor	Minor disruption	4
Bio Filter Ventilation Blower 1	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Minor disruption	4.9
Bio Filter Ventilation Blower 2	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Minor disruption	4.9
Bio Filter Ventilation Blower 3	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Minor disruption	4.9
Bio Filter Ventilation Blower 4	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Minor disruption	4.9
Biological Trickling Tank 1 Structure	Potential for loss of life	More than $250,000	Major	Short-term impact	8.5
Biological Trickling Tank 2 Structure	Potential for loss of life	More than $250,000	Major	Short-term impact	8.5
Recirculation Pump Mag Drive 1	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Minor disruption	4.9
Recirculation Pump Mag Drive 2	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Minor disruption	4.9

Component	Public and Employee Health and Safety	Financial Impact	Environmental or Regulatory Compliance	Customer Service	Total Criticality
Recirculation Tank 1 Pump 1	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Recirculation Tank 1 Pump 2	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Interstage Pump Station					
Interstage Pump 1	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	No impacts	4.3
Interstage Pump 2	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	No impacts	4.3
Interstage Pump 3	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	No impacts	4.3
Interstage Well Structure	No lost-time injuries or medical attention	More than $250,000	Major impact	Long-term impact	8.2
Large isolation Valve 1	No lost-time injuries or medical attention	Less than $25,000	Minor	Minor disruption	3.4
Large Isolation Valve 2	No lost-time injuries or medical attention	Less than $25,000	Minor	Minor disruption	3.4
Large Isolation Valve 3	No lost-time injuries or medical attention	Less than $25,000	Minor	Minor disruption	3.4
VFDs	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	No impacts	4.3
Aerated Activated Sludge					
Aeration Basin 1 Structure	No effect	More than $250,000	Minor	No impacts	3.7
Aeration Basin 2 Structure	No effect	More than $250,000	Minor	No impacts	3.7

Component	Public and Employee Health and Safety	Financial Impact	Environmental or Regulatory Compliance	Customer Service	Total Criticality
Aeration Basin 3 Structure	No effect	More than $250,000	Minor	No impacts	3.7
Aeration Basin 4 Structure	No effect	More than $250,000	Minor	No impacts	3.7
Aeration Basin 5 Structure	No effect	More than $250,000	Minor	No impacts	3.7
Aeration Basin 6 Structure	No effect	More than $250,000	Minor	No impacts	3.7
Blower 1	No effect	More than $250,000	No effect	No impacts	2.8
Blower 2	No effect	More than $250,000	No effect	No impacts	2.8
Blower 3	No effect	More than $250,000	No effect	No impacts	2.8
Blower 4	No effect	More than $250,000	No effect	No impacts	2.8
Blower 5	No effect	More than $250,000	No effect	No impacts	2.8
Diffusers & Piping Basin 1	No effect	More than $250,000	Minor	No impacts	3.7
Diffusers & Piping Basin 2	No effect	More than $250,000	Minor	No impacts	3.7
Diffusers & Piping Basin 3	No effect	More than $250,000	Minor	No impacts	3.7
Diffusers & Piping Basin 4	No effect	More than $250,000	Minor	No impacts	3.7

Component	Public and Employee Health and Safety	Financial Impact	Environmental or Regulatory Compliance	Customer Service	Total Criticality
Diffusers & Piping Basin 5	No effect	More than $250,000	Minor	No impacts	3.7
Diffusers & Piping Basin 6	No effect	More than $250,000	Minor	No impacts	3.7
Sed/RAS/WAS/Flow Equal					
3WHP Facilities Pump 1	No effect	Between $25,000 and $150,000	Minor	No impacts	2.5
3WHP Facilities Pump 2	No effect	Between $25,000 and $150,000	Minor	No impacts	2.5
3WHP Facilities Pump 3	No effect	Between $25,000 and $150,000	Minor	No impacts	2.5
AST Drain Pump	No effect	Between $25,000 and $150,000	No effect	No impacts	1.6
Blowers (18)	No effect	Between $25,000 and $150,000	No effect	No impacts	1.6
Flow Equalization Basin Structure	No effect	More than $250,000	Major impact	Minor disruption	6.1
Flow Equalization Gates & Drives	No effect	Between $25,000 and $150,000	No effect	No impacts	1.6
Flow Equalization Pump 1	No effect	Between $150,000 and $250,000	Minor	No impacts	3.1
Flow Equalization Pump 2	No effect	Between $150,000 and $250,000	Minor	No impacts	3.1
Flow Equalization Pump 3	No effect	Between $150,000 and $250,000	Minor	No impacts	3.1

Component	Public and Employee Health and Safety	Financial Impact	Environmental or Regulatory Compliance	Customer Service	Total Criticality
RAS Pump 1	No effect	Between $150,000 and $250,000	No effect	No impacts	2.2
RAS Pump 2	No effect	Between $150,000 and $250,000	No effect	No impacts	2.2
RAS Pump 3	No effect	Between $150,000 and $250,000	No effect	No impacts	2.2
RAS Pump 4	No effect	Between $150,000 and $250,000	No effect	No impacts	2.2
RAS Pump Galley Ventilation Fan 1	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
RAS Pump Galley Ventilation Fan 2	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Secondary Sed. Collector, Skimmer & Drives (1-16)	No effect	Between $150,000 and $250,000	No effect	No impacts	2.2
Secondary Sed. Collector, Skimmer & Drives (17-18)	No effect	Between $150,000 and $250,000	No effect	No impacts	2.2
Secondary Sed. Sludge Magnetic Flow Meters (18)	No effect	Between $25,000 and $150,000	Minor	No impacts	2.5
Secondary Sedimentation Skimmings Pumps (18)	No effect	Between $25,000 and $150,000	No effect	No impacts	1.6
Secondary Sedimentation Tanks (18)	No effect	More than $250,000	No effect	No impacts	2.8
VFDs	No effect	Between $25,000 and $150,000	No effect	No impacts	1.6

Component	Public and Employee Health and Safety	Financial Impact	Environmental or Regulatory Compliance	Customer Service	Total Criticality
WAS Pump 1	No lost-time injuries or medical attention	Less than $25,000	Major	No impacts	3.7
WAS Pump 2	No lost-time injuries or medical attention	Less than $25,000	Major	No impacts	3.7
WAS Pump 3	No lost-time injuries or medical attention	Less than $25,000	Major	No impacts	3.7
Disinfection Facilities					
Chlorine Contact Gates, Supports & Operators	No effect	Between $25,000 and $150,000	No effect	No impacts	1.6
Chlorine Contact Tank Structure	No lost-time injuries or medical attention	More than $250,000	Minor	Minor disruption	5.2
Hypo Pump 1	No effect	Less than $25,000	No effect	No impacts	1
Hypo Pump 2	No effect	Less than $25,000	No effect	No impacts	1
Hypo Pump 3	No effect	Less than $25,000	No effect	No impacts	1
Hypo Pump 4	No effect	Less than $25,000	No effect	No impacts	1
Hypo Pump 5	No effect	Less than $25,000	No effect	No impacts	1
Hypo Pump 6	No effect	Less than $25,000	No effect	No impacts	1
Hypo Tank 1	Potential for loss of life	Between $25,000 and $150,000	Major	Minor disruption	6.7

Component	Public and Employee Health and Safety	Financial Impact	Environmental or Regulatory Compliance	Customer Service	Total Criticality
Hypo Tank 2	Potential for loss of life	Between $25,000 and $150,000	Major	Minor disruption	6.7
Effluent - Pump Station (EPS)					
Effluent Pump Station Building	Potential for loss of life	More than $250,000	Major	No impacts	7.3
Effluent - Pump Station (EPS)					
Engine Drive 2	No lost-time injuries or medical attention	Between $25,000 and $150,000	Minor	Minor disruption	4
Effluent - Pump Station (EPS)					
Large isolation Valves (4)	No lost-time injuries or medical attention	Less than $25,000	Minor	Minor disruption	3.4
Effluent - Pump Station (EPS)					
MCC-DP4A	No lost-time injuries or medical attention	Between $150,000 and $250,000	Major	Minor disruption	5.5
Effluent - Pump Station (EPS)					
MCC-EDPID	No lost-time injuries or medical attention	Between $150,000 and $250,000	Major	Minor disruption	5.5
Effluent - Pump Station (EPS)					
Pump 1	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Effluent - Pump Station (EPS)					
Pump 2	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Effluent - Pump Station (EPS)					
Pump 3	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1

Component	Public and Employee Health and Safety	Financial Impact	Environmental or Regulatory Compliance	Customer Service	Total Criticality
Effluent - Pump Station (EPS)					
Pump 4	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Effluent - Pump Station (EPS)					
Pump 5 - Big Red	No effect	Less than $25,000	No effect	No impacts	1
Effluent - Pump Station (EPS)					
VFDs	No lost-time injuries or medical attention	Between $25,000 and $150,000	Minor	No impacts	3.4
Gravity Thickeners & Blower Building					
Blower Building	Potential for loss of life	More than $250,000	No effect	No impacts	5.5
Gravity Thickeners & Blower Building					
Blower Building Remote Telemetry Unit (RTU)	No lost-time injuries or medical attention	Between $25,000 and $150,000	Minor	No impacts	3.4
Gravity Thickeners & Blower Building					
Fans/ Louvers Tank 1	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Minor disruption	4.9
Gravity Thickeners & Blower Building					
Fans/ Louvers Tank 2	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Minor disruption	4.9
Gravity Thickeners & Blower Building					
Collector Drive, Walkways, Launders Tank 1	No effect	More than $250,000	Major	Minor disruption	5.2
Gravity Thickeners & Blower Building					

Component	Public and Employee Health and Safety	Financial Impact	Environmental or Regulatory Compliance	Customer Service	Total Criticality
Collector Drive, Walkways, Launders Tank 2	No effect	More than $250,000	Major	Minor disruption	5.2
Gravity Thickeners & Blower Building					
Gravity Thickening Tank 1	Potential for loss of life	More than $250,000	Major	Short-term impact	8.5
Gravity Thickeners & Blower Building					
Gravity Thickening Tank 2	Potential for loss of life	More than $250,000	Major	Short-term impact	8.5
Gravity Thickeners & Blower Building					
MCC -DP3C	No lost-time injuries or medical attention	Between $150,000 and $250,000	Major	Minor disruption	5.5
Gravity Thickeners & Blower Building					
MCC -DP3D	No lost-time injuries or medical attention	Between $150,000 and $250,000	Major	Minor disruption	5.5
Gravity Thickeners & Blower Building					
MCC-NG	No lost-time injuries or medical attention	Between $150,000 and $250,000	Major	Minor disruption	5.5
Gravity Thickeners & Blower Building					
Odor Reduction Tower	Potential for loss of life	More than $250,000	Major	No impacts	7.3
Gravity Thickeners & Blower Building					
Thickened Sludge Pump 1	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Gravity Thickeners & Blower Building					
Thickened Sludge Pump 2	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1

Component	Public and Employee Health and Safety	Financial Impact	Environmental or Regulatory Compliance	Customer Service	Total Criticality
Gravity Thickeners & Blower Building					
Thickened Sludge Pump 3	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
DAF					
DAF Air Saturation Tank #1	Potential for loss of life	Between $25,000 and $150,000	Major	Minor disruption	6.7
DAF Air Saturation Tank #2	Potential for loss of life	Between $25,000 and $150,000	Major	Minor disruption	6.7
DAF Collectors Drives Tank 1	No effect	Between $150,000 and $250,000	Minor	Minor disruption	3.7
DAF Collectors Drives Tank 2	No effect	Between $150,000 and $250,000	Minor	Minor disruption	3.7
DAF Compressor 1	No effect	Less than $25,000	Minor	No impacts	1.9
DAF Compressor 2	No effect	Less than $25,000	Minor	No impacts	1.9
DAF Compressor 3	No effect	Less than $25,000	Minor	No impacts	1.9
DAF Compressor 4	No effect	Less than $25,000	Minor	No impacts	1.9
DAF Starter Rack	No lost-time injuries or medical attention	Between $25,000 and $150,000	Minor	Minor disruption	4
DAF Tank 1	Potential for loss of life	More than $250,000	Major	Short-term impact	8.5
DAF Tank 2	Potential for loss of life	More than $250,000	Major	Short-term impact	8.5

Component	Public and Employee Health and Safety	Financial Impact	Environmental or Regulatory Compliance	Customer Service	Total Criticality
DAF TWAS Sludge Pump 1	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
DAF TWAS Sludge Pump 2	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
DAF Underflow Recirculation Pump 1	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
DAF Underflow Recirculation Pump 2	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
DAF VFDs	No lost-time injuries or medical attention	Between $25,000 and $150,000	Minor	No impacts	3.4
Polymer Blending Unit 1	No lost-time injuries or medical attention	Between $25,000 and $150,000	Minor	Minor disruption	4
Polymer Blending Unit 2	No lost-time injuries or medical attention	Between $25,000 and $150,000	Minor	Minor disruption	4
Polymer Building	Potential for loss of life	More than $250,000	Major	No impacts	7.3
Polymer Bulk Building Storage Tank	Potential for loss of life	Between $25,000 and $150,000	Major	Short-term impact	7.3
Polymer Solution Pump 1	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Polymer Solution Pump 2	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Polymer Solution Pump 3	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1

Component	Public and Employee Health and Safety	Financial Impact	Environmental or Regulatory Compliance	Customer Service	Total Criticality
Polymer Transfer Pump	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Digestion					
Digested Sludge Pump 1	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Digested Sludge Pump 2	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Digested Sludge Pump 3	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Digestor Blower 1	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Minor disruption	4.9
Digestor Blower 2	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Minor disruption	4.9
Digestor Blower 3	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Minor disruption	4.9
Digestor Blower 4	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Minor disruption	4.9
Digestor Blower 5	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Minor disruption	4.9
Digestor Blower 6	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Minor disruption	4.9
Digestor Blower 7	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Minor disruption	4.9
Digestor Control Building	Potential for loss of life	More than $250,000	Major	No impacts	7.3

Component	Public and Employee Health and Safety	Financial Impact	Environmental or Regulatory Compliance	Customer Service	Total Criticality
Digestor Flares	No effect	Less than $25,000	Major	Minor disruption	3.4
Digestor Heat Exchanger 1	No lost-time injuries or medical attention	Between $150,000 and $250,000	Minor	Minor disruption	4.6
Digestor Heat Exchanger 2	No lost-time injuries or medical attention	Between $150,000 and $250,000	Minor	Minor disruption	4.6
Digestor Heat Exchanger 3	No lost-time injuries or medical attention	Between $150,000 and $250,000	Minor	Minor disruption	4.6
Digestor No. 1 Hot Water Pump 4	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Digestor No. 1 Mixing Equipment & Draft Tubes	No lost-time injuries or medical attention	Between $25,000 and $150,000	Minor	Short-term impact	4.6
Digestor No. 1 Tank	Potential for loss of life	More than $250,000	Minor	Short-term impact	7.6
Digestor No. 2 Mixing Equipment & Draft Tubes	No lost-time injuries or medical attention	Between $25,000 and $150,000	Minor	Short-term impact	4.6
Digestor No. 2 Tank	Potential for loss of life	More than $250,000	Minor	Short-term impact	7.6
Digestor No. 3 Mixing Equipment & Draft Tubes	No lost-time injuries or medical attention	Between $25,000 and $150,000	Minor	Short-term impact	4.6
Digestor No. 3 Tank	Potential for loss of life	More than $250,000	Minor	Short-term impact	7.6
MCC-DP2C	No lost-time injuries or medical attention	Between $150,000 and $250,000	Major	Minor disruption	5.5

Component	Public and Employee Health and Safety	Financial Impact	Environmental or Regulatory Compliance	Customer Service	Total Criticality
MCC-EDPIC	No lost-time injuries or medical attention	Between $150,000 and $250,000	Major	Minor disruption	5.5
MCC-GF	No lost-time injuries or medical attention	Between $150,000 and $250,000	Major	Minor disruption	5.5
Petroleum Gas Tank	Potential for loss of life	Between $25,000 and $150,000	Major	Short-term impact	7.3
Remote Telemetry Unit (RTU)	No lost-time injuries or medical attention	Between $25,000 and $150,000	Minor	No impacts	3.4
SCADA System Terminal	No effect	Between $25,000 and $150,000	Minor	No impacts	2.5
Dewatering					
Air Handling Unit and Odord Control	No effect	Less than $25,000	No effect	No impacts	1
Belt Filter Press 1	No lost-time injuries or medical attention	Between $25,000 and $150,000	Minor	Minor disruption	4
Belt Filter Press 2	No lost-time injuries or medical attention	Between $25,000 and $150,000	Minor	Minor disruption	4
Belt Filter Press 3	No lost-time injuries or medical attention	Between $25,000 and $150,000	Minor	Minor disruption	4
Belt Filter Press 4	No lost-time injuries or medical attention	Between $25,000 and $150,000	Minor	Minor disruption	4
Conveyers	No lost-time injuries or medical attention	Between $25,000 and $150,000	Minor	Minor disruption	4
Dewatering Feed Pump 1	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1

Component	Public and Employee Health and Safety	Financial Impact	Environmental or Regulatory Compliance	Customer Service	Total Criticality
Dewatering Feed Pump 2	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Dewatering Feed Pump 3	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Dewatering Feed Pump 4	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Dewatering Feed Pump 5	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Dewatering Feed Sludge Grinder	No lost-time injuries or medical attention	Between $25,000 and $150,000	Minor	Minor disruption	4
Eastern Trunk Pump Station	Potential for loss of life	More than $250,000	Major	No impacts	7.3
Fans/ Louvers	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Minor disruption	4.9
Gravity Thickener Scrubber	No lost-time injuries or medical attention	Between $25,000 and $150,000	Minor	Minor disruption	4
MCC-SH	No lost-time injuries or medical attention	Between $150,000 and $250,000	Major	Minor disruption	5.5
Odor Control Ductworks & Vessels	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Minor disruption	4.9
Polyblend Unit 1	No lost-time injuries or medical attention	Between $25,000 and $150,000	Minor	Minor disruption	4
Polyblend Unit 2	No lost-time injuries or medical attention	Between $25,000 and $150,000	Minor	Minor disruption	4
Polyblend Unit 3	No lost-time injuries or medical attention	Between $25,000 and $150,000	Minor	Minor disruption	4

Component	Public and Employee Health and Safety	Financial Impact	Environmental or Regulatory Compliance	Customer Service	Total Criticality
Polyblend Unit 4	No lost-time injuries or medical attention	Between $25,000 and $150,000	Minor	Minor disruption	4
Solids Processing Building	Potential for loss of life	More than $250,000	Major	No impacts	7.3
Solids Processing Polmer Storage Addition Tank	Potential for loss of life	Between $25,000 and $150,000	Major	Short-term impact	7.3
Solids Processing Polymer Chemical Storage eq	No lost-time injuries or medical attention	Between $25,000 and $150,000	Minor	Minor disruption	4
VFDs	No lost-time injuries or medical attention	Between $25,000 and $150,000	Minor	No impacts	3.4
Washwater Booster Pump 1	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Washwater Booster Pump 2	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Washwater Booster Pump 3	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Washwater Booster Pump 4	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Cogen/Generator Building					
Cogen Air Handling Unit	No lost-time injuries or medical attention	Between $25,000 and $150,000	Minor	Minor disruption	4
Cogen Blended Gas Blower	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Minor disruption	4.9
Cogen Blower 1 DG	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Minor disruption	4.9

Component	Public and Employee Health and Safety	Financial Impact	Environmental or Regulatory Compliance	Customer Service	Total Criticality
Cogen Blower 1 NG	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Minor disruption	4.9
Cogen Blower 2 DG	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Minor disruption	4.9
Cogen Blower 2 NG	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Minor disruption	4.9
Cogen Engine Generator 1	No lost-time injuries or medical attention	More than $250,000	Major	Short-term impact	6.7
Cogen Engine Generator 2	No lost-time injuries or medical attention	More than $250,000	Major	Short-term impact	6.7
Cogen Engine Generator 3	No lost-time injuries or medical attention	More than $250,000	Major	Short-term impact	6.7
Cogen Switchgear	No lost-time injuries or medical attention	Between $25,000 and $150,000	Minor	Minor disruption	4
Cogen/Generator Building	Potential for loss of life	More than $250,000	Major	No impacts	7.3
MCC-DP3B	No lost-time injuries or medical attention	Between $150,000 and $250,000	Major	Minor disruption	5.5
MCC-GA	No lost-time injuries or medical attention	Between $150,000 and $250,000	Major	Minor disruption	5.5
Electrical - Main Electrical Building					
Large Standby Generator 1	No lost-time injuries or medical attention	More than $250,000	Major	Short-term impact	6.7
Electrical - Main Electrical Building					
Large Standby Generator 2	No lost-time injuries or medical attention	More than $250,000	Major	Short-term impact	6.7

Component	Public and Employee Health and Safety	Financial Impact	Environmental or Regulatory Compliance	Customer Service	Total Criticality
Electrical - Main Electrical Building					
500 kW Generator	No effect	Less than $25,000	No effect	No impacts	1
Electrical - Main Electrical Building					
Main Electrical/Switchgear Building	Potential for loss of life	More than $250,000	Major	No impacts	7.3
Electrical - Main Electrical Building					
MCC-DP4	No lost-time injuries or medical attention	Between $150,000 and $250,000	Major	Minor disruption	5.5
Electrical - Main Electrical Building					
MCC-DP4B	No lost-time injuries or medical attention	Between $150,000 and $250,000	Major	Minor disruption	5.5
Electrical - Main Electrical Building					
MCC-GB	No lost-time injuries or medical attention	Between $150,000 and $250,000	Major	Minor disruption	5.5
Electrical - Main Electrical Building					
MCC-GC	No lost-time injuries or medical attention	Between $150,000 and $250,000	Major	Minor disruption	5.5
Electrical - Main Electrical Building					
MCC-GD	No lost-time injuries or medical attention	Between $150,000 and $250,000	Major	Minor disruption	5.5
Electrical - Main Electrical Building					
Older Transformer 1	Lost-time injury or medical attention	Between $150,000 and $250,000	Minor	Short-term impact	6.1
Electrical - Main Electrical Building					

Component	Public and Employee Health and Safety	Financial Impact	Environmental or Regulatory Compliance	Customer Service	Total Criticality
Older Transformer 2	Lost-time injury or medical attention	Between $150,000 and $250,000	Minor	Short-term impact	6.1
Electrical - Main Electrical Building					
Switchboard MA-MB	No lost-time injuries or medical attention	Between $25,000 and $150,000	Minor	Minor disruption	4
Electrical - Main Electrical Building					
Switchgear 1	No lost-time injuries or medical attention	Between $25,000 and $150,000	Minor	Minor disruption	4
Electrical - Main Electrical Building					
Switchgear 2	No lost-time injuries or medical attention	Between $25,000 and $150,000	Minor	Minor disruption	4
Electrical - Main Electrical Building					
Switchgear HW	No lost-time injuries or medical attention	Between $25,000 and $150,000	Minor	Minor disruption	4
Electrical - Main Electrical Building					
Transformer A	Lost-time injury or medical attention	Between $150,000 and $250,000	Minor	Short-term impact	6.1
Electrical - Main Electrical Building					
Transformer B	Lost-time injury or medical attention	Between $150,000 and $250,000	Minor	Short-term impact	6.1
Electrical - North Area Electrical Building					
MCC-NA	No lost-time injuries or medical attention	Between $150,000 and $250,000	Major	Minor disruption	5.5
Electrical - North Area Electrical Building					
MCC-NC	No lost-time injuries or medical attention	Between $150,000 and $250,000	Major	Minor disruption	5.5

Component	Public and Employee Health and Safety	Financial Impact	Environmental or Regulatory Compliance	Customer Service	Total Criticality
Electrical - North Area Electrical Building					
MCC-ND	No lost-time injuries or medical attention	Between $150,000 and $250,000	Major	Minor disruption	5.5
Electrical - North Area Electrical Building					
MCC-NE	No lost-time injuries or medical attention	Between $150,000 and $250,000	Major	Minor disruption	5.5
Electrical - North Area Electrical Building					
MCC-NF	No lost-time injuries or medical attention	Between $150,000 and $250,000	Major	Minor disruption	5.5
Electrical - North Area Electrical Building					
North Area Electrical Building Structure	Potential for loss of life	More than $250,000	Major	No impacts	7.3
Electrical - North Area Electrical Building					
Remote Telemetry Unit (RTU)	No lost-time injuries or medical attention	Between $25,000 and $150,000	Minor	No impacts	3.4
Electrical - North Area Electrical Building					
Switchboard-NB	No lost-time injuries or medical attention	Between $25,000 and $150,000	Minor	Minor disruption	4
Electrical - North Area Electrical Building					
Switchgear	No lost-time injuries or medical attention	Between $25,000 and $150,000	Minor	Minor disruption	4
Electrical - North Area Electrical Building					
Swithcboards Large	No lost-time injuries or medical attention	Between $25,000 and $150,000	Minor	Minor disruption	4
Electrical - North Area Electrical Building					

Component	Public and Employee Health and Safety	Financial Impact	Environmental or Regulatory Compliance	Customer Service	Total Criticality
Transformer TC	Lost-time injury or medical attention	Between $150,000 and $250,000	Minor	Short-term impact	6.1
Electrical - North Area Electrical Building					
Transformer TD	Lost-time injury or medical attention	Between $150,000 and $250,000	Minor	Short-term impact	6.1
Electrical - North Area Electrical Building					
VFDs (13)	No lost-time injuries or medical attention	Between $25,000 and $150,000	Minor	No impacts	3.4
General - Administration Building					
Administration Building	Potential for loss of life	More than $250,000	Major	No impacts	7.3
MCC- DP2D	No lost-time injuries or medical attention	Between $150,000 and $250,000	Major	Minor disruption	5.5
MCC-DP3A	No lost-time injuries or medical attention	Between $150,000 and $250,000	Major	Minor disruption	5.5
MCC-EDPIE	No lost-time injuries or medical attention	Between $150,000 and $250,000	Major	Minor disruption	5.5
Remote Telemetry Unit (RTU)	No lost-time injuries or medical attention	Between $25,000 and $150,000	Minor	No impacts	3.4
General - Plant Control Center					
Operations/Plant Control Center Building	Potential for loss of life	More than $250,000	Major	No impacts	7.3
Remote Telemetry Unit (RTU)	No lost-time injuries or medical attention	Between $25,000 and $150,000	Minor	No impacts	3.4

Component	Public and Employee Health and Safety	Financial Impact	Environmental or Regulatory Compliance	Customer Service	Total Criticality
General - Collection System Maintenance					
Collection System Maintenance Building	Potential for loss of life	More than $250,000	Major	No impacts	7.3
General - Maintenance Building					
Maintenance Building	Potential for loss of life	More than $250,000	Major	No impacts	7.3
Truck Scale	No lost-time injuries or medical attention	Between $25,000 and $150,000	Minor	Minor disruption	4
General - Vacuum Filtration					
Vacuum Filtration Building	Potential for loss of life	More than $250,000	Major	No impacts	7.3
General - Butler Storage Building					
Butler Building 1	Potential for loss of life	More than $250,000	Major	No impacts	7.3
Butler Building 2	No effect	Less than $25,000	No effect	No impacts	1
MCC-HC	No lost-time injuries or medical attention	Between $150,000 and $250,000	Major	Minor disruption	5.5
MCC-HG	No lost-time injuries or medical attention	Between $150,000 and $250,000	Major	Minor disruption	5.5
General - Chemical Handling Facilities					
Chemical Handling Facilities Building	Potential for loss of life	More than $250,000	Major	No impacts	7.3
Ferric Chloride Pump 1	No effect	Less than $25,000	No effect	No impacts	1

Component	Public and Employee Health and Safety	Financial Impact	Environmental or Regulatory Compliance	Customer Service	Total Criticality
Ferric Chloride Pump 2	No effect	Less than $25,000	No effect	No impacts	1

General - Effluent Electrical Building

Component	Public and Employee Health and Safety	Financial Impact	Environmental or Regulatory Compliance	Customer Service	Total Criticality
Effluent Electrical/16 kW Switchgear Building	Potential for loss of life	More than $250,000	Major	No impacts	7.3
Gym Switchgear	Potential for loss of life	More than $250,000	Major	No impacts	7.3
MCC- DP2A	No lost-time injuries or medical attention	Between $150,000 and $250,000	Major	Minor disruption	5.5
MCC- EBPIB	No lost-time injuries or medical attention	Between $150,000 and $250,000	Major	Minor disruption	5.5

WW Lift Stations

Lift Station 01 Cabezone

Component	Public and Employee Health and Safety	Financial Impact	Environmental or Regulatory Compliance	Customer Service	Total Criticality
Flow Meter	No effect	Between $25,000 and $150,000	Minor	No impacts	2.5
MCC	No lost-time injuries or medical attention	Between $150,000 and $250,000	Major	Minor disruption	5.5
SCADA Panel	No effect	Between $25,000 and $150,000	Minor	No impacts	2.5
Submersible Pump 1	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Submersible Pump 2	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Valve Vault	No lost-time injuries or medical attention	Less than $25,000	Minor	Minor disruption	3.4

Component	Public and Employee Health and Safety	Financial Impact	Environmental or Regulatory Compliance	Customer Service	Total Criticality
Wet Well Structure	Lost-time injury or medical attention	Between $25,000 and $150,000	Major	Short-term impact	6.4
Lift Station 02 Harbor					
MCC	No lost-time injuries or medical attention	Between $150,000 and $250,000	Major	Minor disruption	5.5
Paving/Fencing	No effect	Between $25,000 and $150,000	No effect	No impacts	1.6
SCADA Panel	No effect	Between $25,000 and $150,000	Minor	No impacts	2.5
Submersible Pump 1	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Submersible Pump 2	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Valve Vault	No lost-time injuries or medical attention	Less than $25,000	Minor	Minor disruption	3.4
Wet Well Structure	Lost-time injury or medical attention	Between $25,000 and $150,000	Major	Short-term impact	6.4
Lift Station 04 Mandalay & Wooley					
MCC	No lost-time injuries or medical attention	Between $150,000 and $250,000	Major	Minor disruption	5.5
SCADA Panel	No effect	Between $25,000 and $150,000	Minor	No impacts	2.5
Submersible Pump 1	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Submersible Pump 2	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1

Component	Public and Employee Health and Safety	Financial Impact	Environmental or Regulatory Compliance	Customer Service	Total Criticality
Valve Vault	No lost-time injuries or medical attention	Less than $25,000	Minor	Minor disruption	3.4
Wet Well Structure	Lost-time injury or medical attention	Between $25,000 and $150,000	Major	Short-term impact	6.4
Lift Station 06 Canal					
MCC	No lost-time injuries or medical attention	Between $150,000 and $250,000	Major	Minor disruption	5.5
SCADA Panel	No effect	Between $25,000 and $150,000	Minor	No impacts	2.5
Submersible Pump 1	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Submersible Pump 2	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Valve Vault	No lost-time injuries or medical attention	Less than $25,000	Minor	Minor disruption	3.4
Wet Well Structure	Lost-time injury or medical attention	Between $25,000 and $150,000	Major	Short-term impact	6.4
Lift Station 07					
Generator	No lost-time injuries or medical attention	More than $250,000	Major	Short-term impact	6.7
MCC	No lost-time injuries or medical attention	Between $150,000 and $250,000	Major	Minor disruption	5.5
Paving/Fencing	No effect	Between $25,000 and $150,000	No effect	No impacts	1.6
SCADA Panel	No effect	Between $25,000 and $150,000	Minor	No impacts	2.5

Component	Public and Employee Health and Safety	Financial Impact	Environmental or Regulatory Compliance	Customer Service	Total Criticality
Submersible Pump 1	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Submersible Pump 2	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Valve Vault	No lost-time injuries or medical attention	Less than $25,000	Minor	Minor disruption	3.4
Wet Well Structure	Lost-time injury or medical attention	Between $25,000 and $150,000	Major	Short-term impact	6.4
Lift Station 08					
Generator	No lost-time injuries or medical attention	More than $250,000	Major	Short-term impact	6.7
MCC	No lost-time injuries or medical attention	Between $150,000 and $250,000	Major	Minor disruption	5.5
Paving/Fencing	No effect	Between $25,000 and $150,000	No effect	No impacts	1.6
SCADA Panel	No effect	Between $25,000 and $150,000	Minor	No impacts	2.5
Submersible Pump 1	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Submersible Pump 2	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Valve Vault	No lost-time injuries or medical attention	Less than $25,000	Minor	Minor disruption	3.4
Wet Well Structure	Lost-time injury or medical attention	Between $25,000 and $150,000	Major	Short-term impact	6.4

Component	Public and Employee Health and Safety	Financial Impact	Environmental or Regulatory Compliance	Customer Service	Total Criticality
Lift Station 09 Merion Way					
Generator	No lost-time injuries or medical attention	More than $250,000	Major	Short-term impact	6.7
MCC	No lost-time injuries or medical attention	Between $150,000 and $250,000	Major	Minor disruption	5.5
Paving/Fencing	No effect	Between $25,000 and $150,000	No effect	No impacts	1.6
SCADA Panel	No effect	Between $25,000 and $150,000	Minor	No impacts	2.5
Submersible Pump 1	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Submersible Pump 2	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Valve Vault	No lost-time injuries or medical attention	Less than $25,000	Minor	Minor disruption	3.4
Wet Well	Lost-time injury or medical attention	Between $25,000 and $150,000	Major	Short-term impact	6.4
Lift Station 15 Cascade					
MCC	No lost-time injuries or medical attention	Between $150,000 and $250,000	Major	Minor disruption	5.5
SCADA Panel	No effect	Between $25,000 and $150,000	Minor	No impacts	2.5
Submersible Pump 1	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Submersible Pump 2	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1

Component	Public and Employee Health and Safety	Financial Impact	Environmental or Regulatory Compliance	Customer Service	Total Criticality
Valve Vault	No lost-time injuries or medical attention	Less than $25,000	Minor	Minor disruption	3.4
Wet Well Structure	Lost-time injury or medical attention	Between $25,000 and $150,000	Major	Short-term impact	6.4
Lift Station 20 Beardsley					
Generator	No lost-time injuries or medical attention	More than $250,000	Major	Short-term impact	6.7
MCC	No lost-time injuries or medical attention	Between $150,000 and $250,000	Major	Minor disruption	5.5
Paving/Fencing	No effect	Between $25,000 and $150,000	No effect	No impacts	1.6
SCADA Panel	No effect	Between $25,000 and $150,000	Minor	No impacts	2.5
Submerisble Pump 1	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Submersible Pump 2	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Valve Vault	No lost-time injuries or medical attention	Less than $25,000	Minor	Minor disruption	3.4
Wet Well Structure	Lost-time injury or medical attention	Between $25,000 and $150,000	Major	Short-term impact	6.4
Lift Station 23 Wagon Wheel					
MCC	No lost-time injuries or medical attention	Between $150,000 and $250,000	Major	Minor disruption	5.5
SCADA Panel	No effect	Between $25,000 and $150,000	Minor	No impacts	2.5

Component	Public and Employee Health and Safety	Financial Impact	Environmental or Regulatory Compliance	Customer Service	Total Criticality
Submersible Pump 1	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Submersible Pump 2	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Valve Vault	No lost-time injuries or medical attention	Less than $25,000	Minor	Minor disruption	3.4
Wet Well Structure	Lost-time injury or medical attention	Between $25,000 and $150,000	Major	Short-term impact	6.4
Lift Station 24 Handyman					
MCC Box	No lost-time injuries or medical attention	Between $150,000 and $250,000	Major	Minor disruption	5.5
SCADA Panel	No effect	Between $25,000 and $150,000	Minor	No impacts	2.5
Submersible Pump 1	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Submersible Pump 2	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Valve Vault	No lost-time injuries or medical attention	Less than $25,000	Minor	Minor disruption	3.4
Wet Well Structure	Lost-time injury or medical attention	Between $25,000 and $150,000	Major	Short-term impact	6.4
Lift Station 27 Launch Ramp					
MCC	No lost-time injuries or medical attention	Between $150,000 and $250,000	Major	Minor disruption	5.5
Paving/Fencing	No effect	Between $25,000 and $150,000	No effect	No impacts	1.6

Component	Public and Employee Health and Safety	Financial Impact	Environmental or Regulatory Compliance	Customer Service	Total Criticality
SCADA Panel	No effect	Between $25,000 and $150,000	Minor	No impacts	2.5
Submersible Pump 1	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Submersible Pump 2	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Valve Vault	No lost-time injuries or medical attention	Less than $25,000	Minor	Minor disruption	3.4
Wet Well Structure	Lost-time injury or medical attention	Between $25,000 and $150,000	Major	Short-term impact	6.4
Lift Station 28 Hueneme					
Generator	No lost-time injuries or medical attention	More than $250,000	Major	Short-term impact	6.7
MCC	No lost-time injuries or medical attention	Between $150,000 and $250,000	Major	Minor disruption	5.5
Paving/Fencing	No effect	Between $25,000 and $150,000	No effect	No impacts	1.6
SCADA Panel	No effect	Between $25,000 and $150,000	Minor	No impacts	2.5
Submersible Pump 1	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Submersible Pump 2	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Submersible Pump 3	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1

Component	Public and Employee Health and Safety	Financial Impact	Environmental or Regulatory Compliance	Customer Service	Total Criticality
Valve Vault	No lost-time injuries or medical attention	Less than $25,000	Minor	Minor disruption	3.4
Wet Well Structure	Lost-time injury or medical attention	Between $25,000 and $150,000	Major	Short-term impact	6.4
Lift Station 29 Patterson & Hemlock (Large)					
Generator	No lost-time injuries or medical attention	More than $250,000	Major	Short-term impact	6.7
Generator Room Structure	Potential for loss of life	More than $250,000	Major	No impacts	7.3
MCC	No lost-time injuries or medical attention	Between $150,000 and $250,000	Major	Minor disruption	5.5
SCADA Cabinet	No effect	Between $25,000 and $150,000	Minor	No impacts	2.5
Submersible Pump 1	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Submersible Pump 2	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Submersible Pump 3	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Submersible Pump 4	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Switchboard	No lost-time injuries or medical attention	Between $25,000 and $150,000	Minor	Minor disruption	4
Valve Vault	No lost-time injuries or medical attention	Less than $25,000	Minor	Minor disruption	3.4

Component	Public and Employee Health and Safety	Financial Impact	Environmental or Regulatory Compliance	Customer Service	Total Criticality
Wet Well Structure	Lost-time injury or medical attention	Between $25,000 and $150,000	Major	Short-term impact	6.4
Lift Station 30 Colony					
MCC	No lost-time injuries or medical attention	Between $150,000 and $250,000	Major	Minor disruption	5.5
SCADA Panel	No effect	Between $25,000 and $150,000	Minor	No impacts	2.5
Submersible Pump 1	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Submersible Pump 2	No lost-time injuries or medical attention	Between $25,000 and $150,000	Major	Long-term impact	6.1
Valve Vault	No lost-time injuries or medical attention	Less than $25,000	Minor	Minor disruption	3.4
Wet Well Structure	Lost-time injury or medical attention	Between $25,000 and $150,000	Major	Short-term impact	6.4

This document is released for the purpose of information exchange review and planning only under the authority of Tracy Anne Clinton, September 2017, State of California, PE No. 48199 and Elizabeth Abigail Charbonnet, September 2017, State of California, PE No. 84612.

City of Oxnard

Public Works Integrated Master Plan

WASTEWATER

PROJECT MEMORANDUM 3.5
CONDITION ASSESSMENT

REVISED FINAL DRAFT
September 2017

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PREFACE

The analysis and evaluations contained in these Project Memorandum (PM) are based on data and information available at the time of the original date of publication, December 2015. After development of the December 2015 Final Draft PMs, the City continued to move forward on two concurrent aspects: 1) advancing the facilities planning for the water, wastewater, recycled water, and stormwater facilities; and 2) developing Updated Cost of Service (COS) Studies (Carollo, 2017) for the wastewater/collection system and the water/distribution system. The updated 2017 COS studies contain the most recent near-term Capital Improvement Projects (CIP). **The complete updated CIP based on the near-term and long-term projects is contained in the Brief History and Overview of the City of Oxnard Public Works Department's Integrated Planning Efforts: May 2014 – August 2017 section.**

At the time of this Revised PWIMP, minor edits were also incorporated into the PMs. Minor edits included items such as table title changes and updating reports that were completed after the December 2015 original publication date.

City of Oxnard

Public Works Integrated Master Plan

WASTEWATER

PROJECT MEMORANDUM 3.6
SEISMIC ASSESSMENT

TABLE OF CONTENTS

Page No.

LIST OF TABLES

LIST OF FIGURES

SEISMIC ASSESSMENT

1.0 INTRODUCTION

The purpose of the structural assessment of the Oxnard Wastewater Treatment Plant (OWTP) structures was to:

- Establish the anticipated level of performance for each structure during a seismic event.
- Recommend retrofit strategies to meet established performance objectives when deficiencies are identified.
- Evaluate the structure condition to assess the total level of effort required to increase the remaining useful life.

The structural assessment considered two elements when developing recommendations; the structure's resilience or ability to withstand earthquake forces, and the overall condition.

The OWTP structures were categorized building-type or water-retaining structures. *The American Society of Civil Engineers Standard: Seismic Evaluation and Retrofit of Existing Buildings* (ASCE 31-06) provided the methodology adopted for evaluating the building's seismic resiliency. Two basic steps from the standard were used for this assessment; Tier 1 screening, and Tier 2 evaluation. Seismic assessment of existing water-retaining structures was performed using the analysis methods outlined in *American Concrete Institute: Seismic Design of Liquid-Containing Concrete Structures and Commentary* (ACI 350.3-06).

Tier 1 screening, Tier 2 assessments of the buildings, and seismic assessment of the water-retaining structures at the Oxnard Wastewater Treatment Plant (OWTP) resulted in the identification and evaluation of structural and non-structural seismic vulnerabilities. Seismic assessment was completed for a total of eighteen buildings and eight water-retaining structures.

Based on Tier 1 assessment, each building had three possible recommendations:

1. Replacement.
2. Retrofit of non-structural components.
3. Tier 2 analysis.

Recommendation of replacement was based on the results of the: condition of the building, seismic assessment of the building, and plant process considerations. As a result of the Tier 1 screening assessment;

- Eight of the eighteen assessed buildings were recommended for replacement.
- Four buildings required retrofit of non-structural components only.
- Six had deficiencies that required Tier 2 analysis to better understand the associated risk.

One of those six buildings recommended for further analysis is proposed to be replaced as a result of condition assessment bringing the number of buildings recommended for replacement to nine. Tier 2 evaluation was completed for five buildings. Based on the Tier 2 results, structural and/or non-structural retrofits were recommended for all five buildings. Summarizing, nine buildings were recommended for replacement, four buildings require retrofit of non-structural elements, and five buildings require both structural and non-structural retrofits.

Based on the preliminary seismic findings of the eight water-retaining structures:

- Six were recommended for structural retrofits.
- One was recommended for replacement.
- One for pre-stressing evaluation.

All water-retaining structures were also recommended for further concrete condition testing that was completed as a separate task. The concrete testing was completed by V&A in March 2015. In general, the concrete condition for the water-retaining structures was assessed to be fair and concrete coating and/or concrete repair is recommended for the water-retaining structures.

Along with the seismic assessment, the condition assessment and plant process considerations, four water-retaining structures were recommended for replacement. Project Memo 3.7.1 Alternatives Analysis outlines the cost estimates associated with the structural/non-structural retrofits of the buildings, and retrofits and concrete coating/concrete repairs of the water-retaining structures.

1.1 Project Memorandums (PMs) Used for Reference

The findings outlined in this PM are made in concert with recommendations and analyses from other related PMs:

- PM 3.1 - Wastewater System - Background Summary.
- PM 3.5 - Wastewater System - Condition Assessment.
- PM 3.7.1 - Wastewater System - Traditional OWTP Assessment - Upgrade in Place.

1.2 Other Reports Used for Reference

Other documents were used in developing the seismic assessment in this PWIMP. Please see the Reference Section of Appendix A and Appendix B for details on these additional documents.

2.0 BACKGROUND

In June 2014, the City of Oxnard (Oxnard) engaged Carollo Engineers to perform a seismic evaluation of the Oxnard Wastewater Treatment Plant (OWTP).

In order to assess the seismic performance of a building, the performance objective must first be identified. The performance objective of a building is comprised of three components: the level of safety of the building occupants during and after a seismic event, the cost of restoring the building to its pre-event condition, and the length of time the building is removed from service, i.e. not occupiable. A preliminary ASCE 31-06 Tier 1, i.e., screening assessment that identified potential structural and non-structural seismic vulnerabilities of the buildings as they relate to Oxnard seismic performance objectives during the subject earthquake events was completed in October 2014. During the course of completing the Tier 1 assessment, ASCE 31-06 was updated to ASCE 41-13. Deficiencies identified in Tier 1 were further evaluated, and components that require seismic retrofit were identified using the Tier 2 procedures of ASCE 41-13.

Water retaining structures (i.e. non-building type structures) were evaluated for seismic structural vulnerabilities and tested for the concrete condition. Refer to Figure 1 for the preliminary and detailed evaluation process for buildings and water-retaining structures.

3.0 SUMMARY OF FINDINGS

Results of the preliminary screening of the buildings and water-retaining structures, and results of the detailed evaluation of the buildings are shown in Tables 1 and 2, respectively. Results of concrete testing for the water-retaining structures are shown in Table 3. Appendix A is the detailed report on the approach, methodology, assessment results, and recommendations based on preliminary assessment of the buildings and water-retaining structures. Appendix B is the detailed report on the approach, methodology, assessment results, and recommendations based on detailed Tier 2 evaluation of the buildings. Appendix C includes the Tier 1 structural and non-structural checklists. Appendix D includes the final report outlining the procedures and results of the concrete testing conducted by V&A for the water-retaining structures.

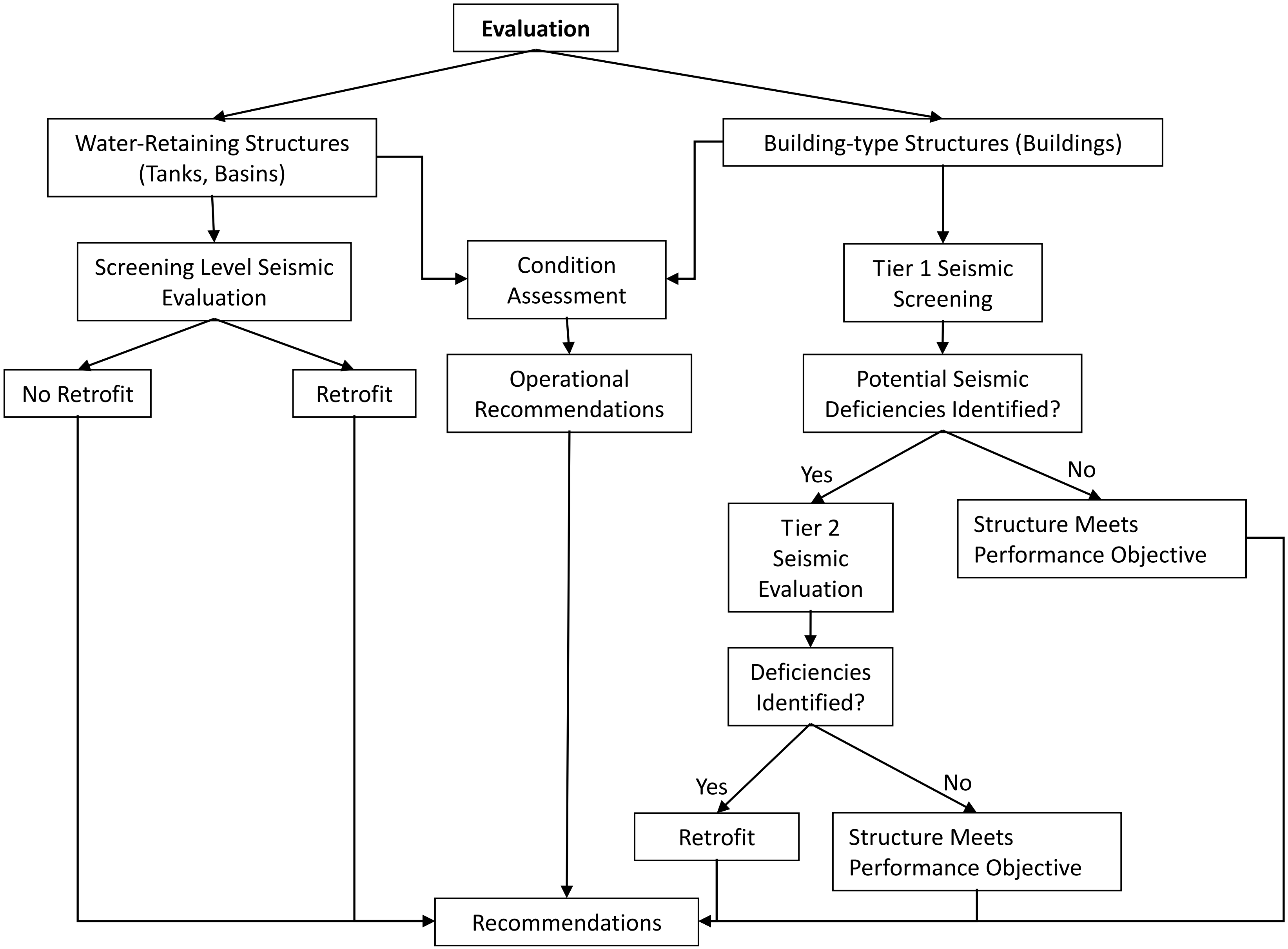


Figure 1 Evaluation Process for Buildings and Water-Retaining Structures

Table 1 shows of the twenty-six structures presented in this memorandum, eight buildings showed significant deterioration of the structural elements and, therefore, were recommended to be replaced. Four buildings required retrofit of non-structural components only, and six buildings were recommended for Tier 2 evaluation. Structural retrofits, replacement, and further concrete testing were recommended for the eight water-retaining structures.

Table 1 Summary of Assessment- Preliminary Screening of Buildings and Water-Retaining Structures Tier 1 Evaluation Public Works Integrated Master Plan City of Oxnard

Structure	Recommendation
Primary Sedimentation	Replace
Main Electrical / Main Switchgear Building	Replace
Digester Control Building	Replace
Operations Center/Plant Control Center Building	Replace
Effluent Pumping Station	Replace
Generator/Co-Generation Building	Replace
Storage-Vacuum Filter Building	Replace
Storage-Butler Building	Replace
Headworks Building	No Structural Deficiencies Identified/ Retrofit Non-Structural Components(2)
Grit Screenings Building	No Structural Deficiencies Identified/ Retrofit Non-Structural Components(2)
Blower Building	No Structural Deficiencies Identified/ Retrofit Non-Structural Components(2)
North Area Electrical Building	No Structural Deficiencies Identified/ Retrofit Non-Structural Components(2)
Solids Processing Building	Tier 2 Evaluation(2)
Maintenance Building	Tier 2 Evaluation(2)
Collection System Maintenance Building	Tier 2 Evaluation(2)
Chemical Handling Facilities	Tier 2 Evaluation(2)
16 kW Switchgear/Effluent Electrical Building	Tier 2 Evaluation(1)
Administration Building	Tier 2 Evaluation(2)
Activated Sludge Tanks/Aeration Basin	Structural Retrofit & Perform Concrete Testing(2)
Secondary Sedimentation Basin	Structural Retrofit & Perform Concrete Testing(2)
Flow Equalization Basin	Structural Retrofit & Perform Concrete Testing(2)
Primary Clarifier Tanks	Structural Retrofit & Perform Concrete Testing(2)
Gravity Thickeners	Replace
Digester Nos. 1, 2 and 3	Evaluate Pre-stressed Reinforcement & Perform Concrete Testing(1)
DAF Tanks	Structural Retrofit & Perform Concrete Testing(2)
Chlorine Contact Tank	Structural Retrofit & Perform Concrete Testing(2)

Notes:
(1) Structure is proposed to be replaced based on condition assessment and plant considerations.
(2) See Tables 2 and 3 for Tier 2 evaluation, and concrete testing results, respectively.

Of the ten buildings recommended for Tier 2 evaluation, the 16 kW Switchgear/Effluent Electrical Building is proposed to be replaced due to operational considerations and was not further evaluated. Table 2 presents the ASCE 41-13 Tier 2 findings. There are nine buildings listed in Table 2. Five were evaluated using the Tier 2 structural evaluation methodology. Non-structural elements of all nine buildings were reevaluated using the ASCE 41-13 Tier 2 methodology. In general, where the Tier 1 screening identified potential deficiencies the detailed Tier 2 evaluation found the buildings met the project performance objective. The deficient non-structural components identified in Tier 1 screening required retrofit to minimize risk of injury, reduce emergency repairs, and down time as a result of a seismic event.

Table 2 Summary of Assessment-Detailed Evaluation of Buildings Tier 2 Evaluation
Public Works Integrated Master Plan
City of Oxnard

Structure	Recommendation: Structural Components	Recommendation: Non-Structural Components
Headworks Building	Tier 2 Not Required(1)	Retrofit Recommended
Grit Screening Building	Tier 2 Not Required(1)	Retrofit Recommended
Blower Building	Tier 2 Not Required(1)	Retrofit Recommended
North Area Electrical Building	Tier 2 Not Required(1)	Retrofit Recommended
Solids Processing Building	No Deficiencies	Retrofit Recommended
Chemical Handling Facilities	Retrofit Recommended: wall-to-diaphragm connection	Retrofit Recommended
Maintenance Building	Retrofit Recommended: wall-to-diaphragm connection	Retrofit Recommended
Collection System Maintenance Building	Retrofit Recommended: wall-to-diaphragm connection	Retrofit Recommended
Administration Building	No Deficiencies	Retrofit Recommended

Note:
(1) No structural Deficiencies Identified in Preliminary Screening (Tier 1).

The concrete condition for the water-retaining structures is good to fair. Structural retrofits, and concrete coating and/or concrete repair of the water-retaining structures will increase the remaining service life. Table 3 outlines the results of the concrete testing for the water-retaining structures.

Table 3 Summary of Concrete Testing and Assessment Public Works Integrated Master Plan City of Oxnard		
	Results	
Structure	**Concrete Condition**	**Recommendation**
Flow Equalization Basin	Good, with minor cracks throughout basin	Repair areas of damaged/cracked concrete Apply corrosion inhibitor to concrete surfaces
Chlorine Contact Tank	Good, with minor cracks throughout basin	Plan to remove and replace existing coating in the next 10 years
Activated Sludge Tanks/Aeration Basin	Good, with moderate cracks throughout basin	Repair/seal cracks
Secondary Sedimentation Basin	Good, with moderate cracks throughout basin	Repair/seal cracks
Primary Clarifier Tanks	Fair, with moderate evidence of deterioration	Repair areas of damaged/cracked concrete Coat interior surfaces of tank with 100% epoxy or polyurethane coating

4.0 CONCLUSION

Based on the Tier 1 screening results and operational considerations, nine buildings were recommended for replacement. Structural and/or non-structural retrofits were recommended for nine buildings. With four of the eight water-retaining structures proposed to be replaced per seismic and operational considerations, structural retrofit, concrete coating and/or concrete repairs were recommended for the remaining four water-retaining structures. Project Memo 3.7.1 Alternatives Analysis presents the cost estimates associated with the structural and non-structural retrofits and concrete coating/concrete repairs. The estimated additional cost associated with retrofitting the buildings and retrofit and repairs for the water-retaining structures is approximately $26.4 million dollars.

APPENDIX A – PRELIMINARY STRUCTURAL SEISMIC ASSESSMENT OF BUILDING-TYPE AND WATER-RETAINING STRUCTURES

TABLE OF CONTENTS

Page No.

LIST OF TABLES

LIST OF FIGURES

APPENDIX A - PRELIMINARY STRUCTURAL SEISMIC ASSESSMENT OF BUILDING-TYPE AND WATER-RETAINING STRUCTURES

1.0 INTRODUCTION

In June 2014, the City of Oxnard (Oxnard) engaged Carollo Engineers to perform a seismic evaluation of the Oxnard Wastewater Treatment Plant (OWTP). The purpose of the evaluation is to identify potential structural and nonstructural seismic vulnerabilities of the structures as they relate to Oxnard seismic performance objectives during design earthquake events. Refer to Figure 1 for the OWTP site map.

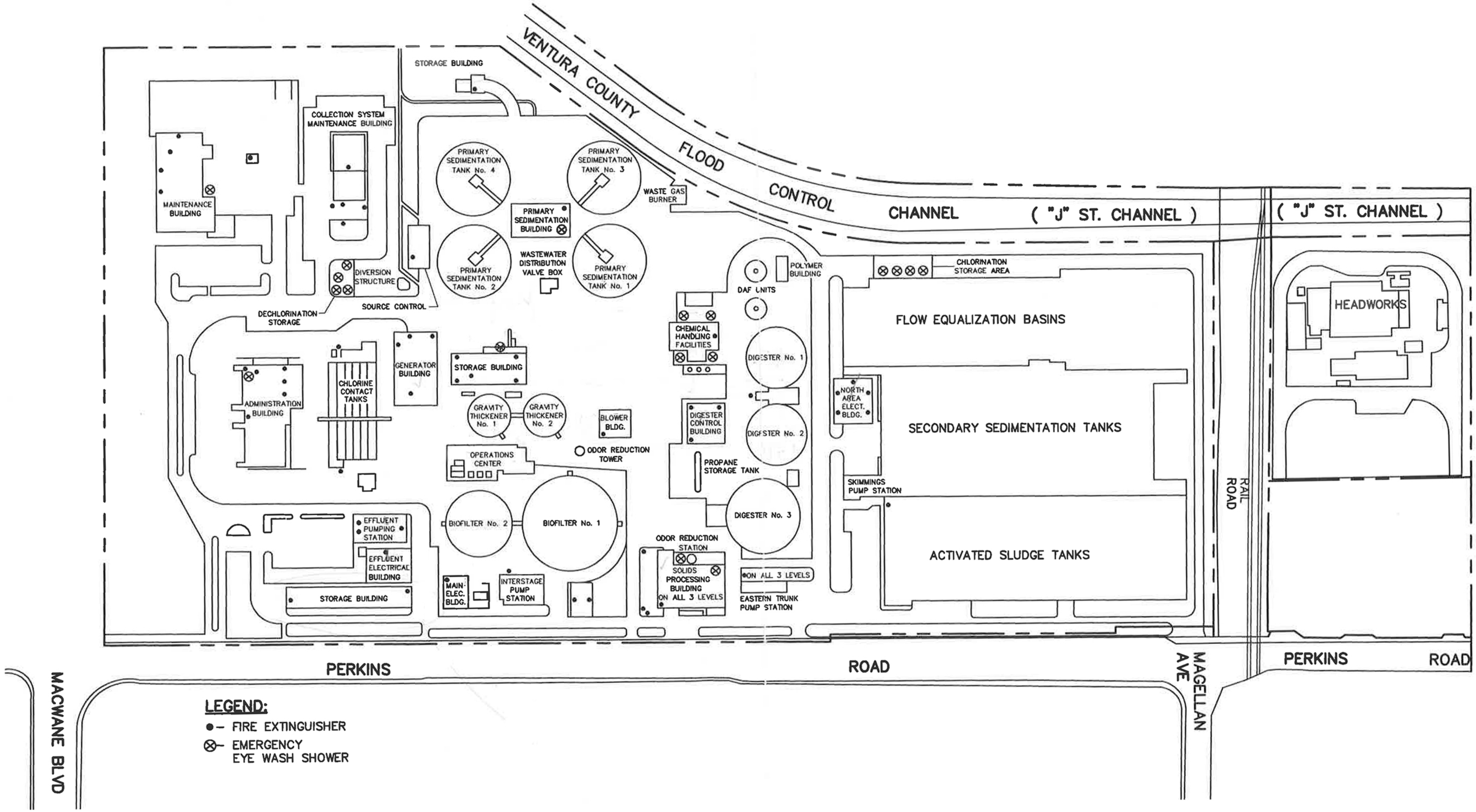
2.0 APPROACH

Preliminary seismic assessments of the existing building-type structure were performed using the *American Society of Civil Engineers Standard: Seismic Evaluation and Retrofit of Existing Buildings* (ASCE 31-06) Tier 1 evaluation procedures. This standard is commonly used as a way to evaluate anticipated seismic performance of existing buildings and the Tier 1 phase is the initial screening step. The purpose of Tier 1 step is to efficiently identify potential deficiencies or the need for additional investigation to properly evaluate the facility. For this assessment, the following three probabilistic scenario events were considered to determine if the existing structures meet an Immediate Occupancy performance level:

- 50 percent probability of exceedance in 50 years (72-year return period).
- 20 percent probability of exceedance in 50 years (225-year return period).
- 10 percent probability of exceedance in 50 years (474-year return period).

The three probabilistic scenarios represent a maximum Seismic Hazard Level of Basic Safety Earthquake (BSE)-1E. Based on the three probabilistic scenarios, buildings are expected to experience little damage from relatively frequent, low to moderate earthquakes (50%/50 years and 20%/50 years), but more damage and potential economic loss from more severe and infrequent earthquake (10%/50 years). Therefore, each scenario evaluates a different level of robustness of the building.

The performance level of a structure can be described in terms of the safety of the building occupants during and after a seismic event, the cost of restoring the building to its pre-event condition, and the length of time the building is removed from service, i.e. not occupiable. The Immediate Occupancy performance level was used to match the overall study objectives of determining the baseline plant operability after each of the three seismic events. ASCE 31-06 defines the Immediate Occupancy performance level as: “the post-earthquake damage state in which a structure remains safe to occupy, essentially retains its



OWTP SITE MAP

FIGURE 1

CITY OF OXNARD

PM NO. 3.6 APPENDIX – SEISMIC ASSESSMENT

PUBLIC WORKS INTEGRATED MASTER PLAN

ox0715f42-9587(PM3-6 FIG1).ai

pre-earthquake strength and stiffness." As part of the Tier 1 screening, ASCE 31 Structural Checklists, along with Nonstructural Checklists, for the buildings shown in Table 1 were completed. An inventory of the specific structures and/or components evaluated is provided in Table 1, including the memorandum section in which the structure's assessment results can be found.

Table 1 List of Facilities
Public Works Integrated Master Plan
City of Oxnard

Structure/Component	Type	Section
Headworks Building	Building	5.1
Grit Screenings Building	Building	5.2
Primary Sedimentation	Building	5.3
Main Electrical / Main Switchgear Building	Building	5.4
Blower Building	Building	5.5
North Area Electrical Building	Building	5.6
Digester Control Building	Building	5.7
Solids Processing Building	Building	5.8
Operations Center/Plant Control Center Building	Building	5.9
Effluent Pumping Station	Building	5.10
Generator/Co-Generation Building	Building	5.11
Maintenance Building	Building	5.12
Collection System Maintenance Building	Building	5.13
Chemical Handling Facilities	Building	5.14
Storage-Vacuum Filter Building	Building	5.15
Storage-Butler Building	Building	5.16
16 kW Switchgear/Effluent Electrical Building	Building	5.17
Administration Building	Building	5.18
Activated Sludge Tanks /Aeration Basin	Water-retaining Structure	5.19
Secondary Sedimentation Basin	Water-retaining Structure	5.20
Flow Equalization Basin	Water-retaining Structure	5.21
Primary Clarifier Tanks	Water-retaining Structure	5.22
Gravity Thickeners	Water-retaining Structure	5.23
Digester Nos. 1, 2 and 3	Water-retaining Structure	5.24
DAF Tanks	Water-retaining Structure	5.25
Chlorine Contact Tank	Water-retaining Structure	5.26

The seismic evaluation of the water-retaining concrete structures listed in Table 1, such as basins and tanks, was performed in accordance with *American Concrete Institute: Seismic Design of Liquid-Containing Concrete Structures and Commentary* (ACI 350.3-06).

3.0 SUMMARY OF FINDINGS

In general, the plant history reflects the evolution of the seismic codes, and older structures have more seismic deficiencies. Of the twenty six structures presented in this memorandum, eighteen were buildings, and eight were water-retaining structures.

For buildings with seismic concerns identified by Tier 1 checklists, if to remain, a Tier 2 evaluation may be recommended. Of the eighteen buildings, eight show significant deterioration to the structural elements and, therefore, were not recommended for a Tier 2 evaluation. It is recommended that those buildings be replaced. Only non-structural deficiencies were identified for four buildings, therefore, retrofit of those non-structural components is recommended. The remaining buildings were determined to be nonconforming for the Immediate Occupancy performance level for the specified seismic events and, are therefore, recommended for further Tier 2 evaluation. Table 2 lists all of the structures evaluated and their associated recommendations. Non-structural checklists reveal concerns that, when addressed, will improve safety of personnel during an earthquake. In general, there are many instances pertaining to building content and furnishing, as well as rigid piping connections, which may rupture perform well in an earthquake.

For the water-retaining structures, six of the eight structures were recommended for structural retrofits, one structure was recommend for replacement, and one structure was recommended for pre-stressing evaluation. In addition, all water-retaining structures were also recommended for further concrete condition testing.

4.0 SEISMIC ASSESSMENT METHODOLOGY

4.1 Building Structures

The seismic evaluation of the building structures at the OWTP was performed in accordance with ASCE 31-06 Tier 1 analysis procedures. Existing structural systems were determined by review of original design drawings for each building. The as-built condition of the structural system was verified through observation during a walk-through of each building. The buildings were evaluated for Immediate Occupancy performance in accordance with ASCE 31-06 Tier 1 analysis procedures to match the overall study objectives determining the baseline plant operability after a seismic event.

Table 2	**Summary of Assessment Public Works Integrated Master Plan City of Oxnard**
Structure/Component	**Recommendation**
Headworks Building	No Structural Deficiencies Identified/ Retrofit Non-Structural Components
Grit Screenings Building	No Structural Deficiencies Identified/ Retrofit Non-Structural Components
Primary Sedimentation	Replace
Main Electrical / Main Switchgear Building	Replace
Blower Building	No Structural Deficiencies Identified/ Retrofit Non-Structural Components
North Area Electrical Building	No Structural Deficiencies Identified/ Retrofit Non-Structural Components
Digester Control Building	Replace
Solids Processing Building	Tier 2 Evaluation
Operations Center / Plant Control Center Building	Replace
Effluent Pumping Station	Replace
Generator / Co-Generation Building	Replace
Maintenance Building	Tier 2 Evaluation
Collection System Maintenance Building	Tier 2 Evaluation
Chemical Handling Facilities	Tier 2 Evaluation
Storage-Vacuum Filter Building	Replace
Storage-Butler Building	Replace
16 kW Switchgear / Effluent Electrical Building	Tier 2 Evaluation
Administration Building	Tier 2 Evaluation
Activated Sludge Tanks / Aeration Basin	Structural Retrofit & Concrete Testing
Secondary Sedimentation Basin	Structural Retrofit & Concrete Testing
Flow Equalization Basin	Structural Retrofit & Concrete Testing
Primary Clarifier Tanks	Structural Retrofit & Concrete Testing
Gravity Thickeners	Replace
Digester Nos. 1, 2 and 3	Evaluate Pre-stressed Reinforcement & Concrete Testing
DAF Tanks	Structural Retrofit & Concrete Testing
Chlorine Contact Tank	Structural Retrofit & Concrete Testing

The Tier 1 structural analysis procedures are based on structural checklists, which allow for an overall preliminary assessment of the building's lateral force resisting system. The structural checklists are comprised of the Geologic and Foundation checklist and building type specific checklists. The building type is determined based on the building's lateral force resisting system (e.g. concrete shear wall, steel moment frame, etc.) as defined in ASCE 31-06. For each building type, there are two levels of structural checklists, "Life Safety" and "Immediate Occupancy." Depending on the level of seismicity for an earthquake event (e.g. low, moderate, or high) and the level of performance (e.g. Life Safety or Immediate Occupancy), the use of the different checklists is triggered. The level of seismicity is based on the Seismic Design Category, which is based on the seismic design parameters such as the design short-period spectral response acceleration and the design spectral response acceleration at 1-sec period. The level of seismicity for the Oxnard WTP was determined to be high.

Using these checklists and the "Quick Check" analysis procedures outlined in the ASCE 31-06 Tier 1 procedure, the buildings' structural lateral force resisting components were evaluated for compliance or noncompliance. Summaries of the structural seismic assessment results for each building are found in Section 5. Based on the results of the structural seismic assessment, overall condition assessment, and plant process assessment, Tier 2 evaluation or replacement of the building was recommended. Where non-compliant items were identified, buildings that were proposed to remain with repairable deterioration were recommended for further evaluation. The Tier 2 evaluation is in Appendix B.

4.2 Nonstructural Components

The seismic evaluation of the nonstructural components at the OWTP was performed in accordance with ASCE 31-06 Tier 1 analysis procedures. Lack of seismic anchorage and restraint of nonstructural items, such as architectural, mechanical, and electrical components, including process piping and equipment, were observed during the walk-through. The condition of nonstructural items was reviewed for Immediate Occupancy retention performance in accordance with ASCE 31-06 Tier 1 analysis procedures. ASCE 31-06 defines Immediate Occupancy for nonstructural components as "post-earthquake damage state in which nonstructural components are damaged but building access and life safety systems…generally remain available and operable, provided that power is available."

The Tier 1 nonstructural analysis procedures use a checklist that evaluates these elements. Depending on the level of seismicity for an earthquake event (e.g. low, moderate, or high) and the level of performance (e.g. Hazard Reduced, Life Safety, Immediate Occupancy, or Operational), the use of the different checklists is triggered.

Using these checklists as a guide, with our judgment, the nonstructural components were evaluated for compliance or noncompliance. Summaries of the nonstructural seismic assessment results for each structure are found in Section 5. In buildings that are proposed to remain, non-compliant non-structural elements should be retrofit. Retrofit requirements are discussed in Appendix B.

4.3 Water-retaining Structures

The seismic evaluation of the water-retaining concrete structures listed in Table 1, such as basins and tanks, was performed in accordance with ACI 350.3-06. During a seismic event, these structures will experience hydrostatic, hydrodynamic and in some cases, soil loads.

The structures were divided into two structure type categories: basins and tanks. The major structural components of the oldest and newest structure in each structure type category were evaluated for seismic performance in order to envelope the anticipated performance of all water-retaining structures. Summaries of the seismic assessment results for each structure are found in Section 5.

5.0 SEISMIC ASSESSMENT RESULTS

All of the buildings were analyzed for Immediate Occupancy in accordance with ASCE 31-06 Tier 1 analysis procedures. For structural elements, it should be noted that a more detailed structural analysis may result in revised conclusions.

The following set of design drawings were available to review.

BROWN AND CALDWELL CONSULTING ENGINEERS. 1975. *City of Oxnard-Wastewater Treatment Plant 1975 Improvements, October 1975.* Construction Drawings Prepared for City of Oxnard, California.

J.S. MURK ENGINEERS, INC. 1988. *Oxnard Wastewater Treatment Plant-Phase 1 Expansion, May 1988*. Construction Drawings Prepared for City of Oxnard, California.

MALCOLM PIRNIE. 2003. *Oxnard Wastewater Treatment Plant Headworks Project, July 2003.* Construction Drawings Prepared for City of Oxnard, California.

5.1 Headworks Building

5.1.1 Existing Structure Description

The Headworks Building is a reinforced concrete structure designed in 2003. A complete set of the design drawings was available for review. A site visit confirmed that the drawings appear to be consistent with observed conditions. The building makes up a part of the Headworks Area, which also includes the Grit Screening Building. The overall dimensions of the building are 47 feet in the north-south direction and 68 feet in the east-west direction. The building is a one-story structure which houses an electrical room, utility storage room, workstations, and lunch/meeting room.

5.1.2 Structural Assessment Results Summary

Per Table 3-1 of ASCE 31-06, the Headworks Building is considered a benchmark building. A benchmark building is defined as a building “designed and constructed or evaluated in accordance with the benchmark provisions," and "satisfies BSE-1E for the designated Performance Level." The Headworks Building was designed in accordance with the 2000 edition of the International Building Code and its latest supplements; therefore, a Tier 1 seismic evaluation is not required. However, an evaluation for its nonstructural components is still required.

5.1.3 Nonstructural Assessment Results Summary

The items listed in Table 3 were found to be non-compliant for the Immediate Occupancy performance level during the specified seismic events. The complete checklist can be found in Appendix C. Retrofit of non-structural components is recommended for this building.

Table 3 Headworks Building: Nonstructural Deficiencies
Public Works Integrated Master Plan
City of Oxnard

Deficient Issue	Description
Piping: Flexible Coupling	Fluid and gas piping does not have flexible couplings.
Building Contents and Furnishing: Drawers	Cabinet drawers do not have latches to keep them closed during an earthquake.
Building Contents and Furnishing: File Cabinets Attachments, Doors, and Drawer Locks	Cabinet doors and drawers do not have latches to keep them closed during an earthquake.

5.2 Grit Screenings Building

5.2.1 Existing Structure Description

The Grit Screenings Building is a reinforced concrete structure designed in 2003. A complete set of the design drawings was available for review. A site visit confirmed that the drawings appear to be consistent with observed conditions. The building makes up a part of the Headworks Area, which also includes the Headworks Building. The overall dimensions of the building are 112 feet in the north-south direction and 31 feet in the east-west direction. There is no reference to the original seismic design parameters.

5.2.2 Structural Assessment Results Summary

All items from the structural checklist were found to be compliant. The complete checklist can be found in Appendix C. During the visual assessment, there was no significant sign of deterioration of concrete or reinforcement in any of the vertical or lateral-force-resisting elements.

5.2.3 Nonstructural Assessment Results Summary

The items listed in Table 4 were found to be non-compliant for the Immediate Occupancy performance level during the specified seismic events. The complete checklist can be found in Appendix C. Retrofit of non-structural components is recommended for this building.

Table 4 Grit Screenings Building: Nonstructural Deficiencies
Public Works Integrated Master Plan
City of Oxnard

Deficient Issue	Description
Light Fixtures:	Emergency lighting is not anchored or braced to prevent failing or swaying during an earthquake.

5.3 Primary Sedimentation

5.3.1 Existing Structure Description

The Primary Sedimentation Building is a reinforced masonry bearing walls building with a flexible diaphragm designed in 1988. A complete set of design drawings was available for review. A site visit confirmed that the drawings appear to be consistent with observed conditions. There is no reference to the original seismic design parameters.

The building has overall dimensions of 36 feet in the north-south direction and approximately 18 feet in the east-west direction. The roof consists of 6x14 and 4x8 timber members and 3/4-inch CDX plywood sheathing. The masonry walls are reinforced with #5 @ 32-inch o.c. vertical and #5 @ 48-inch o.c. horizontal reinforcement.

5.3.2 Structural Assessment Results Summary

The items listed in Table 5 were found to be non-compliant for the Immediate Occupancy performance level during the specified seismic events. The complete checklist can be found in Appendix C. During the visual assessment, significant sign of deterioration, shrinkage and other damage to the wood members, deterioration of masonry units and mortar, and corrosion to equipment support anchorage components was noted. Due to the level of visual damage and deterioration, and results of the overall condition assessment, further Tier 2 evaluation is not recommended for this building. Replacement of this building is recommended.

5.3.3 Nonstructural Assessment Results Summary

The items listed in Table 6 were found to be non-compliant for the Immediate Occupancy performance level during the specified seismic events. The complete checklist can be found in Appendix C.

Table 5 Primary Sedimentation Building: Structural Deficiencies
Public Works Integrated Master Plan
City of Oxnard

Deficient Issue	Description
Building System: Deterioration of Wood	There are signs of decay, shrinkage, and splitting in the wood members.
Building System: Masonry Units	There is visible deterioration of masonry units.
Building System: Masonry Mortar	The mortar can be easily scraped away from the joints by hand with a metal tool.
Lateral-Force-Resisting System: Reinforcing Steel	The total vertical and horizontal reinforcing steel ratio is less than 0.002 of the wall.
Diaphragm: Cross Ties	There are no continuous cross ties between diaphragm chords.
Diaphragm: Straight Sheathing	The aspect ratio of the straight sheathing is not less than 1-1 in either direction being considered.
Diaphragm: Spans	Wood diaphragms with spans greater than 12 ft do not consist of wood structural panels.

Table 6 Primary Sedimentation Building: Nonstructural Deficiencies
Public Works Integrated Master Plan
City of Oxnard

Deficient Issue	Description
Mechanical & Electrical Equipment: Deterioration	There is evidence of deterioration, damage, or corrosion in the anchorage or supports of mechanical and electrical equipment.
Piping: Fire Suppression Piping	Fire suppression piping is not anchored and braced in accordance with NFPA-13.
Piping: Flexible Couplings	Fluid, gas, and fire suppression piping does not have flexible couplings.
Building Contents and Furnishing: Drawers	Cabinet drawers do not have latches to keep them closed during an earthquake.
Building Contents and Furnishing: File Cabinets Attachments, Doors, and Drawer Locks	Cabinet doors and drawers do not have latches to keep them closed during an earthquake.
Mechanical & Electrical Equipment: Electrical Equipment Bracing	Electrical equipment and associated wiring is not laterally braced.
Parapets, Cornices, Ornamentation, and Appendages: Appendages	Insufficient information available to determine whether concrete parapet is anchored per specified spacing.
Parapets, Cornices, Ornamentation, and Appendages: Concrete Parapets	Concrete parapet with height-to-thickness ratios greater than 2.5 does not have vertical reinforcement.

5.4 Main Electrical / Main Switchgear Building

5.4.1 Existing Structure Description

The Main Electrical Building is a reinforced masonry bearing walls building with a flexible diaphragm and designed in 1975. A complete set of design drawings was available for review. A site visit confirmed that the drawings appear to be consistent with observed conditions. There is no reference to the original seismic design parameters.

The building has overall dimensions approximately 31 feet in the north-south direction and approximately 47 feet in the east-west direction. The roof consists W14x30 steel beams running in the north-south direction, 2x8 timber joists in the east-west direction, and ½" standard grade plywood sheathing. The masonry walls are reinforced with #5 @ 32-inch o.c. vertical and #5 @ 48-inch o.c. horizontal reinforcement.

5.4.2 Structural Assessment Results Summary

The items listed in Table 7 were found to be non-compliant for the Immediate Occupancy performance level during the specified seismic events. The complete checklist can be found in Appendix C. During the visual assessment, significant sign of deterioration, shrinkage, and other damage to the wood members and corrosion to equipment support anchorage components was noted. Due to the level of visual damage and deterioration, further Tier 2 evaluation is not recommended for this building. Replacement of this building is recommended.

Table 7 Main Electrical Building: Structural Deficiencies
Public Works Integrated Master Plan
City of Oxnard

Deficient Issue	Description
Building System: Deterioration of Wood	There are signs of decay, shrinkage, and splitting in the wood members.
Lateral-Force-Resisting System: Reinforcing Steel	The total vertical and horizontal reinforcing steel ratio is less than 0.002 of the wall.
Connections: Wall Anchorage	Exterior masonry walls that are dependent on the diaphragm for lateral support are not anchored for out-of-plane forces at each diaphragm level. The connections do not have adequate strength to resist the connection forces.
Diaphragm: Cross Ties	There are no continuous cross ties between diaphragm chords.
Diaphragm: Diagonally Sheathed and Unblocked Diaphragms	Unblocked wood structural panel diaphragm does not have horizontal spans less than 30 feet.

5.4.3 Nonstructural Assessment Results Summary

The items listed in Table 8 were found to be non-compliant for the Immediate Occupancy performance level during the specified seismic events. The complete checklist can be found in Appendix C.

Table 8 Main Electrical Building: Nonstructural Deficiencies
Public Works Integrated Master Plan
City of Oxnard

Deficient Issue	Description
Piping: Fire Suppression Piping	Fire suppression piping is not anchored and braced in accordance with NFPA-13.
Piping: Flexible Couplings	Fluid, gas, and fire suppression piping does not have flexible couplings.
Mechanical & Electrical Equipment: Electrical Equipment	Electrical Equipment is not laterally braced to the structure.

5.5 Blower Building

5.5.1 Existing Structure Description

The Blower Building is a reinforced masonry bearing walls building with a flexible diaphragm designed in 1975. A complete set of design drawings was available for review. A site visit confirmed that the drawings appear to be consistent with observed conditions. There is no reference to the original seismic design parameters.

The building has overall dimensions approximately 21 feet in the north-south direction and approximately 33 feet in the east-west direction. The roof consists of 2x12 timber joists with 2 by blocking, and 1/2-inch CDX grade plywood sheathing. The masonry walls are reinforced with #5 @ 40-inch o.c. each way.

5.5.2 Structural Assessment Results Summary

All items from the structural checklist were found to be compliant for the Immediate Occupancy performance level during the specified seismic events. The complete checklist can be found in Appendix C.

5.5.3 Nonstructural Assessment Results Summary

The items listed in Table 9 were found to be non-compliant for the Immediate Occupancy performance level during the specified seismic events. The complete checklist can be found in Appendix C. Retrofit of non-structural components is recommended for this building.

Table 9	Blower Building: Nonstructural Deficiencies Public Works Integrated Master Plan City of Oxnard
Deficient Issue	**Description**
Light Fixtures: Emergency Lighting Anchorage	Emergency lighting is not anchored or braced to prevent failing or swaying during an earthquake.
Mechanical & Electrical Equipment: Deterioration	There is evidence of deterioration, damage, or corrosion in the anchorage or supports of mechanical and electrical equipment.

5.6 North Area Electrical Building

5.6.1 Existing Structure Description

The North Area Electrical Building is a reinforced concrete shearing walls building with a stiff diaphragm designed in 1988. A complete set of design drawings was available for review. A site visit confirmed that the drawings appear to be consistent with observed conditions. There is no reference to the original seismic design parameters.

The building has overall dimensions approximately 42 feet in the north-south direction and approximately 55 feet in the east-west direction. The roof consists W16x36 and W14x22 steel beams running in the east-west direction, and a steel deck with 2-1/2-inch concrete topping. The 8-inch concrete walls are reinforced with #5 @ 12-inch o.c. each way.

5.6.2 Structural Assessment Results Summary

All items from the structural checklist were found to be compliant for the Immediate Occupancy performance level during the specified seismic events. The complete checklist can be found in Appendix C. During the visual assessment, there was no significant sign of deterioration of concrete or reinforcement in any of the vertical or lateral-force-resisting elements.

5.6.3 Nonstructural Assessment Results Summary

The items listed in Table 10 were found to be non-compliant for the Immediate Occupancy performance level during the specified seismic events. The complete checklist can be found in Appendix C. Retrofit of non-structural components is recommended for this building.

Table 10	North Area Electrical Building: Nonstructural Deficiencies Public Works Integrated Master Plan City of Oxnard
Deficient Issue	**Description**
Contents and Furnishing: Tall Narrow Contents	Contents more than 4 ft high with a height-to-depth or height-to-wide ratio or great than 3-to-1 (such as file cabinets) are not anchored to the structure or each other.
Piping: Fire Suppression Piping	Fire suppression piping is not anchored and braced in accordance with NFPA-13.
Contents and Furnishing: Drawers	Cabinet drawers do not have latches to keep them closed during an earthquake.
Contents and Furnishing: File Cabinets	File cabinets arranged in groups are not attached to one another.
Building Contents and Furnishing: File Cabinets Attachments, Doors, and Drawers Locks	Cabinet doors and drawers do not have latches to keep them closed during an earthquake.

5.7 Digester Control Building

5.7.1 Existing Structure Description

The Digester Control Building is a reinforced masonry bearing walls building with a flexible diaphragm designed in 1975. A complete set of design drawings was available for review. A site visit confirmed that the drawings appear to be consistent with observed conditions. There is no reference to the original seismic design parameters.

The building has overall dimensions approximately 37 feet in the north-south direction and approximately 46 feet in the east-west direction. The roof consists of W16x31 steel beams running in the north-south direction, 2x8 timber joists in the east-west direction with 2 by blocking, and 1/2-inch CDX grade plywood sheathing. The masonry walls are reinforced with #5 @ 32-inch o.c. vertical and #5 @ 48-inch o.c. horizontal reinforcement.

5.7.2 Structural Assessment Results Summary

The items listed in Table 11 were found to be non-compliant for the Immediate Occupancy performance level during the specified seismic events. The complete checklist can be found in Appendix C. During the visual assessment, significant sign of deterioration, shrinkage, and other damage to the wood members, deterioration of the masonry units, and corrosion to equipment support anchorage components was noted. Due to the level of visual damage and deterioration, further Tier 2 evaluation is not recommended for this building. Replacement of this building is recommended.

Table 11 Digester Control Building: Structural Deficiencies Public Works Integrated Master Plan City of Oxnard	
Deficient Issue	**Description**
Building System: Deterioration of Wood	There are signs of decay, shrinkage, and splitting in the wood members.
Building System: Masonry Units	There is visible deterioration of masonry units.
Lateral-Force-Resisting System: Reinforcing Steel	The total vertical and horizontal reinforcing steel ratio is less than 0.002 of the wall.
Connections: Wood Ledger	Unable-To-Determine: The connection between the wall panels and the diaphragm does not induce cross-grain bending or tension in the wood ledgers.
Diaphragm: Cross Ties	There are no continuous cross ties between diaphragm chords.
Diaphragm: Diagonally Sheathed and Unblocked Diaphragms	Unblocked wood structural panel diaphragm does not have horizontal spans less than 30 feet.

5.7.3 Nonstructural Assessment Results Summary

The items listed in Table 12 were found to be non-compliant for the Immediate Occupancy performance level during the specified seismic events. The complete checklist can be found in Appendix C.

Table 12 Digester Control Building: Nonstructural Deficiencies Public Works Integrated Master Plan City of Oxnard	
Deficient Issue	**Description**
Piping: Flexible Couplings	Fluid, gas, and fire suppression piping does not have flexible couplings.
Mechanical and Electrical Equipment: Vibration Isolators Restrained	Equipment mounted on vibration isolators are not equipped with restraints or snubbers.

5.8 Solids Processing Building

5.8.1 Existing Structure Description

The Solids Processing Building is a three-story reinforced masonry bearing walls building with a stiff diaphragm designed in 1988. A complete set of design drawings was available for review. A site visit confirmed that the drawings appear to be consistent with observed conditions. There is no reference to the original seismic design parameters.

The building has overall dimensions approximately 92 feet in the north-south direction and approximately 84 feet in the east-west direction. The roof consists of 8-inch reinforced concrete floor slab. The masonry walls are reinforced with #5 @ 24-inch o.c. vertical and #4 @ 24-inch o.c. horizontal reinforcement.

5.8.2 Structural Assessment Results Summary

The items listed in Table 13 were found to be non-compliant for the Immediate Occupancy performance level during the specified seismic events. The complete checklist can be found in Appendix C. Further Tier 2 evaluation is recommended for this building.

Table 13 Solids Processing Building: Structural Deficiencies
Public Works Integrated Master Plan
City of Oxnard

Deficient Issue	Description
Lateral –Force-Resisting System: Shear Stress Check	The shear stress in the reinforced masonry shear walls is greater than 70 psi.
Lateral –Force-Resisting System: Reinforcing Steel	The total vertical and horizontal reinforcing steel ratio is less than 0.002 of the wall.
Connections: Girder/Column Connection	There is not a positive connection utilizing plates, connection hardware, or straps between the girder and column support.
Diaphragm: Openings at Exterior Masonry Shear Walls	Diaphragm opening immediately adjacent to exterior masonry shear walls are greater than 8 feet long.

5.8.3 Nonstructural Assessment Results Summary

The items listed in Table 14 were found to be non-compliant for the Immediate Occupancy performance level during the specified seismic events. The complete checklist can be found in Appendix C.

Table 14 Solids Processing Building: Nonstructural Deficiencies
Public Works Integrated Master Plan
City of Oxnard

Deficient Issue	Description
Light Fixtures: Independent Support	Light fixtures in suspended grid ceiling are not supported independently of the ceiling suspension system by a minimum of two wires.
Mechanical & Electrical Equipment: Deterioration	There is evidence of deterioration, damage, or corrosion in the anchorage or supports of mechanical and electrical equipment.
Piping: Flexible Couplings	Fluid, gas, and fire suppression piping does not have flexible couplings.
Mechanical and Electrical Equipment: Vibration Isolators Restrained	Equipment mounted on vibration isolators are not equipped with restraints or snubbers.
Piping: Fluid and Gas Piping Anchorage and Bracing	Fluid and gas piping are not anchored and braced to the structure to prevent breakage.

5.9 Operations Center / Plant Control Center Building

5.9.1 Existing Structure Description

The Operations Center is a reinforced masonry bearing walls building with a flexible diaphragm designed pre-1975. It was expanded to include a corridor as part of the 1975 Wastewater Treatment Plant Improvements Project, however original design drawings were not available for review. Therefore, certain information regarding the lateral-force-resisting system could not be determined. There is no reference to the original seismic design parameters. It has since been renamed as the Plant Control Center.

The building has overall dimensions approximately 90 feet in the north-south direction and approximately 50 feet in the east-west direction. From the expansion drawings, it was determined that the existing roof is a built up roof with ½" plywood. Any other information on the lateral-force-resisting system (wall thickness, reinforcement, etc.) is not available.

5.9.2 Structural Assessment Results Summary

Although some items on the structural checklist are considered compliant, due to insufficient information available on the structure, this structure is considered non-compliant for the Immediate Occupancy performance level. The complete checklist can be found in Appendix C. During the visual assessment, significant sign of deterioration, shrinkage and other damage to the wood members, and deterioration of the masonry units was noted. In order to further evaluate this building, destructive and non-destructive testing is necessary to document the building construction. Due to the level of visual damage and deterioration, and lack of design or record drawings, further Tier 2 evaluation is not recommended for this building. Replacement of this building is recommended.

5.9.3 Nonstructural Assessment Results Summary

The items listed in Table 15 were found to be non-compliant for the Immediate Occupancy performance level during the specified seismic events. The complete checklist can be found in Appendix C.

5.10 Effluent Pumping Station

5.10.1 Existing Structure Description

The Effluent Pump Station is a reinforced masonry bearing walls building with a flexible diaphragm designed pre-1975. It was expanded to include a below grade access structure as part of the 1975 Wastewater Treatment Plant Improvements Project, however original drawings were not available for review. Therefore, information regarding the lateral-force-resisting system could not be determined. There is no reference to the original seismic design parameters.

Table 15	Operations Center: Nonstructural Deficiencies Public Works Integrated Master Plan City of Oxnard
Deficient Issue	**Description**
Piping: Fire Suppression Piping	Fire suppression piping is not anchored and braced in accordance with NFPA-13.
Piping: Flexible Couplings	Fluid, gas, and fire suppression piping does not have flexible couplings.
Contents and Furnishing: Drawers	Cabinet drawers do not have latches to keep them closed during an earthquake.
Contents and Furnishing: File Cabinets	File cabinets arranged in groups are not attached to one another.
Building Contents and Furnishing: File Cabinets Attachments, Doors, and Drawer Locks	Cabinet doors and drawers do not have latches to keep them closed during an earthquake.
Light Fixtures: Lens Covers	Lens covers on light fixtures are not supplied with safety devices.
Contents and Furnishings: Fall-Prone Contents	Equipment, stored items, or other contents weighing more than 20 lbs whose center of mass is more than 4 ft above the floor level are not braced or restrained.
Parapets, Cornices, Ornamentation, and Appendages: Appendages	Insufficient information available to determine whether concrete parapet is anchored per specified spacing.

5.10.2 Structural Assessment Results Summary

Although some items on the structural checklist are considered compliant due to visual assessment, due to insufficient information available on the structure, this structure is considered non-compliant for the Immediate Occupancy performance level. The complete checklist can be found in Appendix C. During the visual assessment, significant sign of deterioration, shrinkage, and other damage to the wood members, deterioration of the masonry units and mortar, and significant wall cracks were noted. In order to further evaluate this building, destructive and non-destructive testing is necessary to document the building construction. Due to the level of damage and deterioration and lack of record drawings, further Tier 2 evaluation is not recommended for this building. Replacement of this building is recommended.

5.10.3 Nonstructural Assessment Results Summary

The items listed in Table 16 below were found to be non-compliant for the Immediate Occupancy performance level during the specified seismic events. The complete checklist can be found in Appendix C.

Table 16 Effluent Pumping Station: Nonstructural Deficiencies Public Works Integrated Master Plan City of Oxnard	
Deficient Issue	**Description**
Mechanical & Electrical Equipment: Deterioration	There is evidence of deterioration, damage, or corrosion in the anchorage or supports of mechanical and electrical equipment.
Piping Fire Suppression Piping	Fire suppression piping is not anchored and braced in accordance with NFPA-13.
Piping: Flexible Couplings	Fluid, gas, and fire suppression piping does not have flexible couplings.
Contents and Furnishing: File Cabinets	File cabinets arranged in groups are not attached to one another.
Building Contents and Furnishing: File Cabinets Attachments, Doors, and Drawer Locks	Cabinet doors and drawers do not have latches to keep them closed during an earthquake.
Ducts: Duct Bracing	Rectangular ductworks exceeding 6 square feet in cross-sectional area are not braced.
Mechanical and Electrical Equipment: Vibration Isolators Restrained	Equipment mounted on vibration isolators are not equipped with restraints or snubbers.

5.11 Generator / Co-Generation Building

5.11.1 Existing Structure Description

The Generator Building is a reinforced masonry bearing walls building with a flexible diaphragm designed in 1975. A complete set of design drawings was available for review. A site visit confirmed that the drawings appear to be consistent with observed conditions. There is no reference to the original seismic design parameters.

The building has overall dimensions approximately 52 feet in the north-south direction and approximately 105 feet in the east-west direction. The roof consists of W21x44 steel beams with a metal deck in the Generator Room and 2x8 timber joists with 2 by blocking, and 1/2-inch CDX grade plywood sheathing in the Control Room. The masonry walls are reinforced with #6 @ 24-inch o.c. vertical and #5 @ 32-inch o.c. horizontal reinforcement.

5.11.2 Structural Assessment Results Summary

The items listed in Table 17 were found to be non-compliant for the Immediate Occupancy performance level during the specified seismic events. The complete checklist can be found in Appendix C. During the visual assessment, significant sign of deterioration, shrinkage, and other damage to the wood members, deterioration of the masonry units, and corrosion to equipment support anchorage components was noted. Further Tier 2 evaluation is not recommended for this structure. Replacement of this building is recommended.

Table 17 Generator Building: Structural Deficiencies Public Works Integrated Master Plan City of Oxnard	
Deficient Issue	**Description**
Building System: Deterioration of Wood	There are signs of decay, shrinkage, and splitting in the wood members.
Building System: Masonry Units	There is visible deterioration of masonry units.
Lateral-Force-Resisting System: Reinforcing Steel	The total vertical and horizontal reinforcing steel ratio is less than 0.002 of the wall.
Diaphragm: Cross Ties	There are no continuous cross ties between diaphragm chords.
Diaphragm: Diagonally Sheathed and Unblocked Diaphragms	Unblocked wood structural panel diaphragm does not have horizontal spans less than 30 feet.

5.11.3 Nonstructural Assessment Results Summary

The items listed in Table 18 were found to be non-compliant for the Immediate Occupancy performance level during the specified seismic events. The complete checklist can be found in Appendix C.

5.12 Maintenance Building

5.12.1 Existing Structure Description

The Maintenance Building is a reinforced masonry bearing walls building with a flexible diaphragm designed in 1977. Record drawings were not available for review. Therefore, information regarding the lateral-force-resisting system could not be determined. There is no reference to the original seismic design parameters.

5.12.2 Structural Assessment Results Summary

Although some items on the structural checklist are considered compliant by visual assessment, due to insufficient information available on the structure, this structure is considered non-compliant for the Immediate Occupancy performance level. The complete checklist can be found in Appendix C. During the visual assessment, deterioration of wood members was noted. Further Tier 2 evaluation is recommended for this building.

5.12.3 Nonstructural Assessment Results Summary

The items listed in Table 19 below were found to be non-compliant for the Immediate Occupancy performance level during the specified seismic events. The complete checklist can be found in Appendix C.

Table 18	**Generator Building: Nonstructural Deficiencies Public Works Integrated Master Plan City of Oxnard**
Deficient Issue	**Description**
Mechanical & Electrical Equipment: Deterioration	There is evidence of deterioration, damage, or corrosion in the anchorage or supports of mechanical and electrical equipment.
Parapets: Urm Parapets	There is a laterally unsupported unreinforced masonry parapet with a height-to-thickness ratio greater than 1.5
Piping Fire Suppression Piping	Fire suppression piping is not anchored and braced in accordance with NFPA-13.
Piping: Flexible Couplings	Fluid, gas, and fire suppression piping does not have flexible couplings.
Contents and Furnishing: Drawers	Cabinet drawers do not have latches to keep them closed during an earthquake.
Contents and Furnishing: File Cabinets	File cabinets arranged in groups are not attached to one another.
Building Contents and Furnishing: File Cabinets Attachments, Doors, and Drawer Locks	Cabinet doors and drawers do not have latches to keep them closed during an earthquake.
Ducts: Duct Bracing	Rectangular ductworks exceeding 6 square feet in cross-sectional area, are not braced.
Mechanical and Electrical Equipment: Electrical Equipment Bracing	Electrical equipment and associated wiring is not laterally braced to the structural system.
Mechanical and Electrical Equipment: Vibration Isolators Restrained	Equipment mounted on vibration isolators are not equipped with restraints or snubbers.
Parapets: Urm Parapets	Parapets are not reinforced and anchored to the structural system at a spacing less than 10 feet.

Table 19 Maintenance Building: Nonstructural Deficiencies Public Works Integrated Master Plan City of Oxnard	
Deficient Issue	**Description**
Mechanical & Electrical Equipment: Deterioration	There is evidence of deterioration, damage or corrosion in the anchorage or supports of mechanical and electrical equipment.
Piping Fire Suppression Piping	Fire suppression piping is not anchored and braced in accordance with NFPA-13.
Contents and Furnishing: Drawers	Cabinet drawers do not have latches to keep them closed during an earthquake.
Contents and Furnishing: File Cabinets	File cabinets arranged in groups are not attached to one another.
Building Contents and Furnishing: File Cabinets Attachments, Doors, and Drawer Locks	Cabinet doors and drawers do not have latches to keep them closed during an earthquake.

5.13 Collection System Maintenance Building

5.13.1 Existing Structure Description

The Collection System Maintenance Building is a reinforced masonry bearing walls building with a flexible diaphragm designed in 1988. A partial set of design drawings was available for review. A site visit confirmed that the drawings appear to be consistent with observed conditions. The building is currently used as a maintenance building and houses staff offices and does not serve its original purpose. There is no reference to the original seismic design parameters.

The building has overall dimensions approximately 45 feet in the north-south direction and approximately 134 feet in the east-west direction. The roof consists of timber joists with 2 by blocking, and 1/2-inch CDX grade plywood sheathing. The masonry walls are reinforced with #5 @ 32-inch o.c. vertical and #5 @ 48-inch o.c. horizontal reinforcement. Complete information pertaining to the lateral force resisting system was not provided in the set of drawings available, therefore, some structural items were found to be non-compliant.

5.13.2 Structural Assessment Results Summary

The items listed in Table 20 were found to be non-compliant for the Immediate Occupancy performance level during the specified seismic events. The complete checklist can be found in Appendix C. Further Tier 2 evaluation is recommended for this building.

Table 20	Collection System Maintenance Building: Structural Deficiencies Public Works Integrated Master Plan City of Oxnard
Deficient Issue	**Description**
Connections: Wood Ledgers	The connection between the wall panels and the diaphragm induces cross-grain bending or tension in the wood legers.
Lateral –Force-Resisting System: Shear Stress Check	Unable-to-Determine: The shear stress in the reinforced masonry shear walls shall be less than 70 psi.
Lateral –Force-Resisting System: Reinforcing Steel	Unable-to-Determine: The total vertical and horizontal reinforcing steel ratio of the shear walls is less than 0.002.
Lateral –Force-Resisting System: Proportions	Unable-to-Determine: The height-to-thickness ratio of the shear walls shall be less than 30.
Diaphragm: Straight Sheathing	Straight-sheathed diaphragm does not have an aspect ratio of less than 2-to-1.
Diaphragm: Diagonally Sheathed and Unblocked Diaphragms	Unblocked wood structural panel diaphragm does not have horizontal spans less than 30 feet.

5.13.3 Nonstructural Assessment Results Summary

The items listed in Table 21 were found to be non-compliant for the Immediate Occupancy performance level during the specified seismic events. The complete checklist can be found in Appendix C.

5.14 Chemical Handling Facilities

5.14.1 Existing Structure Description

The Chemical Handling Building is a reinforced masonry bearing walls building with a flexible diaphragm designed in 1988. A complete set of design drawings was available for review. A site visit confirmed that the drawings appear to be consistent with observed conditions. The building is currently used as the electrical shop and does not serve its original purpose. There is no reference to the original seismic design parameters.

The building has overall dimensions approximately 45 feet in the north-south direction and approximately 134 feet in the east-west direction. The roof consists of timber joists with 2 by blocking, and 1/2-inch CDX grade plywood sheathing. The masonry walls are reinforced with #5 @ 32-inch o.c. vertical and #5 @ 48-inch o.c. horizontal reinforcement. Complete information pertaining to the lateral force resisting system was not provided in the set of drawings available, therefore, some structural items were found to be non-compliant.

Table 21 Collection System Maintenance Building: Nonstructural Deficiencies
Public Works Integrated Master Plan
City of Oxnard

Deficient Issue	Description
Light Fixtures: Emergency Lighting Anchorage	Emergency lighting is not anchored or braced to prevent failing or swaying during an earthquake.
Piping Fire Suppression Piping	Fire suppression piping is not anchored and braced in accordance with NFPA-13.
Piping: Flexible Couplings	Fluid, gas, and fire suppression piping does not have flexible couplings.
Contents and Furnishing: Drawers	Cabinet drawers do not have latches to keep them closed during an earthquake.
Contents and Furnishing: File Cabinets	File cabinets arranged in groups are not attached to one another.
Building Contents and Furnishing: File Cabinets Attachments, Doors, and Drawer Locks	Cabinet doors and drawers do not have latches to keep them closed during an earthquake.
Ducts: Duct Bracing	Rectangular ductworks exceeding 6 square feet in cross-sectional area are not braced.
Mechanical and Electrical Equipment: Vibration Isolators Restrained	Equipment mounted on vibration isolators are not equipped with restraints or snubbers.

5.14.2 Structural Assessment Results Summary

The items listed in Table 22 were found to be non-compliant for the Immediate Occupancy performance level during the specified seismic events. The complete checklist can be found in Appendix C. Further Tier 2 evaluation is recommended for this building.

Table 22 Chemical Handling Facilities: Structural Deficiencies
Public Works Integrated Master Plan
City of Oxnard

Deficient Issue	Description
Connections: Wood Ledgers	The connection between the wall panels and the diaphragm induces cross-grain bending or tension in the wood legers.
Lateral –Force-Resisting System: Reinforcing Steel	The total vertical and horizontal reinforcing steel ratio is less than 0.002 of the wall.
Lateral –Force-Resisting System: Proportions	The height-to-thickness ratio of the shear walls is not less than 30.
Diaphragm: Straight Sheathing	Straight-sheathed diaphragm does not have an aspect ratio of less than 2-to-1.

5.14.3 Nonstructural Assessment Results Summary

The items listed in Table 23 were found to be non-compliant for the Immediate Occupancy performance level during the specified seismic events. The complete checklist can be found in Appendix C.

Table 23 Chemical Handling Facilities: Nonstructural Deficiencies
Public Works Integrated Master Plan
City of Oxnard

Deficient Issue	Description
Building Contents and Furnishing: Tall Narrow Contents	Contents over 4 feet in height with a height-to-depth ratio greater than 3-to-1 are not anchored to the floor slab or adjacent walls.
Mechanical & Electrical Equipment: Deterioration	There is evidence of deterioration, damage, or corrosion in the anchorage or supports of mechanical and electrical equipment.
Piping Fire Suppression Piping	Fire suppression piping is not anchored and braced in accordance with NFPA-13.
Piping: Flexible Couplings	Fluid, gas, and fire suppression piping does not have flexible coupling.
Contents and Furnishing: Drawers	Cabinet drawers do not have latches to keep them closed during an earthquake.
Contents and Furnishing: File Cabinets	File cabinets arranged in groups are not attached to one another.
Building Contents and Furnishing: File Cabinets Attachments, Doors, and Drawer Locks	Cabinet doors and drawers do not have latches to keep them closed during an earthquake.

5.15 Storage-Vacuum Filter Building

5.15.1 Existing Structure Description

The Storage-Vacuum Filter Building is a reinforced masonry bearing walls building with a flexible designed pre-1975. Record drawings were not available for review. Therefore, information regarding the lateral-force-resisting system could not be determined. There is no reference to the original seismic design parameters.

5.15.2 Structural Assessment Results Summary

Although some items on the structural checklist are considered compliant by visual assessment, due to insufficient information available on the structure, this structure is considered non-compliant for the Immediate Occupancy performance level. The complete checklist can be found in Appendix C. During the visual assessment, significant sign of deterioration, shrinkage and other damage to the wood members, deterioration of the masonry units and mortar, and significant wall cracks were noted. Due to the level of damage and deterioration and lack of record drawings, further Tier 2 evaluation is not recommended for this building. Replacement of this building is recommended.

5.15.3 Nonstructural Assessment Results Summary

The items listed in Table 24 below were found to be non-compliant for the Immediate Occupancy performance level during the specified seismic events. The complete checklist can be found in Appendix C.

Table 24 Storage-Vacuum Filter Building: Nonstructural Deficiencies Public Works Integrated Master Plan City of Oxnard

Deficient Issue	Description
Building Contents and Furnishing: Tall Narrow Contents	Contents over 4 feet in height with a height-to-depth ratio greater than 3-to-1 are not anchored to the floor slab or adjacent walls.
Mechanical & Electrical Equipment: Deterioration	There is evidence of deterioration, damage, or corrosion in the anchorage or supports of mechanical and electrical equipment.
Piping Fire Suppression Piping	Fire suppression piping is not anchored and braced in accordance with NFPA-13.
Piping: Flexible Couplings	Fluid, gas, and fire suppression piping does not have flexible couplings.
Contents and Furnishing: File Cabinets	File cabinets arranged in groups are not attached to one another.
Building Contents and Furnishing: File Cabinets Attachments, Doors, and Drawer Locks	Cabinet doors and drawers do not have latches to keep them closed during an earthquake.
Ducts: Duct Bracing	Rectangular ductworks exceeding 6 square feet in cross-sectional area are not braced.
Mechanical and Electrical Equipment: Heavy Equipment Anchorage	Equipment weighing over 100 lbs is not anchored to the structure or foundation.

5.16 Storage-Butler Building

5.16.1 Existing Structure Description

The two Storage-Butler Buildings are manufactured steel building systems. Butler Building A, currently known as the Storage Building, located to the north of the Collection System/Maintenance Building has significant steel deterioration and was not accessible for an interior visual assessment. Butler Building B, currently known as the second Storage Building, located east of the Effluent Pumping Station, has steel deterioration, and was accessible for both exterior and interior visual assessment. Record drawings for either building were not available for review. Therefore, information regarding the lateral-force-resisting system could not be determined. There is no reference to the original seismic design parameters.

5.16.2 Structural Assessment Results Summary

Due to insufficient information available on Butler Building A, and lack of accessibility, this structure is considered non-compliant for the Immediate Occupancy performance level. Although some items on the structural checklist are considered compliant by visual assessment of Butler Building B, due to insufficient information available on the structure, this structure is considered non-compliant for the Immediate Occupancy performance level. The complete checklist can be found in Appendix C. During the visual assessment, significant deterioration of steel was noted. Due to the level of damage and deterioration and lack of record drawings for both buildings, further Tier 2 evaluation is not recommended for these buildings. Replacement of these buildings is recommended.

5.16.3 Nonstructural Assessment Results Summary

Due to lack of accessibility of Butler Building A, this building is considered non-compliant for the Immediate Occupancy performance level during the specified seismic events. The items listed in Table 25 were found to be non-compliant for Butler Building B for the Immediate Occupancy performance level during the specified seismic events. The complete checklist can be found in Appendix C.

Table 25 Butler Buildings: Nonstructural Deficiencies
Public Works Integrated Master Plan
City of Oxnard

Deficient Issue	Description
Building Contents and Furnishing: Tall Narrow Contents	Contents over 4 feet in height with a height-to-depth ratio greater than 3-to-1 are not anchored to the floor slab or adjacent walls.
Mechanical & Electrical Equipment: Attached Equipment	Equipment weighting over 20 lbs supported 4 feet above the floor level is not mounted.
Mechanical & Electrical Equipment: Deterioration	There is evidence of deterioration, damage, or corrosion in the anchorage or supports of mechanical and electrical equipment.
Mechanical and Electrical Equipment: Heavy Equipment Anchorage	Equipment weighing over 100 lbs is not anchored to the foundation.

5.17 16 kW Switchgear Building / Effluent Electrical Building

5.17.1 Existing Structure Description

The 16-kW Switchgear Building is a part of the current Effluent Electrical Building. Record drawings were not available for review. Therefore, information regarding the lateral-force-resisting system could not be determined. From visual assessment, the building can be assumed as a reinforced masonry bearing walls building with a flexible diaphragm. There is no reference to the original seismic design parameters.

5.17.2 Structural Assessment Results Summary

Although some items on the structural checklist are considered compliant by visual assessment, due to insufficient information available on the structure, this structure is considered non-compliant for the Immediate Occupancy performance level. The complete checklist can be found in Appendix C. If this building is to remain, further Tier 2 evaluation is recommended for this building.

5.17.3 Nonstructural Assessment Results Summary

The items listed in Table 26 below were found to be non-compliant for the Immediate Occupancy performance level during the specified seismic events. The complete checklist can be found in Appendix C.

**Table 26 16-kW Switchgear Building: Nonstructural Deficiencies
Public Works Integrated Master Plan
City of Oxnard**

Deficient Issue	Description
Light Fixtures: Emergency Lighting Anchorage	Emergency lighting is not anchored or braced to prevent failing or swaying during an earthquake.
Contents and Furnishing: File Cabinets	File cabinets arranged in groups are not attached to one another.
Building Contents and Furnishing: File Cabinets Attachments, Doors, and Drawer Locks	Cabinet doors and drawers do not have latches to keep them closed during an earthquake.
Mechanical and Electrical Equipment: Electrical Equipment Bracing	Electrical equipment and associated wiring is not laterally braced to the structure.

5.18 Administration Building

5.18.1 Existing Structure Description

The Administration Building is a wood framed building designed in 1975. A complete set of design drawings was available for review. A site visit confirmed that the drawings appear to be consistent with observed conditions. There is no reference to the original seismic design parameters.

The building has overall dimensions of 63 feet in the north-south direction and approximately 144 feet in the east-west direction. The roof consists of timber members and 1/2-inch CDX plywood sheathing. The building is used as a laboratory and office space.

5.18.2 Structural Assessment Results Summary

The items listed in Table 27 were found to be non-compliant for the Immediate Occupancy performance level during the specified seismic events. The complete checklist can be found in Appendix C. During the visual assessment, damage to the wood members was noted. Further Tier 2 evaluation is recommended for this structure.

Table 27 Administration Building: Structural Deficiencies
Public Works Integrated Master Plan
City of Oxnard

Deficient Issue	Description
Building System: Deterioration of Wood	There are signs of decay, shrinkage, and splitting in the wood members.
Lateral-Force-Resisting System: Shear Stress Check	The shear stress in the shear walls is less than 1000 plf for structural panels.
Diaphragm: Straight Sheathing	The aspect ratio of the straight sheathing is not less than 2-1 in either direction being considered.

5.18.3 Nonstructural Assessment Results Summary

The items listed in Table 28 were found to be non-compliant for the Immediate Occupancy performance level during the specified seismic events. The complete checklist can be found in Appendix C.

5.19 Activated Sludge Tanks/Aeration Basin

The new Activated Sludge Tanks were built during the of the 1988 expansion project. The design structural drawings were available for review. The Activated Sludge Basin is a reinforced concrete tank with a rectangular plan. The exterior 16-inch thick basin walls are approximately 21 feet tall.

The exterior wall was analyzed using hydrostatic and hydrodynamic seismic loads. The walls will experience excessive deflection in a seismic event, however, deflection and crack control is not considered for seismic loads. The walls, however, are under-reinforced and at risk of shear failure. Therefore, structural retrofitting of these tanks is recommended. Testing of the concrete condition is also recommended to assess the feasibility of retrofitting the tanks.

5.20 Secondary Sedimentation Basin

The Secondary Sedimentation Basin was built during the 1988 expansion project. The design structural drawings were available for review. The Secondary Sedimentation Basin is a rectangular reinforced concrete tank. The exterior 14” thick basin walls are approximately 15 feet tall.

Table 28	Administration Building: Nonstructural Deficiencies Public Works Integrated Master Plan City of Oxnard
Deficient Issue	**Description**
Hazardous Material Storage and Distribution: Toxic Substances Lateral Bracing and Anchorage	Toxic and hazardous substances stored in breakable containers not are restrained from falling by latched doors, shelf clips, wires or other methods.
Light Fixtures: Independent Support	Light fixtures in suspended grid ceiling are not supported independently of the ceiling suspension system by a minimum of two wires.
Mechanical & Electrical Equipment: Attached Equipment	Equipment weighting over 20 lbs that is attached to the walls is not mounted.
Mechanical & Electrical Equipment: Deterioration	There is evidence of deterioration, damage, or corrosion in the anchorage of mechanical equipment.
Piping: Fire Suppression Piping	Fire suppression piping is not anchored and braced in accordance with NFPA-13.
Building Contents and Furnishing: Drawers	Cabinet drawers do not have latches to keep them closed during an earthquake.
Building Contents and Furnishing: File Cabinets	File cabinets arranged in groups are not attached to one another.
Building Contents and Furnishing: File Cabinets Attachments, Doors, and Drawers Locks	Cabinet doors and drawers do not have latches to keep them closed during an earthquake.
Mechanical & Electrical Equipment: Electrical Equipment Bracing	Electrical equipment and associated wiring is not laterally braced.

The walls were analyzed using hydrostatic and hydrodynamic seismic loads. Similar to the Aeration Basin, the walls will experience excessive deflection. The walls are under-reinforced in flexure and shear is not of a concern. Therefore, structural retrofitting of these tanks is recommended. Testing of the concrete condition is also recommended. Based on the condition of the concrete, retrofit options, such as composite fiber fabric to strengthen the walls, can be recommended.

5.21 Flow Equalization Basin

The Flow Equalization Basin was built during the 1988 expansion project. The construction details of the Flow Equalization Basin are the same as the Secondary Sedimentation Basin. Therefore, it was deicide to assume that it will behave in a similar manner in a seismic event and it will have the same concerns as the structure discussed in section 5.20.

Structural retrofitting and testing of the concrete condition is recommended for these basins. Based on the condition of the concrete, retrofit options, such as composite fiber fabric to strengthen the walls, can be recommended.

5.22 Primary Clarifier Tanks

The Primary Clarifier Tanks were built in 1971. The “as built” structural drawings, dated March 1971 were available for review. Due to the condition of the drawings, some information, such as the height of the tanks, could not be determined. This information was reasonably assumed for analysis purposes.

The tanks were analyzed using methods presented in ASCE 7-10 and the 2012 International Building Code. The tank wall hoop reinforcement near the water surface level and vertical reinforcement at the base of the tank are minimally overstressed. The center mechanism column has the potential of being overstressed and therefore, replacement of the center column and foundation is recommended. Testing of the concrete condition is also recommended for these tanks.

5.23 Gravity Thickeners

The Gravity Thickeners were built prior to 1964. Record drawings were not available for review. Due to the age of the structures and the period in which they were installed, it is reasonable to assume that these structures will not perform up to the current code standards. Due to the age of the tanks and the lack of information, replacement of these tanks is recommended.

5.24 Digester Nos. 1, 2 and 3

Digester Nos. 1 and 2 were built in 1975 and improved in 1988. Digester No. 3 was built in 1988. The design structural drawings, dated October 1975 and June 1988 were available for review.

The approximately 43 feet high tanks were analyzed using methods presented in ASCE 7-10 and the 2012 International Building Code. The hoop and vertical reinforcement of these pre-stressed tanks are minimally overstressed.

Testing of the concrete condition and evaluation of the pre-stressing of a five year cycle is recommended for these tanks.

5.25 DAF Tanks

The DAF Tanks were built in 1988. The construction details of the DAF Tanks are similar to the Digester Tanks. Therefore, it was decided to assume that it will behave in a similar manner in a seismic event and it will have the same concerns as the Digesters.

Testing of the concrete condition and evaluation of the pre-stressing of a five year cycle is recommended for these tanks.

5.26 Chlorine Contact Tank

The Chlorine Contact Tanks were built in 1975. The construction details of the Chlorine Contact Tanks are similar to the Secondary Sedimentation Basin. Therefore, it was decided to assume that it will behave in a similar manner in a seismic event and it will have the same concerns as the basins.

Structural retrofitting and testing of the concrete condition is recommended for these basins. Based on the condition of the concrete, retrofit options, such as composite fiber fabric to strengthen the walls, can be recommended.

6.0 RECOMMENDED ACTIONS

Based on visual assessment, and the Tier 1 screening results, replacement of the following buildings is recommended: Primary Sedimentation Building, Main Electrical / Main Switchgear Building, Digester Control Building, Operations Center / Plant Control Center Building, Effluent Pumping Station, Generator / Co-Generation Building, Storage-Vacuum Filter Building, and Storage-Butler Building. Retrofit of non-structural components is recommended for the following buildings: Headworks Building, Grit Screenings Building, Blower Building, and North Area Electrical Building.

Tier 2 evaluation is recommended for the following structures: Solids Processing Building, Maintenance Building, Collection System Maintenance Building, Chemical Handling Facilities, 16 kW Switchgear / Effluent Electrical Building, and Administration Building. Structural retrofits for six of the eight structures, replacement of one structure, further evaluation of one structure, and concrete condition testing for all eight structures is recommended for the water-retaining structures.

7.0 CONCLUSION

This study resulted in the recommendation of further investigation of several buildings at the Oxnard WTP. Seismic analysis resulted in recommendation of retrofit, replacement, and further concrete condition testing for all of the water-retaining structures.

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APPENDIX B – DETAILED STRUCTURAL SEISMIC EVALUATION AND NON-STRUCTURAL RETROFITS OF BUILDING-TYPE STRUCTURES

TABLE OF CONTENTS

Page No.

LIST OF TABLES

APPENDIX B - DETAILED STRUCTURAL SEISMIC EVALUATION AND NON-STRUCTURAL RETROFITS OF BUILDING-TYPE STRUCTURES

1.0 INTRODUCTION

In June 2014, the City of Oxnard (Oxnard) engaged Carollo Engineers to perform a seismic evaluation of the Oxnard Wastewater Treatment Plant (OWTP). A Tier 1, i.e., screening assessment that identified potential structural and non-structural seismic vulnerabilities of the structures as they relate to Oxnard seismic performance objectives during design earthquake events was completed in October 2014. The purpose of the evaluation is to perform a deficiency based evaluation and identify components that require seismic retrofit for structures that were identified as non-compliant with the Tier 1 screening criteria.

Six buildings were recommended for further Tier 2 analysis and four were recommended for retrofit of non-structural components. One of those six buildings recommended for further analysis is proposed to be replaced as a result of overall condition assessment and therefore, is not included in this report.

2.0 APPROACH

Preliminary seismic assessments of the existing building-type structure were performed using the 2006 version of *American Society of Engineers Standards: Seismic Evaluation and Retrofit of Existing Buildings* (ASCE 31) Tier 1 evaluation procedures. This standard is commonly used as a way to evaluate anticipated seismic performance of existing buildings. ASCE 31-06 was updated and replaced with *Seismic Evaluation and Retrofit of Existing Buildings* (ASCE 41-13), which was used for the Tier 2 evaluation. Tier 2 is a follow-up step to further evaluate potential deficiencies identified in Tier 1. The purpose of Tier 2 evaluation is to perform a seismic evaluation and determine required retrofits. The additional analysis of Tier 2 is sufficient to either confirm the identified deficiency or demonstrate the adequacy of the structure.

Based on the structure's risk category as defined in ASCE 41, a Seismic Hazard Level of BPOE (Basic Performance Objective for Existing Buildings) was used. The risk category of the plant is III (three) and Damage Control Structural Performance and Position Retention Non-structural Performance levels were selected for the Tier 2 analysis. ASCE 41 defines the Damage Control Performance Level (S-2) as: "the post-earthquake damage state between the Life Safety Structural Performance Level (S-3) and the Immediate Occupancy Structural Performance Level (S-1)." Life Safety and Immediate Occupancy are defined as, "post-earthquake damage state in which a structure has damaged components but retains a margin against the onset of partial or total collapse," and "post-earthquake damage state in which a structure remains safe to occupy and essentially retains its pre-earthquake strength and stiffness," respectively. An inventory of the specific structures evaluated for Tier 2 is provided in Table 1, including the appendix section in which the structure's assessment results can be found.

Table 1 List of Facilities
Public Works Integrated Master Plan
City of Oxnard

Structure	Section
Headworks Building	5.1
Grit Screening Building	5.2
Blower Building	5.3
North Area Electrical Building	5.4
Solids Processing Building	5.5
Chemical Handling Facilities	5.6.1
Maintenance Building	5.6.2
Collection System Maintenance Building	5.6.3
Administration Building	5.7

3.0 SUMMARY OF FINDINGS

The findings of Tier 1 screening completed with the procedures of ASCE 31-06 were updated in this report to ASCE 41-13. Table 2 lists all the structures evaluated with associated findings.

In general, the structural deficiencies that were analyzed in the Tier 2 evaluation are adequate for the performance objective. The deficient non-structural components identified in the Tier 1 screening require retrofit. With the update from ASCE 31-06 to 41-13, some of non-structural components found in ASCE 31-06 were removed from the non-structural checklist in ASCE 41-13. Although not recommended by the standard, retrofit/repair for those removed components is recommended based on our judgment.

4.0 SEISMIC ASSESSMENT METHODOLOGY

4.1 Structural Components

The seismic evaluation of the building structures at the OWTP was performed in accordance with ASCE 41-13 Tier 2 analysis procedures.

The selection of structural elements for Tier 2 evaluation was based on the Tier 1 Structural Checklist finding. The potentially deficient elements were further analyzed to determine the demands and capacities of structural systems, components, and connections associated with the deficiencies. Of the nine structures included in this report, three are reinforced masonry with flexible diaphragm buildings, one is a reinforced masonry with stiff diaphragm building, one is a wood framed building, and four buildings have only non-structural deficiencies. Based on the building type, similarities in potential deficiencies identified in Tier 1 and similar structural detailing specified on the record drawings, the three reinforced masonry with flexible diaphragm buildings were grouped together. The conclusion of the three buildings was based on the results of the building with the higher quantity of deficiencies identified.

Table 2 Summary of Tier 2 Assessment
Public Works Integrated Master Plan
City of Oxnard

Structure	Results	
	Structural Components	Non-Structural Components
Headworks Building	Tier 2 Not Required(1)	Retrofit Recommended
Grit Screening Building	Tier 2 Not Required(1)	Retrofit Recommended
Blower Building	Tier 2 Not Required(1)	Retrofit Recommended
North Area Electrical Building	Tier 2 Not Required(1)	Retrofit Recommended
Solids Processing Building	No Deficiencies	Retrofit Recommended
Chemical Handling Facilities	Retrofit Recommended: wall-to-diaphragm connection	Retrofit Recommended
Maintenance Building	Retrofit Recommended: wall-to-diaphragm connection	Retrofit Recommended
Collection System Maintenance Building	Retrofit Recommended: wall-to-diaphragm connection	Retrofit Recommended
Administration Building	No Deficiencies	Retrofit Recommended

Note:
(1) No structural deficiencies identified in Tier 1.

Detailed findings of the Tier 2 structural elements recommended for retrofit are found in Section 5.

4.2 Non-structural Components

ASCE 41-13 recommends retrofit of deficient non-structural components. Further technical analysis is not required for non-structural components.

Summaries of the non-structural components recommended for retrofit are found in Section 5.

5.0 TIER 2 EVALUATION RESULTS

5.1 Headworks Building

5.1.1 Existing Structure Description

The Headworks Building is a reinforced concrete structure designed in 2003. A complete set of the design drawings was available for review. Based on the Tier 1 screening, only non-structural components were determined to be deficient.

5.1.2 Non-structural Assessment Results Summary

Table 3 summarizes non-structural deficiencies identified in the Tier 1 evaluation that are recommended for retrofit.

Table 3 Headworks Building: Non-structural Findings
Public Works Integrated Master Plan
City of Oxnard

Component	Retrofit Action
Piping: Flexible Coupling	Retrofit: Provide flexible coupling at tees and pipe diameter transitions for fluid, and fire suppression piping located in the ground floor of the building.
Building Contents and Furnishing: Drawers	This component does not require analysis per ASCE 41-13. Recommendation: Drawers should be repaired to have latches to keep them closed during an earthquake.
Building Contents and Furnishing: File Cabinets Attachments, Doors, and Drawer Locks	This component does not require analysis per ASCE 41-13. Recommendation: Cabinet doors and drawers should be repaired to have latches to keep them closed during an earthquake.

5.2 Grit Screenings Building

5.2.1 Existing Structure Description

The Grit Screenings Building is a reinforced concrete structure designed in 2003. A complete set of design drawings was available for review. Based on the Tier 1 screening, only non-structural components were determined to be deficient.

5.2.2 Non-structural Assessment Results Summary

Table 4 summarizes non-structural deficiencies identified in the Tier 1 evaluation that are recommended for retrofit.

Table 4 Grit Screenings Building: Non-structural Findings
Public Works Integrated Master Plan
City of Oxnard

Component	Retrofit Action
Light Fixtures	Retrofit: Upgrade emergency lighting anchorage to prevent failing or impact damage due to swaying during an earthquake.

5.3 Blower Building

5.3.1 Existing Structure Description

The Blower Building has reinforced masonry bearing walls building with a flexible designed in 1975. A complete set of design drawings was available for review. Based on the Tier 1 screening, only non-structural components were determined to be deficient.

5.3.2 Non-structural Assessment Results Summary

Table 5 summarizes non-structural deficiencies identified in Tier 1 evaluation that are recommended for retrofit.

Table 5 Blower Building: Non-structural Findings
Public Works Integrated Master Plan
City of Oxnard

Component	Retrofit Action
Light Fixtures: Emergency Lighting Anchorage	Retrofit: Emergency lighting anchoring system shall be retrofit to prevent failing or swaying during an earthquake.
Mechanical & Electrical Equipment: Deterioration	This component does not require analysis per ASCE 41-13. Repair of deterioration recommended.

5.4 North Area Electrical Building

5.4.1 Existing Structure Description

The North Area Electrical Building is a reinforced concrete shear walls building with a stiff diaphragm designed in 1988. A complete set of design drawings was available for review. Based on the Tier 1 screening, only non-structural components were identified to be potentially deficient.

5.4.2 Non-structural Assessment Results Summary

Table 6 summarizes non-structural deficiencies identified in Tier 1 evaluation that are recommended for retrofit.

Table 6 North Area Electrical Building: Non-structural Findings
Public Works Integrated Master Plan
City of Oxnard

Component	Retrofit Action
Contents and Furnishing: Tall Narrow Contents	Retrofit: Anchor contents over 6 feet in height to the floor slab or adjacent walls to prevent damage during an earthquake.
Piping: Fire Suppression Piping	Retrofit: Anchor fire suppression piping in accordance with NFPA-13.
Contents and Furnishing: Drawers	This component does not require analysis per ASCE 41-13. Recommendation: Drawers should be repaired to have latches to keep them closed during an earthquake.
Contents and Furnishing: File Cabinets	This component does not require analysis per ASCE 41-13. Recommendation: Cabinets that are arranged in groups should be attached to one another.
Building Contents and Furnishing: File Cabinets Attachments, Doors, and Drawers Locks	This component does not require analysis per ASCE 41-13. Recommendation: Cabinet doors and drawers should be repaired to have latches to keep them closed during an earthquake.

5.5 Solids Processing Building

5.5.1 Existing Structure Description

The Solids Processing Building is a three-story reinforced masonry bearing walls building with a stiff diaphragm designed in 1988. A complete set of design drawings was available for review.

5.5.2 Structural Assessment Results Summary

The structural deficiencies identified in Tier 1 were further analyzed to determine the adequacy of the building shear walls and roof diaphragm. The results of the structural items analyzed using the Tier 2 procedures are listed in Table 7.

Table 7	Solids Processing Building: Structural Findings Public Works Integrated Master Plan City of Oxnard
Component	**Retrofit Action**
Lateral –Force-Resisting System: Shear Stress Check	Shear walls are adequate for the anticipated seismic hazard level. Retrofit not recommend.
Lateral –Force-Resisting System: Reinforcing Steel	Shear walls are adequate for the anticipated seismic hazard level. Retrofit not recommend.
Connections: Girder/Column Connection	No Tier 2 procedure is available to demonstrate compliance of this component. Retrofit recommended based on the demand capacity ratio of the connection.

5.5.3 Non-structural Assessment Results Summary

Table 8 summarizes non-structural deficiencies identified in Tier 1 evaluation that are recommended for retrofit.

Table 8	Solids Processing Building: Non-structural Findings Public Works Integrated Master Plan City of Oxnard
Component	**Retrofit Action**
Light Fixtures	Retrofit: Independently support light fixtures in suspended grid ceiling by a minimum of two wires.
Mechanical & Electrical Equipment: Deterioration	This component does not require analysis per ASCE 41-13. Repair of deterioration recommended.
Piping: Flexible Couplings	Retrofit: Provide flexible coupling at tees and pipe diameter transitions for fluid, and fire suppression piping located in the ground floor of the building.
Mechanical and Electrical Equipment: Vibration Isolators Restrained	Retrofit: Retrofit the anchoring system of equipment mounted on vibration isolators to be equipped with restraints or snubbers.
Piping: Fluid and Gas Piping Anchorage and Bracing	Retrofit: Anchor or brace fluid and gas piping to the structure to prevent breakage.

5.6 Grouped Buildings

5.6.1 Chemical Handling Facilities

5.6.1.1 Existing Structure Description

The Chemical Handling Building is a reinforced masonry bearing walls building with a flexible diaphragm designed in 1988. The building is currently used as the electrical shop and does not serve its original purpose.

5.6.1.2 Structural Assessment Results Summary

The structural deficiencies identified in Tier 1 were further analyzed to determine the adequacy of the building shear walls, roof diaphragm, and wall to diaphragm connections. The results of the structural items analyzed using the Tier 2 procedures are listed in Table 9.

Table 9 Chemical Handling Facilities: Structural Findings
Public Works Integrated Master Plan
City of Oxnard

Component	Retrofit Action
Lateral –Force-Resisting System: Reinforcing Steel	Shears walls are adequate for the anticipated seismic hazard level. Retrofit not recommended.
Lateral –Force-Resisting System: Proportions	Shears walls are adequate for the anticipated seismic hazard level. Retrofit not recommended.
Diaphragm: Straight Sheathing	Shears walls are adequate for the anticipated seismic hazard level. Retrofit not recommended.
Connections: Wood Ledgers	The connection between the wall panels and diaphragm induces cross-grain bending. Retrofit wall-to-diaphragm connection using strap ties.

5.6.1.3 Non-structural Assessment Results Summary

Table 10 summarizes non-structural deficiencies identified in Tier 1 evaluation that are recommended for retrofit.

5.6.2 Maintenance Building

5.6.2.1 Existing Structure Description

The Maintenance Building is a reinforced masonry bearing walls building with a flexible diaphragm designed in 1977. Record drawings were not available for review. Due to lack of information, and based on the similar building type, similarities in potential deficiencies identified in Tier 1, and because Chemical Handling Building identified more deficiencies, the adequacy of the Maintenance Building is grouped with the structural results of the Chemical Handling Building.

Table 10 Chemical Handling Facilities: Non-structural Findings Public Works Integrated Master Plan City of Oxnard	
Component	**Retrofit Action**
Building Contents and Furnishing: Tall Narrow Contents	Retrofit: Anchor contents over 6 feet in height to the floor slab or adjacent walls to prevent damage during an earthquake.
Mechanical & Electrical Equipment: Deterioration	This component does not require analysis per ASCE 41-13. Repair of deterioration recommended.
Piping: Fire Suppression Piping	Retrofit: Anchor fire suppression piping in accordance with NFPA-13.
Piping: Flexible Couplings	Retrofit: Provide flexible coupling at tees and pipe diameter transitions for fluid, and fire suppression piping.
Contents and Furnishing: Drawers	This component does not require analysis per ASCE 41-13. Recommendation: Drawers should be repaired to have latches to keep them closed during an earthquake.
Contents and Furnishing: File Cabinets	This component does not require analysis per ASCE 41-13. Recommendation: Cabinets that are arranged in groups should be attached to one another.
Building Contents and Furnishing: File Cabinets Attachments, Doors, and Drawer Locks	This component does not require analysis per ASCE 41-13. Recommendation: Cabinet doors and drawers should be repaired to have latches to keep them closed during an earthquake.

5.6.2.2 Structural Assessment Results Summary

The structural deficiencies identified in Tier 1 were further analyzed to determine the adequacy of the building shear walls, roof diaphragm, and wall to diaphragm connections. The results of the Maintenance Building were grouped with the results of the Chemical Handling Building, and are summarized in Table 11.

5.6.2.3 Non-structural Assessment Results Summary

Table 12 summarizes non-structural deficiencies identified in Tier 1 evaluation that are recommended for retrofit.

Table 11 Maintenance Building: Structural Findings
Public Works Integrated Master Plan
City of Oxnard

Component	Retrofit Action
Lateral-Force-Resisting System: Reinforcing Steel	Shear walls are adequate for the anticipated seismic hazard level. Retrofit not recommended.
Diaphragm: Spans	The diaphragm is adequate for the anticipated seismic hazard level. Retrofit not recommended.
Diaphragm: Straight Sheathing	The diaphragm is adequate for the anticipated seismic hazard level. Retrofit not recommended.
Connections: Wood Ledgers	The connection between the wall panels and diaphragm induces cross-grain bending. Retrofit wall-to-diaphragm connection using strap ties.

Table 12 Maintenance Building: Non-structural Findings
Public Works Integrated Master Plan
City of Oxnard

Component	Retrofit Action
Mechanical & Electrical Equipment: Deterioration	This component does not require analysis per ASCE 41-13. Repair of deterioration recommended.
Piping: Fire Suppression Piping	Retrofit: Anchor fire suppression piping in accordance with NFPA-13.
Building Contents and Furnishing: Drawers	This component does not require analysis per ASCE 41-13. Recommendation: Drawers should be repaired to have latches to keep them closed during an earthquake.
Building Contents and Furnishing: File Cabinets	This component does not require analysis per ASCE 41-13. Recommendation: Cabinets that are arranged in groups should be attached to one another.
Building Contents and Furnishing: File Cabinets Attachments, Doors, and Drawer Locks	This component does not require analysis per ASCE 41-13. Recommendation: Cabinet doors and drawers should be repaired to have latches to keep them closed during an earthquake.

5.6.3 Collection System Maintenance Building

5.6.3.1 Existing Structure Description

The Collection System Maintenance Building is a reinforced masonry bearing walls building with a flexible diaphragm designed in 1988. A partial set of design drawings was available for review. The building is currently used as a maintenance building and houses staff offices. Based on the building type, similarities in potential deficiencies identified in Tier 1, and similar structural detailing specified on the design drawings, the adequacy of the Collection System Maintenance Building is grouped with the structural results of the Chemical Handling Building.

5.6.3.2 Structural Assessment Results Summary

The structural deficiencies identified in Tier 1 were further analyzed to determine the adequacy of the building shear walls, roof diaphragm, and wall to diaphragm connections. The results of the Collection System Maintenance Building is grouped with the results of the Chemical Handling Building, and are summarized in Table 13.

Table 13 Collection System Maintenance Building: Structural Findings
Public Works Integrated Master Plan
City of Oxnard

Component	Retrofit Action
Lateral –Force-Resisting System: Shear Stress Check	Shear walls are adequate for the anticipated seismic hazard level. Retrofit not recommend.
Lateral –Force-Resisting System: Reinforcing Steel	Shear walls are adequate for the anticipated seismic hazard level. Retrofit not recommend.
Diaphragm: Straight Sheathing	The diaphragm is adequate or the anticipated seismic hazard level. Retrofit not recommend.
Diaphragm: Diagonally Sheathed and Unblocked Diaphragms	The diaphragm is adequate for the anticipated seismic hazard level. Retrofit not recommend.
Connections: Wood Ledgers	The connection between the wall panels and diaphragm induces cross-grain bending. Retrofit wall-to-diaphragm connection using strap ties.

5.6.3.3 Non-structural Assessment Results Summary

Table 14 summarizes non-structural deficiencies identified in Tier 1 evaluation that are recommended for retrofit.

5.7 Administration Building

5.7.1 Existing Structure Description

The Administration Building is a wood framed building designed in 1975. The building is used as a laboratory and office space.

Table 14	Collection System Maintenance Building: Non-structural Findings Public Works Integrated Master Plan City of Oxnard
Component	**Retrofit Action**
Light Fixtures: Emergency Lighting Anchorage	Retrofit: Upgrade emergency lighting anchorage to prevent failing or impact damage due to swaying during an earthquake.
Piping Fire Suppression Piping	Retrofit: Anchor fire suppression piping in accordance with NFPA-13.
Piping: Flexible Couplings	Retrofit: Provide flexible coupling at tees and pipe diameter transitions for fluid, and fire suppression piping located in the east room of the building.
Contents and Furnishing: Drawers	This component does not require analysis per ASCE 41-13. Recommendation: Drawers should be repaired to have latches to keep them closed during an earthquake.
Contents and Furnishing: File Cabinets	This component does not require analysis per ASCE 41-13. Recommendation: Cabinets that are arranged in groups should be attached to one another.
Building Contents and Furnishing: File Cabinets Attachments, Doors, and Drawer Locks	This component does not require analysis per ASCE 41-13. Recommendation: Cabinet doors and drawers should be repaired to have latches to keep them closed during an earthquake.
Ducts: Duct Bracing	Retrofit: Retrofit the anchoring system for rectangular ductworks to prevent failing or impact damage due to swaying during an earthquake.
Mechanical and Electrical Equipment: Vibration Isolators Restrained	Retrofit: Retrofit the anchoring system of equipment mounted on vibration isolators to be equipped with restraints or snubbers.

5.7.2 Structural Assessment Results Summary

The structural deficiencies identified in Tier 1 were further analyzed to determine the adequacy of the building shear walls. The results of the structural items analyzed using the Tier 2 procedures are listed in Table 15.

Table 15	Administration Building: Structural Findings Public Works Integrated Master Plan City of Oxnard
Component	**Retrofit Action**
Lateral-Force-Resisting System: Shear Stress Check	Shear walls are adequate for the anticipated seismic hazard level. Retrofit not recommend.

5.7.3 Non-structural Assessment Results Summary

Table 16 summarizes non-structural deficiencies identified in Tier 1 evaluation that are recommended for retrofit.

Table 16 Administration Building: Non-structural Components
Public Works Integrated Master Plan
City of Oxnard

Component	Retrofit Action
Hazardous Material Storage and Distribution: Toxic Substances Lateral Bracing and Anchorage	Retrofit: Restrain toxic/hazardous substances stored in breakable containers to prevent from falling with means of latched doors, shelf clips, wires or other methods.
Light Fixtures: Independent Support	Retrofit: Independently support light fixtures in suspended grid ceiling by a minimum of two wires.
Mechanical & Electrical Equipment: Fall-pone Equipment	Retrofit: Mount equipment that is attached to the walls and weighs over 20 lbs.
Mechanical & Electrical Equipment: Deterioration	This component does not require analysis per ASCE 41-13.
Piping: Fire Suppression Piping	Retrofit: Anchor fire suppression piping in accordance with NFPA-13.
Building Contents and Furnishing: Drawers	This component does not require analysis per ASCE 41-13.
Building Contents and Furnishing: File Cabinets	This component does not require analysis per ASCE 41-13.
Building Contents and Furnishing: File Cabinets Attachments, Doors, and Drawers Locks	This component does not require analysis per ASCE 41-13.
Mechanical & Electrical Equipment: Electrical Equipment Bracing	Retrofit: Laterally brace and anchor electrical and mechanical equipment and associated wiring for the equipment located in the Mechanical and Electrical Equipment Room 129 on the second floor.

6.0 RECOMMENDED ACTIONS

Based on the Tier 2 evaluation results, a structural retrofit is recommended for the following structures:

- Chemical Handling Facilities.
- Maintenance Building.
- Collection System Maintenance Building.

Non-structural retrofits are recommended for the following structures:

- Headworks Building.
- Grit Screenings Building.
- Blower Building.
- North Area Electrical Building.
- Solids Processing Building.
- Chemical Handling Facilities.
- Maintenance Building.
- Collection System Maintenance Building.
- Administration Building.

7.0 CONCLUSION

Based on the Tier 2 evaluation results, structural and non-structural retrofits are recommended for the nine structures discussed in this memo. Project Memo 3.7.1 Alternatives Analysis outlines the cost estimates associated with the recommended structural and non-structural retrofits based on the results of the of the Tier 2 evaluation, and the general condition assessment of the buildings at OWTP.

8.0 REFERENCES

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APPENDIX C – PRELIMINARY STRUCTURAL SEISMIC ASSESSMENT OF BUILDINGS – STRUCTURAL AND NON-STRUCTURAL FINDINGS

ASCE31 Tier 1 Seismic Screening
Structural and Non-Structural Findings

Headworks Building

3.7.9 Concrete Shear Walls with Stiff Diaphragms

Building System

		Compliance
CONCRETE WALL CRACKS	All existing diagonal cracks in wall elements shall be less than 1/8 inch for Life Safety and 1116 inch for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern. (Tier 2: Sec. 4.3.3.9)	C
DETERIORATION OF CONCRETE	There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting elements. (Tier 2: Sec. 4.3.3.4)	NC
GEOMETRY	There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30 percent in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines. (Tier 2: Sec. 4.3.2.3)	NA
LOAD PATH	The structure shall contain a minimum of one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)	C
MASS	There shall be no change in effective mass more than 50 percent from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses, and mezzanines need not be considered. (Tier 2: Sec. 4.3.2.5)	NA
MEZZANINES	Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.3)	NA
POST-TENSIONING ANCHORS	There shall be no evidence of corrosion or spalling in the vicinity of post-tensioning or end fittings. Coil anchors shall not have been used. (Tier 2: Sec. 4.3.3.5)	NA

		Compliance
SOFT STORY	The stiffness of the lateral-force-resisting system in any story shall not be less than 70 percent of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80 percent of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2)	NA
TORSION	The estimated distance bt':tween the story center of mass and the story center of rigidity shall be less than 20 percent of the building width in either plan dimension for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.6)	C
VERTICAL DISCONTINUITIES	All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)	NA
WEAK STORY	The strength of the lateral-force-resisting system in any story shall not be less than 80 percent of the strength in an adjacent story, above or below, for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)	NA
Connections		
FOUNDATION DOWELS	Wall reinforcement shall be doweled into the foundation for Life Safety, and the dowels shall be able to develop the lesser of the strength of the walls or the uplift capacity of the foundation for Immediate Occupancy. (Tier 2: Sec. 4.6.3.5)	C
TRANSFER TO SHEAR WALLS	Diaphragms shall be connected for transfer of loads to the shear walls for Life Safety and the connections shall be able to develop the lesser of the shear strength of the walls or diaphragms for Immediate Occupancy. (Tier 2: Sec. 4.6.2.1)	C
Lateral Force Resisting System		
COMPLETE FRAMES	Steel or concrete frames classified as secondary components shall form a complete vertical-load-carrying system. (Tier 2: Sec. 4.4.1.6.1)	NA
REDUNDANCY	The number of lines of shear walls in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.1.1)	C

Headworks Building

		Compliance
REINFORCING STEEL	The ratio of reinforcing steel area to gross concrete area shall be not less than 0.0015 in the vertical direction and 0.0025 in the horizontal direction for Life Safety and Immediate Occupancy. The spacing of reinforcing steel shall be equal to or less than 18 inches for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.2.2)	C
SHEAR STRESS CHECK	The shear stress in the concrete shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than the greater of 100 psi or 2 sqrt(f'c) for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.2.1)	C

3.7.9S Concrete Shear Walls with Stiff Diaphragms

Connections

UPLIFT AT PILE CAPS	Pile caps shall have top reinforcement and piles shall be anchored to the pile caps for Life Safety, and the pile cap reinforcement and pile anchorage shall be able to develop the tensile capacity of the piles for Immediate Occupancy. (Tier 2: Sec. 4.6.3.10)	NA

Diaphragms

DIAPHRAGM CONTINUITY	The diaphragms shall not be composed of split-level floors and shall not have expansion joints. (Tier 2: Sec. 4.5.1.1)	C
DIAPHRAGM REINFORCEMENT AT OPENINGS	There shall be reinforcing around all diaphragm openings larger than 50 percent of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)	NA
OPENINGS AT SHEAR WALLS	Diaphragm openings immediately adjacent to the shear walls shall be less than 25 percent of the wall length for Life Safety and 15 percent of the wall length for Immediate Occupancy. (Tier 2: Sec. 4.5.1.4)	NA
PLAN IRREGULARITIES	There shall be tensile capacity to develop the strength of the diaphragm at re-entrant corners or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)	NA

Lateral Force Resisting System

CONFINEMENT REINFORCING	For shear walls with aspect ratios greater than 2-to-1, the boundary elements shall be confined with spirals or ties with spacing less than 8db This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.5)	NA
COUPLING BEAMS	The stirrups in coupling beams over means of egress shall be spaced at or less than d/2 and shall be anchored into the confined core of the beam with hooks of 1350 or more for Life Safety. All coupling beams shall comply with the requirements above and shall have the capacity in shear to develop the uplift capacity of the adjacent wall for Immediate Occupancy. (Tier 2: Sec. 4.4.2.2.3)	NA

		Compliance
DEFLECTION COMPATIBILITY	Secondary components shall have the shear capacity to develop the flexural strength of the components for Life Safety and shall meet the requirements of Sections 4.4.1.4.9, 4.4.1.4.10, 4.4.1.4.11, 4.4.1.4.12 and 4.4.1.4.15 for Immediate Occupancy. (Tier 2: Sec. 4.4.1.6.2)	NA
FLAT SLABS	Flat slabs/plates not part of lateral-force-resisting system shall have continuous bottom steel through the column joints for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.1.6.3)	NA
OVERTURNING	All shear walls shall have aspect ratios less than 4-to-1. Wall piers need not be considered. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.4)	C
WALL THICKNESS	Thickness of bearing walls shall not be less than 1/25 the unsupported height or length, whichever is shorter, nor less than 4 inches. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.7)	C

Lateral Force Resisting SystemLateral Force Resisting System

REINFORCING AT OPENINGS	There shall be added trim reinforcement around all wall openings with a dimension greater than three times the thickness of the wall. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.6)	C

Compliance

3.9.1 Basic Nonstructural Component Checklist

Building Contents and Furnishing

Tall Narrow Contents	Contents over 4 feet in height with a height-to-depth or height-to-width ratio greater than 3-to-1 shall be anchored to the floor slab or adjacent structural walls. A height-to-depth or height-to-width ratio of up to 4-to-1 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.11.1)	C

Ceiling Systems

Integrated Ceilings	Integrated suspended ceilings at exits and corridors or weighing more than 2 lb/ft^2 shall be laterally restrained by a minimum of 4 diagonal wires or rigid members attached to the structure above at a spacing equal to or less than 12 ft (Tier 2: Sec. 4.8.2.1)	NA
Lay-In Tiles	Lay-in tiles used in ceiling panels located at exits and corridors shall be secured with clips. (Tier 2: Sec. 4.8.2.2)	C
Supporting Partitions	The integrated suspended ceiling system shall not be used to laterally support the tops of gypsum board, masonry, or hollow clay tile partitions. Gypsum board partitions need not be evaluated where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.2.1)	C
Suspended Lath and Plaster	Ceilings consisting of suspended lath and plaster or gypsum board shall be attached for each 10 square feet of area (Tier 2: Sec. 4.8.2.4)	NA

Cladding and Glazing

Bearing Connections	Where bearing connections are required, there shall be a minimum of two bearing connections for each wall panel. (Tier 2: Sec. 4.8.4.5)	NA
Cladding Anchorage	Cladding components weighing more than 10 psf shall be mechanically anchored to the exterior wall framing at a spacing equal to or less than 4 feet. A spacing of up to 6 feet is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2 (Tier 2: Sec. 4.8.4.1)	NA
Cladding Isolation	For moment frame buildings of steel or concrete, panel connections shall be detailed to accommodate a drift ratio of 0.02 for Life Safety and 0.01for Immediate Occupancy (Tier 2: Sec. 4.8.4.2)	NA

		Compliance
Connections Out of Plane	Exterior cladding panels shall be anchored out-of-plane with a minimum of 4 connections for each wall panel. Two connections per wall panel are permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.7)	NA
Damage	There shall be no damage to exterior wall cladding. (Tier 4.8.4.8)	NA
Deterioration in Connections	There shall be no evidence of deterioration, damage or corrosion in any of the connection elements. (Tier 2: Sec. 4.8.4.2)	NA
Drift Isolation	For moment frame buildings of steel or concrete, panel connections shall be detailed to accommodate a story drift ratio of 0.02. Panel connection detailing for a story drift ratio of 0.01 is permitted where only the Basic nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.3)	NA
Glazing	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall be laminated, annealed, or heat strengthened safety glass that will remain in the frame when cracked (Tier 2: Sec. 4.8.4.9)	NA
Inserts	Where inserts are used in concrete connections, the inserts shall be anchored to reinforcing steel or other positive anchorage. (Tier 2: Sec. 4.8.4.6)	NA
Multi-Story Panels Drift	For multi-story panels attached at each floor level, panel connections shall be detailed to accommodate a story drift ratio of 0.02 and 0.01 for immediate occupancy. Panel connection detailing for a story drift ratio (Tier 2: Sec. 4.8.4.4)	NA
Panel Connections	Exterior cladding panels shall be anchored with a minimum of 2 connections for each wall panel for Life Safety and 4 connections for Immediate Occupancy. (Tier 2: Sec. 4.8.4.6)	NA

Hazardous Materials Storage and Distribution

Toxic Substances Lateral Bracing and Anchorage	Toxic and hazardous substances stored in breakable containers shall be restrained from falling by latched doors, shelf lips, wires, or other methods. (Tier 2: Sec 4.8.15.1)	NA

		Compliance
Light Fixtures		
Emergency Lighting Anchorage	Emergency lighting shall be anchored or braced to prevent falling or swaying during an earthquake. (Tier 2: Sec. 4.8.3.2)	C
Independent Support	Light fixtures in suspended grid ceilings shall be supported independently of the ceiling suspension system by a minimum of two wires at diagonally opposite corners of the fixtures (Tier 2: Sec. 4.8.3.1)	NA
Masonry Chimneys		
Urm Chimneys	No reinforced masonry chimney shall extend above the roof surface more than twice the least dimension of the chimney. A height above the roof surface of up to three times the least dimension of the chimney is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.9.1)	NA
Masonry Veneer		
Deterioration	There shall be no evidence of deterioration, damage or corrosion in any of the connection elements. (Tier 2: Sec. 4.8.5.4)	NA
Shelf Angles	Masonry veneer shall be supported by shelf angles or other elements at each floor 30 feet or more above ground for Life Safety and at each floor above the first floor for Immediate Occupancy. (Tier 2: Sec. 4.8.5.1)	NA
Ties	Masonry veneer shall be connected to the back-up with corrosion-resistant ties. The ties shall have a spacing equal to or less than 24 inches with a minimum of one tie for every 2-2/3 square feet. A spacing of up to 36 inches is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2. (Tier 2: Sec. 4.8.5.2)	NA
Weakened Planes	Masonry veneer shall be anchored to the back-up adjacent to weakened planes, such as at the locations of flashing. (Tier 2: Sec. 4.8.5.3)	NA
Mechanical and Electrical Equipment		
Attached Equipment	Equipment weighting over 20 lb that is attached to ceilings, walls, or other supports 4 feet above the floor level shall be mounted. (Tier 2: Sec 4.8.12.2)	C

		Compliance
Deterioration	There shall be no evidence of deterioration, damage, or corrosion in any of the anchorage or supports of mechanical or electrical equipment. (Tier 2: Sec. 4.8.12.3)	C
Emergency Power Mounting	Equipment used as part of an emergency power system shall be mounted to maintain continued operation after an earthquake. (Tier 2: Sec. 4.8.12.1)	C
Hazardous Material Equipment	HVAC or other equipment containing hazardous material shall not have damaged supply lines or unbraced isolation supports. (Tier 2: Sec. 4.8.12.2)	NA

Parapets, Cornices, Ornamentation, and Appendages

Canopies	Canopies located at building exits shall be anchored to the structural framing at a spacing of 6 feet or less. An anchorage spacing of up to 10 feet is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.8.2)	NA
Urm Parapets	There shall be no laterally unsupported unreinforced masonry parapets or cornices with height-to-thickness ratios greater than 1.5. A height-to-thickness ratio of up to 2.5 is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2. (Tier 2: Sec. 4.8.8.1)	NA

Partitions

Unreinforced Masonry Bracing	Unreinforced masonry or hollow clay tile partitions shall be braded at a spacing equal to or less than 10 feet in levels of low or moderate seismicity and 6 feet in levels of high seismicity. (Tier 2: Sec. 4.8.1.1)	NA

Piping

Fire Suppression Piping	Fire suppression piping shall be anchored and braced in accordance with NFPA-13 (NFPA, 1996). (Tier 2: Sec. 4.8.13.1)	C
Flexible Couplings	Fluid, gas, and fire suppression piping shall have flexible couplings. (Tier 2: Sec. 4.8.13.2)	NC

		Compliance
Stairs		
Stair Details	In moment frame structures, the connection between the stairs and the structure shall not rely on shallow anchors in concrete. Alternatively, the stair details shall be capable of accommodating the drift calculated using the Quick Check procedure of Section 3.5.3.1 without including tension in the anchors. (Tier 2: Sec. 4.8.10.2)	NA
Urm Walls	Walls around stair enclosures shall not consist of unbraced hollow clay tile or unreinforced masonry with a height-to-thickness ratio greater than 12-to-1. A height-to-thickness ratio of up to 15-to-1 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.10.1)	NA

		Compliance

3.9.1S Supplemental Nonstructural Component Checklist

Building Contents and Furnishing

Access Floor Anchorage	Access floors over 9 inches in height shall be braced. (Tier 2: Sec. 4.8.11.4)	NA
Drawers	Cabinet drawers shall have latches to keep them closed during an earthquake (Tier 2: Sec 4.8.11.3)	NC
Equipment Bracing and Anchorage to Access Floors	Equipment and computers supported on access floor systems shall be either attached to the structure or fastened to a laterally braced floor system. (Tier 2: Sec. 4.8.11.5)	NA
File Cabinets	File cabinets arranged in groups shall be attached to one another. (Tier 2: Sec. 4.8.11.2)	NA
File Cabinets Attachments, Doors, and Drawer Locks	Cabinet doors and drawers shall have latches to keep them closed during an earthquake. (Tier 2: Sec. 4.8.11.3)	NC

Ceiling Systems

Edges Separation	The edges of integrated suspended ceilings shall be separated from enclosing walls by a minimum of 1/2 inch. (Tier 2: Sec. 4.8.2.5)	C
Seismic Joint	The ceiling system shall not extend continuously across any seismic joint. (Tier 2: Sec. 4.8.2.6)	C

Cladding and Glazing

Safety Glass	All exterior glazing shall be laminated, annealed or laminated heat-strengthened safety glass or other glazing system that will remain in the frame when glass is cracked. (Tier 2: Sec. 4.8.4.9)	NA

Concrete Block and Masonry Back-Up Systems

Anchorage	Back-up shall have a positive anchorage to the structural framing at a spacing equal to or less than 4 feet along the floors and roof. (Tier 2: Sec. 4.8.7.1)	NA
Concrete Block	Concrete block shall qualify as reinforced masonry (Tier 2: Sec. 4.8.7.1)	NA

		Compliance
Urm Back-Up	There shall be no unreinforced masonry back-up. (Tier 2: Sec. 4.8.7.2)	NA
Ducts		
Duct Bracing	Rectangular ductwork exceeding 6 square feet in cross-sectional area, and round ducts exceeding 28 inches in diameter, shall be braced. Maximum spacing of transverse bracing shall not exceed 30 feet. Maximum spacing of longitudinal bracing shall not exceed 60 feet. Intermediate supports shall not be considered part of the lateral-force resisting system. (Tier 2: Sec. 4.8.14.2)	NA
Duct Supports	Ducts shall not be supported by piping or electrical conduit. (Tier 2: Sec. 4.8.14.3)	C
Stair and Smoke Duct Bracing	Stair pressurization and smoke flow of gas and high temperature energy in the event of an earthquake-induced failure. (Tier 2: Sec. 4.8.13.4)	NA
Elevators		
Brackets	The brackets that tie the car rails and the counterweight rail to the building structure shall be sized in accordance with ASME A17.1. (Tier 2: Sec. 4.8.16.7)	NA
Counterweight Rails	All counterweight rails and divider beams shall be sized in accordance with ASME A17.1. (Tier 2: Sec. 4.8.16.6)	NA
Go-Slow Elevators	The building shall have a go-slow elevator system. (Tier 2: Sec. 4.8.16.9)	NA
Retainer Guards	Cable retainer guards on sheaves and drums shall be present to inhibit the displacement of cables. (Tier 2: Sec. 4.8.16.4)	NA
Retainer Plate	A retainer plate shall be present at the top and bottom of both car and counterweight. (Tier 2: Sec. 4.8.16.5)	NA
Seismic Switch	All elevators shall be equipped with seismic switches that will terminate operations when the ground motion exceeds 0.10g. (Tier 2: Sec. 4.8.16.2)	NA
Shaft Walls	All elevator shaft walls shall be anchored and reinforced to prevent toppling into the shaft during strong shaking. (Tier 2: Sec. 4.8.16.3)	NA

		Compliance
Spreader Bracket	Spreader brackets shall not be used to resist seismic forces. (Tier 2: Sec. 4.8.16.8)	NA
Support System	All elements of the elevator system shall be anchored. (Tier 2: Sec. 4.8.16.1)	NA
Hazardous Materials Storage and Distribution		
Gas Cylinder Restraints	Compressed gas-cylinders shall be restrained. (Tier 2: Sec. 4.8.15.2)	NA
Hazardous Materials Shutoff Valves	Piping containing hazardous materials shall have shut-off valves or other devices to prevent major spills or leaks. (Tier 2: Sec. 4.8.16.4)	NA
Light Fixtures		
Lens Covers	Lens covers on light fixtures shall be attached or supplied with safety devices. (Tier 2: Sec. 4.8.3.4)	C
Pendant Supports	Light fixtures on pendant supports shall be attached at a spacing equal to or less than 6 feet and, if rigidly, supported, shall be free to move with the structure to which they are attached without damaging adjoining materials. (Tier 2: Sec. 4.8.3.3)	C
Masonry Veneer		
Mortar	The mortar in masonry veneer shall not be easily scraped away from the joints by hand with a metal tool, and there shall not be significant areas of eroded mortar. (Tier 2: Sec. 4.8.5.5)	NA
Stone Cracks	There shall be no visible cracks or signs of visible distortion in the stone. (Tier 2: Sec. 4.8.5.7)	NA
Weep Holes	In veneer braced by stud walls, functioning weep holes and base flashing shall be present. (Tier 2: Sec. 4.8.5.6)	NA
Mechanical and Electrical Equipment		
Door Drift Allowance	Mechanically operated doors shall be detailed to operate at a story drift ratio of 0.01. (Tier 2: Sec. 4.8.12.8)	NA
Electrical Equipment Bracing	Electrical equipment and associated wiring shall be laterally braced to the structural system. (Tier 2: Sec. 4.8.12.7)	C

		Compliance
Heavy Equipment Anchorage	Equipment weighing over 100 pounds shall be anchored to the structure or foundation. (Tier 2: Sec. 4.8.12.6)	C
Vibration Isolators Restrained	Equipment mounted on vibration isolators shall be equipped with restraints or snubbers. (Tier 2: Sec. 4.8.12.4)	NA

Metal Stud Back-Up Systems

Openings	Steel studs shall frame window and door openings. (Tier 2: Sec. 4.8.6.2)	C
Stud Tracks	Stud tracks shall be fastened to structural framing at a spacing equal to or less than 24 inches on center. (Tier 2: Sec. 4.8.6.1)	C

Parapets, Cornices, Ornamentation, and Appendages

Appendages	Cornices, parapets, signs, and other appendages that extend above the highest anchorage level or cantilever from exterior wall faces and other exterior wall ornamentation shall be reinforced and anchored to the structural system at a spacing equal to or less than 10 feet for Life Safety and 6 feet for Immediate Occupancy. This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. f4.8.8.4)	NA
Concrete Parapets	Concrete parapets with height-to-thickness ratios greater than 2.5 shall have vertical reinforcement. (Tier 2: Sec. 4.8.8.3)	NA

Partitions

Drift Allowance	Rigid cementitious partitions shall be detailed to accommodate a drift ratio of 0.02 in steel moment frame, concrete moment frame, and wood frame buildings. Rigid cementitious partitions shall be detailed to accommodate a drift ratio of 0.005 in other buildings. (Tier 2: Sec. 4.8.1.2)	NA
Lateral Bracing for Tops	The tops of framed or panelized partitions that only extend to the ceiling line shall have lateral bracing to the building structure at a spacing equal to or less than 6 feet. (Tier 2: Sec. 4.8.1.4)	NA
Seismic Control Joints	Partitions at structural separations shall have seismic or control joints. (Tier 2: Sec. 4.8.1.3)	NA

Headworks Building

		Compliance
Piping		
C-Clamps	One-sided C-clamps that support piping greater than 2.5 inches in diameter shall be restrained. (Tier 2: Sec. 4.8.13.5)	C
Fluid and Gas Piping Anchorage and Bracing	Fluid and gas piping shall be anchored and braced to the structure to prevent breakage in piping. (Tier 2: Sec 4.8.13.3)	C
Shut-Off Valves	Shut-off devices shall be present at building utility interfaces to shut off the flow of gas and high-temperature energy in the event of earthquake-induced failure. (Tier 2: Sec. 4.8.13.4)	C

Compliance

3.9.2 Intermediate Nonstructural Component Checklist

Ceiling Systems		
Integrated Ceilings	Integrated suspended ceilings at exists and corridors or weighing more than 2 pounds per square foot shall be laterally restrained with a minimum of four diagonal wires or rigid members attached to the structure above at a spacing equal to or less than 12 feet. (Tier 2: Sec. 4.8.2.3)	NA
Lay-In Tiles	Lay-in tiles used in ceiling panels located at exits and corridors shall be secured with clips. (Tier 2: Sec. 4.8.2.2)	C
Suspended Lath and Plaster	Ceilings consisting of suspended lath and plaster or gypsum board shall be attached to resist seismic forced for every 12 square feet of area. (Tier 2: Sec. 4.8.2.4)	NA
Cladding and Glazing		
Glazing	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall have safety glazing. Such glazing located over 10 feet above an exterior walking surface shall be laminated, annealed, or laminated heat strengthened safety glass that will remain in the frame when cracked (Tier 2: Sec. 4.8.4.8)	NA
Laminated Safety Glass	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall have safety glazing. Such glazing located over 10 feet above an exterior walking surface shall be laminated annealed or laminated heat-strengthened safety glass or other glazing system that will remain in the frame when glass is cracked. (Tier 2: Sec. 4.8.4.8)	NA
Ducts		
Stair and Smoke Duct Bracing	Stair pressurization and smoke control ducts shall be braced and shall have flexible connections at seismic joints. (Tier 2: Sec. 4.8.14.1)	NA
Light Fixtures		
Independent Support	Light fixtures in suspended grid ceilings shall be supported independently of the ceiling suspension system by a minimum of two wires at diagonally opposite. (Tier 2: Sec. 4.8.3.2)	NA

Headworks Building		Compliance
Masonry Chimneys		
Anchorage	Masonry chimneys shall be anchored at each floor level and the roof. (Tier 2: Sec. 4.8.9.2)This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. 4.8.8.4)	NA
Mechanical and Electrical Equipment		
Vibration Isolators Restrained	Equipment mounted on vibration isolators shall be equipped with restraints or snubbers. (Tier 2: Sec. 4.8.12.4)	NA
Parapets, Cornices, Ornamentation, and Appendages		
Appendages	Cornices, parapets, signs, and other appendages that extend above the highest point of anchorage to the structure or cantilever from exterior wall faces and other exterior wall ornamentation shall be reinforced and anchored to the structural system at a spacing equal to or less than 10 feet for Life Safety and 6 feet for Immediate Occupancy. This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. 4.8.8.4)	NA
Concrete Parapets	Concrete parapets with height-to-thickness ratios greater than 2.5 shall have vertical reinforcement. (Tier 2: Sec. 4.8.8.3)	NA

ASCE31 Tier 1 Seismic Screening
Structural and Non-Structural Findings

Grit Screens Building

Compliance

3.7.9 Concrete Shear Walls with Stiff Diaphragms

Building System

		Compliance
CONCRETE WALL CRACKS	All existing diagonal cracks in wall elements shall be less than 1/8 inch for Life Safety and 1116 inch for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern. (Tier 2: Sec. 4.3.3.9)	C
DETERIORATION OF CONCRETE	There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting elements. (Tier 2: Sec. 4.3.3.4)	NC
GEOMETRY	There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30 percent in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines. (Tier 2: Sec. 4.3.2.3)	C
LOAD PATH	The structure shall contain a minimum of one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)	C
MASS	There shall be no change in effective mass more than 50 percent from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses, and mezzanines need not be considered. (Tier 2: Sec. 4.3.2.5)	C
MEZZANINES	Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.3)	NA
POST-TENSIONING ANCHORS	There shall be no evidence of corrosion or spalling in the vicinity of post-tensioning or end fittings. Coil anchors shall not have been used. (Tier 2: Sec. 4.3.3.5)	NA

		Compliance
SOFT STORY	The stiffness of the lateral-force-resisting system in any story shall not be less than 70 percent of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80 percent of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2)	C
TORSION	The estimated distance bt':tween the story center of mass and the story center of rigidity shall be less than 20 percent of the building width in either plan dimension for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.6)	C
VERTICAL DISCONTINUITIES	All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)	C
WEAK STORY	The strength of the lateral-force-resisting system in any story shall not be less than 80 percent of the strength in an adjacent story, above or below, for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)	C

Connections

FOUNDATION DOWELS	Wall reinforcement shall be doweled into the foundation for Life Safety, and the dowels shall be able to develop the lesser of the strength of the walls or the uplift capacity of the foundation for Immediate Occupancy. (Tier 2: Sec. 4.6.3.5)	C
TRANSFER TO SHEAR WALLS	Diaphragms shall be connected for transfer of loads to the shear walls for Life Safety and the connections shall be able to develop the lesser of the shear strength of the walls or diaphragms for Immediate Occupancy. (Tier 2: Sec. 4.6.2.1)	C

Lateral Force Resisting System

COMPLETE FRAMES	Steel or concrete frames classified as secondary components shall form a complete vertical-load-carrying system. (Tier 2: Sec. 4.4.1.6.1)	NA
REDUNDANCY	The number of lines of shear walls in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.1.1)	C

Grit Screens Building

		Compliance
REINFORCING STEEL	The ratio of reinforcing steel area to gross concrete area shall be not less than 0.0015 in the vertical direction and 0.0025 in the horizontal direction for Life Safety and Immediate Occupancy. The spacing of reinforcing steel shall be equal to or less than 18 inches for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.2.2)	C
SHEAR STRESS CHECK	The shear stress in the concrete shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than the greater of 100 psi or 2 sqrt(f'c) for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.2.1)	C

Compliance

3.7.9S Concrete Shear Walls with Stiff Diaphragms

Connections

UPLIFT AT PILE CAPS	Pile caps shall have top reinforcement and piles shall be anchored to the pile caps for Life Safety, and the pile cap reinforcement and pile anchorage shall be able to develop the tensile capacity of the piles for Immediate Occupancy. (Tier 2: Sec. 4.6.3.10)	NA

Diaphragms

DIAPHRAGM CONTINUITY	The diaphragms shall not be composed of split-level floors and shall not have expansion joints. (Tier 2: Sec. 4.5.1.1)	NA
DIAPHRAGM REINFORCEMENT AT OPENINGS	There shall be reinforcing around all diaphragm openings larger than 50 percent of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)	C
OPENINGS AT SHEAR WALLS	Diaphragm openings immediately adjacent to the shear walls shall be less than 25 percent of the wall length for Life Safety and 15 percent of the wall length for Immediate Occupancy. (Tier 2: Sec. 4.5.1.4)	C
PLAN IRREGULARITIES	There shall be tensile capacity to develop the strength of the diaphragm at re-entrant corners or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)	NA

Lateral Force Resisting System

CONFINEMENT REINFORCING	For shear walls with aspect ratios greater than 2-to-1, the boundary elements shall be confined with spirals or ties with spacing less than 8db This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.5)	NA
COUPLING BEAMS	The stirrups in coupling beams over means of egress shall be spaced at or less than d/2 and shall be anchored into the confined core of the beam with hooks of 1350 or more for Life Safety. All coupling beams shall comply with the requirements above and shall have the capacity in shear to develop the uplift capacity of the adjacent wall for Immediate Occupancy. (Tier 2: Sec. 4.4.2.2.3)	NA

		Compliance
DEFLECTION COMPATIBILITY	Secondary components shall have the shear capacity to develop the flexural strength of the components for Life Safety and shall meet the requirements of Sections 4.4.1.4.9, 4.4.1.4.10, 4.4.1.4.11, 4.4.1.4.12 and 4.4.1.4.15 for Immediate Occupancy. (Tier 2: Sec. 4.4.1.6.2)	NA
FLAT SLABS	Flat slabs/plates not part of lateral-force-resisting system shall have continuous bottom steel through the column joints for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.1.6.3)	BA
OVERTURNING	All shear walls shall have aspect ratios less than 4-to-1. Wall piers need not be considered. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.4)	C
WALL THICKNESS	Thickness of bearing walls shall not be less than 1/25 the unsupported height or length, whichever is shorter, nor less than 4 inches. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.7)	C

Lateral Force Resisting SystemLateral Force Resisting System

REINFORCING AT OPENINGS	There shall be added trim reinforcement around all wall openings with a dimension greater than three times the thickness of the wall. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.6)	C

Compliance

3.9.1 Basic Nonstructural Component Checklist

Building Contents and Furnishing

Tall Narrow Contents	Contents over 4 feet in height with a height-to-depth or height-to-width ratio greater than 3-to-1 shall be anchored to the floor slab or adjacent structural walls. A height-to-depth or height-to-width ratio of up to 4-to-1 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.11.1)	C

Ceiling Systems

Integrated Ceilings	Integrated suspended ceilings at exits and corridors or weighing more than 2 lb/ft^2 shall be laterally restrained by a minimum of 4 diagonal wires or rigid members attached to the structure above at a spacing equal to or less than 12 ft (Tier 2: Sec. 4.8.2.1)	NA
Lay-In Tiles	Lay-in tiles used in ceiling panels located at exits and corridors shall be secured with clips. (Tier 2: Sec. 4.8.2.2)	NA
Supporting Partitions	The integrated suspended ceiling system shall not be used to laterally support the tops of gypsum board, masonry, or hollow clay tile partitions. Gypsum board partitions need not be evaluated where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.2.1)	NA
Suspended Lath and Plaster	Ceilings consisting of suspended lath and plaster or gypsum board shall be attached for each 10 square feet of area (Tier 2: Sec. 4.8.2.4)	NA

Cladding and Glazing

Bearing Connections	Where bearing connections are required, there shall be a minimum of two bearing connections for each wall panel. (Tier 2: Sec. 4.8.4.5)	NA
Cladding Anchorage	Cladding components weighing more than 10 psf shall be mechanically anchored to the exterior wall framing at a spacing equal to or less than 4 feet. A spacing of up to 6 feet is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2 (Tier 2: Sec. 4.8.4.1)	NA
Cladding Isolation	For moment frame buildings of steel or concrete, panel connections shall be detailed to accommodate a drift ratio of 0.02 for Life Safety and 0.01for Immediate Occupancy (Tier 2: Sec. 4.8.4.2)	NA

		Compliance
Connections Out of Plane	Exterior cladding panels shall be anchored out-of-plane with a minimum of 4 connections for each wall panel. Two connections per wall panel are permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.7)	NA
Damage	There shall be no damage to exterior wall cladding. (Tier 4.8.4.8)	NA
Deterioration in Connections	There shall be no evidence of deterioration, damage or corrosion in any of the connection elements. (Tier 2: Sec. 4.8.4.2)	NA
Drift Isolation	For moment frame buildings of steel or concrete, panel connections shall be detailed to accommodate a story drift ratio of 0.02. Panel connection detailing for a story drift ratio of 0.01 is permitted where only the Basic nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.3)	NA
Glazing	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall be laminated, annealed, or heat strengthened safety glass that will remain in the frame when cracked (Tier 2: Sec. 4.8.4.9)	NA
Inserts	Where inserts are used in concrete connections, the inserts shall be anchored to reinforcing steel or other positive anchorage. (Tier 2: Sec. 4.8.4.6)	NA
Multi-Story Panels Drift	For multi-story panels attached at each floor level, panel connections shall be detailed to accommodate a story drift ratio of 0.02 and 0.01 for immediate occupancy. Panel connection detailing for a story drift ratio (Tier 2: Sec. 4.8.4.4)	NA
Panel Connections	Exterior cladding panels shall be anchored with a minimum of 2 connections for each wall panel for Life Safety and 4 connections for Immediate Occupancy. (Tier 2: Sec. 4.8.4.6)	NA

Hazardous Materials Storage and Distribution

Toxic Substances Lateral Bracing and Anchorage	Toxic and hazardous substances stored in breakable containers shall be restrained from falling by latched doors, shelf lips, wires, or other methods. (Tier 2: Sec 4.8.15.1)	C

		Compliance
Light Fixtures		
Emergency Lighting Anchorage	Emergency lighting shall be anchored or braced to prevent falling or swaying during an earthquake. (Tier 2: Sec. 4.8.3.2)	NC
Independent Support	Light fixtures in suspended grid ceilings shall be supported independently of the ceiling suspension system by a minimum of two wires at diagonally opposite corners of the fixtures (Tier 2: Sec. 4.8.3.1)	NA
Masonry Chimneys		
Urm Chimneys	No reinforced masonry chimney shall extend above the roof surface more than twice the least dimension of the chimney. A height above the roof surface of up to three times the least dimension of the chimney is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.9.1)	NA
Masonry Veneer		
Deterioration	There shall be no evidence of deterioration, damage or corrosion in any of the connection elements. (Tier 2: Sec. 4.8.5.4)	NA
Shelf Angles	Masonry veneer shall be supported by shelf angles or other elements at each floor 30 feet or more above ground for Life Safety and at each floor above the first floor for Immediate Occupancy. (Tier 2: Sec. 4.8.5.1)	NA
Ties	Masonry veneer shall be connected to the back-up with corrosion-resistant ties. The ties shall have a spacing equal to or less than 24 inches with a minimum of one tie for every 2-2/3 square feet. A spacing of up to 36 inches is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2. (Tier 2: Sec. 4.8.5.2)	NA
Weakened Planes	Masonry veneer shall be anchored to the back-up adjacent to weakened planes, such as at the locations of flashing. (Tier 2: Sec. 4.8.5.3)	NA
Mechanical and Electrical Equipment		
Attached Equipment	Equipment weighting over 20 lb that is attached to ceilings, walls, or other supports 4 feet above the floor level shall be mounted. (Tier 2: Sec 4.8.12.2)	C

		Compliance
Deterioration	There shall be no evidence of deterioration, damage, or corrosion in any of the anchorage or supports of mechanical or electrical equipment. (Tier 2: Sec. 4.8.12.3)	C
Emergency Power Mounting	Equipment used as part of an emergency power system shall be mounted to maintain continued operation after an earthquake. (Tier 2: Sec. 4.8.12.1)	C
Hazardous Material Equipment	HVAC or other equipment containing hazardous material shall not have damaged supply lines or unbraced isolation supports. (Tier 2: Sec. 4.8.12.2)	C

Parapets, Cornices, Ornamentation, and Appendages

Canopies	Canopies located at building exits shall be anchored to the structural framing at a spacing of 6 feet or less. An anchorage spacing of up to 10 feet is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.8.2)	NA
Urm Parapets	There shall be no laterally unsupported unreinforced masonry parapets or cornices with height-to-thickness ratios greater than 1.5. A height-to-thickness ratio of up to 2.5 is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2. (Tier 2: Sec. 4.8.8.1)	NA

Partitions

Unreinforced Masonry Bracing	Unreinforced masonry or hollow clay tile partitions shall be braded at a spacing equal to or less than 10 feet in levels of low or moderate seismicity and 6 feet in levels of high seismicity. (Tier 2: Sec. 4.8.1.1)	NA

Piping

Fire Suppression Piping	Fire suppression piping shall be anchored and braced in accordance with NFPA-13 (NFPA, 1996). (Tier 2: Sec. 4.8.13.1)	C
Flexible Couplings	Fluid, gas, and fire suppression piping shall have flexible couplings. (Tier 2: Sec. 4.8.13.2)	C

		Compliance
Stairs		
Stair Details	In moment frame structures, the connection between the stairs and the structure shall not rely on shallow anchors in concrete. Alternatively, the stair details shall be capable of accommodating the drift calculated using the Quick Check procedure of Section 3.5.3.1 without including tension in the anchors. (Tier 2: Sec. 4.8.10.2)	C
Urm Walls	Walls around stair enclosures shall not consist of unbraced hollow clay tile or unreinforced masonry with a height-to-thickness ratio greater than 12-to-1. A height-to-thickness ratio of up to 15-to-1 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.10.1)	C

		Compliance

3.9.1S Supplemental Nonstructural Component Checklist

Building Contents and Furnishing

Access Floor Anchorage	Access floors over 9 inches in height shall be braced. (Tier 2: Sec. 4.8.11.4)	NA
Drawers	Cabinet drawers shall have latches to keep them closed during an earthquake (Tier 2: Sec 4.8.11.3)	NA
Equipment Bracing and Anchorage to Access Floors	Equipment and computers supported on access floor systems shall be either attached to the structure or fastened to a laterally braced floor system. (Tier 2: Sec. 4.8.11.5)	NA
File Cabinets	File cabinets arranged in groups shall be attached to one another. (Tier 2: Sec. 4.8.11.2)	NA
File Cabinets Attachments, Doors, and Drawer Locks	Cabinet doors and drawers shall have latches to keep them closed during an earthquake. (Tier 2: Sec. 4.8.11.3)	NA

Ceiling Systems

Edges Separation	The edges of integrated suspended ceilings shall be separated from enclosing walls by a minimum of 1/2 inch. (Tier 2: Sec. 4.8.2.5)	NA
Seismic Joint	The ceiling system shall not extend continuously across any seismic joint. (Tier 2: Sec. 4.8.2.6)	NA

Cladding and Glazing

Safety Glass	All exterior glazing shall be laminated, annealed or laminated heat-strengthened safety glass or other glazing system that will remain in the frame when glass is cracked. (Tier 2: Sec. 4.8.4.9)	NA

Concrete Block and Masonry Back-Up Systems

Anchorage	Back-up shall have a positive anchorage to the structural framing at a spacing equal to or less than 4 feet along the floors and roof. (Tier 2: Sec. 4.8.7.1)	NA
Concrete Block	Concrete block shall qualify as reinforced masonry (Tier 2: Sec. 4.8.7.1)	NA

		Compliance
Urm Back-Up	There shall be no unreinforced masonry back-up. (Tier 2: Sec. 4.8.7.2)	NA
Ducts		
Duct Bracing	Rectangular ductwork exceeding 6 square feet in cross-sectional area, and round ducts exceeding 28 inches in diameter, shall be braced. Maximum spacing of transverse bracing shall not exceed 30 feet. Maximum spacing of longitudinal bracing shall not exceed 60 feet. Intermediate supports shall not be considered part of the lateral-force resisting system. (Tier 2: Sec. 4.8.14.2)	NA
Duct Supports	Ducts shall not be supported by piping or electrical conduit. (Tier 2: Sec. 4.8.14.3)	C
Stair and Smoke Duct Bracing	Stair pressurization and smoke flow of gas and high temperature energy in the event of an earthquake-induced failure. (Tier 2: Sec. 4.8.13.4)	NA
Elevators		
Brackets	The brackets that tie the car rails and the counterweight rail to the building structure shall be sized in accordance with ASME A17.1. (Tier 2: Sec. 4.8.16.7)	NA
Counterweight Rails	All counterweight rails and divider beams shall be sized in accordance with ASME A17.1. (Tier 2: Sec. 4.8.16.6)	NA
Go-Slow Elevators	The building shall have a go-slow elevator system. (Tier 2: Sec. 4.8.16.9)	NA
Retainer Guards	Cable retainer guards on sheaves and drums shall be present to inhibit the displacement of cables. (Tier 2: Sec. 4.8.16.4)	NA
Retainer Plate	A retainer plate shall be present at the top and bottom of both car and counterweight. (Tier 2: Sec. 4.8.16.5)	NA
Seismic Switch	All elevators shall be equipped with seismic switches that will terminate operations when the ground motion exceeds 0.10g. (Tier 2: Sec. 4.8.16.2)	NA
Shaft Walls	All elevator shaft walls shall be anchored and reinforced to prevent toppling into the shaft during strong shaking. (Tier 2: Sec. 4.8.16.3)	NA

Grit Screens Building

		Compliance
Spreader Bracket	Spreader brackets shall not be used to resist seismic forces. (Tier 2: Sec. 4.8.16.8)	NA
Support System	All elements of the elevator system shall be anchored. (Tier 2: Sec. 4.8.16.1)	NA
Hazardous Materials Storage and Distribution		
Gas Cylinder Restraints	Compressed gas-cylinders shall be restrained. (Tier 2: Sec. 4.8.15.2)	C
Hazardous Materials Shutoff Valves	Piping containing hazardous materials shall have shut-off valves or other devices to prevent major spills or leaks. (Tier 2: Sec. 4.8.16.4)	C
Light Fixtures		
Lens Covers	Lens covers on light fixtures shall be attached or supplied with safety devices. (Tier 2: Sec. 4.8.3.4)	C
Pendant Supports	Light fixtures on pendant supports shall be attached at a spacing equal to or less than 6 feet and, if rigidly, supported, shall be free to move with the structure to which they are attached without damaging adjoining materials. (Tier 2: Sec. 4.8.3.3)	NA
Masonry Veneer		
Mortar	The mortar in masonry veneer shall not be easily scraped away from the joints by hand with a metal tool, and there shall not be significant areas of eroded mortar. (Tier 2: Sec. 4.8.5.5)	NA
Stone Cracks	There shall be no visible cracks or signs of visible distortion in the stone. (Tier 2: Sec. 4.8.5.7)	NA
Weep Holes	In veneer braced by stud walls, functioning weep holes and base flashing shall be present. (Tier 2: Sec. 4.8.5.6)	NA
Mechanical and Electrical Equipment		
Door Drift Allowance	Mechanically operated doors shall be detailed to operate at a story drift ratio of 0.01. (Tier 2: Sec. 4.8.12.8)	NA
Electrical Equipment Bracing	Electrical equipment and associated wiring shall be laterally braced to the structural system. (Tier 2: Sec. 4.8.12.7)	C

		Compliance
Heavy Equipment Anchorage	Equipment weighing over 100 pounds shall be anchored to the structure or foundation. (Tier 2: Sec. 4.8.12.6)	C
Vibration Isolators Restrained	Equipment mounted on vibration isolators shall be equipped with restraints or snubbers. (Tier 2: Sec. 4.8.12.4)	C

Metal Stud Back-Up Systems

Openings	Steel studs shall frame window and door openings. (Tier 2: Sec. 4.8.6.2)	C
Stud Tracks	Stud tracks shall be fastened to structural framing at a spacing equal to or less than 24 inches on center. (Tier 2: Sec. 4.8.6.1)	C

Parapets, Cornices, Ornamentation, and Appendages

Appendages	Cornices, parapets, signs, and other appendages that extend above the highest anchorage level or cantilever from exterior wall faces and other exterior wall ornamentation shall be reinforced and anchored to the structural system at a spacing equal to or less than 10 feet for Life Safety and 6 feet for Immediate Occupancy. This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. f4.8.8.4)	NA
Concrete Parapets	Concrete parapets with height-to-thickness ratios greater than 2.5 shall have vertical reinforcement. (Tier 2: Sec. 4.8.8.3)	NA

Partitions

Drift Allowance	Rigid cementitious partitions shall be detailed to accommodate a drift ratio of 0.02 in steel moment frame, concrete moment frame, and wood frame buildings. Rigid cementitious partitions shall be detailed to accommodate a drift ratio of 0.005 in other buildings. (Tier 2: Sec. 4.8.1.2)	NA
Lateral Bracing for Tops	The tops of framed or panelized partitions that only extend to the ceiling line shall have lateral bracing to the building structure at a spacing equal to or less than 6 feet. (Tier 2: Sec. 4.8.1.4)	NA
Seismic Control Joints	Partitions at structural separations shall have seismic or control joints. (Tier 2: Sec. 4.8.1.3)	NA

Grit Screens Building

Piping		Compliance
C-Clamps	One-sided C-clamps that support piping greater than 2.5 inches in diameter shall be restrained. (Tier 2: Sec. 4.8.13.5)	C
Fluid and Gas Piping Anchorage and Bracing	Fluid and gas piping shall be anchored and braced to the structure to prevent breakage in piping. (Tier 2: Sec 4.8.13.3)	C
Shut-Off Valves	Shut-off devices shall be present at building utility interfaces to shut off the flow of gas and high-temperature energy in the event of earthquake-induced failure. (Tier 2: Sec. 4.8.13.4)	C

3.9.2 Intermediate Nonstructural Component Checklist

Ceiling Systems

Integrated Ceilings	Integrated suspended ceilings at exists and corridors or weighing more than 2 pounds per square foot shall be laterally restrained with a minimum of four diagonal wires or rigid members attached to the structure above at a spacing equal to or less than 12 feet. (Tier 2: Sec. 4.8.2.3)	NA
Lay-In Tiles	Lay-in tiles used in ceiling panels located at exits and corridors shall be secured with clips. (Tier 2: Sec. 4.8.2.2)	NA
Suspended Lath and Plaster	Ceilings consisting of suspended lath and plaster or gypsum board shall be attached to resist seismic forced for every 12 square feet of area. (Tier 2: Sec. 4.8.2.4)	NA

Cladding and Glazing

Glazing	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall have safety glazing. Such glazing located over 10 feet above an exterior walking surface shall be laminated, annealed, or laminated heat strengthened safety glass that will remain in the frame when cracked (Tier 2: Sec. 4.8.4.8)	NA
Laminated Safety Glass	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall have safety glazing. Such glazing located over 10 feet above an exterior walking surface shall be laminated annealed or laminated heat-strengthened safety glass or other glazing system that will remain in the frame when glass is cracked. (Tier 2: Sec. 4.8.4.8)	NA

Ducts

Stair and Smoke Duct Bracing	Stair pressurization and smoke control ducts shall be braced and shall have flexible connections at seismic joints. (Tier 2: Sec. 4.8.14.1)	NA

Light Fixtures

Independent Support	Light fixtures in suspended grid ceilings shall be supported independently of the ceiling suspension system by a minimum of two wires at diagonally opposite. (Tier 2: Sec. 4.8.3.2)	NA

		Compliance
Masonry Chimneys		
Anchorage	Masonry chimneys shall be anchored at each floor level and the roof. (Tier 2: Sec. 4.8.9.2)This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. 4.8.8.4)	NA
Mechanical and Electrical Equipment		
Vibration Isolators Restrained	Equipment mounted on vibration isolators shall be equipped with restraints or snubbers. (Tier 2: Sec. 4.8.12.4)	NA
Parapets, Cornices, Ornamentation, and Appendages		
Appendages	Cornices, parapets, signs, and other appendages that extend above the highest point of anchorage to the structure or cantilever from exterior wall faces and other exterior wall ornamentation shall be reinforced and anchored to the structural system at a spacing equal to or less than 10 feet for Life Safety and 6 feet for Immediate Occupancy. This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. 4.8.8.4)	NA
Concrete Parapets	Concrete parapets with height-to-thickness ratios greater than 2.5 shall have vertical reinforcement. (Tier 2: Sec. 4.8.8.3)	NA

ASCE31 Tier 1 Seismic Screening
Structural and Non-Structural Findings

Primary Sedimentation Building

3.7.13 Reinforced Masonry Bearing Walls with Flexible Diaphragms

Building System

		Compliance
ADJACENT BUILDINGS	The clear distance between the building being evaluated and any adjacent building shall be greater than 4 percent of the height of the shorter building for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.1.2)	C
DETERIORATION OF WOOD	There shall be no signs of decay, shrinkage, splitting, fire damage, or sagging in any of the wood members, and none of the metal connection hardware shall be deteriorated, broken, or loose. (Tier 2: Sec. 4.3.3.1)	NC
GEOMETRY	There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30 percent in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines. (Tier 2: Sec. 4.3.2.3)	C
LOAD PATH	The structure shall contain a minimum of one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)	C
MASONRY JOINTS	The mortar shall not be easily scraped away from the joints by hand with a metal tool, and there shall be no areas of eroded mortar. (Tier 2: Sec. 4.3.3.8)	NC
MASONRY UNITS	There shall be no visible deterioration of masonry units. (Tier 2: Sec. 4.3.3.7)	NC
MASS	There shall be no change in effective mass more than 50 percent from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses, and mezzanines need not be considered. (Tier 2: Sec. 4.3.2.5)	C
MEZZANINES	Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.3)	NA

		Compliance
REINFORCED MASONRY WALL CRACKS	All existing diagonal cracks in wall elements shall be less than 1/8 inch for Life Safety and 1/16 inch for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern. (Tier 2: Sec. 4.3.3.10)	C
SOFT STORY	The stiffness of the lateral-force-resisting system in any story shall not be less than 70 percent of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80 percent of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2)	NA
VERTICAL DISCONTINUITIES	All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)	C
WEAK STORY	The strength of the lateral-force-resisting system in any story shall not be less than 80 percent of the strength in an adjacent story, above or below, for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)	C

Connections

FOUNDATION DOWELS	Wall reinforcement shall be doweled into the foundation for Life Safety, and the dowels shall be able to develop the lesser of the strength of the walls or the uplift capacity of the foundation for Immediate Occupancy. (Tier 2: Sec. 4.6.3.5)	C
GIRDER/COLUMN CONNECTION	There shall be a positive connection utilizing plates, connection hardware, or straps between the girder and the column support. (Tier 2: Sec. 4.6.4.1)	C
TRANSFER TO SHEAR WALLS	Diaphragms shall be connected for transfer of loads to the shear walls for Life Safety and the connections shall be able to develop the lesser of the shear strength of the walls or diaphragms for Immediate Occupancy. (Tier 2: Sec. 4.6.2.1)	C
WALL ANCHORAGE	Exterior concrete or masonry walls that are dependent on the diaphragm for lateral support shall be anchored for out-of-plane forces at each diaphragm level with steel anchors, reinforcing dowels, or straps that are developed into the diaphragm. Connections shall have adequate strength to resist the connection force calculated in the Quick Check procedure of Section 3.5.3.7. (Tier 2: Sec. 4.6.1.1)	C

		Compliance
WOOD LEDGERS	The connection between the wall panels and the diaphragm shall not induce cross-grain bending or tension in the wood ledgers. (Tier 2: Sec. 4.6.1.2)	C

Lateral Force Resisting System

REDUNDANCY	The number of lines of shear walls in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.1.1)	C
REINFORCING STEEL	The total vertical and horizontal reinforcing steel ratio in reinforced masonry walls shall be greater than 0.002 for Life Safety and Immediate Occupancy of the wall with the minimum of 0.0007 for Life Safety and Immediate Occupancy in either of the two directions; the spacing of reinforcing steel shall be less than 48 inches for Life Safety and Immediate Occupancy; and all vertical bars shall extend to the top of the walls. (Tier 2: Sec. 4.4.2.4.2)	NC
SHEAR STRESS CHECK	The shear stress in the reinforced masonry shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 70 psi for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.4.1)	C

 Compliance

3.7.13S Reinforced Masonry Bearing Walls with Flexible Diaphragms

Connections

		Compliance
STIFFNESS OF WALL ANCHORS	Anchors of concrete or masonry walls to wood structural elements shall be installed taut and shall be stiff enough to limit the relative movement between the wall and the diaphragm to no greater than 1/8 inch prior to engagement of the anchors. (Tier 2: Sec. 4.6.1.4)	C

Diaphragms

		Compliance
CROSS TIES	There shall be continuous cross ties between diaphragm chords. (Tier 2: Sec. 4.5.1.2)	C
DIAPHRAGM REINFORCEMENT AT OPENINGS	There shall be reinforcing around all diaphragm openings larger than 50 percent of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)	NA
NON-CONCRETE FILLED DIAPHRAGMS	Untopped metal deck diaphragms or metal deck diaphragms with fill other than concrete shall consist of horizontal spans of less than 40 feet and shall have span/depth ratios less than 4-to-l. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.3.1)	C
OPENINGS AT EXTERIOR MASONRY SHEAR WALLS	Diaphragm openings immediately adjacent to exterior masonry shear walls shall not be greater than 8 feet long for Life Safety and 4 feet long for Immediate Occupancy. (Tier 2: Sec. 4.5.1.6)	NA
OPENINGS AT SHEAR WALLS	Diaphragm openings immediately adjacent to the shear walls shall be less than 25 percent of the wall length for Life Safety and 15 percent of the wall length for Immediate Occupancy. (Tier 2: Sec. 4.5.1.4)	NA
OTHER DIAPHRAGMS	The diaphragm shall not consist of a system other than wood, metal deck, concrete, or horizontal bracing. (Tier 2: Sec. 4.5.7.1)	C
PLAN IRREGULARITIES	There shall be tensile capacity to develop the strength of the diaphragm at re-entrant comers or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)	NA
SPANS	All wood diaphragms with spans greater than 24 feet for Life Safety and 12 feet for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing. (Tier 2: Sec. 4.5.2.2)	NC

Primary Sedimentation Building

		Compliance
STRAIGHT SHEATHING	All straight sheathed diaphragms shall have aspect ratios less than 2- to-1 for Life Safety and 1-to-1 for Immediate Occupancy in the direction being considered. (Tier 2: Sec. 4.5.2.1)	NC
UNBLOCKED DIAPHRAGMS	All diagonally sheathed or unblocked wood structural panel diaphragms shall have horizontal spans less than 40 feet for Life Safety and 30 feet for Immediate Occupancy and shall have aspect ratios less than or equal to 4-to-1 for Life Safety and 3-to-l for Immediate Occupancy. (Tier 2: Sec. 4.5.2.3)	C

Lateral Force Resisting System

PROPORTIONS	The height-to-thickness ratio of the shear walls at each story shall be less than 30. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.4.4)	C
REINFORCING AT OPENINGS	All wall openings that interrupt rebar shall have trim reinforcing on all sides. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.4.3)	C

Primary Sedimentation Building

Compliance

3.9.1 Basic Nonstructural Component Checklist

Building Contents and Furnishing

Tall Narrow Contents	Contents over 4 feet in height with a height-to-depth or height-to-width ratio greater than 3-to-1 shall be anchored to the floor slab or adjacent structural walls. A height-to-depth or height-to-width ratio of up to 4-to-1 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.11.1)	C

Ceiling Systems

Integrated Ceilings	Integrated suspended ceilings at exits and corridors or weighing more than 2 lb/ft^2 shall be laterally restrained by a minimum of 4 diagonal wires or rigid members attached to the structure above at a spacing equal to or less than 12 ft (Tier 2: Sec. 4.8.2.1)	NA
Lay-In Tiles	Lay-in tiles used in ceiling panels located at exits and corridors shall be secured with clips. (Tier 2: Sec. 4.8.2.2)	NA
Supporting Partitions	The integrated suspended ceiling system shall not be used to laterally support the tops of gypsum board, masonry, or hollow clay tile partitions. Gypsum board partitions need not be evaluated where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.2.1)	NA
Suspended Lath and Plaster	Ceilings consisting of suspended lath and plaster or gypsum board shall be attached for each 10 square feet of area (Tier 2: Sec. 4.8.2.4)	NA

Cladding and Glazing

Bearing Connections	Where bearing connections are required, there shall be a minimum of two bearing connections for each wall panel. (Tier 2: Sec. 4.8.4.5)	NA
Cladding Anchorage	Cladding components weighing more than 10 psf shall be mechanically anchored to the exterior wall framing at a spacing equal to or less than 4 feet. A spacing of up to 6 feet is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2 (Tier 2: Sec. 4.8.4.1)	NA
Cladding Isolation	For moment frame buildings of steel or concrete, panel connections shall be detailed to accommodate a drift ratio of 0.02 for Life Safety and 0.01for Immediate Occupancy (Tier 2: Sec. 4.8.4.2)	NA

		Compliance
Connections Out of Plane	Exterior cladding panels shall be anchored out-of-plane with a minimum of 4 connections for each wall panel. Two connections per wall panel are permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.7)	NA
Damage	There shall be no damage to exterior wall cladding. (Tier 4.8.4.8)	NA
Deterioration in Connections	There shall be no evidence of deterioration, damage or corrosion in any of the connection elements. (Tier 2: Sec. 4.8.4.2)	NA
Drift Isolation	For moment frame buildings of steel or concrete, panel connections shall be detailed to accommodate a story drift ratio of 0.02. Panel connection detailing for a story drift ratio of 0.01 is permitted where only the Basic nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.3)	NA
Glazing	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall be laminated, annealed, or heat strengthened safety glass that will remain in the frame when cracked (Tier 2: Sec. 4.8.4.9)	NA
Inserts	Where inserts are used in concrete connections, the inserts shall be anchored to reinforcing steel or other positive anchorage. (Tier 2: Sec. 4.8.4.6)	NA
Multi-Story Panels Drift	For multi-story panels attached at each floor level, panel connections shall be detailed to accommodate a story drift ratio of 0.02 and 0.01 for immediate occupancy. Panel connection detailing for a story drift ratio (Tier 2: Sec. 4.8.4.4)	NA
Panel Connections	Exterior cladding panels shall be anchored with a minimum of 2 connections for each wall panel for Life Safety and 4 connections for Immediate Occupancy. (Tier 2: Sec. 4.8.4.6)	NA

Hazardous Materials Storage and Distribution

Toxic Substances Lateral Bracing and Anchorage	Toxic and hazardous substances stored in breakable containers shall be restrained from falling by latched doors, shelf lips, wires, or other methods. (Tier 2: Sec 4.8.15.1)	C

		Compliance
Light Fixtures		
Emergency Lighting Anchorage	Emergency lighting shall be anchored or braced to prevent falling or swaying during an earthquake. (Tier 2: Sec. 4.8.3.2)	C
Independent Support	Light fixtures in suspended grid ceilings shall be supported independently of the ceiling suspension system by a minimum of two wires at diagonally opposite corners of the fixtures (Tier 2: Sec. 4.8.3.1)	NA
Masonry Chimneys		
Urm Chimneys	No reinforced masonry chimney shall extend above the roof surface more than twice the least dimension of the chimney. A height above the roof surface of up to three times the least dimension of the chimney is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.9.1)	NA
Masonry Veneer		
Deterioration	There shall be no evidence of deterioration, damage or corrosion in any of the connection elements. (Tier 2: Sec. 4.8.5.4)	NA
Shelf Angles	Masonry veneer shall be supported by shelf angles or other elements at each floor 30 feet or more above ground for Life Safety and at each floor above the first floor for Immediate Occupancy. (Tier 2: Sec. 4.8.5.1)	NA
Ties	Masonry veneer shall be connected to the back-up with corrosion-resistant ties. The ties shall have a spacing equal to or less than 24 inches with a minimum of one tie for every 2-2/3 square feet. A spacing of up to 36 inches is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2. (Tier 2: Sec. 4.8.5.2)	NA
Weakened Planes	Masonry veneer shall be anchored to the back-up adjacent to weakened planes, such as at the locations of flashing. (Tier 2: Sec. 4.8.5.3)	NA
Mechanical and Electrical Equipment		
Attached Equipment	Equipment weighting over 20 lb that is attached to ceilings, walls, or other supports 4 feet above the floor level shall be mounted. (Tier 2: Sec 4.8.12.2)	C

		Compliance
Deterioration	There shall be no evidence of deterioration, damage, or corrosion in any of the anchorage or supports of mechanical or electrical equipment. (Tier 2: Sec. 4.8.12.3)	NC
Emergency Power Mounting	Equipment used as part of an emergency power system shall be mounted to maintain continued operation after an earthquake. (Tier 2: Sec. 4.8.12.1)	C
Hazardous Material Equipment	HVAC or other equipment containing hazardous material shall not have damaged supply lines or unbraced isolation supports. (Tier 2: Sec. 4.8.12.2)	C

Parapets, Cornices, Ornamentation, and Appendages

Canopies	Canopies located at building exits shall be anchored to the structural framing at a spacing of 6 feet or less. An anchorage spacing of up to 10 feet is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.8.2)	NA
Urm Parapets	There shall be no laterally unsupported unreinforced masonry parapets or cornices with height-to-thickness ratios greater than 1.5. A height-to-thickness ratio of up to 2.5 is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2. (Tier 2: Sec. 4.8.8.1)	NA

Partitions

Unreinforced Masonry Bracing	Unreinforced masonry or hollow clay tile partitions shall be braded at a spacing equal to or less than 10 feet in levels of low or moderate seismicity and 6 feet in levels of high seismicity. (Tier 2: Sec. 4.8.1.1)	NA

Piping

Fire Suppression Piping	Fire suppression piping shall be anchored and braced in accordance with NFPA-13 (NFPA, 1996). (Tier 2: Sec. 4.8.13.1)	NC
Flexible Couplings	Fluid, gas, and fire suppression piping shall have flexible couplings. (Tier 2: Sec. 4.8.13.2)	NC

Primary Sedimentation Building		Compliance
Stairs		
Stair Details	In moment frame structures, the connection between the stairs and the structure shall not rely on shallow anchors in concrete. Alternatively, the stair details shall be capable of accommodating the drift calculated using the Quick Check procedure of Section 3.5.3.1 without including tension in the anchors. (Tier 2: Sec. 4.8.10.2)	NA
Urm Walls	Walls around stair enclosures shall not consist of unbraced hollow clay tile or unreinforced masonry with a height-to-thickness ratio greater than 12-to-1. A height-to-thickness ratio of up to 15-to-1 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.10.1)	NA

Primary Sedimentation Building

Compliance

3.9.1S Supplemental Nonstructural Component Checklist

Building Contents and Furnishing

Access Floor Anchorage	Access floors over 9 inches in height shall be braced. (Tier 2: Sec. 4.8.11.4)	NA
Drawers	Cabinet drawers shall have latches to keep them closed during an earthquake (Tier 2: Sec 4.8.11.3)	NA
Equipment Bracing and Anchorage to Access Floors	Equipment and computers supported on access floor systems shall be either attached to the structure or fastened to a laterally braced floor system. (Tier 2: Sec. 4.8.11.5)	NA
File Cabinets	File cabinets arranged in groups shall be attached to one another. (Tier 2: Sec. 4.8.11.2)	NC
File Cabinets Attachments, Doors, and Drawer Locks	Cabinet doors and drawers shall have latches to keep them closed during an earthquake. (Tier 2: Sec. 4.8.11.3)	NC

Ceiling Systems

Edges Separation	The edges of integrated suspended ceilings shall be separated from enclosing walls by a minimum of 1/2 inch. (Tier 2: Sec. 4.8.2.5)	NA
Seismic Joint	The ceiling system shall not extend continuously across any seismic joint. (Tier 2: Sec. 4.8.2.6)	NA

Cladding and Glazing

Safety Glass	All exterior glazing shall be laminated, annealed or laminated heat-strengthened safety glass or other glazing system that will remain in the frame when glass is cracked. (Tier 2: Sec. 4.8.4.9)	NA

Concrete Block and Masonry Back-Up Systems

Anchorage	Back-up shall have a positive anchorage to the structural framing at a spacing equal to or less than 4 feet along the floors and roof. (Tier 2: Sec. 4.8.7.1)	NA
Concrete Block	Concrete block shall qualify as reinforced masonry (Tier 2: Sec. 4.8.7.1)	NA

		Compliance
Urm Back-Up	There shall be no unreinforced masonry back-up. (Tier 2: Sec. 4.8.7.2)	NA
Ducts		
Duct Bracing	Rectangular ductwork exceeding 6 square feet in cross-sectional area, and round ducts exceeding 28 inches in diameter, shall be braced. Maximum spacing of transverse bracing shall not exceed 30 feet. Maximum spacing of longitudinal bracing shall not exceed 60 feet. Intermediate supports shall not be considered part of the lateral-force resisting system. (Tier 2: Sec. 4.8.14.2)	C
Duct Supports	Ducts shall not be supported by piping or electrical conduit. (Tier 2: Sec. 4.8.14.3)	C
Stair and Smoke Duct Bracing	Stair pressurization and smoke flow of gas and high temperature energy in the event of an earthquake-induced failure. (Tier 2: Sec. 4.8.13.4)	C
Elevators		
Brackets	The brackets that tie the car rails and the counterweight rail to the building structure shall be sized in accordance with ASME A17.1. (Tier 2: Sec. 4.8.16.7)	NA
Counterweight Rails	All counterweight rails and divider beams shall be sized in accordance with ASME A17.1. (Tier 2: Sec. 4.8.16.6)	NA
Go-Slow Elevators	The building shall have a go-slow elevator system. (Tier 2: Sec. 4.8.16.9)	NA
Retainer Guards	Cable retainer guards on sheaves and drums shall be present to inhibit the displacement of cables. (Tier 2: Sec. 4.8.16.4)	NA
Retainer Plate	A retainer plate shall be present at the top and bottom of both car and counterweight. (Tier 2: Sec. 4.8.16.5)	NA
Seismic Switch	All elevators shall be equipped with seismic switches that will terminate operations when the ground motion exceeds 0.10g. (Tier 2: Sec. 4.8.16.2)	NA
Shaft Walls	All elevator shaft walls shall be anchored and reinforced to prevent toppling into the shaft during strong shaking. (Tier 2: Sec. 4.8.16.3)	NA

		Compliance
Spreader Bracket	Spreader brackets shall not be used to resist seismic forces. (Tier 2: Sec. 4.8.16.8)	NA
Support System	All elements of the elevator system shall be anchored. (Tier 2: Sec. 4.8.16.1)	NA
Hazardous Materials Storage and Distribution		
Gas Cylinder Restraints	Compressed gas-cylinders shall be restrained. (Tier 2: Sec. 4.8.15.2)	NA
Hazardous Materials Shutoff Valves	Piping containing hazardous materials shall have shut-off valves or other devices to prevent major spills or leaks. (Tier 2: Sec. 4.8.16.4)	C
Light Fixtures		
Lens Covers	Lens covers on light fixtures shall be attached or supplied with safety devices. (Tier 2: Sec. 4.8.3.4)	C
Pendant Supports	Light fixtures on pendant supports shall be attached at a spacing equal to or less than 6 feet and, if rigidly, supported, shall be free to move with the structure to which they are attached without damaging adjoining materials. (Tier 2: Sec. 4.8.3.3)	C
Masonry Veneer		
Mortar	The mortar in masonry veneer shall not be easily scraped away from the joints by hand with a metal tool, and there shall not be significant areas of eroded mortar. (Tier 2: Sec. 4.8.5.5)	NA
Stone Cracks	There shall be no visible cracks or signs of visible distortion in the stone. (Tier 2: Sec. 4.8.5.7)	NA
Weep Holes	In veneer braced by stud walls, functioning weep holes and base flashing shall be present. (Tier 2: Sec. 4.8.5.6)	NA
Mechanical and Electrical Equipment		
Door Drift Allowance	Mechanically operated doors shall be detailed to operate at a story drift ratio of 0.01. (Tier 2: Sec. 4.8.12.8)	NA
Electrical Equipment Bracing	Electrical equipment and associated wiring shall be laterally braced to the structural system. (Tier 2: Sec. 4.8.12.7)	NC

		Compliance
Heavy Equipment Anchorage	Equipment weighing over 100 pounds shall be anchored to the structure or foundation. (Tier 2: Sec. 4.8.12.6)	C
Vibration Isolators Restrained	Equipment mounted on vibration isolators shall be equipped with restraints or snubbers. (Tier 2: Sec. 4.8.12.4)	NA

Metal Stud Back-Up Systems

Openings	Steel studs shall frame window and door openings. (Tier 2: Sec. 4.8.6.2)	C
Stud Tracks	Stud tracks shall be fastened to structural framing at a spacing equal to or less than 24 inches on center. (Tier 2: Sec. 4.8.6.1)	C

Parapets, Cornices, Ornamentation, and Appendages

Appendages	Cornices, parapets, signs, and other appendages that extend above the highest anchorage level or cantilever from exterior wall faces and other exterior wall ornamentation shall be reinforced and anchored to the structural system at a spacing equal to or less than 10 feet for Life Safety and 6 feet for Immediate Occupancy. This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. f4.8.8.4)	NC
Concrete Parapets	Concrete parapets with height-to-thickness ratios greater than 2.5 shall have vertical reinforcement. (Tier 2: Sec. 4.8.8.3)	C

Partitions

Drift Allowance	Rigid cementitious partitions shall be detailed to accommodate a drift ratio of 0.02 in steel moment frame, concrete moment frame, and wood frame buildings. Rigid cementitious partitions shall be detailed to accommodate a drift ratio of 0.005 in other buildings. (Tier 2: Sec. 4.8.1.2)	NA
Lateral Bracing for Tops	The tops of framed or panelized partitions that only extend to the ceiling line shall have lateral bracing to the building structure at a spacing equal to or less than 6 feet. (Tier 2: Sec. 4.8.1.4)	NA
Seismic Control Joints	Partitions at structural separations shall have seismic or control joints. (Tier 2: Sec. 4.8.1.3)	NA

Primary Sedimentation Building

		Compliance
Piping		
C-Clamps	One-sided C-clamps that support piping greater than 2.5 inches in diameter shall be restrained. (Tier 2: Sec. 4.8.13.5)	C
Fluid and Gas Piping Anchorage and Bracing	Fluid and gas piping shall be anchored and braced to the structure to prevent breakage in piping. (Tier 2: Sec 4.8.13.3)	C
Shut-Off Valves	Shut-off devices shall be present at building utility interfaces to shut off the flow of gas and high-temperature energy in the event of earthquake-induced failure. (Tier 2: Sec. 4.8.13.4)	C

3.9.2 Intermediate Nonstructural Component Checklist

Ceiling Systems

		Compliance
Integrated Ceilings	Integrated suspended ceilings at exists and corridors or weighing more than 2 pounds per square foot shall be laterally restrained with a minimum of four diagonal wires or rigid members attached to the structure above at a spacing equal to or less than 12 feet. (Tier 2: Sec. 4.8.2.3)	NA
Lay-In Tiles	Lay-in tiles used in ceiling panels located at exits and corridors shall be secured with clips. (Tier 2: Sec. 4.8.2.2)	NA
Suspended Lath and Plaster	Ceilings consisting of suspended lath and plaster or gypsum board shall be attached to resist seismic forced for every 12 square feet of area. (Tier 2: Sec. 4.8.2.4)	NA

Cladding and Glazing

Glazing	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall have safety glazing. Such glazing located over 10 feet above an exterior walking surface shall be laminated, annealed, or laminated heat strengthened safety glass that will remain in the frame when cracked (Tier 2: Sec. 4.8.4.8)	NA
Laminated Safety Glass	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall have safety glazing. Such glazing located over 10 feet above an exterior walking surface shall be laminated annealed or laminated heat-strengthened safety glass or other glazing system that will remain in the frame when glass is cracked. (Tier 2: Sec. 4.8.4.8)	NA

Ducts

Stair and Smoke Duct Bracing	Stair pressurization and smoke control ducts shall be braced and shall have flexible connections at seismic joints. (Tier 2: Sec. 4.8.14.1)	C

Light Fixtures

Independent Support	Light fixtures in suspended grid ceilings shall be supported independently of the ceiling suspension system by a minimum of two wires at diagonally opposite. (Tier 2: Sec. 4.8.3.2)	NA

Primary Sedimentation Building

		Compliance
Masonry Chimneys		
Anchorage	Masonry chimneys shall be anchored at each floor level and the roof. (Tier 2: Sec. 4.8.9.2)This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. 4.8.8.4)	NA
Mechanical and Electrical Equipment		
Vibration Isolators Restrained	Equipment mounted on vibration isolators shall be equipped with restraints or snubbers. (Tier 2: Sec. 4.8.12.4)	NA
Parapets, Cornices, Ornamentation, and Appendages		
Appendages	Cornices, parapets, signs, and other appendages that extend above the highest point of anchorage to the structure or cantilever from exterior wall faces and other exterior wall ornamentation shall be reinforced and anchored to the structural system at a spacing equal to or less than 10 feet for Life Safety and 6 feet for Immediate Occupancy. This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. 4.8.8.4)	NC
Concrete Parapets	Concrete parapets with height-to-thickness ratios greater than 2.5 shall have vertical reinforcement. (Tier 2: Sec. 4.8.8.3)	C

ASCE31 Tier 1 Seismic Screening
Structural and Non-Structural Findings

Main Switch Building

3.7.13 Reinforced Masonry Bearing Walls with Flexible Diaphragms

Building System

		Compliance
ADJACENT BUILDINGS	The clear distance between the building being evaluated and any adjacent building shall be greater than 4 percent of the height of the shorter building for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.1.2)	C
DETERIORATION OF WOOD	There shall be no signs of decay, shrinkage, splitting, fire damage, or sagging in any of the wood members, and none of the metal connection hardware shall be deteriorated, broken, or loose. (Tier 2: Sec. 4.3.3.1)	NC
GEOMETRY	There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30 percent in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines. (Tier 2: Sec. 4.3.2.3)	C
LOAD PATH	The structure shall contain a minimum of one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)	C
MASONRY JOINTS	The mortar shall not be easily scraped away from the joints by hand with a metal tool, and there shall be no areas of eroded mortar. (Tier 2: Sec. 4.3.3.8)	C
MASONRY UNITS	There shall be no visible deterioration of masonry units. (Tier 2: Sec. 4.3.3.7)	C
MASS	There shall be no change in effective mass more than 50 percent from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses, and mezzanines need not be considered. (Tier 2: Sec. 4.3.2.5)	NA
MEZZANINES	Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.3)	NA

		Compliance
REINFORCED MASONRY WALL CRACKS	All existing diagonal cracks in wall elements shall be less than 1/8 inch for Life Safety and 1/16 inch for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern. (Tier 2: Sec. 4.3.3.10)	C
SOFT STORY	The stiffness of the lateral-force-resisting system in any story shall not be less than 70 percent of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80 percent of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2)	NA
VERTICAL DISCONTINUITIES	All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)	C
WEAK STORY	The strength of the lateral-force-resisting system in any story shall not be less than 80 percent of the strength in an adjacent story, above or below, for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)	NA

Connections

FOUNDATION DOWELS	Wall reinforcement shall be doweled into the foundation for Life Safety, and the dowels shall be able to develop the lesser of the strength of the walls or the uplift capacity of the foundation for Immediate Occupancy. (Tier 2: Sec. 4.6.3.5)	C
GIRDER/COLUMN CONNECTION	There shall be a positive connection utilizing plates, connection hardware, or straps between the girder and the column support. (Tier 2: Sec. 4.6.4.1)	C
TRANSFER TO SHEAR WALLS	Diaphragms shall be connected for transfer of loads to the shear walls for Life Safety and the connections shall be able to develop the lesser of the shear strength of the walls or diaphragms for Immediate Occupancy. (Tier 2: Sec. 4.6.2.1)	C
WALL ANCHORAGE	Exterior concrete or masonry walls that are dependent on the diaphragm for lateral support shall be anchored for out-of-plane forces at each diaphragm level with steel anchors, reinforcing dowels, or straps that are developed into the diaphragm. Connections shall have adequate strength to resist the connection force calculated in the Quick Check procedure of Section 3.5.3.7. (Tier 2: Sec. 4.6.1.1)	NC

		Compliance
WOOD LEDGERS	The connection between the wall panels and the diaphragm shall not induce cross-grain bending or tension in the wood ledgers. (Tier 2: Sec. 4.6.1.2)	C

Lateral Force Resisting System

REDUNDANCY	The number of lines of shear walls in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.1.1)	C
REINFORCING STEEL	The total vertical and horizontal reinforcing steel ratio in reinforced masonry walls shall be greater than 0.002 for Life Safety and Immediate Occupancy of the wall with the minimum of 0.0007 for Life Safety and Immediate Occupancy in either of the two directions; the spacing of reinforcing steel shall be less than 48 inches for Life Safety and Immediate Occupancy; and all vertical bars shall extend to the top of the walls. (Tier 2: Sec. 4.4.2.4.2)	NC
SHEAR STRESS CHECK	The shear stress in the reinforced masonry shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 70 psi for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.4.1)	C

3.7.13S Reinforced Masonry Bearing Walls with Flexible Diaphragms

Connections

STIFFNESS OF WALL ANCHORS	Anchors of concrete or masonry walls to wood structural elements shall be installed taut and shall be stiff enough to limit the relative movement between the wall and the diaphragm to no greater than 1/8 inch prior to engagement of the anchors. (Tier 2: Sec. 4.6.1.4)	C

Diaphragms

CROSS TIES	There shall be continuous cross ties between diaphragm chords. (Tier 2: Sec. 4.5.1.2)	NC
DIAPHRAGM REINFORCEMENT AT OPENINGS	There shall be reinforcing around all diaphragm openings larger than 50 percent of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)	NA
NON-CONCRETE FILLED DIAPHRAGMS	Untopped metal deck diaphragms or metal deck diaphragms with fill other than concrete shall consist of horizontal spans of less than 40 feet and shall have span/depth ratios less than 4-to-l. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.3.1)	NA
OPENINGS AT EXTERIOR MASONRY SHEAR WALLS	Diaphragm openings immediately adjacent to exterior masonry shear walls shall not be greater than 8 feet long for Life Safety and 4 feet long for Immediate Occupancy. (Tier 2: Sec. 4.5.1.6)	NA
OPENINGS AT SHEAR WALLS	Diaphragm openings immediately adjacent to the shear walls shall be less than 25 percent of the wall length for Life Safety and 15 percent of the wall length for Immediate Occupancy. (Tier 2: Sec. 4.5.1.4)	NA
OTHER DIAPHRAGMS	The diaphragm shall not consist of a system other than wood, metal deck, concrete, or horizontal bracing. (Tier 2: Sec. 4.5.7.1)	C
PLAN IRREGULARITIES	There shall be tensile capacity to develop the strength of the diaphragm at re-entrant comers or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)	NA
SPANS	All wood diaphragms with spans greater than 24 feet for Life Safety and 12 feet for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing. (Tier 2: Sec. 4.5.2.2)	C

		Compliance
STRAIGHT SHEATHING	All straight sheathed diaphragms shall have aspect ratios less than 2- to-1 for Life Safety and 1-to-1 for Immediate Occupancy in the direction being considered. (Tier 2: Sec. 4.5.2.1)	C
UNBLOCKED DIAPHRAGMS	All diagonally sheathed or unblocked wood structural panel diaphragms shall have horizontal spans less than 40 feet for Life Safety and 30 feet for Immediate Occupancy and shall have aspect ratios less than or equal to 4-to-1 for Life Safety and 3-to-l for Immediate Occupancy. (Tier 2: Sec. 4.5.2.3)	NC

Lateral Force Resisting System

PROPORTIONS	The height-to-thickness ratio of the shear walls at each story shall be less than 30. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.4.4)	C
REINFORCING AT OPENINGS	All wall openings that interrupt rebar shall have trim reinforcing on all sides. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.4.3)	C

 Compliance

3.9.1 Basic Nonstructural Component Checklist

Building Contents and Furnishing

		Compliance
Tall Narrow Contents	Contents over 4 feet in height with a height-to-depth or height-to-width ratio greater than 3-to-1 shall be anchored to the floor slab or adjacent structural walls. A height-to-depth or height-to-width ratio of up to 4-to-1 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.11.1)	C

Ceiling Systems

Integrated Ceilings	Integrated suspended ceilings at exits and corridors or weighing more than 2 lb/ft^2 shall be laterally restrained by a minimum of 4 diagonal wires or rigid members attached to the structure above at a spacing equal to or less than 12 ft (Tier 2: Sec. 4.8.2.1)	NA
Lay-In Tiles	Lay-in tiles used in ceiling panels located at exits and corridors shall be secured with clips. (Tier 2: Sec. 4.8.2.2)	NA
Supporting Partitions	The integrated suspended ceiling system shall not be used to laterally support the tops of gypsum board, masonry, or hollow clay tile partitions. Gypsum board partitions need not be evaluated where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.2.1)	NA
Suspended Lath and Plaster	Ceilings consisting of suspended lath and plaster or gypsum board shall be attached for each 10 square feet of area (Tier 2: Sec. 4.8.2.4)	NA

Cladding and Glazing

Bearing Connections	Where bearing connections are required, there shall be a minimum of two bearing connections for each wall panel. (Tier 2: Sec. 4.8.4.5)	NA
Cladding Anchorage	Cladding components weighing more than 10 psf shall be mechanically anchored to the exterior wall framing at a spacing equal to or less than 4 feet. A spacing of up to 6 feet is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2 (Tier 2: Sec. 4.8.4.1)	NA
Cladding Isolation	For moment frame buildings of steel or concrete, panel connections shall be detailed to accommodate a drift ratio of 0.02 for Life Safety and 0.01for Immediate Occupancy (Tier 2: Sec. 4.8.4.2)	NA

		Compliance
Connections Out of Plane	Exterior cladding panels shall be anchored out-of-plane with a minimum of 4 connections for each wall panel. Two connections per wall panel are permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.7)	NA
Damage	There shall be no damage to exterior wall cladding. (Tier 4.8.4.8)	NA
Deterioration in Connections	There shall be no evidence of deterioration, damage or corrosion in any of the connection elements. (Tier 2: Sec. 4.8.4.2)	NA
Drift Isolation	For moment frame buildings of steel or concrete, panel connections shall be detailed to accommodate a story drift ratio of 0.02. Panel connection detailing for a story drift ratio of 0.01 is permitted where only the Basic nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.3)	NA
Glazing	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall be laminated, annealed, or heat strengthened safety glass that will remain in the frame when cracked (Tier 2: Sec. 4.8.4.9)	NA
Inserts	Where inserts are used in concrete connections, the inserts shall be anchored to reinforcing steel or other positive anchorage. (Tier 2: Sec. 4.8.4.6)	NA
Multi-Story Panels Drift	For multi-story panels attached at each floor level, panel connections shall be detailed to accommodate a story drift ratio of 0.02 and 0.01 for immediate occupancy. Panel connection detailing for a story drift ratio (Tier 2: Sec. 4.8.4.4)	NA
Panel Connections	Exterior cladding panels shall be anchored with a minimum of 2 connections for each wall panel for Life Safety and 4 connections for Immediate Occupancy. (Tier 2: Sec. 4.8.4.6)	NA

Hazardous Materials Storage and Distribution

Toxic Substances Lateral Bracing and Anchorage	Toxic and hazardous substances stored in breakable containers shall be restrained from falling by latched doors, shelf lips, wires, or other methods. (Tier 2: Sec 4.8.15.1)	C

Light Fixtures

Emergency Lighting Anchorage	Emergency lighting shall be anchored or braced to prevent falling or swaying during an earthquake. (Tier 2: Sec. 4.8.3.2)	C
Independent Support	Light fixtures in suspended grid ceilings shall be supported independently of the ceiling suspension system by a minimum of two wires at diagonally opposite corners of the fixtures (Tier 2: Sec. 4.8.3.1)	NA

Masonry Chimneys

Urm Chimneys	No reinforced masonry chimney shall extend above the roof surface more than twice the least dimension of the chimney. A height above the roof surface of up to three times the least dimension of the chimney is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.9.1)	NA

Masonry Veneer

Deterioration	There shall be no evidence of deterioration, damage or corrosion in any of the connection elements. (Tier 2: Sec. 4.8.5.4)	NA
Shelf Angles	Masonry veneer shall be supported by shelf angles or other elements at each floor 30 feet or more above ground for Life Safety and at each floor above the first floor for Immediate Occupancy. (Tier 2: Sec. 4.8.5.1)	NA
Ties	Masonry veneer shall be connected to the back-up with corrosion-resistant ties. The ties shall have a spacing equal to or less than 24 inches with a minimum of one tie for every 2-2/3 square feet. A spacing of up to 36 inches is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2. (Tier 2: Sec. 4.8.5.2)	NA
Weakened Planes	Masonry veneer shall be anchored to the back-up adjacent to weakened planes, such as at the locations of flashing. (Tier 2: Sec. 4.8.5.3)	NA

Mechanical and Electrical Equipment

Attached Equipment	Equipment weighting over 20 lb that is attached to ceilings, walls, or other supports 4 feet above the floor level shall be mounted. (Tier 2: Sec 4.8.12.2)	C

		Compliance
Deterioration	There shall be no evidence of deterioration, damage, or corrosion in any of the anchorage or supports of mechanical or electrical equipment. (Tier 2: Sec. 4.8.12.3)	C
Emergency Power Mounting	Equipment used as part of an emergency power system shall be mounted to maintain continued operation after an earthquake. (Tier 2: Sec. 4.8.12.1)	C
Hazardous Material Equipment	HVAC or other equipment containing hazardous material shall not have damaged supply lines or unbraced isolation supports. (Tier 2: Sec. 4.8.12.2)	C
Parapets, Cornices, Ornamentation, and Appendages		
Canopies	Canopies located at building exits shall be anchored to the structural framing at a spacing of 6 feet or less. An anchorage spacing of up to 10 feet is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.8.2)	NA
Urm Parapets	There shall be no laterally unsupported unreinforced masonry parapets or cornices with height-to-thickness ratios greater than 1.5. A height-to-thickness ratio of up to 2.5 is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2. (Tier 2: Sec. 4.8.8.1)	NA
Partitions		
Unreinforced Masonry Bracing	Unreinforced masonry or hollow clay tile partitions shall be braded at a spacing equal to or less than 10 feet in levels of low or moderate seismicity and 6 feet in levels of high seismicity. (Tier 2: Sec. 4.8.1.1)	NA
Piping		
Fire Suppression Piping	Fire suppression piping shall be anchored and braced in accordance with NFPA-13 (NFPA, 1996). (Tier 2: Sec. 4.8.13.1)	NC
Flexible Couplings	Fluid, gas, and fire suppression piping shall have flexible couplings. (Tier 2: Sec. 4.8.13.2)	NC

Compliance

Stairs

Stair Details	In moment frame structures, the connection between the stairs and the structure shall not rely on shallow anchors in concrete. Alternatively, the stair details shall be capable of accommodating the drift calculated using the Quick Check procedure of Section 3.5.3.1 without including tension in the anchors. (Tier 2: Sec. 4.8.10.2)	NA
Urm Walls	Walls around stair enclosures shall not consist of unbraced hollow clay tile or unreinforced masonry with a height-to-thickness ratio greater than 12-to-1. A height-to-thickness ratio of up to 15-to-1 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.10.1)	NA

Compliance

3.9.1S Supplemental Nonstructural Component Checklist

Building Contents and Furnishing		
Access Floor Anchorage	Access floors over 9 inches in height shall be braced. (Tier 2: Sec. 4.8.11.4)	NA
Drawers	Cabinet drawers shall have latches to keep them closed during an earthquake (Tier 2: Sec 4.8.11.3)	NA
Equipment Bracing and Anchorage to Access Floors	Equipment and computers supported on access floor systems shall be either attached to the structure or fastened to a laterally braced floor system. (Tier 2: Sec. 4.8.11.5)	NA
File Cabinets	File cabinets arranged in groups shall be attached to one another. (Tier 2: Sec. 4.8.11.2)	NA
File Cabinets Attachments, Doors, and Drawer Locks	Cabinet doors and drawers shall have latches to keep them closed during an earthquake. (Tier 2: Sec. 4.8.11.3)	NA
Ceiling Systems		
Edges Separation	The edges of integrated suspended ceilings shall be separated from enclosing walls by a minimum of 1/2 inch. (Tier 2: Sec. 4.8.2.5)	NA
Seismic Joint	The ceiling system shall not extend continuously across any seismic joint. (Tier 2: Sec. 4.8.2.6)	NA
Cladding and Glazing		
Safety Glass	All exterior glazing shall be laminated, annealed or laminated heat-strengthened safety glass or other glazing system that will remain in the frame when glass is cracked. (Tier 2: Sec. 4.8.4.9)	NA
Concrete Block and Masonry Back-Up Systems		
Anchorage	Back-up shall have a positive anchorage to the structural framing at a spacing equal to or less than 4 feet along the floors and roof. (Tier 2: Sec. 4.8.7.1)	NA
Concrete Block	Concrete block shall qualify as reinforced masonry (Tier 2: Sec. 4.8.7.1)	NA

		Compliance
Urm Back-Up	There shall be no unreinforced masonry back-up. (Tier 2: Sec. 4.8.7.2)	NA
Ducts		
Duct Bracing	Rectangular ductwork exceeding 6 square feet in cross-sectional area, and round ducts exceeding 28 inches in diameter, shall be braced. Maximum spacing of transverse bracing shall not exceed 30 feet. Maximum spacing of longitudinal bracing shall not exceed 60 feet. Intermediate supports shall not be considered part of the lateral-force resisting system. (Tier 2: Sec. 4.8.14.2)	C
Duct Supports	Ducts shall not be supported by piping or electrical conduit. (Tier 2: Sec. 4.8.14.3)	C
Stair and Smoke Duct Bracing	Stair pressurization and smoke flow of gas and high temperature energy in the event of an earthquake-induced failure. (Tier 2: Sec. 4.8.13.4)	NA
Elevators		
Brackets	The brackets that tie the car rails and the counterweight rail to the building structure shall be sized in accordance with ASME A17.1. (Tier 2: Sec. 4.8.16.7)	NA
Counterweight Rails	All counterweight rails and divider beams shall be sized in accordance with ASME A17.1. (Tier 2: Sec. 4.8.16.6)	NA
Go-Slow Elevators	The building shall have a go-slow elevator system. (Tier 2: Sec. 4.8.16.9)	NA
Retainer Guards	Cable retainer guards on sheaves and drums shall be present to inhibit the displacement of cables. (Tier 2: Sec. 4.8.16.4)	NA
Retainer Plate	A retainer plate shall be present at the top and bottom of both car and counterweight. (Tier 2: Sec. 4.8.16.5)	NA
Seismic Switch	All elevators shall be equipped with seismic switches that will terminate operations when the ground motion exceeds 0.10g. (Tier 2: Sec. 4.8.16.2)	NA
Shaft Walls	All elevator shaft walls shall be anchored and reinforced to prevent toppling into the shaft during strong shaking. (Tier 2: Sec. 4.8.16.3)	NA

		Compliance
Spreader Bracket	Spreader brackets shall not be used to resist seismic forces. (Tier 2: Sec. 4.8.16.8)	NA
Support System	All elements of the elevator system shall be anchored. (Tier 2: Sec. 4.8.16.1)	NA
Hazardous Materials Storage and Distribution		
Gas Cylinder Restraints	Compressed gas-cylinders shall be restrained. (Tier 2: Sec. 4.8.15.2)	NA
Hazardous Materials Shutoff Valves	Piping containing hazardous materials shall have shut-off valves or other devices to prevent major spills or leaks. (Tier 2: Sec. 4.8.16.4)	NA
Light Fixtures		
Lens Covers	Lens covers on light fixtures shall be attached or supplied with safety devices. (Tier 2: Sec. 4.8.3.4)	C
Pendant Supports	Light fixtures on pendant supports shall be attached at a spacing equal to or less than 6 feet and, if rigidly, supported, shall be free to move with the structure to which they are attached without damaging adjoining materials. (Tier 2: Sec. 4.8.3.3)	C
Masonry Veneer		
Mortar	The mortar in masonry veneer shall not be easily scraped away from the joints by hand with a metal tool, and there shall not be significant areas of eroded mortar. (Tier 2: Sec. 4.8.5.5)	NA
Stone Cracks	There shall be no visible cracks or signs of visible distortion in the stone. (Tier 2: Sec. 4.8.5.7)	NA
Weep Holes	In veneer braced by stud walls, functioning weep holes and base flashing shall be present. (Tier 2: Sec. 4.8.5.6)	NA
Mechanical and Electrical Equipment		
Door Drift Allowance	Mechanically operated doors shall be detailed to operate at a story drift ratio of 0.01. (Tier 2: Sec. 4.8.12.8)	NA
Electrical Equipment Bracing	Electrical equipment and associated wiring shall be laterally braced to the structural system. (Tier 2: Sec. 4.8.12.7)	NC

		Compliance
Heavy Equipment Anchorage	Equipment weighing over 100 pounds shall be anchored to the structure or foundation. (Tier 2: Sec. 4.8.12.6)	C
Vibration Isolators Restrained	Equipment mounted on vibration isolators shall be equipped with restraints or snubbers. (Tier 2: Sec. 4.8.12.4)	NA

Metal Stud Back-Up Systems

Openings	Steel studs shall frame window and door openings. (Tier 2: Sec. 4.8.6.2)	C
Stud Tracks	Stud tracks shall be fastened to structural framing at a spacing equal to or less than 24 inches on center. (Tier 2: Sec. 4.8.6.1)	C

Parapets, Cornices, Ornamentation, and Appendages

Appendages	Cornices, parapets, signs, and other appendages that extend above the highest anchorage level or cantilever from exterior wall faces and other exterior wall ornamentation shall be reinforced and anchored to the structural system at a spacing equal to or less than 10 feet for Life Safety and 6 feet for Immediate Occupancy. This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. f4.8.8.4)	NA
Concrete Parapets	Concrete parapets with height-to-thickness ratios greater than 2.5 shall have vertical reinforcement. (Tier 2: Sec. 4.8.8.3)	NA

Partitions

Drift Allowance	Rigid cementitious partitions shall be detailed to accommodate a drift ratio of 0.02 in steel moment frame, concrete moment frame, and wood frame buildings. Rigid cementitious partitions shall be detailed to accommodate a drift ratio of 0.005 in other buildings. (Tier 2: Sec. 4.8.1.2)	NA
Lateral Bracing for Tops	The tops of framed or panelized partitions that only extend to the ceiling line shall have lateral bracing to the building structure at a spacing equal to or less than 6 feet. (Tier 2: Sec. 4.8.1.4)	NA
Seismic Control Joints	Partitions at structural separations shall have seismic or control joints. (Tier 2: Sec. 4.8.1.3)	NA

		Compliance
Piping		
C-Clamps	One-sided C-clamps that support piping greater than 2.5 inches in diameter shall be restrained. (Tier 2: Sec. 4.8.13.5)	C
Fluid and Gas Piping Anchorage and Bracing	Fluid and gas piping shall be anchored and braced to the structure to prevent breakage in piping. (Tier 2: Sec 4.8.13.3)	C
Shut-Off Valves	Shut-off devices shall be present at building utility interfaces to shut off the flow of gas and high-temperature energy in the event of earthquake-induced failure. (Tier 2: Sec. 4.8.13.4)	C

Compliance

3.9.2 Intermediate Nonstructural Component Checklist

Ceiling Systems		
Integrated Ceilings	Integrated suspended ceilings at exists and corridors or weighing more than 2 pounds per square foot shall be laterally restrained with a minimum of four diagonal wires or rigid members attached to the structure above at a spacing equal to or less than 12 feet. (Tier 2: Sec. 4.8.2.3)	NA
Lay-In Tiles	Lay-in tiles used in ceiling panels located at exits and corridors shall be secured with clips. (Tier 2: Sec. 4.8.2.2)	NA
Suspended Lath and Plaster	Ceilings consisting of suspended lath and plaster or gypsum board shall be attached to resist seismic forced for every 12 square feet of area. (Tier 2: Sec. 4.8.2.4)	NA
Cladding and Glazing		
Glazing	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall have safety glazing. Such glazing located over 10 feet above an exterior walking surface shall be laminated, annealed, or laminated heat strengthened safety glass that will remain in the frame when cracked (Tier 2: Sec. 4.8.4.8)	NA
Laminated Safety Glass	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall have safety glazing. Such glazing located over 10 feet above an exterior walking surface shall be laminated annealed or laminated heat-strengthened safety glass or other glazing system that will remain in the frame when glass is cracked. (Tier 2: Sec. 4.8.4.8)	NA
Ducts		
Stair and Smoke Duct Bracing	Stair pressurization and smoke control ducts shall be braced and shall have flexible connections at seismic joints. (Tier 2: Sec. 4.8.14.1)	NA
Light Fixtures		
Independent Support	Light fixtures in suspended grid ceilings shall be supported independently of the ceiling suspension system by a minimum of two wires at diagonally opposite. (Tier 2: Sec. 4.8.3.2)	NA

		Compliance
Masonry Chimneys		
Anchorage	Masonry chimneys shall be anchored at each floor level and the roof. (Tier 2: Sec. 4.8.9.2)This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. 4.8.8.4)	NA
Mechanical and Electrical Equipment		
Vibration Isolators Restrained	Equipment mounted on vibration isolators shall be equipped with restraints or snubbers. (Tier 2: Sec. 4.8.12.4)	NA
Parapets, Cornices, Ornamentation, and Appendages		
Appendages	Cornices, parapets, signs, and other appendages that extend above the highest point of anchorage to the structure or cantilever from exterior wall faces and other exterior wall ornamentation shall be reinforced and anchored to the structural system at a spacing equal to or less than 10 feet for Life Safety and 6 feet for Immediate Occupancy. This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. 4.8.8.4)	NA
Concrete Parapets	Concrete parapets with height-to-thickness ratios greater than 2.5 shall have vertical reinforcement. (Tier 2: Sec. 4.8.8.3)	NA

ASCE31 Tier 1 Seismic Screening
Structural and Non-Structural Findings

Blower Building

3.7.13 Reinforced Masonry Bearing Walls with Flexible Diaphragms

Building System

		Compliance
ADJACENT BUILDINGS	The clear distance between the building being evaluated and any adjacent building shall be greater than 4 percent of the height of the shorter building for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.1.2)	C
DETERIORATION OF WOOD	There shall be no signs of decay, shrinkage, splitting, fire damage, or sagging in any of the wood members, and none of the metal connection hardware shall be deteriorated, broken, or loose. (Tier 2: Sec. 4.3.3.1)	C
GEOMETRY	There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30 percent in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines. (Tier 2: Sec. 4.3.2.3)	NA
LOAD PATH	The structure shall contain a minimum of one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)	C
MASONRY JOINTS	The mortar shall not be easily scraped away from the joints by hand with a metal tool, and there shall be no areas of eroded mortar. (Tier 2: Sec. 4.3.3.8)	C
MASONRY UNITS	There shall be no visible deterioration of masonry units. (Tier 2: Sec. 4.3.3.7)	C
MASS	There shall be no change in effective mass more than 50 percent from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses, and mezzanines need not be considered. (Tier 2: Sec. 4.3.2.5)	NA
MEZZANINES	Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.3)	NA

		Compliance
REINFORCED MASONRY WALL CRACKS	All existing diagonal cracks in wall elements shall be less than 1/8 inch for Life Safety and 1/16 inch for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern. (Tier 2: Sec. 4.3.3.10)	C
SOFT STORY	The stiffness of the lateral-force-resisting system in any story shall not be less than 70 percent of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80 percent of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2)	NA
VERTICAL DISCONTINUITIES	All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)	C
WEAK STORY	The strength of the lateral-force-resisting system in any story shall not be less than 80 percent of the strength in an adjacent story, above or below, for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)	NA

Connections

FOUNDATION DOWELS	Wall reinforcement shall be doweled into the foundation for Life Safety, and the dowels shall be able to develop the lesser of the strength of the walls or the uplift capacity of the foundation for Immediate Occupancy. (Tier 2: Sec. 4.6.3.5)	C
GIRDER/COLUMN CONNECTION	There shall be a positive connection utilizing plates, connection hardware, or straps between the girder and the column support. (Tier 2: Sec. 4.6.4.1)	C
TRANSFER TO SHEAR WALLS	Diaphragms shall be connected for transfer of loads to the shear walls for Life Safety and the connections shall be able to develop the lesser of the shear strength of the walls or diaphragms for Immediate Occupancy. (Tier 2: Sec. 4.6.2.1)	C
WALL ANCHORAGE	Exterior concrete or masonry walls that are dependent on the diaphragm for lateral support shall be anchored for out-of-plane forces at each diaphragm level with steel anchors, reinforcing dowels, or straps that are developed into the diaphragm. Connections shall have adequate strength to resist the connection force calculated in the Quick Check procedure of Section 3.5.3.7. (Tier 2: Sec. 4.6.1.1)	C

		Compliance
WOOD LEDGERS	The connection between the wall panels and the diaphragm shall not induce cross-grain bending or tension in the wood ledgers. (Tier 2: Sec. 4.6.1.2)	C

Lateral Force Resisting System

REDUNDANCY	The number of lines of shear walls in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.1.1)	C
REINFORCING STEEL	The total vertical and horizontal reinforcing steel ratio in reinforced masonry walls shall be greater than 0.002 for Life Safety and Immediate Occupancy of the wall with the minimum of 0.0007 for Life Safety and Immediate Occupancy in either of the two directions; the spacing of reinforcing steel shall be less than 48 inches for Life Safety and Immediate Occupancy; and all vertical bars shall extend to the top of the walls. (Tier 2: Sec. 4.4.2.4.2)	C
SHEAR STRESS CHECK	The shear stress in the reinforced masonry shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 70 psi for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.4.1)	C

Compliance

3.7.13S Reinforced Masonry Bearing Walls with Flexible Diaphragms

Connections

STIFFNESS OF WALL ANCHORS	Anchors of concrete or masonry walls to wood structural elements shall be installed taut and shall be stiff enough to limit the relative movement between the wall and the diaphragm to no greater than 1/8 inch prior to engagement of the anchors. (Tier 2: Sec. 4.6.1.4)	C

Diaphragms

CROSS TIES	There shall be continuous cross ties between diaphragm chords. (Tier 2: Sec. 4.5.1.2)	C
DIAPHRAGM REINFORCEMENT AT OPENINGS	There shall be reinforcing around all diaphragm openings larger than 50 percent of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)	C
NON-CONCRETE FILLED DIAPHRAGMS	Untopped metal deck diaphragms or metal deck diaphragms with fill other than concrete shall consist of horizontal spans of less than 40 feet and shall have span/depth ratios less than 4-to-l. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.3.1)	NA
OPENINGS AT EXTERIOR MASONRY SHEAR WALLS	Diaphragm openings immediately adjacent to exterior masonry shear walls shall not be greater than 8 feet long for Life Safety and 4 feet long for Immediate Occupancy. (Tier 2: Sec. 4.5.1.6)	NA
OPENINGS AT SHEAR WALLS	Diaphragm openings immediately adjacent to the shear walls shall be less than 25 percent of the wall length for Life Safety and 15 percent of the wall length for Immediate Occupancy. (Tier 2: Sec. 4.5.1.4)	C
OTHER DIAPHRAGMS	The diaphragm shall not consist of a system other than wood, metal deck, concrete, or horizontal bracing. (Tier 2: Sec. 4.5.7.1)	C
PLAN IRREGULARITIES	There shall be tensile capacity to develop the strength of the diaphragm at re-entrant comers or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)	NA
SPANS	All wood diaphragms with spans greater than 24 feet for Life Safety and 12 feet for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing. (Tier 2: Sec. 4.5.2.2)	C

		Compliance
STRAIGHT SHEATHING	All straight sheathed diaphragms shall have aspect ratios less than 2- to-1 for Life Safety and 1-to-1 for Immediate Occupancy in the direction being considered. (Tier 2: Sec. 4.5.2.1)	C
UNBLOCKED DIAPHRAGMS	All diagonally sheathed or unblocked wood structural panel diaphragms shall have horizontal spans less than 40 feet for Life Safety and 30 feet for Immediate Occupancy and shall have aspect ratios less than or equal to 4-to-1 for Life Safety and 3-to-l for Immediate Occupancy. (Tier 2: Sec. 4.5.2.3)	NA

Lateral Force Resisting System

PROPORTIONS	The height-to-thickness ratio of the shear walls at each story shall be less than 30. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.4.4)	C
REINFORCING AT OPENINGS	All wall openings that interrupt rebar shall have trim reinforcing on all sides. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.4.3)	C

Blower Building

Compliance

3.9.1 Basic Nonstructural Component Checklist

Building Contents and Furnishing

Tall Narrow Contents	Contents over 4 feet in height with a height-to-depth or height-to-width ratio greater than 3-to-1 shall be anchored to the floor slab or adjacent structural walls. A height-to-depth or height-to-width ratio of up to 4-to-1 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.11.1)	C

Ceiling Systems

Integrated Ceilings	Integrated suspended ceilings at exits and corridors or weighing more than 2 lb/ft^2 shall be laterally restrained by a minimum of 4 diagonal wires or rigid members attached to the structure above at a spacing equal to or less than 12 ft (Tier 2: Sec. 4.8.2.1)	NA
Lay-In Tiles	Lay-in tiles used in ceiling panels located at exits and corridors shall be secured with clips. (Tier 2: Sec. 4.8.2.2)	NA
Supporting Partitions	The integrated suspended ceiling system shall not be used to laterally support the tops of gypsum board, masonry, or hollow clay tile partitions. Gypsum board partitions need not be evaluated where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.2.1)	NA
Suspended Lath and Plaster	Ceilings consisting of suspended lath and plaster or gypsum board shall be attached for each 10 square feet of area (Tier 2: Sec. 4.8.2.4)	NA

Cladding and Glazing

Bearing Connections	Where bearing connections are required, there shall be a minimum of two bearing connections for each wall panel. (Tier 2: Sec. 4.8.4.5)	NA
Cladding Anchorage	Cladding components weighing more than 10 psf shall be mechanically anchored to the exterior wall framing at a spacing equal to or less than 4 feet. A spacing of up to 6 feet is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2 (Tier 2: Sec. 4.8.4.1)	NA
Cladding Isolation	For moment frame buildings of steel or concrete, panel connections shall be detailed to accommodate a drift ratio of 0.02 for Life Safety and 0.01for Immediate Occupancy (Tier 2: Sec. 4.8.4.2)	NA

		Compliance
Connections Out of Plane	Exterior cladding panels shall be anchored out-of-plane with a minimum of 4 connections for each wall panel. Two connections per wall panel are permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.7)	NA
Damage	There shall be no damage to exterior wall cladding. (Tier 4.8.4.8)	NA
Deterioration in Connections	There shall be no evidence of deterioration, damage or corrosion in any of the connection elements. (Tier 2: Sec. 4.8.4.2)	NA
Drift Isolation	For moment frame buildings of steel or concrete, panel connections shall be detailed to accommodate a story drift ratio of 0.02. Panel connection detailing for a story drift ratio of 0.01 is permitted where only the Basic nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.3)	NA
Glazing	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall be laminated, annealed, or heat strengthened safety glass that will remain in the frame when cracked (Tier 2: Sec. 4.8.4.9)	NA
Inserts	Where inserts are used in concrete connections, the inserts shall be anchored to reinforcing steel or other positive anchorage. (Tier 2: Sec. 4.8.4.6)	NA
Multi-Story Panels Drift	For multi-story panels attached at each floor level, panel connections shall be detailed to accommodate a story drift ratio of 0.02 and 0.01 for immediate occupancy. Panel connection detailing for a story drift ratio (Tier 2: Sec. 4.8.4.4)	NA
Panel Connections	Exterior cladding panels shall be anchored with a minimum of 2 connections for each wall panel for Life Safety and 4 connections for Immediate Occupancy. (Tier 2: Sec. 4.8.4.6)	NA

Hazardous Materials Storage and Distribution

Toxic Substances Lateral Bracing and Anchorage	Toxic and hazardous substances stored in breakable containers shall be restrained from falling by latched doors, shelf lips, wires, or other methods. (Tier 2: Sec 4.8.15.1)	NA

Blower Building

		Compliance
Light Fixtures		
Emergency Lighting Anchorage	Emergency lighting shall be anchored or braced to prevent falling or swaying during an earthquake. (Tier 2: Sec. 4.8.3.2)	NC
Independent Support	Light fixtures in suspended grid ceilings shall be supported independently of the ceiling suspension system by a minimum of two wires at diagonally opposite corners of the fixtures (Tier 2: Sec. 4.8.3.1)	NA
Masonry Chimneys		
Urm Chimneys	No reinforced masonry chimney shall extend above the roof surface more than twice the least dimension of the chimney. A height above the roof surface of up to three times the least dimension of the chimney is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.9.1)	NA
Masonry Veneer		
Deterioration	There shall be no evidence of deterioration, damage or corrosion in any of the connection elements. (Tier 2: Sec. 4.8.5.4)	NA
Shelf Angles	Masonry veneer shall be supported by shelf angles or other elements at each floor 30 feet or more above ground for Life Safety and at each floor above the first floor for Immediate Occupancy. (Tier 2: Sec. 4.8.5.1)	NA
Ties	Masonry veneer shall be connected to the back-up with corrosion-resistant ties. The ties shall have a spacing equal to or less than 24 inches with a minimum of one tie for every 2-2/3 square feet. A spacing of up to 36 inches is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2. (Tier 2: Sec. 4.8.5.2)	NA
Weakened Planes	Masonry veneer shall be anchored to the back-up adjacent to weakened planes, such as at the locations of flashing. (Tier 2: Sec. 4.8.5.3)	NA
Mechanical and Electrical Equipment		
Attached Equipment	Equipment weighting over 20 lb that is attached to ceilings, walls, or other supports 4 feet above the floor level shall be mounted. (Tier 2: Sec 4.8.12.2)	C

Blower Building

		Compliance
Deterioration	There shall be no evidence of deterioration, damage, or corrosion in any of the anchorage or supports of mechanical or electrical equipment. (Tier 2: Sec. 4.8.12.3)	NC
Emergency Power Mounting	Equipment used as part of an emergency power system shall be mounted to maintain continued operation after an earthquake. (Tier 2: Sec. 4.8.12.1)	C
Hazardous Material Equipment	HVAC or other equipment containing hazardous material shall not have damaged supply lines or unbraced isolation supports. (Tier 2: Sec. 4.8.12.2)	C

Parapets, Cornices, Ornamentation, and Appendages

Canopies	Canopies located at building exits shall be anchored to the structural framing at a spacing of 6 feet or less. An anchorage spacing of up to 10 feet is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.8.2)	NA
Urm Parapets	There shall be no laterally unsupported unreinforced masonry parapets or cornices with height-to-thickness ratios greater than 1.5. A height-to-thickness ratio of up to 2.5 is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2. (Tier 2: Sec. 4.8.8.1)	NA

Partitions

Unreinforced Masonry Bracing	Unreinforced masonry or hollow clay tile partitions shall be braded at a spacing equal to or less than 10 feet in levels of low or moderate seismicity and 6 feet in levels of high seismicity. (Tier 2: Sec. 4.8.1.1)	NA

Piping

Fire Suppression Piping	Fire suppression piping shall be anchored and braced in accordance with NFPA-13 (NFPA, 1996). (Tier 2: Sec. 4.8.13.1)	NC
Flexible Couplings	Fluid, gas, and fire suppression piping shall have flexible couplings. (Tier 2: Sec. 4.8.13.2)	NC

Blower Building

		Compliance
Stairs		
Stair Details	In moment frame structures, the connection between the stairs and the structure shall not rely on shallow anchors in concrete. Alternatively, the stair details shall be capable of accommodating the drift calculated using the Quick Check procedure of Section 3.5.3.1 without including tension in the anchors. (Tier 2: Sec. 4.8.10.2)	NA
Urm Walls	Walls around stair enclosures shall not consist of unbraced hollow clay tile or unreinforced masonry with a height-to-thickness ratio greater than 12-to-1. A height-to-thickness ratio of up to 15-to-1 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.10.1)	NA

Compliance

3.9.1S Supplemental Nonstructural Component Checklist

Building Contents and Furnishing

Access Floor Anchorage	Access floors over 9 inches in height shall be braced. (Tier 2: Sec. 4.8.11.4)	NA
Drawers	Cabinet drawers shall have latches to keep them closed during an earthquake (Tier 2: Sec 4.8.11.3)	NA
Equipment Bracing and Anchorage to Access Floors	Equipment and computers supported on access floor systems shall be either attached to the structure or fastened to a laterally braced floor system. (Tier 2: Sec. 4.8.11.5)	NA
File Cabinets	File cabinets arranged in groups shall be attached to one another. (Tier 2: Sec. 4.8.11.2)	NA
File Cabinets Attachments, Doors, and Drawer Locks	Cabinet doors and drawers shall have latches to keep them closed during an earthquake. (Tier 2: Sec. 4.8.11.3)	NA

Ceiling Systems

Edges Separation	The edges of integrated suspended ceilings shall be separated from enclosing walls by a minimum of 1/2 inch. (Tier 2: Sec. 4.8.2.5)	NA
Seismic Joint	The ceiling system shall not extend continuously across any seismic joint. (Tier 2: Sec. 4.8.2.6)	NA

Cladding and Glazing

Safety Glass	All exterior glazing shall be laminated, annealed or laminated heat-strengthened safety glass or other glazing system that will remain in the frame when glass is cracked. (Tier 2: Sec. 4.8.4.9)	NA

Concrete Block and Masonry Back-Up Systems

Anchorage	Back-up shall have a positive anchorage to the structural framing at a spacing equal to or less than 4 feet along the floors and roof. (Tier 2: Sec. 4.8.7.1)	NA
Concrete Block	Concrete block shall qualify as reinforced masonry (Tier 2: Sec. 4.8.7.1)	NA

		Compliance
Urm Back-Up	There shall be no unreinforced masonry back-up. (Tier 2: Sec. 4.8.7.2)	NA
Ducts		
Duct Bracing	Rectangular ductwork exceeding 6 square feet in cross-sectional area, and round ducts exceeding 28 inches in diameter, shall be braced. Maximum spacing of transverse bracing shall not exceed 30 feet. Maximum spacing of longitudinal bracing shall not exceed 60 feet. Intermediate supports shall not be considered part of the lateral-force resisting system. (Tier 2: Sec. 4.8.14.2)	NA
Duct Supports	Ducts shall not be supported by piping or electrical conduit. (Tier 2: Sec. 4.8.14.3)	NA
Stair and Smoke Duct Bracing	Stair pressurization and smoke flow of gas and high temperature energy in the event of an earthquake-induced failure. (Tier 2: Sec. 4.8.13.4)	NA
Elevators		
Brackets	The brackets that tie the car rails and the counterweight rail to the building structure shall be sized in accordance with ASME A17.1. (Tier 2: Sec. 4.8.16.7)	NA
Counterweight Rails	All counterweight rails and divider beams shall be sized in accordance with ASME A17.1. (Tier 2: Sec. 4.8.16.6)	NA
Go-Slow Elevators	The building shall have a go-slow elevator system. (Tier 2: Sec. 4.8.16.9)	NA
Retainer Guards	Cable retainer guards on sheaves and drums shall be present to inhibit the displacement of cables. (Tier 2: Sec. 4.8.16.4)	NA
Retainer Plate	A retainer plate shall be present at the top and bottom of both car and counterweight. (Tier 2: Sec. 4.8.16.5)	NA
Seismic Switch	All elevators shall be equipped with seismic switches that will terminate operations when the ground motion exceeds 0.10g. (Tier 2: Sec. 4.8.16.2)	NA
Shaft Walls	All elevator shaft walls shall be anchored and reinforced to prevent toppling into the shaft during strong shaking. (Tier 2: Sec. 4.8.16.3)	NA

		Compliance
Spreader Bracket	Spreader brackets shall not be used to resist seismic forces. (Tier 2: Sec. 4.8.16.8)	NA
Support System	All elements of the elevator system shall be anchored. (Tier 2: Sec. 4.8.16.1)	NA
Hazardous Materials Storage and Distribution		
Gas Cylinder Restraints	Compressed gas-cylinders shall be restrained. (Tier 2: Sec. 4.8.15.2)	NA
Hazardous Materials Shutoff Valves	Piping containing hazardous materials shall have shut-off valves or other devices to prevent major spills or leaks. (Tier 2: Sec. 4.8.16.4)	NA
Light Fixtures		
Lens Covers	Lens covers on light fixtures shall be attached or supplied with safety devices. (Tier 2: Sec. 4.8.3.4)	C
Pendant Supports	Light fixtures on pendant supports shall be attached at a spacing equal to or less than 6 feet and, if rigidly, supported, shall be free to move with the structure to which they are attached without damaging adjoining materials. (Tier 2: Sec. 4.8.3.3)	NC
Masonry Veneer		
Mortar	The mortar in masonry veneer shall not be easily scraped away from the joints by hand with a metal tool, and there shall not be significant areas of eroded mortar. (Tier 2: Sec. 4.8.5.5)	NA
Stone Cracks	There shall be no visible cracks or signs of visible distortion in the stone. (Tier 2: Sec. 4.8.5.7)	NA
Weep Holes	In veneer braced by stud walls, functioning weep holes and base flashing shall be present. (Tier 2: Sec. 4.8.5.6)	NA
Mechanical and Electrical Equipment		
Door Drift Allowance	Mechanically operated doors shall be detailed to operate at a story drift ratio of 0.01. (Tier 2: Sec. 4.8.12.8)	NA
Electrical Equipment Bracing	Electrical equipment and associated wiring shall be laterally braced to the structural system. (Tier 2: Sec. 4.8.12.7)	NC

		Compliance
Heavy Equipment Anchorage	Equipment weighing over 100 pounds shall be anchored to the structure or foundation. (Tier 2: Sec. 4.8.12.6)	C
Vibration Isolators Restrained	Equipment mounted on vibration isolators shall be equipped with restraints or snubbers. (Tier 2: Sec. 4.8.12.4)	NA

Metal Stud Back-Up Systems

Openings	Steel studs shall frame window and door openings. (Tier 2: Sec. 4.8.6.2)	C
Stud Tracks	Stud tracks shall be fastened to structural framing at a spacing equal to or less than 24 inches on center. (Tier 2: Sec. 4.8.6.1)	C

Parapets, Cornices, Ornamentation, and Appendages

Appendages	Cornices, parapets, signs, and other appendages that extend above the highest anchorage level or cantilever from exterior wall faces and other exterior wall ornamentation shall be reinforced and anchored to the structural system at a spacing equal to or less than 10 feet for Life Safety and 6 feet for Immediate Occupancy. This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. f4.8.8.4)	NA
Concrete Parapets	Concrete parapets with height-to-thickness ratios greater than 2.5 shall have vertical reinforcement. (Tier 2: Sec. 4.8.8.3)	NA

Partitions

Drift Allowance	Rigid cementitious partitions shall be detailed to accommodate a drift ratio of 0.02 in steel moment frame, concrete moment frame, and wood frame buildings. Rigid cementitious partitions shall be detailed to accommodate a drift ratio of 0.005 in other buildings. (Tier 2: Sec. 4.8.1.2)	NA
Lateral Bracing for Tops	The tops of framed or panelized partitions that only extend to the ceiling line shall have lateral bracing to the building structure at a spacing equal to or less than 6 feet. (Tier 2: Sec. 4.8.1.4)	NA
Seismic Control Joints	Partitions at structural separations shall have seismic or control joints. (Tier 2: Sec. 4.8.1.3)	NA

Blower Building

		Compliance
Piping		
C-Clamps	One-sided C-clamps that support piping greater than 2.5 inches in diameter shall be restrained. (Tier 2: Sec. 4.8.13.5)	C
Fluid and Gas Piping Anchorage and Bracing	Fluid and gas piping shall be anchored and braced to the structure to prevent breakage in piping. (Tier 2: Sec 4.8.13.3)	C
Shut-Off Valves	Shut-off devices shall be present at building utility interfaces to shut off the flow of gas and high-temperature energy in the event of earthquake-induced failure. (Tier 2: Sec. 4.8.13.4)	C

		Compliance

3.9.2 Intermediate Nonstructural Component Checklist

Ceiling Systems

Integrated Ceilings	Integrated suspended ceilings at exists and corridors or weighing more than 2 pounds per square foot shall be laterally restrained with a minimum of four diagonal wires or rigid members attached to the structure above at a spacing equal to or less than 12 feet. (Tier 2: Sec. 4.8.2.3)	NA
Lay-In Tiles	Lay-in tiles used in ceiling panels located at exits and corridors shall be secured with clips. (Tier 2: Sec. 4.8.2.2)	NA
Suspended Lath and Plaster	Ceilings consisting of suspended lath and plaster or gypsum board shall be attached to resist seismic forced for every 12 square feet of area. (Tier 2: Sec. 4.8.2.4)	NA

Cladding and Glazing

Glazing	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall have safety glazing. Such glazing located over 10 feet above an exterior walking surface shall be laminated, annealed, or laminated heat strengthened safety glass that will remain in the frame when cracked (Tier 2: Sec. 4.8.4.8)	NA
Laminated Safety Glass	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall have safety glazing. Such glazing located over 10 feet above an exterior walking surface shall be laminated annealed or laminated heat-strengthened safety glass or other glazing system that will remain in the frame when glass is cracked. (Tier 2: Sec. 4.8.4.8)	NA

Ducts

Stair and Smoke Duct Bracing	Stair pressurization and smoke control ducts shall be braced and shall have flexible connections at seismic joints. (Tier 2: Sec. 4.8.14.1)	NA

Light Fixtures

Independent Support	Light fixtures in suspended grid ceilings shall be supported independently of the ceiling suspension system by a minimum of two wires at diagonally opposite. (Tier 2: Sec. 4.8.3.2)	NA

		Compliance
Masonry Chimneys		
Anchorage	Masonry chimneys shall be anchored at each floor level and the roof. (Tier 2: Sec. 4.8.9.2)This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. 4.8.8.4)	NA
Mechanical and Electrical Equipment		
Vibration Isolators Restrained	Equipment mounted on vibration isolators shall be equipped with restraints or snubbers. (Tier 2: Sec. 4.8.12.4)	NA
Parapets, Cornices, Ornamentation, and Appendages		
Appendages	Cornices, parapets, signs, and other appendages that extend above the highest point of anchorage to the structure or cantilever from exterior wall faces and other exterior wall ornamentation shall be reinforced and anchored to the structural system at a spacing equal to or less than 10 feet for Life Safety and 6 feet for Immediate Occupancy. This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. 4.8.8.4)	NA
Concrete Parapets	Concrete parapets with height-to-thickness ratios greater than 2.5 shall have vertical reinforcement. (Tier 2: Sec. 4.8.8.3)	NA

ASCE31 Tier 1 Seismic Screening
Structural and Non-Structural Findings

North Area Electrical Building

3.7.9 Concrete Shear Walls with Stiff Diaphragms

Building System

		Compliance
CONCRETE WALL CRACKS	All existing diagonal cracks in wall elements shall be less than 1/8 inch for Life Safety and 1116 inch for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern. (Tier 2: Sec. 4.3.3.9)	C
DETERIORATION OF CONCRETE	There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting elements. (Tier 2: Sec. 4.3.3.4)	C
GEOMETRY	There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30 percent in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines. (Tier 2: Sec. 4.3.2.3)	C
LOAD PATH	The structure shall contain a minimum of one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)	C
MASS	There shall be no change in effective mass more than 50 percent from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses, and mezzanines need not be considered. (Tier 2: Sec. 4.3.2.5)	NA
MEZZANINES	Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.3)	NA
POST-TENSIONING ANCHORS	There shall be no evidence of corrosion or spalling in the vicinity of post-tensioning or end fittings. Coil anchors shall not have been used. (Tier 2: Sec. 4.3.3.5)	NA

		Compliance
SOFT STORY	The stiffness of the lateral-force-resisting system in any story shall not be less than 70 percent of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80 percent of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2)	NA
TORSION	The estimated distance bt':tween the story center of mass and the story center of rigidity shall be less than 20 percent of the building width in either plan dimension for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.6)	C
VERTICAL DISCONTINUITIES	All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)	C
WEAK STORY	The strength of the lateral-force-resisting system in any story shall not be less than 80 percent of the strength in an adjacent story, above or below, for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)	NA

Connections

FOUNDATION DOWELS	Wall reinforcement shall be doweled into the foundation for Life Safety, and the dowels shall be able to develop the lesser of the strength of the walls or the uplift capacity of the foundation for Immediate Occupancy. (Tier 2: Sec. 4.6.3.5)	C
TRANSFER TO SHEAR WALLS	Diaphragms shall be connected for transfer of loads to the shear walls for Life Safety and the connections shall be able to develop the lesser of the shear strength of the walls or diaphragms for Immediate Occupancy. (Tier 2: Sec. 4.6.2.1)	C

Lateral Force Resisting System

COMPLETE FRAMES	Steel or concrete frames classified as secondary components shall form a complete vertical-load-carrying system. (Tier 2: Sec. 4.4.1.6.1)	NA
REDUNDANCY	The number of lines of shear walls in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.1.1)	C

North Area Electrical Building

		Compliance
REINFORCING STEEL	The ratio of reinforcing steel area to gross concrete area shall be not less than 0.0015 in the vertical direction and 0.0025 in the horizontal direction for Life Safety and Immediate Occupancy. The spacing of reinforcing steel shall be equal to or less than 18 inches for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.2.2)	C
SHEAR STRESS CHECK	The shear stress in the concrete shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than the greater of 100 psi or 2 sqrt(f’c) for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.2.1)	C

Compliance

3.7.9S Concrete Shear Walls with Stiff Diaphragms

Connections

UPLIFT AT PILE CAPS	Pile caps shall have top reinforcement and piles shall be anchored to the pile caps for Life Safety, and the pile cap reinforcement and pile anchorage shall be able to develop the tensile capacity of the piles for Immediate Occupancy. (Tier 2: Sec. 4.6.3.10)	NA

Diaphragms

DIAPHRAGM CONTINUITY	The diaphragms shall not be composed of split-level floors and shall not have expansion joints. (Tier 2: Sec. 4.5.1.1)	C
DIAPHRAGM REINFORCEMENT AT OPENINGS	There shall be reinforcing around all diaphragm openings larger than 50 percent of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)	NA
OPENINGS AT SHEAR WALLS	Diaphragm openings immediately adjacent to the shear walls shall be less than 25 percent of the wall length for Life Safety and 15 percent of the wall length for Immediate Occupancy. (Tier 2: Sec. 4.5.1.4)	NA
PLAN IRREGULARITIES	There shall be tensile capacity to develop the strength of the diaphragm at re-entrant corners or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)	NA

Lateral Force Resisting System

CONFINEMENT REINFORCING	For shear walls with aspect ratios greater than 2-to-1, the boundary elements shall be confined with spirals or ties with spacing less than 8db This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.5)	NA
COUPLING BEAMS	The stirrups in coupling beams over means of egress shall be spaced at or less than d/2 and shall be anchored into the confined core of the beam with hooks of 1350 or more for Life Safety. All coupling beams shall comply with the requirements above and shall have the capacity in shear to develop the uplift capacity of the adjacent wall for Immediate Occupancy. (Tier 2: Sec. 4.4.2.2.3)	NA

		Compliance
DEFLECTION COMPATIBILITY	Secondary components shall have the shear capacity to develop the flexural strength of the components for Life Safety and shall meet the requirements of Sections 4.4.1.4.9, 4.4.1.4.10, 4.4.1.4.11, 4.4.1.4.12 and 4.4.1.4.15 for Immediate Occupancy. (Tier 2: Sec. 4.4.1.6.2)	C
FLAT SLABS	Flat slabs/plates not part of lateral-force-resisting system shall have continuous bottom steel through the column joints for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.1.6.3)	NA
OVERTURNING	All shear walls shall have aspect ratios less than 4-to-1. Wall piers need not be considered. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.4)	C
WALL THICKNESS	Thickness of bearing walls shall not be less than 1/25 the unsupported height or length, whichever is shorter, nor less than 4 inches. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.7)	C

Lateral Force Resisting SystemLateral Force Resisting System

REINFORCING AT OPENINGS	There shall be added trim reinforcement around all wall openings with a dimension greater than three times the thickness of the wall. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.6)	C

3.9.1 Basic Nonstructural Component Checklist

		Compliance
Building Contents and Furnishing		
Tall Narrow Contents	Contents over 4 feet in height with a height-to-depth or height-to-width ratio greater than 3-to-1 shall be anchored to the floor slab or adjacent structural walls. A height-to-depth or height-to-width ratio of up to 4-to-1 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.11.1)	C
Ceiling Systems		
Integrated Ceilings	Integrated suspended ceilings at exits and corridors or weighing more than 2 lb/ft^2 shall be laterally restrained by a minimum of 4 diagonal wires or rigid members attached to the structure above at a spacing equal to or less than 12 ft (Tier 2: Sec. 4.8.2.1)	C
Lay-In Tiles	Lay-in tiles used in ceiling panels located at exits and corridors shall be secured with clips. (Tier 2: Sec. 4.8.2.2)	C
Supporting Partitions	The integrated suspended ceiling system shall not be used to laterally support the tops of gypsum board, masonry, or hollow clay tile partitions. Gypsum board partitions need not be evaluated where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.2.1)	C
Suspended Lath and Plaster	Ceilings consisting of suspended lath and plaster or gypsum board shall be attached for each 10 square feet of area (Tier 2: Sec. 4.8.2.4)	NA
Cladding and Glazing		
Bearing Connections	Where bearing connections are required, there shall be a minimum of two bearing connections for each wall panel. (Tier 2: Sec. 4.8.4.5)	NA
Cladding Anchorage	Cladding components weighing more than 10 psf shall be mechanically anchored to the exterior wall framing at a spacing equal to or less than 4 feet. A spacing of up to 6 feet is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2 (Tier 2: Sec. 4.8.4.1)	NA
Cladding Isolation	For moment frame buildings of steel or concrete, panel connections shall be detailed to accommodate a drift ratio of 0.02 for Life Safety and 0.01for Immediate Occupancy (Tier 2: Sec. 4.8.4.2)	NA

		Compliance
Connections Out of Plane	Exterior cladding panels shall be anchored out-of-plane with a minimum of 4 connections for each wall panel. Two connections per wall panel are permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.7)	NA
Damage	There shall be no damage to exterior wall cladding. (Tier 4.8.4.8)	NA
Deterioration in Connections	There shall be no evidence of deterioration, damage or corrosion in any of the connection elements. (Tier 2: Sec. 4.8.4.2)	NA
Drift Isolation	For moment frame buildings of steel or concrete, panel connections shall be detailed to accommodate a story drift ratio of 0.02. Panel connection detailing for a story drift ratio of 0.01 is permitted where only the Basic nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.3)	NA
Glazing	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall be laminated, annealed, or heat strengthened safety glass that will remain in the frame when cracked (Tier 2: Sec. 4.8.4.9)	NA
Inserts	Where inserts are used in concrete connections, the inserts shall be anchored to reinforcing steel or other positive anchorage. (Tier 2: Sec. 4.8.4.6)	NA
Multi-Story Panels Drift	For multi-story panels attached at each floor level, panel connections shall be detailed to accommodate a story drift ratio of 0.02 and 0.01 for immediate occupancy. Panel connection detailing for a story drift ratio (Tier 2: Sec. 4.8.4.4)	NA
Panel Connections	Exterior cladding panels shall be anchored with a minimum of 2 connections for each wall panel for Life Safety and 4 connections for Immediate Occupancy. (Tier 2: Sec. 4.8.4.6)	NA

Hazardous Materials Storage and Distribution

Toxic Substances Lateral Bracing and Anchorage	Toxic and hazardous substances stored in breakable containers shall be restrained from falling by latched doors, shelf lips, wires, or other methods. (Tier 2: Sec 4.8.15.1)	NA

		Compliance
Light Fixtures		
Emergency Lighting Anchorage	Emergency lighting shall be anchored or braced to prevent falling or swaying during an earthquake. (Tier 2: Sec. 4.8.3.2)	C
Independent Support	Light fixtures in suspended grid ceilings shall be supported independently of the ceiling suspension system by a minimum of two wires at diagonally opposite corners of the fixtures (Tier 2: Sec. 4.8.3.1)	C
Masonry Chimneys		
Urm Chimneys	No reinforced masonry chimney shall extend above the roof surface more than twice the least dimension of the chimney. A height above the roof surface of up to three times the least dimension of the chimney is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.9.1)	NA
Masonry Veneer		
Deterioration	There shall be no evidence of deterioration, damage or corrosion in any of the connection elements. (Tier 2: Sec. 4.8.5.4)	NA
Shelf Angles	Masonry veneer shall be supported by shelf angles or other elements at each floor 30 feet or more above ground for Life Safety and at each floor above the first floor for Immediate Occupancy. (Tier 2: Sec. 4.8.5.1)	NA
Ties	Masonry veneer shall be connected to the back-up with corrosion-resistant ties. The ties shall have a spacing equal to or less than 24 inches with a minimum of one tie for every 2-2/3 square feet. A spacing of up to 36 inches is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2. (Tier 2: Sec. 4.8.5.2)	NA
Weakened Planes	Masonry veneer shall be anchored to the back-up adjacent to weakened planes, such as at the locations of flashing. (Tier 2: Sec. 4.8.5.3)	NA
Mechanical and Electrical Equipment		
Attached Equipment	Equipment weighting over 20 lb that is attached to ceilings, walls, or other supports 4 feet above the floor level shall be mounted. (Tier 2: Sec 4.8.12.2)	C

		Compliance
Deterioration	There shall be no evidence of deterioration, damage, or corrosion in any of the anchorage or supports of mechanical or electrical equipment. (Tier 2: Sec. 4.8.12.3)	C
Emergency Power Mounting	Equipment used as part of an emergency power system shall be mounted to maintain continued operation after an earthquake. (Tier 2: Sec. 4.8.12.1)	C
Hazardous Material Equipment	HVAC or other equipment containing hazardous material shall not have damaged supply lines or unbraced isolation supports. (Tier 2: Sec. 4.8.12.2)	NA

Parapets, Cornices, Ornamentation, and Appendages

Canopies	Canopies located at building exits shall be anchored to the structural framing at a spacing of 6 feet or less. An anchorage spacing of up to 10 feet is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.8.2)	NA
Urm Parapets	There shall be no laterally unsupported unreinforced masonry parapets or cornices with height-to-thickness ratios greater than 1.5. A height-to-thickness ratio of up to 2.5 is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2. (Tier 2: Sec. 4.8.8.1)	NA

Partitions

Unreinforced Masonry Bracing	Unreinforced masonry or hollow clay tile partitions shall be braded at a spacing equal to or less than 10 feet in levels of low or moderate seismicity and 6 feet in levels of high seismicity. (Tier 2: Sec. 4.8.1.1)	NA

Piping

Fire Suppression Piping	Fire suppression piping shall be anchored and braced in accordance with NFPA-13 (NFPA, 1996). (Tier 2: Sec. 4.8.13.1)	NC
Flexible Couplings	Fluid, gas, and fire suppression piping shall have flexible couplings. (Tier 2: Sec. 4.8.13.2)	NC

		Compliance
Stairs		
Stair Details	In moment frame structures, the connection between the stairs and the structure shall not rely on shallow anchors in concrete. Alternatively, the stair details shall be capable of accommodating the drift calculated using the Quick Check procedure of Section 3.5.3.1 without including tension in the anchors. (Tier 2: Sec. 4.8.10.2)	NA
Urm Walls	Walls around stair enclosures shall not consist of unbraced hollow clay tile or unreinforced masonry with a height-to-thickness ratio greater than 12-to-1. A height-to-thickness ratio of up to 15-to-1 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.10.1)	NA

3.9.1S Supplemental Nonstructural Component Checklist

		Compliance
Building Contents and Furnishing		
Access Floor Anchorage	Access floors over 9 inches in height shall be braced. (Tier 2: Sec. 4.8.11.4)	NA
Drawers	Cabinet drawers shall have latches to keep them closed during an earthquake (Tier 2: Sec 4.8.11.3)	NC
Equipment Bracing and Anchorage to Access Floors	Equipment and computers supported on access floor systems shall be either attached to the structure or fastened to a laterally braced floor system. (Tier 2: Sec. 4.8.11.5)	NA
File Cabinets	File cabinets arranged in groups shall be attached to one another. (Tier 2: Sec. 4.8.11.2)	NC
File Cabinets Attachments, Doors, and Drawer Locks	Cabinet doors and drawers shall have latches to keep them closed during an earthquake. (Tier 2: Sec. 4.8.11.3)	NC
Ceiling Systems		
Edges Separation	The edges of integrated suspended ceilings shall be separated from enclosing walls by a minimum of 1/2 inch. (Tier 2: Sec. 4.8.2.5)	C
Seismic Joint	The ceiling system shall not extend continuously across any seismic joint. (Tier 2: Sec. 4.8.2.6)	C
Cladding and Glazing		
Safety Glass	All exterior glazing shall be laminated, annealed or laminated heat-strengthened safety glass or other glazing system that will remain in the frame when glass is cracked. (Tier 2: Sec. 4.8.4.9)	NA
Concrete Block and Masonry Back-Up Systems		
Anchorage	Back-up shall have a positive anchorage to the structural framing at a spacing equal to or less than 4 feet along the floors and roof. (Tier 2: Sec. 4.8.7.1)	NA
Concrete Block	Concrete block shall qualify as reinforced masonry (Tier 2: Sec. 4.8.7.1)	NA

		Compliance
Urm Back-Up	There shall be no unreinforced masonry back-up. (Tier 2: Sec. 4.8.7.2)	NA
Ducts		
Duct Bracing	Rectangular ductwork exceeding 6 square feet in cross-sectional area, and round ducts exceeding 28 inches in diameter, shall be braced. Maximum spacing of transverse bracing shall not exceed 30 feet. Maximum spacing of longitudinal bracing shall not exceed 60 feet. Intermediate supports shall not be considered part of the lateral-force resisting system. (Tier 2: Sec. 4.8.14.2)	NA
Duct Supports	Ducts shall not be supported by piping or electrical conduit. (Tier 2: Sec. 4.8.14.3)	NA
Stair and Smoke Duct Bracing	Stair pressurization and smoke flow of gas and high temperature energy in the event of an earthquake-induced failure. (Tier 2: Sec. 4.8.13.4)	NA
Elevators		
Brackets	The brackets that tie the car rails and the counterweight rail to the building structure shall be sized in accordance with ASME A17.1. (Tier 2: Sec. 4.8.16.7)	NA
Counterweight Rails	All counterweight rails and divider beams shall be sized in accordance with ASME A17.1. (Tier 2: Sec. 4.8.16.6)	NA
Go-Slow Elevators	The building shall have a go-slow elevator system. (Tier 2: Sec. 4.8.16.9)	NA
Retainer Guards	Cable retainer guards on sheaves and drums shall be present to inhibit the displacement of cables. (Tier 2: Sec. 4.8.16.4)	NA
Retainer Plate	A retainer plate shall be present at the top and bottom of both car and counterweight. (Tier 2: Sec. 4.8.16.5)	NA
Seismic Switch	All elevators shall be equipped with seismic switches that will terminate operations when the ground motion exceeds 0.10g. (Tier 2: Sec. 4.8.16.2)	NA
Shaft Walls	All elevator shaft walls shall be anchored and reinforced to prevent toppling into the shaft during strong shaking. (Tier 2: Sec. 4.8.16.3)	NA

		Compliance
Spreader Bracket	Spreader brackets shall not be used to resist seismic forces. (Tier 2: Sec. 4.8.16.8)	NA
Support System	All elements of the elevator system shall be anchored. (Tier 2: Sec. 4.8.16.1)	NA
Hazardous Materials Storage and Distribution		
Gas Cylinder Restraints	Compressed gas-cylinders shall be restrained. (Tier 2: Sec. 4.8.15.2)	NA
Hazardous Materials Shutoff Valves	Piping containing hazardous materials shall have shut-off valves or other devices to prevent major spills or leaks. (Tier 2: Sec. 4.8.16.4)	NA
Light Fixtures		
Lens Covers	Lens covers on light fixtures shall be attached or supplied with safety devices. (Tier 2: Sec. 4.8.3.4)	C
Pendant Supports	Light fixtures on pendant supports shall be attached at a spacing equal to or less than 6 feet and, if rigidly, supported, shall be free to move with the structure to which they are attached without damaging adjoining materials. (Tier 2: Sec. 4.8.3.3)	NA
Masonry Veneer		
Mortar	The mortar in masonry veneer shall not be easily scraped away from the joints by hand with a metal tool, and there shall not be significant areas of eroded mortar. (Tier 2: Sec. 4.8.5.5)	C
Stone Cracks	There shall be no visible cracks or signs of visible distortion in the stone. (Tier 2: Sec. 4.8.5.7)	C
Weep Holes	In veneer braced by stud walls, functioning weep holes and base flashing shall be present. (Tier 2: Sec. 4.8.5.6)	NA
Mechanical and Electrical Equipment		
Door Drift Allowance	Mechanically operated doors shall be detailed to operate at a story drift ratio of 0.01. (Tier 2: Sec. 4.8.12.8)	NA
Electrical Equipment Bracing	Electrical equipment and associated wiring shall be laterally braced to the structural system. (Tier 2: Sec. 4.8.12.7)	NA

		Compliance
Heavy Equipment Anchorage	Equipment weighing over 100 pounds shall be anchored to the structure or foundation. (Tier 2: Sec. 4.8.12.6)	C
Vibration Isolators Restrained	Equipment mounted on vibration isolators shall be equipped with restraints or snubbers. (Tier 2: Sec. 4.8.12.4)	NA

Metal Stud Back-Up Systems

Openings	Steel studs shall frame window and door openings. (Tier 2: Sec. 4.8.6.2)	C
Stud Tracks	Stud tracks shall be fastened to structural framing at a spacing equal to or less than 24 inches on center. (Tier 2: Sec. 4.8.6.1)	C

Parapets, Cornices, Ornamentation, and Appendages

Appendages	Cornices, parapets, signs, and other appendages that extend above the highest anchorage level or cantilever from exterior wall faces and other exterior wall ornamentation shall be reinforced and anchored to the structural system at a spacing equal to or less than 10 feet for Life Safety and 6 feet for Immediate Occupancy. This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. f4.8.8.4)	NA
Concrete Parapets	Concrete parapets with height-to-thickness ratios greater than 2.5 shall have vertical reinforcement. (Tier 2: Sec. 4.8.8.3)	NA

Partitions

Drift Allowance	Rigid cementitious partitions shall be detailed to accommodate a drift ratio of 0.02 in steel moment frame, concrete moment frame, and wood frame buildings. Rigid cementitious partitions shall be detailed to accommodate a drift ratio of 0.005 in other buildings. (Tier 2: Sec. 4.8.1.2)	NA
Lateral Bracing for Tops	The tops of framed or panelized partitions that only extend to the ceiling line shall have lateral bracing to the building structure at a spacing equal to or less than 6 feet. (Tier 2: Sec. 4.8.1.4)	NA
Seismic Control Joints	Partitions at structural separations shall have seismic or control joints. (Tier 2: Sec. 4.8.1.3)	NA

		Compliance
Piping		
C-Clamps	One-sided C-clamps that support piping greater than 2.5 inches in diameter shall be restrained. (Tier 2: Sec. 4.8.13.5)	C
Fluid and Gas Piping Anchorage and Bracing	Fluid and gas piping shall be anchored and braced to the structure to prevent breakage in piping. (Tier 2: Sec 4.8.13.3)	NA
Shut-Off Valves	Shut-off devices shall be present at building utility interfaces to shut off the flow of gas and high-temperature energy in the event of earthquake-induced failure. (Tier 2: Sec. 4.8.13.4)	NA

Compliance

3.9.2 Intermediate Nonstructural Component Checklist

Ceiling Systems

Integrated Ceilings	Integrated suspended ceilings at exists and corridors or weighing more than 2 pounds per square foot shall be laterally restrained with a minimum of four diagonal wires or rigid members attached to the structure above at a spacing equal to or less than 12 feet. (Tier 2: Sec. 4.8.2.3)	C
Lay-In Tiles	Lay-in tiles used in ceiling panels located at exits and corridors shall be secured with clips. (Tier 2: Sec. 4.8.2.2)	C
Suspended Lath and Plaster	Ceilings consisting of suspended lath and plaster or gypsum board shall be attached to resist seismic forced for every 12 square feet of area. (Tier 2: Sec. 4.8.2.4)	NA

Cladding and Glazing

Glazing	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall have safety glazing. Such glazing located over 10 feet above an exterior walking surface shall be laminated, annealed, or laminated heat strengthened safety glass that will remain in the frame when cracked (Tier 2: Sec. 4.8.4.8)	NA
Laminated Safety Glass	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall have safety glazing. Such glazing located over 10 feet above an exterior walking surface shall be laminated annealed or laminated heat-strengthened safety glass or other glazing system that will remain in the frame when glass is cracked. (Tier 2: Sec. 4.8.4.8)	NA

Ducts

Stair and Smoke Duct Bracing	Stair pressurization and smoke control ducts shall be braced and shall have flexible connections at seismic joints. (Tier 2: Sec. 4.8.14.1)	NS

Light Fixtures

Independent Support	Light fixtures in suspended grid ceilings shall be supported independently of the ceiling suspension system by a minimum of two wires at diagonally opposite. (Tier 2: Sec. 4.8.3.2)	C

		Compliance
Masonry Chimneys		
Anchorage	Masonry chimneys shall be anchored at each floor level and the roof. (Tier 2: Sec. 4.8.9.2)This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. 4.8.8.4)	NA
Mechanical and Electrical Equipment		
Vibration Isolators Restrained	Equipment mounted on vibration isolators shall be equipped with restraints or snubbers. (Tier 2: Sec. 4.8.12.4)	NA
Parapets, Cornices, Ornamentation, and Appendages		
Appendages	Cornices, parapets, signs, and other appendages that extend above the highest point of anchorage to the structure or cantilever from exterior wall faces and other exterior wall ornamentation shall be reinforced and anchored to the structural system at a spacing equal to or less than 10 feet for Life Safety and 6 feet for Immediate Occupancy. This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. 4.8.8.4)	NA
Concrete Parapets	Concrete parapets with height-to-thickness ratios greater than 2.5 shall have vertical reinforcement. (Tier 2: Sec. 4.8.8.3)	NA

ASCE31 Tier 1 Seismic Screening
Structural and Non-Structural Findings

Digestor Control Building

3.7.13 Reinforced Masonry Bearing Walls with Flexible Diaphragms

Building System

		Compliance
ADJACENT BUILDINGS	The clear distance between the building being evaluated and any adjacent building shall be greater than 4 percent of the height of the shorter building for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.1.2)	C
DETERIORATION OF WOOD	There shall be no signs of decay, shrinkage, splitting, fire damage, or sagging in any of the wood members, and none of the metal connection hardware shall be deteriorated, broken, or loose. (Tier 2: Sec. 4.3.3.1)	NC
GEOMETRY	There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30 percent in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines. (Tier 2: Sec. 4.3.2.3)	C
LOAD PATH	The structure shall contain a minimum of one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)	C
MASONRY JOINTS	The mortar shall not be easily scraped away from the joints by hand with a metal tool, and there shall be no areas of eroded mortar. (Tier 2: Sec. 4.3.3.8)	C
MASONRY UNITS	There shall be no visible deterioration of masonry units. (Tier 2: Sec. 4.3.3.7)	NC
MASS	There shall be no change in effective mass more than 50 percent from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses, and mezzanines need not be considered. (Tier 2: Sec. 4.3.2.5)	C
MEZZANINES	Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.3)	NA

		Compliance
REINFORCED MASONRY WALL CRACKS	All existing diagonal cracks in wall elements shall be less than 1/8 inch for Life Safety and 1/16 inch for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern. (Tier 2: Sec. 4.3.3.10)	C
SOFT STORY	The stiffness of the lateral-force-resisting system in any story shall not be less than 70 percent of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80 percent of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2)	NA
VERTICAL DISCONTINUITIES	All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)	C
WEAK STORY	The strength of the lateral-force-resisting system in any story shall not be less than 80 percent of the strength in an adjacent story, above or below, for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)	NA
Connections		
FOUNDATION DOWELS	Wall reinforcement shall be doweled into the foundation for Life Safety, and the dowels shall be able to develop the lesser of the strength of the walls or the uplift capacity of the foundation for Immediate Occupancy. (Tier 2: Sec. 4.6.3.5)	C
GIRDER/COLUMN CONNECTION	There shall be a positive connection utilizing plates, connection hardware, or straps between the girder and the column support. (Tier 2: Sec. 4.6.4.1)	C
TRANSFER TO SHEAR WALLS	Diaphragms shall be connected for transfer of loads to the shear walls for Life Safety and the connections shall be able to develop the lesser of the shear strength of the walls or diaphragms for Immediate Occupancy. (Tier 2: Sec. 4.6.2.1)	C
WALL ANCHORAGE	Exterior concrete or masonry walls that are dependent on the diaphragm for lateral support shall be anchored for out-of-plane forces at each diaphragm level with steel anchors, reinforcing dowels, or straps that are developed into the diaphragm. Connections shall have adequate strength to resist the connection force calculated in the Quick Check procedure of Section 3.5.3.7. (Tier 2: Sec. 4.6.1.1)	NC

		Compliance
WOOD LEDGERS	The connection between the wall panels and the diaphragm shall not induce cross-grain bending or tension in the wood ledgers. (Tier 2: Sec. 4.6.1.2)	C

Lateral Force Resisting System

REDUNDANCY	The number of lines of shear walls in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.1.1)	C
REINFORCING STEEL	The total vertical and horizontal reinforcing steel ratio in reinforced masonry walls shall be greater than 0.002 for Life Safety and Immediate Occupancy of the wall with the minimum of 0.0007 for Life Safety and Immediate Occupancy in either of the two directions; the spacing of reinforcing steel shall be less than 48 inches for Life Safety and Immediate Occupancy; and all vertical bars shall extend to the top of the walls. (Tier 2: Sec. 4.4.2.4.2)	NC
SHEAR STRESS CHECK	The shear stress in the reinforced masonry shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 70 psi for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.4.1)	C

Compliance

3.7.13S Reinforced Masonry Bearing Walls with Flexible Diaphragms

Connections

STIFFNESS OF WALL ANCHORS	Anchors of concrete or masonry walls to wood structural elements shall be installed taut and shall be stiff enough to limit the relative movement between the wall and the diaphragm to no greater than 1/8 inch prior to engagement of the anchors. (Tier 2: Sec. 4.6.1.4)	C

Diaphragms

CROSS TIES	There shall be continuous cross ties between diaphragm chords. (Tier 2: Sec. 4.5.1.2)	NC
DIAPHRAGM REINFORCEMENT AT OPENINGS	There shall be reinforcing around all diaphragm openings larger than 50 percent of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)	NA
NON-CONCRETE FILLED DIAPHRAGMS	Untopped metal deck diaphragms or metal deck diaphragms with fill other than concrete shall consist of horizontal spans of less than 40 feet and shall have span/depth ratios less than 4-to-l. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.3.1)	NA
OPENINGS AT EXTERIOR MASONRY SHEAR WALLS	Diaphragm openings immediately adjacent to exterior masonry shear walls shall not be greater than 8 feet long for Life Safety and 4 feet long for Immediate Occupancy. (Tier 2: Sec. 4.5.1.6)	C
OPENINGS AT SHEAR WALLS	Diaphragm openings immediately adjacent to the shear walls shall be less than 25 percent of the wall length for Life Safety and 15 percent of the wall length for Immediate Occupancy. (Tier 2: Sec. 4.5.1.4)	NA
OTHER DIAPHRAGMS	The diaphragm shall not consist of a system other than wood, metal deck, concrete, or horizontal bracing. (Tier 2: Sec. 4.5.7.1)	C
PLAN IRREGULARITIES	There shall be tensile capacity to develop the strength of the diaphragm at re-entrant comers or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)	NA
SPANS	All wood diaphragms with spans greater than 24 feet for Life Safety and 12 feet for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing. (Tier 2: Sec. 4.5.2.2)	C

		Compliance
STRAIGHT SHEATHING	All straight sheathed diaphragms shall have aspect ratios less than 2- to-1 for Life Safety and 1-to-1 for Immediate Occupancy in the direction being considered. (Tier 2: Sec. 4.5.2.1)	C
UNBLOCKED DIAPHRAGMS	All diagonally sheathed or unblocked wood structural panel diaphragms shall have horizontal spans less than 40 feet for Life Safety and 30 feet for Immediate Occupancy and shall have aspect ratios less than or equal to 4-to-1 for Life Safety and 3-to-l for Immediate Occupancy. (Tier 2: Sec. 4.5.2.3)	NC

Lateral Force Resisting System

PROPORTIONS	The height-to-thickness ratio of the shear walls at each story shall be less than 30. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.4.4)	C
REINFORCING AT OPENINGS	All wall openings that interrupt rebar shall have trim reinforcing on all sides. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.4.3)	C

Compliance

3.9.1 Basic Nonstructural Component Checklist

Building Contents and Furnishing

Tall Narrow Contents	Contents over 4 feet in height with a height-to-depth or height-to-width ratio greater than 3-to-1 shall be anchored to the floor slab or adjacent structural walls. A height-to-depth or height-to-width ratio of up to 4-to-1 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.11.1)	C

Ceiling Systems

Integrated Ceilings	Integrated suspended ceilings at exits and corridors or weighing more than 2 lb/ft^2 shall be laterally restrained by a minimum of 4 diagonal wires or rigid members attached to the structure above at a spacing equal to or less than 12 ft (Tier 2: Sec. 4.8.2.1)	NA
Lay-In Tiles	Lay-in tiles used in ceiling panels located at exits and corridors shall be secured with clips. (Tier 2: Sec. 4.8.2.2)	NA
Supporting Partitions	The integrated suspended ceiling system shall not be used to laterally support the tops of gypsum board, masonry, or hollow clay tile partitions. Gypsum board partitions need not be evaluated where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.2.1)	NA
Suspended Lath and Plaster	Ceilings consisting of suspended lath and plaster or gypsum board shall be attached for each 10 square feet of area (Tier 2: Sec. 4.8.2.4)	NA

Cladding and Glazing

Bearing Connections	Where bearing connections are required, there shall be a minimum of two bearing connections for each wall panel. (Tier 2: Sec. 4.8.4.5)	NA
Cladding Anchorage	Cladding components weighing more than 10 psf shall be mechanically anchored to the exterior wall framing at a spacing equal to or less than 4 feet. A spacing of up to 6 feet is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2 (Tier 2: Sec. 4.8.4.1)	NA
Cladding Isolation	For moment frame buildings of steel or concrete, panel connections shall be detailed to accommodate a drift ratio of 0.02 for Life Safety and 0.01for Immediate Occupancy (Tier 2: Sec. 4.8.4.2)	NA

		Compliance
Connections Out of Plane	Exterior cladding panels shall be anchored out-of-plane with a minimum of 4 connections for each wall panel. Two connections per wall panel are permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.7)	NA
Damage	There shall be no damage to exterior wall cladding. (Tier 4.8.4.8)	NA
Deterioration in Connections	There shall be no evidence of deterioration, damage or corrosion in any of the connection elements. (Tier 2: Sec. 4.8.4.2)	NA
Drift Isolation	For moment frame buildings of steel or concrete, panel connections shall be detailed to accommodate a story drift ratio of 0.02. Panel connection detailing for a story drift ratio of 0.01 is permitted where only the Basic nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.3)	NA
Glazing	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall be laminated, annealed, or heat strengthened safety glass that will remain in the frame when cracked (Tier 2: Sec. 4.8.4.9)	NA
Inserts	Where inserts are used in concrete connections, the inserts shall be anchored to reinforcing steel or other positive anchorage. (Tier 2: Sec. 4.8.4.6)	NA
Multi-Story Panels Drift	For multi-story panels attached at each floor level, panel connections shall be detailed to accommodate a story drift ratio of 0.02 and 0.01 for immediate occupancy. Panel connection detailing for a story drift ratio (Tier 2: Sec. 4.8.4.4)	NA
Panel Connections	Exterior cladding panels shall be anchored with a minimum of 2 connections for each wall panel for Life Safety and 4 connections for Immediate Occupancy. (Tier 2: Sec. 4.8.4.6)	NA

Hazardous Materials Storage and Distribution

Toxic Substances Lateral Bracing and Anchorage	Toxic and hazardous substances stored in breakable containers shall be restrained from falling by latched doors, shelf lips, wires, or other methods. (Tier 2: Sec 4.8.15.1)	NA

		Compliance
Light Fixtures		
Emergency Lighting Anchorage	Emergency lighting shall be anchored or braced to prevent falling or swaying during an earthquake. (Tier 2: Sec. 4.8.3.2)	C
Independent Support	Light fixtures in suspended grid ceilings shall be supported independently of the ceiling suspension system by a minimum of two wires at diagonally opposite corners of the fixtures (Tier 2: Sec. 4.8.3.1)	NA
Masonry Chimneys		
Urm Chimneys	No reinforced masonry chimney shall extend above the roof surface more than twice the least dimension of the chimney. A height above the roof surface of up to three times the least dimension of the chimney is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.9.1)	NA
Masonry Veneer		
Deterioration	There shall be no evidence of deterioration, damage or corrosion in any of the connection elements. (Tier 2: Sec. 4.8.5.4)	NA
Shelf Angles	Masonry veneer shall be supported by shelf angles or other elements at each floor 30 feet or more above ground for Life Safety and at each floor above the first floor for Immediate Occupancy. (Tier 2: Sec. 4.8.5.1)	NA
Ties	Masonry veneer shall be connected to the back-up with corrosion-resistant ties. The ties shall have a spacing equal to or less than 24 inches with a minimum of one tie for every 2-2/3 square feet. A spacing of up to 36 inches is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2. (Tier 2: Sec. 4.8.5.2)	NA
Weakened Planes	Masonry veneer shall be anchored to the back-up adjacent to weakened planes, such as at the locations of flashing. (Tier 2: Sec. 4.8.5.3)	NA
Mechanical and Electrical Equipment		
Attached Equipment	Equipment weighting over 20 lb that is attached to ceilings, walls, or other supports 4 feet above the floor level shall be mounted. (Tier 2: Sec 4.8.12.2)	C

Digestor Control Building

		Compliance
Deterioration	There shall be no evidence of deterioration, damage, or corrosion in any of the anchorage or supports of mechanical or electrical equipment. (Tier 2: Sec. 4.8.12.3)	NC
Emergency Power Mounting	Equipment used as part of an emergency power system shall be mounted to maintain continued operation after an earthquake. (Tier 2: Sec. 4.8.12.1)	C
Hazardous Material Equipment	HVAC or other equipment containing hazardous material shall not have damaged supply lines or unbraced isolation supports. (Tier 2: Sec. 4.8.12.2)	NA

Parapets, Cornices, Ornamentation, and Appendages

Canopies	Canopies located at building exits shall be anchored to the structural framing at a spacing of 6 feet or less. An anchorage spacing of up to 10 feet is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.8.2)	NA
Urm Parapets	There shall be no laterally unsupported unreinforced masonry parapets or cornices with height-to-thickness ratios greater than 1.5. A height-to-thickness ratio of up to 2.5 is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2. (Tier 2: Sec. 4.8.8.1)	NA

Partitions

Unreinforced Masonry Bracing	Unreinforced masonry or hollow clay tile partitions shall be braded at a spacing equal to or less than 10 feet in levels of low or moderate seismicity and 6 feet in levels of high seismicity. (Tier 2: Sec. 4.8.1.1)	NA

Piping

Fire Suppression Piping	Fire suppression piping shall be anchored and braced in accordance with NFPA-13 (NFPA, 1996). (Tier 2: Sec. 4.8.13.1)	C
Flexible Couplings	Fluid, gas, and fire suppression piping shall have flexible couplings. (Tier 2: Sec. 4.8.13.2)	NC

		Compliance
Stairs		
Stair Details	In moment frame structures, the connection between the stairs and the structure shall not rely on shallow anchors in concrete. Alternatively, the stair details shall be capable of accommodating the drift calculated using the Quick Check procedure of Section 3.5.3.1 without including tension in the anchors. (Tier 2: Sec. 4.8.10.2)	NA
Urm Walls	Walls around stair enclosures shall not consist of unbraced hollow clay tile or unreinforced masonry with a height-to-thickness ratio greater than 12-to-1. A height-to-thickness ratio of up to 15-to-1 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.10.1)	NA

Compliance

3.9.1S Supplemental Nonstructural Component Checklist

Building Contents and Furnishing

Access Floor Anchorage	Access floors over 9 inches in height shall be braced. (Tier 2: Sec. 4.8.11.4)	NA
Drawers	Cabinet drawers shall have latches to keep them closed during an earthquake (Tier 2: Sec 4.8.11.3)	NA
Equipment Bracing and Anchorage to Access Floors	Equipment and computers supported on access floor systems shall be either attached to the structure or fastened to a laterally braced floor system. (Tier 2: Sec. 4.8.11.5)	NA
File Cabinets	File cabinets arranged in groups shall be attached to one another. (Tier 2: Sec. 4.8.11.2)	NA
File Cabinets Attachments, Doors, and Drawer Locks	Cabinet doors and drawers shall have latches to keep them closed during an earthquake. (Tier 2: Sec. 4.8.11.3)	NA

Ceiling Systems

Edges Separation	The edges of integrated suspended ceilings shall be separated from enclosing walls by a minimum of 1/2 inch. (Tier 2: Sec. 4.8.2.5)	NA
Seismic Joint	The ceiling system shall not extend continuously across any seismic joint. (Tier 2: Sec. 4.8.2.6)	NA

Cladding and Glazing

Safety Glass	All exterior glazing shall be laminated, annealed or laminated heat-strengthened safety glass or other glazing system that will remain in the frame when glass is cracked. (Tier 2: Sec. 4.8.4.9)	NA

Concrete Block and Masonry Back-Up Systems

Anchorage	Back-up shall have a positive anchorage to the structural framing at a spacing equal to or less than 4 feet along the floors and roof. (Tier 2: Sec. 4.8.7.1)	NA
Concrete Block	Concrete block shall qualify as reinforced masonry (Tier 2: Sec. 4.8.7.1)	C

		Compliance
Urm Back-Up	There shall be no unreinforced masonry back-up. (Tier 2: Sec. 4.8.7.2)	NA
Ducts		
Duct Bracing	Rectangular ductwork exceeding 6 square feet in cross-sectional area, and round ducts exceeding 28 inches in diameter, shall be braced. Maximum spacing of transverse bracing shall not exceed 30 feet. Maximum spacing of longitudinal bracing shall not exceed 60 feet. Intermediate supports shall not be considered part of the lateral-force resisting system. (Tier 2: Sec. 4.8.14.2)	NA
Duct Supports	Ducts shall not be supported by piping or electrical conduit. (Tier 2: Sec. 4.8.14.3)	NA
Stair and Smoke Duct Bracing	Stair pressurization and smoke flow of gas and high temperature energy in the event of an earthquake-induced failure. (Tier 2: Sec. 4.8.13.4)	NA
Elevators		
Brackets	The brackets that tie the car rails and the counterweight rail to the building structure shall be sized in accordance with ASME A17.1. (Tier 2: Sec. 4.8.16.7)	NA
Counterweight Rails	All counterweight rails and divider beams shall be sized in accordance with ASME A17.1. (Tier 2: Sec. 4.8.16.6)	NA
Go-Slow Elevators	The building shall have a go-slow elevator system. (Tier 2: Sec. 4.8.16.9)	NA
Retainer Guards	Cable retainer guards on sheaves and drums shall be present to inhibit the displacement of cables. (Tier 2: Sec. 4.8.16.4)	NA
Retainer Plate	A retainer plate shall be present at the top and bottom of both car and counterweight. (Tier 2: Sec. 4.8.16.5)	NA
Seismic Switch	All elevators shall be equipped with seismic switches that will terminate operations when the ground motion exceeds 0.10g. (Tier 2: Sec. 4.8.16.2)	NA
Shaft Walls	All elevator shaft walls shall be anchored and reinforced to prevent toppling into the shaft during strong shaking. (Tier 2: Sec. 4.8.16.3)	NA

		Compliance
Spreader Bracket	Spreader brackets shall not be used to resist seismic forces. (Tier 2: Sec. 4.8.16.8)	NA
Support System	All elements of the elevator system shall be anchored. (Tier 2: Sec. 4.8.16.1)	NA
Hazardous Materials Storage and Distribution		
Gas Cylinder Restraints	Compressed gas-cylinders shall be restrained. (Tier 2: Sec. 4.8.15.2)	NA
Hazardous Materials Shutoff Valves	Piping containing hazardous materials shall have shut-off valves or other devices to prevent major spills or leaks. (Tier 2: Sec. 4.8.16.4)	NA
Light Fixtures		
Lens Covers	Lens covers on light fixtures shall be attached or supplied with safety devices. (Tier 2: Sec. 4.8.3.4)	C
Pendant Supports	Light fixtures on pendant supports shall be attached at a spacing equal to or less than 6 feet and, if rigidly, supported, shall be free to move with the structure to which they are attached without damaging adjoining materials. (Tier 2: Sec. 4.8.3.3)	NA
Masonry Veneer		
Mortar	The mortar in masonry veneer shall not be easily scraped away from the joints by hand with a metal tool, and there shall not be significant areas of eroded mortar. (Tier 2: Sec. 4.8.5.5)	NA
Stone Cracks	There shall be no visible cracks or signs of visible distortion in the stone. (Tier 2: Sec. 4.8.5.7)	NA
Weep Holes	In veneer braced by stud walls, functioning weep holes and base flashing shall be present. (Tier 2: Sec. 4.8.5.6)	NA
Mechanical and Electrical Equipment		
Door Drift Allowance	Mechanically operated doors shall be detailed to operate at a story drift ratio of 0.01. (Tier 2: Sec. 4.8.12.8)	NA
Electrical Equipment Bracing	Electrical equipment and associated wiring shall be laterally braced to the structural system. (Tier 2: Sec. 4.8.12.7)	NA

		Compliance
Heavy Equipment Anchorage	Equipment weighing over 100 pounds shall be anchored to the structure or foundation. (Tier 2: Sec. 4.8.12.6)	C
Vibration Isolators Restrained	Equipment mounted on vibration isolators shall be equipped with restraints or snubbers. (Tier 2: Sec. 4.8.12.4)	NC

Metal Stud Back-Up Systems

Openings	Steel studs shall frame window and door openings. (Tier 2: Sec. 4.8.6.2)	C
Stud Tracks	Stud tracks shall be fastened to structural framing at a spacing equal to or less than 24 inches on center. (Tier 2: Sec. 4.8.6.1)	C

Parapets, Cornices, Ornamentation, and Appendages

Appendages	Cornices, parapets, signs, and other appendages that extend above the highest anchorage level or cantilever from exterior wall faces and other exterior wall ornamentation shall be reinforced and anchored to the structural system at a spacing equal to or less than 10 feet for Life Safety and 6 feet for Immediate Occupancy. This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. f4.8.8.4)	NA
Concrete Parapets	Concrete parapets with height-to-thickness ratios greater than 2.5 shall have vertical reinforcement. (Tier 2: Sec. 4.8.8.3)	NA

Partitions

Drift Allowance	Rigid cementitious partitions shall be detailed to accommodate a drift ratio of 0.02 in steel moment frame, concrete moment frame, and wood frame buildings. Rigid cementitious partitions shall be detailed to accommodate a drift ratio of 0.005 in other buildings. (Tier 2: Sec. 4.8.1.2)	NA
Lateral Bracing for Tops	The tops of framed or panelized partitions that only extend to the ceiling line shall have lateral bracing to the building structure at a spacing equal to or less than 6 feet. (Tier 2: Sec. 4.8.1.4)	NA
Seismic Control Joints	Partitions at structural separations shall have seismic or control joints. (Tier 2: Sec. 4.8.1.3)	NA

Digestor Control Building

Piping		Compliance
C-Clamps	One-sided C-clamps that support piping greater than 2.5 inches in diameter shall be restrained. (Tier 2: Sec. 4.8.13.5)	C
Fluid and Gas Piping Anchorage and Bracing	Fluid and gas piping shall be anchored and braced to the structure to prevent breakage in piping. (Tier 2: Sec 4.8.13.3)	C
Shut-Off Valves	Shut-off devices shall be present at building utility interfaces to shut off the flow of gas and high-temperature energy in the event of earthquake-induced failure. (Tier 2: Sec. 4.8.13.4)	C

Compliance

3.9.2 Intermediate Nonstructural Component Checklist

Ceiling Systems

Integrated Ceilings	Integrated suspended ceilings at exists and corridors or weighing more than 2 pounds per square foot shall be laterally restrained with a minimum of four diagonal wires or rigid members attached to the structure above at a spacing equal to or less than 12 feet. (Tier 2: Sec. 4.8.2.3)	NA
Lay-In Tiles	Lay-in tiles used in ceiling panels located at exits and corridors shall be secured with clips. (Tier 2: Sec. 4.8.2.2)	NA
Suspended Lath and Plaster	Ceilings consisting of suspended lath and plaster or gypsum board shall be attached to resist seismic forced for every 12 square feet of area. (Tier 2: Sec. 4.8.2.4)	NA

Cladding and Glazing

Glazing	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall have safety glazing. Such glazing located over 10 feet above an exterior walking surface shall be laminated, annealed, or laminated heat strengthened safety glass that will remain in the frame when cracked (Tier 2: Sec. 4.8.4.8)	NA
Laminated Safety Glass	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall have safety glazing. Such glazing located over 10 feet above an exterior walking surface shall be laminated annealed or laminated heat-strengthened safety glass or other glazing system that will remain in the frame when glass is cracked. (Tier 2: Sec. 4.8.4.8)	NA

Ducts

Stair and Smoke Duct Bracing	Stair pressurization and smoke control ducts shall be braced and shall have flexible connections at seismic joints. (Tier 2: Sec. 4.8.14.1)	NA

Light Fixtures

Independent Support	Light fixtures in suspended grid ceilings shall be supported independently of the ceiling suspension system by a minimum of two wires at diagonally opposite. (Tier 2: Sec. 4.8.3.2)	NA

Digestor Control Building

		Compliance
Masonry Chimneys		
Anchorage	Masonry chimneys shall be anchored at each floor level and the roof. (Tier 2: Sec. 4.8.9.2)This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. 4.8.8.4)	NA
Mechanical and Electrical Equipment		
Vibration Isolators Restrained	Equipment mounted on vibration isolators shall be equipped with restraints or snubbers. (Tier 2: Sec. 4.8.12.4)	NC
Parapets, Cornices, Ornamentation, and Appendages		
Appendages	Cornices, parapets, signs, and other appendages that extend above the highest point of anchorage to the structure or cantilever from exterior wall faces and other exterior wall ornamentation shall be reinforced and anchored to the structural system at a spacing equal to or less than 10 feet for Life Safety and 6 feet for Immediate Occupancy. This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. 4.8.8.4)	NA
Concrete Parapets	Concrete parapets with height-to-thickness ratios greater than 2.5 shall have vertical reinforcement. (Tier 2: Sec. 4.8.8.3)	NA

ASCE31 Tier 1 Seismic Screening
Structural and Non-Structural Findings

Solids Processing Building

3.7.14 Reinforced Masonry Bearing Walls with Stiff Diaphragms

Building System

		Compliance
DETERIORATION OF CONCRETE	There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting elements. (Tier 2: Sec. 4.3.3.4)	C
GEOMETRY	There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30 percent in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines. (Tier 2: Sec. 4.3.2.3)	C
LOAD PATH	The structure shall contain a minimum of one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)	C
MASONRY JOINTS	The mortar shall not be easily scraped away from the joints by hand with a metal tool, and there shall be no areas of eroded mortar. (Tier 2: Sec. 4.3.3.8)	C
MASONRY UNITS	There shall be no visible deterioration of masonry units. (Tier 2: Sec. 4.3.3.7)	C
MASS	There shall be no change in effective mass more than 50 percent from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses, and mezzanines need not be considered. (Tier 2: Sec. 4.3.2.5)	C
MEZZANINES	Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.3)	C
REINFORCED MASONRY WALL CRACKS	All existing diagonal cracks in wall elements shall be less than 1/8 inch for Life Safety and 1116 inch for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern. (Tier 2: Sec. 4.3.3.10)	C

		Compliance
SOFT STORY	The stiffness of the lateral-force-resisting system in any story shall not be less than 70 percent of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80 percent of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2)	NA
TORSION	The estimated distance between the story center of mass and the story center of rigidity shall be less than 20 percent of the building width in either plan dimension for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.6)	C
VERTICAL DISCONTINUITIES	All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)	C
WEAK STORY	The strength of the lateral-force-resisting system in any story shall not be less than 80 percent of the strength in an adjacent story, above or below, for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)	C

Connections

FOUNDATION DOWELS	Wall reinforcement shall be doweled into the foundation for Life Safety, and the dowels shall be able to develop the lesser of the strength of the walls or the uplift capacity of the foundation for Immediate Occupancy. (Tier 2: Sec. 4.6.3.5)	C
GIRDER/COLUMN CONNECTION	There shall be a positive connection utilizing plates, connection hardware, or straps between the girder and the column support. (Tier 2: Sec. 4.6.4.1)	NC
TOPPING SLAB TO WALLS OR FRAMES	Reinforced concrete topping slabs that interconnect the precast concrete diaphragm elements shall be doweled for transfer of forces into the shear wall or frame elements for Life Safety, and the dowels shall be able to develop the lesser of the shear strength of the walls, frames, or slabs for Immediate Occupancy. (Tier 2: Sec. 4.6.2.3)	NA
TRANSFER TO SHEAR WALLS	Diaphragms shall be connected for transfer of loads to the shear walls for Life Safety and the connections shall be able to develop the lesser of the shear strength of the walls or diaphragms for Immediate Occupancy. (Tier 2: Sec. 4.6.2.1)	C

		Compliance
WALL ANCHORAGE	Exterior concrete or masonry walls that are dependent on the diaphragm for lateral support shall be anchored for out-of-plane forces at each diaphragm level with steel anchors, reinforcing dowels, or straps that are developed into the diaphragm. Connections shall have adequate strength to resist the connection force calculated in the Quick Check procedure of Section 3.5.3.7. (Tier 2: Sec. 4.6.1.1)	C

Diaphragms

TOPPING SLAB	Precast concrete diaphragm elements shall be interconnected by a continuous reinforced concrete topping slab. (Tier 2: Sec. 4.5.5.1)	NA

Lateral Force Resisting System

REDUNDANCY	The number of lines of shear walls in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.1.1)	C
REINFORCING STEEL	The total vertical and horizontal reinforcing steel ratio in reinforced masonry walls shall be greater than 0.002 for Life Safety and Immediate Occupancy of the wall with the minimum of 0.0007 for Life Safety and Immediate Occupancy in either of the two directions; the spacing of reinforcing steel shall be less than 48 inches for Life Safety and Immediate Occupancy; and all vertical bars shall extend to the top of the walls. (Tier 2: Sec. 4.4.2.4.2)	NC
SHEAR STRESS CHECK	The shear stress in the reinforced masonry shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 70 psi for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.4.1)	NC

Compliance

3.7.14S Reinforced Masonry Bearing Walls with Stiff Diaphragms

Diaphragms

DIAPHRAGM REINFORCEMENT AT OPENINGS	There shall be reinforcing around all diaphragm openings larger than 50 percent of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)	C
OPENINGS AT EXTERIOR MASONRY SHEAR WALLS	Diaphragm openings immediately adjacent to exterior masonry shear walls shall not be greater than 8 feet long for Life Safety and 4. feet long for Immediate Occupancy. (Tier 2: Sec. 4.5.1.6)	C
OPENINGS AT SHEAR WALLS	Diaphragm openings immediately adjacent to the shear walls shall be less than 25 percent of the wall length for Life Safety and 15 percent of the wall length for Immediate Occupancy. (Tier 2: Sec. 4.5.1.4)	C
PLAN IRREGULARITIES	There shall be tensile capacity to develop the strength of the diaphragm at re-entrant comers or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)	NA

Lateral Force Resisting System

PROPORTIONS	The height-to-thickness ratio of the shear walls at each story shall be less than 30. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.4.4)	C
REINFORCING AT OPENINGS	There shall be added trim reinforcement around all wall openings with a dimension greater than three times the thickness of the wall. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.6)	C

Masonry Bearing Walls with Stiff Diaphragms

PROPORTIONS	The height-to-thickness ratio of the shear walls at each story shall be less than 30. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.4.4)	C
REINFORCING AT OPENINGS	There shall be added trim reinforcement around all wall openings with a dimension greater than three times the thickness of the wall. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.6)	C

Solids Processing Building

Compliance

3.9.1 Basic Nonstructural Component Checklist

Building Contents and Furnishing

Tall Narrow Contents	Contents over 4 feet in height with a height-to-depth or height-to-width ratio greater than 3-to-1 shall be anchored to the floor slab or adjacent structural walls. A height-to-depth or height-to-width ratio of up to 4-to-1 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.11.1)	C

Ceiling Systems

Integrated Ceilings	Integrated suspended ceilings at exits and corridors or weighing more than 2 lb/ft^2 shall be laterally restrained by a minimum of 4 diagonal wires or rigid members attached to the structure above at a spacing equal to or less than 12 ft (Tier 2: Sec. 4.8.2.1)	C
Lay-In Tiles	Lay-in tiles used in ceiling panels located at exits and corridors shall be secured with clips. (Tier 2: Sec. 4.8.2.2)	C
Supporting Partitions	The integrated suspended ceiling system shall not be used to laterally support the tops of gypsum board, masonry, or hollow clay tile partitions. Gypsum board partitions need not be evaluated where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.2.1)	C
Suspended Lath and Plaster	Ceilings consisting of suspended lath and plaster or gypsum board shall be attached for each 10 square feet of area (Tier 2: Sec. 4.8.2.4)	NA

Cladding and Glazing

Bearing Connections	Where bearing connections are required, there shall be a minimum of two bearing connections for each wall panel. (Tier 2: Sec. 4.8.4.5)	NA
Cladding Anchorage	Cladding components weighing more than 10 psf shall be mechanically anchored to the exterior wall framing at a spacing equal to or less than 4 feet. A spacing of up to 6 feet is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2 (Tier 2: Sec. 4.8.4.1)	NA
Cladding Isolation	For moment frame buildings of steel or concrete, panel connections shall be detailed to accommodate a drift ratio of 0.02 for Life Safety and 0.01for Immediate Occupancy (Tier 2: Sec. 4.8.4.2)	NA

		Compliance
Connections Out of Plane	Exterior cladding panels shall be anchored out-of-plane with a minimum of 4 connections for each wall panel. Two connections per wall panel are permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.7)	NA
Damage	There shall be no damage to exterior wall cladding. (Tier 4.8.4.8)	NA
Deterioration in Connections	There shall be no evidence of deterioration, damage or corrosion in any of the connection elements. (Tier 2: Sec. 4.8.4.2)	NA
Drift Isolation	For moment frame buildings of steel or concrete, panel connections shall be detailed to accommodate a story drift ratio of 0.02. Panel connection detailing for a story drift ratio of 0.01 is permitted where only the Basic nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.3)	NA
Glazing	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall be laminated, annealed, or heat strengthened safety glass that will remain in the frame when cracked (Tier 2: Sec. 4.8.4.9)	NA
Inserts	Where inserts are used in concrete connections, the inserts shall be anchored to reinforcing steel or other positive anchorage. (Tier 2: Sec. 4.8.4.6)	NA
Multi-Story Panels Drift	For multi-story panels attached at each floor level, panel connections shall be detailed to accommodate a story drift ratio of 0.02 and 0.01 for immediate occupancy. Panel connection detailing for a story drift ratio (Tier 2: Sec. 4.8.4.4)	NA
Panel Connections	Exterior cladding panels shall be anchored with a minimum of 2 connections for each wall panel for Life Safety and 4 connections for Immediate Occupancy. (Tier 2: Sec. 4.8.4.6)	NA

Hazardous Materials Storage and Distribution

Toxic Substances Lateral Bracing and Anchorage	Toxic and hazardous substances stored in breakable containers shall be restrained from falling by latched doors, shelf lips, wires, or other methods. (Tier 2: Sec 4.8.15.1)	NA

Solids Processing Building

		Compliance
Light Fixtures		
Emergency Lighting Anchorage	Emergency lighting shall be anchored or braced to prevent falling or swaying during an earthquake. (Tier 2: Sec. 4.8.3.2)	C
Independent Support	Light fixtures in suspended grid ceilings shall be supported independently of the ceiling suspension system by a minimum of two wires at diagonally opposite corners of the fixtures (Tier 2: Sec. 4.8.3.1)	NC
Masonry Chimneys		
Urm Chimneys	No reinforced masonry chimney shall extend above the roof surface more than twice the least dimension of the chimney. A height above the roof surface of up to three times the least dimension of the chimney is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.9.1)	NA
Masonry Veneer		
Deterioration	There shall be no evidence of deterioration, damage or corrosion in any of the connection elements. (Tier 2: Sec. 4.8.5.4)	NA
Shelf Angles	Masonry veneer shall be supported by shelf angles or other elements at each floor 30 feet or more above ground for Life Safety and at each floor above the first floor for Immediate Occupancy. (Tier 2: Sec. 4.8.5.1)	NA
Ties	Masonry veneer shall be connected to the back-up with corrosion-resistant ties. The ties shall have a spacing equal to or less than 24 inches with a minimum of one tie for every 2-2/3 square feet. A spacing of up to 36 inches is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2. (Tier 2: Sec. 4.8.5.2)	NA
Weakened Planes	Masonry veneer shall be anchored to the back-up adjacent to weakened planes, such as at the locations of flashing. (Tier 2: Sec. 4.8.5.3)	TBD
Mechanical and Electrical Equipment		
Attached Equipment	Equipment weighting over 20 lb that is attached to ceilings, walls, or other supports 4 feet above the floor level shall be mounted. (Tier 2: Sec 4.8.12.2)	C

		Compliance
Deterioration	There shall be no evidence of deterioration, damage, or corrosion in any of the anchorage or supports of mechanical or electrical equipment. (Tier 2: Sec. 4.8.12.3)	NC
Emergency Power Mounting	Equipment used as part of an emergency power system shall be mounted to maintain continued operation after an earthquake. (Tier 2: Sec. 4.8.12.1)	C
Hazardous Material Equipment	HVAC or other equipment containing hazardous material shall not have damaged supply lines or unbraced isolation supports. (Tier 2: Sec. 4.8.12.2)	C

Parapets, Cornices, Ornamentation, and Appendages

Canopies	Canopies located at building exits shall be anchored to the structural framing at a spacing of 6 feet or less. An anchorage spacing of up to 10 feet is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.8.2)	NA
Urm Parapets	There shall be no laterally unsupported unreinforced masonry parapets or cornices with height-to-thickness ratios greater than 1.5. A height-to-thickness ratio of up to 2.5 is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2. (Tier 2: Sec. 4.8.8.1)	NA

Partitions

Unreinforced Masonry Bracing	Unreinforced masonry or hollow clay tile partitions shall be braded at a spacing equal to or less than 10 feet in levels of low or moderate seismicity and 6 feet in levels of high seismicity. (Tier 2: Sec. 4.8.1.1)	NA

Piping

Fire Suppression Piping	Fire suppression piping shall be anchored and braced in accordance with NFPA-13 (NFPA, 1996). (Tier 2: Sec. 4.8.13.1)	C
Flexible Couplings	Fluid, gas, and fire suppression piping shall have flexible couplings. (Tier 2: Sec. 4.8.13.2)	NC

		Compliance
Stairs		
Stair Details	In moment frame structures, the connection between the stairs and the structure shall not rely on shallow anchors in concrete. Alternatively, the stair details shall be capable of accommodating the drift calculated using the Quick Check procedure of Section 3.5.3.1 without including tension in the anchors. (Tier 2: Sec. 4.8.10.2)	NA
Urm Walls	Walls around stair enclosures shall not consist of unbraced hollow clay tile or unreinforced masonry with a height-to-thickness ratio greater than 12-to-1. A height-to-thickness ratio of up to 15-to-1 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.10.1)	NA

Solids Processing Building

Compliance

3.9.1S Supplemental Nonstructural Component Checklist

Building Contents and Furnishing		
Access Floor Anchorage	Access floors over 9 inches in height shall be braced. (Tier 2: Sec. 4.8.11.4)	NA
Drawers	Cabinet drawers shall have latches to keep them closed during an earthquake (Tier 2: Sec 4.8.11.3)	NA
Equipment Bracing and Anchorage to Access Floors	Equipment and computers supported on access floor systems shall be either attached to the structure or fastened to a laterally braced floor system. (Tier 2: Sec. 4.8.11.5)	NA
File Cabinets	File cabinets arranged in groups shall be attached to one another. (Tier 2: Sec. 4.8.11.2)	NA
File Cabinets Attachments, Doors, and Drawer Locks	Cabinet doors and drawers shall have latches to keep them closed during an earthquake. (Tier 2: Sec. 4.8.11.3)	NA
Ceiling Systems		
Edges Separation	The edges of integrated suspended ceilings shall be separated from enclosing walls by a minimum of 1/2 inch. (Tier 2: Sec. 4.8.2.5)	C
Seismic Joint	The ceiling system shall not extend continuously across any seismic joint. (Tier 2: Sec. 4.8.2.6)	NA
Cladding and Glazing		
Safety Glass	All exterior glazing shall be laminated, annealed or laminated heat-strengthened safety glass or other glazing system that will remain in the frame when glass is cracked. (Tier 2: Sec. 4.8.4.9)	NA
Concrete Block and Masonry Back-Up Systems		
Anchorage	Back-up shall have a positive anchorage to the structural framing at a spacing equal to or less than 4 feet along the floors and roof. (Tier 2: Sec. 4.8.7.1)	NA
Concrete Block	Concrete block shall qualify as reinforced masonry (Tier 2: Sec. 4.8.7.1)	NA

		Compliance
Urm Back-Up	There shall be no unreinforced masonry back-up. (Tier 2: Sec. 4.8.7.2)	NA
Ducts		
Duct Bracing	Rectangular ductwork exceeding 6 square feet in cross-sectional area, and round ducts exceeding 28 inches in diameter, shall be braced. Maximum spacing of transverse bracing shall not exceed 30 feet. Maximum spacing of longitudinal bracing shall not exceed 60 feet. Intermediate supports shall not be considered part of the lateral-force resisting system. (Tier 2: Sec. 4.8.14.2)	NA
Duct Supports	Ducts shall not be supported by piping or electrical conduit. (Tier 2: Sec. 4.8.14.3)	C
Stair and Smoke Duct Bracing	Stair pressurization and smoke flow of gas and high temperature energy in the event of an earthquake-induced failure. (Tier 2: Sec. 4.8.13.4)	NA
Elevators		
Brackets	The brackets that tie the car rails and the counterweight rail to the building structure shall be sized in accordance with ASME A17.1. (Tier 2: Sec. 4.8.16.7)	NA
Counterweight Rails	All counterweight rails and divider beams shall be sized in accordance with ASME A17.1. (Tier 2: Sec. 4.8.16.6)	NA
Go-Slow Elevators	The building shall have a go-slow elevator system. (Tier 2: Sec. 4.8.16.9)	NA
Retainer Guards	Cable retainer guards on sheaves and drums shall be present to inhibit the displacement of cables. (Tier 2: Sec. 4.8.16.4)	NA
Retainer Plate	A retainer plate shall be present at the top and bottom of both car and counterweight. (Tier 2: Sec. 4.8.16.5)	NA
Seismic Switch	All elevators shall be equipped with seismic switches that will terminate operations when the ground motion exceeds 0.10g. (Tier 2: Sec. 4.8.16.2)	NA
Shaft Walls	All elevator shaft walls shall be anchored and reinforced to prevent toppling into the shaft during strong shaking. (Tier 2: Sec. 4.8.16.3)	NA

		Compliance
Spreader Bracket	Spreader brackets shall not be used to resist seismic forces. (Tier 2: Sec. 4.8.16.8)	NA
Support System	All elements of the elevator system shall be anchored. (Tier 2: Sec. 4.8.16.1)	NA
Hazardous Materials Storage and Distribution		
Gas Cylinder Restraints	Compressed gas-cylinders shall be restrained. (Tier 2: Sec. 4.8.15.2)	NA
Hazardous Materials Shutoff Valves	Piping containing hazardous materials shall have shut-off valves or other devices to prevent major spills or leaks. (Tier 2: Sec. 4.8.16.4)	NA
Light Fixtures		
Lens Covers	Lens covers on light fixtures shall be attached or supplied with safety devices. (Tier 2: Sec. 4.8.3.4)	C
Pendant Supports	Light fixtures on pendant supports shall be attached at a spacing equal to or less than 6 feet and, if rigidly, supported, shall be free to move with the structure to which they are attached without damaging adjoining materials. (Tier 2: Sec. 4.8.3.3)	C
Masonry Veneer		
Mortar	The mortar in masonry veneer shall not be easily scraped away from the joints by hand with a metal tool, and there shall not be significant areas of eroded mortar. (Tier 2: Sec. 4.8.5.5)	NA
Stone Cracks	There shall be no visible cracks or signs of visible distortion in the stone. (Tier 2: Sec. 4.8.5.7)	NA
Weep Holes	In veneer braced by stud walls, functioning weep holes and base flashing shall be present. (Tier 2: Sec. 4.8.5.6)	NA
Mechanical and Electrical Equipment		
Door Drift Allowance	Mechanically operated doors shall be detailed to operate at a story drift ratio of 0.01. (Tier 2: Sec. 4.8.12.8)	NA
Electrical Equipment Bracing	Electrical equipment and associated wiring shall be laterally braced to the structural system. (Tier 2: Sec. 4.8.12.7)	C

Solids Processing Building

		Compliance
Heavy Equipment Anchorage	Equipment weighing over 100 pounds shall be anchored to the structure or foundation. (Tier 2: Sec. 4.8.12.6)	C
Vibration Isolators Restrained	Equipment mounted on vibration isolators shall be equipped with restraints or snubbers. (Tier 2: Sec. 4.8.12.4)	NC
Metal Stud Back-Up Systems		
Openings	Steel studs shall frame window and door openings. (Tier 2: Sec. 4.8.6.2)	C
Stud Tracks	Stud tracks shall be fastened to structural framing at a spacing equal to or less than 24 inches on center. (Tier 2: Sec. 4.8.6.1)	C
Parapets, Cornices, Ornamentation, and Appendages		
Appendages	Cornices, parapets, signs, and other appendages that extend above the highest anchorage level or cantilever from exterior wall faces and other exterior wall ornamentation shall be reinforced and anchored to the structural system at a spacing equal to or less than 10 feet for Life Safety and 6 feet for Immediate Occupancy. This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. f4.8.8.4)	C
Concrete Parapets	Concrete parapets with height-to-thickness ratios greater than 2.5 shall have vertical reinforcement. (Tier 2: Sec. 4.8.8.3)	NA
Partitions		
Drift Allowance	Rigid cementitious partitions shall be detailed to accommodate a drift ratio of 0.02 in steel moment frame, concrete moment frame, and wood frame buildings. Rigid cementitious partitions shall be detailed to accommodate a drift ratio of 0.005 in other buildings. (Tier 2: Sec. 4.8.1.2)	NA
Lateral Bracing for Tops	The tops of framed or panelized partitions that only extend to the ceiling line shall have lateral bracing to the building structure at a spacing equal to or less than 6 feet. (Tier 2: Sec. 4.8.1.4)	NA
Seismic Control Joints	Partitions at structural separations shall have seismic or control joints. (Tier 2: Sec. 4.8.1.3)	NA

Solids Processing Building

		Compliance
Piping		
C-Clamps	One-sided C-clamps that support piping greater than 2.5 inches in diameter shall be restrained. (Tier 2: Sec. 4.8.13.5)	C
Fluid and Gas Piping Anchorage and Bracing	Fluid and gas piping shall be anchored and braced to the structure to prevent breakage in piping. (Tier 2: Sec 4.8.13.3)	NC
Shut-Off Valves	Shut-off devices shall be present at building utility interfaces to shut off the flow of gas and high-temperature energy in the event of earthquake-induced failure. (Tier 2: Sec. 4.8.13.4)	C

Compliance

3.9.2 Intermediate Nonstructural Component Checklist

Ceiling Systems		
Integrated Ceilings	Integrated suspended ceilings at exists and corridors or weighing more than 2 pounds per square foot shall be laterally restrained with a minimum of four diagonal wires or rigid members attached to the structure above at a spacing equal to or less than 12 feet. (Tier 2: Sec. 4.8.2.3)	C
Lay-In Tiles	Lay-in tiles used in ceiling panels located at exits and corridors shall be secured with clips. (Tier 2: Sec. 4.8.2.2)	C
Suspended Lath and Plaster	Ceilings consisting of suspended lath and plaster or gypsum board shall be attached to resist seismic forced for every 12 square feet of area. (Tier 2: Sec. 4.8.2.4)	NA
Cladding and Glazing		
Glazing	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall have safety glazing. Such glazing located over 10 feet above an exterior walking surface shall be laminated, annealed, or laminated heat strengthened safety glass that will remain in the frame when cracked (Tier 2: Sec. 4.8.4.8)	NA
Laminated Safety Glass	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall have safety glazing. Such glazing located over 10 feet above an exterior walking surface shall be laminated annealed or laminated heat-strengthened safety glass or other glazing system that will remain in the frame when glass is cracked. (Tier 2: Sec. 4.8.4.8)	NA
Ducts		
Stair and Smoke Duct Bracing	Stair pressurization and smoke control ducts shall be braced and shall have flexible connections at seismic joints. (Tier 2: Sec. 4.8.14.1)	NA
Light Fixtures		
Independent Support	Light fixtures in suspended grid ceilings shall be supported independently of the ceiling suspension system by a minimum of two wires at diagonally opposite. (Tier 2: Sec. 4.8.3.2)	NC

Solids Processing Building

		Compliance
Masonry Chimneys		
Anchorage	Masonry chimneys shall be anchored at each floor level and the roof. (Tier 2: Sec. 4.8.9.2)This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. 4.8.8.4)	NA
Mechanical and Electrical Equipment		
Vibration Isolators Restrained	Equipment mounted on vibration isolators shall be equipped with restraints or snubbers. (Tier 2: Sec. 4.8.12.4)	NA
Parapets, Cornices, Ornamentation, and Appendages		
Appendages	Cornices, parapets, signs, and other appendages that extend above the highest point of anchorage to the structure or cantilever from exterior wall faces and other exterior wall ornamentation shall be reinforced and anchored to the structural system at a spacing equal to or less than 10 feet for Life Safety and 6 feet for Immediate Occupancy. This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. 4.8.8.4)	C
Concrete Parapets	Concrete parapets with height-to-thickness ratios greater than 2.5 shall have vertical reinforcement. (Tier 2: Sec. 4.8.8.3)	NA

ASCE31 Tier 1 Seismic Screening
Structural and Non-Structural Findings

Plant Control Center Building

3.7.13 Reinforced Masonry Bearing Walls with Flexible Diaphragms

Building System

		Compliance
ADJACENT BUILDINGS	The clear distance between the building being evaluated and any adjacent building shall be greater than 4 percent of the height of the shorter building for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.1.2)	NA
DETERIORATION OF WOOD	There shall be no signs of decay, shrinkage, splitting, fire damage, or sagging in any of the wood members, and none of the metal connection hardware shall be deteriorated, broken, or loose. (Tier 2: Sec. 4.3.3.1)	NC
GEOMETRY	There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30 percent in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines. (Tier 2: Sec. 4.3.2.3)	NC
LOAD PATH	The structure shall contain a minimum of one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)	C
MASONRY JOINTS	The mortar shall not be easily scraped away from the joints by hand with a metal tool, and there shall be no areas of eroded mortar. (Tier 2: Sec. 4.3.3.8)	C
MASONRY UNITS	There shall be no visible deterioration of masonry units. (Tier 2: Sec. 4.3.3.7)	NC
MASS	There shall be no change in effective mass more than 50 percent from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses, and mezzanines need not be considered. (Tier 2: Sec. 4.3.2.5)	C
MEZZANINES	Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.3)	NA

		Compliance
REINFORCED MASONRY WALL CRACKS	All existing diagonal cracks in wall elements shall be less than 1/8 inch for Life Safety and 1/16 inch for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern. (Tier 2: Sec. 4.3.3.10)	C
SOFT STORY	The stiffness of the lateral-force-resisting system in any story shall not be less than 70 percent of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80 percent of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2)	NA
VERTICAL DISCONTINUITIES	All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)	C
WEAK STORY	The strength of the lateral-force-resisting system in any story shall not be less than 80 percent of the strength in an adjacent story, above or below, for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)	NA

Connections

FOUNDATION DOWELS	Wall reinforcement shall be doweled into the foundation for Life Safety, and the dowels shall be able to develop the lesser of the strength of the walls or the uplift capacity of the foundation for Immediate Occupancy. (Tier 2: Sec. 4.6.3.5)	NC
GIRDER/COLUMN CONNECTION	There shall be a positive connection utilizing plates, connection hardware, or straps between the girder and the column support. (Tier 2: Sec. 4.6.4.1)	NC
TRANSFER TO SHEAR WALLS	Diaphragms shall be connected for transfer of loads to the shear walls for Life Safety and the connections shall be able to develop the lesser of the shear strength of the walls or diaphragms for Immediate Occupancy. (Tier 2: Sec. 4.6.2.1)	NC
WALL ANCHORAGE	Exterior concrete or masonry walls that are dependent on the diaphragm for lateral support shall be anchored for out-of-plane forces at each diaphragm level with steel anchors, reinforcing dowels, or straps that are developed into the diaphragm. Connections shall have adequate strength to resist the connection force calculated in the Quick Check procedure of Section 3.5.3.7. (Tier 2: Sec. 4.6.1.1)	NC

		Compliance
WOOD LEDGERS	The connection between the wall panels and the diaphragm shall not induce cross-grain bending or tension in the wood ledgers. (Tier 2: Sec. 4.6.1.2)	NC

Lateral Force Resisting System

REDUNDANCY	The number of lines of shear walls in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.1.1)	C
REINFORCING STEEL	The total vertical and horizontal reinforcing steel ratio in reinforced masonry walls shall be greater than 0.002 for Life Safety and Immediate Occupancy of the wall with the minimum of 0.0007 for Life Safety and Immediate Occupancy in either of the two directions; the spacing of reinforcing steel shall be less than 48 inches for Life Safety and Immediate Occupancy; and all vertical bars shall extend to the top of the walls. (Tier 2: Sec. 4.4.2.4.2)	NC
SHEAR STRESS CHECK	The shear stress in the reinforced masonry shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 70 psi for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.4.1)	C

3.7.13S Reinforced Masonry Bearing Walls with Flexible Diaphragms

Connections

STIFFNESS OF WALL ANCHORS	Anchors of concrete or masonry walls to wood structural elements shall be installed taut and shall be stiff enough to limit the relative movement between the wall and the diaphragm to no greater than 1/8 inch prior to engagement of the anchors. (Tier 2: Sec. 4.6.1.4)	NC

Diaphragms

CROSS TIES	There shall be continuous cross ties between diaphragm chords. (Tier 2: Sec. 4.5.1.2)	NC
DIAPHRAGM REINFORCEMENT AT OPENINGS	There shall be reinforcing around all diaphragm openings larger than 50 percent of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)	NA
NON-CONCRETE FILLED DIAPHRAGMS	Untopped metal deck diaphragms or metal deck diaphragms with fill other than concrete shall consist of horizontal spans of less than 40 feet and shall have span/depth ratios less than 4-to-l. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.3.1)	NA
OPENINGS AT EXTERIOR MASONRY SHEAR WALLS	Diaphragm openings immediately adjacent to exterior masonry shear walls shall not be greater than 8 feet long for Life Safety and 4 feet long for Immediate Occupancy. (Tier 2: Sec. 4.5.1.6)	N/A
OPENINGS AT SHEAR WALLS	Diaphragm openings immediately adjacent to the shear walls shall be less than 25 percent of the wall length for Life Safety and 15 percent of the wall length for Immediate Occupancy. (Tier 2: Sec. 4.5.1.4)	NA
OTHER DIAPHRAGMS	The diaphragm shall not consist of a system other than wood, metal deck, concrete, or horizontal bracing. (Tier 2: Sec. 4.5.7.1)	NA
PLAN IRREGULARITIES	There shall be tensile capacity to develop the strength of the diaphragm at re-entrant comers or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)	NA
SPANS	All wood diaphragms with spans greater than 24 feet for Life Safety and 12 feet for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing. (Tier 2: Sec. 4.5.2.2)	NC

		Compliance
STRAIGHT SHEATHING	All straight sheathed diaphragms shall have aspect ratios less than 2- to-1 for Life Safety and 1-to-1 for Immediate Occupancy in the direction being considered. (Tier 2: Sec. 4.5.2.1)	C
UNBLOCKED DIAPHRAGMS	All diagonally sheathed or unblocked wood structural panel diaphragms shall have horizontal spans less than 40 feet for Life Safety and 30 feet for Immediate Occupancy and shall have aspect ratios less than or equal to 4-to-1 for Life Safety and 3-to-l for Immediate Occupancy. (Tier 2: Sec. 4.5.2.3)	NC

Lateral Force Resisting System

PROPORTIONS	The height-to-thickness ratio of the shear walls at each story shall be less than 30. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.4.4)	C
REINFORCING AT OPENINGS	All wall openings that interrupt rebar shall have trim reinforcing on all sides. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.4.3)	C

3.9.1 Basic Nonstructural Component Checklist

		Compliance
Building Contents and Furnishing		
Tall Narrow Contents	Contents over 4 feet in height with a height-to-depth or height-to-width ratio greater than 3-to-1 shall be anchored to the floor slab or adjacent structural walls. A height-to-depth or height-to-width ratio of up to 4-to-1 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.11.1)	C
Ceiling Systems		
Integrated Ceilings	Integrated suspended ceilings at exits and corridors or weighing more than 2 lb/ft^2 shall be laterally restrained by a minimum of 4 diagonal wires or rigid members attached to the structure above at a spacing equal to or less than 12 ft (Tier 2: Sec. 4.8.2.1)	NA
Lay-In Tiles	Lay-in tiles used in ceiling panels located at exits and corridors shall be secured with clips. (Tier 2: Sec. 4.8.2.2)	C
Supporting Partitions	The integrated suspended ceiling system shall not be used to laterally support the tops of gypsum board, masonry, or hollow clay tile partitions. Gypsum board partitions need not be evaluated where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.2.1)	C
Suspended Lath and Plaster	Ceilings consisting of suspended lath and plaster or gypsum board shall be attached for each 10 square feet of area (Tier 2: Sec. 4.8.2.4)	C
Cladding and Glazing		
Bearing Connections	Where bearing connections are required, there shall be a minimum of two bearing connections for each wall panel. (Tier 2: Sec. 4.8.4.5)	NA
Cladding Anchorage	Cladding components weighing more than 10 psf shall be mechanically anchored to the exterior wall framing at a spacing equal to or less than 4 feet. A spacing of up to 6 feet is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2 (Tier 2: Sec. 4.8.4.1)	NA
Cladding Isolation	For moment frame buildings of steel or concrete, panel connections shall be detailed to accommodate a drift ratio of 0.02 for Life Safety and 0.01for Immediate Occupancy (Tier 2: Sec. 4.8.4.2)	NA

		Compliance
Connections Out of Plane	Exterior cladding panels shall be anchored out-of-plane with a minimum of 4 connections for each wall panel. Two connections per wall panel are permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.7)	NA
Damage	There shall be no damage to exterior wall cladding. (Tier 4.8.4.8)	NA
Deterioration in Connections	There shall be no evidence of deterioration, damage or corrosion in any of the connection elements. (Tier 2: Sec. 4.8.4.2)	NA
Drift Isolation	For moment frame buildings of steel or concrete, panel connections shall be detailed to accommodate a story drift ratio of 0.02. Panel connection detailing for a story drift ratio of 0.01 is permitted where only the Basic nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.3)	NA
Glazing	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall be laminated, annealed, or heat strengthened safety glass that will remain in the frame when cracked (Tier 2: Sec. 4.8.4.9)	NA
Inserts	Where inserts are used in concrete connections, the inserts shall be anchored to reinforcing steel or other positive anchorage. (Tier 2: Sec. 4.8.4.6)	NA
Multi-Story Panels Drift	For multi-story panels attached at each floor level, panel connections shall be detailed to accommodate a story drift ratio of 0.02 and 0.01 for immediate occupancy. Panel connection detailing for a story drift ratio (Tier 2: Sec. 4.8.4.4)	NA
Panel Connections	Exterior cladding panels shall be anchored with a minimum of 2 connections for each wall panel for Life Safety and 4 connections for Immediate Occupancy. (Tier 2: Sec. 4.8.4.6)	NA

Hazardous Materials Storage and Distribution

Toxic Substances Lateral Bracing and Anchorage	Toxic and hazardous substances stored in breakable containers shall be restrained from falling by latched doors, shelf lips, wires, or other methods. (Tier 2: Sec 4.8.15.1)	NA

		Compliance
Light Fixtures		
Emergency Lighting Anchorage	Emergency lighting shall be anchored or braced to prevent falling or swaying during an earthquake. (Tier 2: Sec. 4.8.3.2)	C
Independent Support	Light fixtures in suspended grid ceilings shall be supported independently of the ceiling suspension system by a minimum of two wires at diagonally opposite corners of the fixtures (Tier 2: Sec. 4.8.3.1)	C
Masonry Chimneys		
Urm Chimneys	No reinforced masonry chimney shall extend above the roof surface more than twice the least dimension of the chimney. A height above the roof surface of up to three times the least dimension of the chimney is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.9.1)	NA
Masonry Veneer		
Deterioration	There shall be no evidence of deterioration, damage or corrosion in any of the connection elements. (Tier 2: Sec. 4.8.5.4)	NA
Shelf Angles	Masonry veneer shall be supported by shelf angles or other elements at each floor 30 feet or more above ground for Life Safety and at each floor above the first floor for Immediate Occupancy. (Tier 2: Sec. 4.8.5.1)	NA
Ties	Masonry veneer shall be connected to the back-up with corrosion-resistant ties. The ties shall have a spacing equal to or less than 24 inches with a minimum of one tie for every 2-2/3 square feet. A spacing of up to 36 inches is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2. (Tier 2: Sec. 4.8.5.2)	NA
Weakened Planes	Masonry veneer shall be anchored to the back-up adjacent to weakened planes, such as at the locations of flashing. (Tier 2: Sec. 4.8.5.3)	NA
Mechanical and Electrical Equipment		
Attached Equipment	Equipment weighting over 20 lb that is attached to ceilings, walls, or other supports 4 feet above the floor level shall be mounted. (Tier 2: Sec 4.8.12.2)	C

		Compliance
Deterioration	There shall be no evidence of deterioration, damage, or corrosion in any of the anchorage or supports of mechanical or electrical equipment. (Tier 2: Sec. 4.8.12.3)	NC
Emergency Power Mounting	Equipment used as part of an emergency power system shall be mounted to maintain continued operation after an earthquake. (Tier 2: Sec. 4.8.12.1)	C
Hazardous Material Equipment	HVAC or other equipment containing hazardous material shall not have damaged supply lines or unbraced isolation supports. (Tier 2: Sec. 4.8.12.2)	C

Parapets, Cornices, Ornamentation, and Appendages

Canopies	Canopies located at building exits shall be anchored to the structural framing at a spacing of 6 feet or less. An anchorage spacing of up to 10 feet is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.8.2)	NA
Urm Parapets	There shall be no laterally unsupported unreinforced masonry parapets or cornices with height-to-thickness ratios greater than 1.5. A height-to-thickness ratio of up to 2.5 is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2. (Tier 2: Sec. 4.8.8.1)	NA

Partitions

Unreinforced Masonry Bracing	Unreinforced masonry or hollow clay tile partitions shall be braded at a spacing equal to or less than 10 feet in levels of low or moderate seismicity and 6 feet in levels of high seismicity. (Tier 2: Sec. 4.8.1.1)	NA

Piping

Fire Suppression Piping	Fire suppression piping shall be anchored and braced in accordance with NFPA-13 (NFPA, 1996). (Tier 2: Sec. 4.8.13.1)	NC
Flexible Couplings	Fluid, gas, and fire suppression piping shall have flexible couplings. (Tier 2: Sec. 4.8.13.2)	NC

Compliance

Stairs

Stair Details	In moment frame structures, the connection between the stairs and the structure shall not rely on shallow anchors in concrete. Alternatively, the stair details shall be capable of accommodating the drift calculated using the Quick Check procedure of Section 3.5.3.1 without including tension in the anchors. (Tier 2: Sec. 4.8.10.2)	NA
Urm Walls	Walls around stair enclosures shall not consist of unbraced hollow clay tile or unreinforced masonry with a height-to-thickness ratio greater than 12-to-1. A height-to-thickness ratio of up to 15-to-1 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.10.1)	NA

3.9.1S Supplemental Nonstructural Component Checklist

		Compliance
Building Contents and Furnishing		
Access Floor Anchorage	Access floors over 9 inches in height shall be braced. (Tier 2: Sec. 4.8.11.4)	NA
Drawers	Cabinet drawers shall have latches to keep them closed during an earthquake (Tier 2: Sec 4.8.11.3)	NC
Equipment Bracing and Anchorage to Access Floors	Equipment and computers supported on access floor systems shall be either attached to the structure or fastened to a laterally braced floor system. (Tier 2: Sec. 4.8.11.5)	NA
File Cabinets	File cabinets arranged in groups shall be attached to one another. (Tier 2: Sec. 4.8.11.2)	NC
File Cabinets Attachments, Doors, and Drawer Locks	Cabinet doors and drawers shall have latches to keep them closed during an earthquake. (Tier 2: Sec. 4.8.11.3)	NC
Ceiling Systems		
Edges Separation	The edges of integrated suspended ceilings shall be separated from enclosing walls by a minimum of 1/2 inch. (Tier 2: Sec. 4.8.2.5)	C
Seismic Joint	The ceiling system shall not extend continuously across any seismic joint. (Tier 2: Sec. 4.8.2.6)	NA
Cladding and Glazing		
Safety Glass	All exterior glazing shall be laminated, annealed or laminated heat-strengthened safety glass or other glazing system that will remain in the frame when glass is cracked. (Tier 2: Sec. 4.8.4.9)	NA
Concrete Block and Masonry Back-Up Systems		
Anchorage	Back-up shall have a positive anchorage to the structural framing at a spacing equal to or less than 4 feet along the floors and roof. (Tier 2: Sec. 4.8.7.1)	C
Concrete Block	Concrete block shall qualify as reinforced masonry (Tier 2: Sec. 4.8.7.1)	C

		Compliance
Urm Back-Up	There shall be no unreinforced masonry back-up. (Tier 2: Sec. 4.8.7.2)	C
Ducts		
Duct Bracing	Rectangular ductwork exceeding 6 square feet in cross-sectional area, and round ducts exceeding 28 inches in diameter, shall be braced. Maximum spacing of transverse bracing shall not exceed 30 feet. Maximum spacing of longitudinal bracing shall not exceed 60 feet. Intermediate supports shall not be considered part of the lateral-force resisting system. (Tier 2: Sec. 4.8.14.2)	NA
Duct Supports	Ducts shall not be supported by piping or electrical conduit. (Tier 2: Sec. 4.8.14.3)	C
Stair and Smoke Duct Bracing	Stair pressurization and smoke flow of gas and high temperature energy in the event of an earthquake-induced failure. (Tier 2: Sec. 4.8.13.4)	NA
Elevators		
Brackets	The brackets that tie the car rails and the counterweight rail to the building structure shall be sized in accordance with ASME A17.1. (Tier 2: Sec. 4.8.16.7)	NA
Counterweight Rails	All counterweight rails and divider beams shall be sized in accordance with ASME A17.1. (Tier 2: Sec. 4.8.16.6)	NA
Go-Slow Elevators	The building shall have a go-slow elevator system. (Tier 2: Sec. 4.8.16.9)	NA
Retainer Guards	Cable retainer guards on sheaves and drums shall be present to inhibit the displacement of cables. (Tier 2: Sec. 4.8.16.4)	NA
Retainer Plate	A retainer plate shall be present at the top and bottom of both car and counterweight. (Tier 2: Sec. 4.8.16.5)	NA
Seismic Switch	All elevators shall be equipped with seismic switches that will terminate operations when the ground motion exceeds 0.10g. (Tier 2: Sec. 4.8.16.2)	NA
Shaft Walls	All elevator shaft walls shall be anchored and reinforced to prevent toppling into the shaft during strong shaking. (Tier 2: Sec. 4.8.16.3)	NA

		Compliance
Spreader Bracket	Spreader brackets shall not be used to resist seismic forces. (Tier 2: Sec. 4.8.16.8)	NA
Support System	All elements of the elevator system shall be anchored. (Tier 2: Sec. 4.8.16.1)	NA
Hazardous Materials Storage and Distribution		
Gas Cylinder Restraints	Compressed gas-cylinders shall be restrained. (Tier 2: Sec. 4.8.15.2)	NA
Hazardous Materials Shutoff Valves	Piping containing hazardous materials shall have shut-off valves or other devices to prevent major spills or leaks. (Tier 2: Sec. 4.8.16.4)	NA
Light Fixtures		
Lens Covers	Lens covers on light fixtures shall be attached or supplied with safety devices. (Tier 2: Sec. 4.8.3.4)	NC
Pendant Supports	Light fixtures on pendant supports shall be attached at a spacing equal to or less than 6 feet and, if rigidly, supported, shall be free to move with the structure to which they are attached without damaging adjoining materials. (Tier 2: Sec. 4.8.3.3)	NA
Masonry Veneer		
Mortar	The mortar in masonry veneer shall not be easily scraped away from the joints by hand with a metal tool, and there shall not be significant areas of eroded mortar. (Tier 2: Sec. 4.8.5.5)	NA
Stone Cracks	There shall be no visible cracks or signs of visible distortion in the stone. (Tier 2: Sec. 4.8.5.7)	NA
Weep Holes	In veneer braced by stud walls, functioning weep holes and base flashing shall be present. (Tier 2: Sec. 4.8.5.6)	NA
Mechanical and Electrical Equipment		
Door Drift Allowance	Mechanically operated doors shall be detailed to operate at a story drift ratio of 0.01. (Tier 2: Sec. 4.8.12.8)	NA
Electrical Equipment Bracing	Electrical equipment and associated wiring shall be laterally braced to the structural system. (Tier 2: Sec. 4.8.12.7)	NA

		Compliance
Heavy Equipment Anchorage	Equipment weighing over 100 pounds shall be anchored to the structure or foundation. (Tier 2: Sec. 4.8.12.6)	C
Vibration Isolators Restrained	Equipment mounted on vibration isolators shall be equipped with restraints or snubbers. (Tier 2: Sec. 4.8.12.4)	NA

Metal Stud Back-Up Systems

Openings	Steel studs shall frame window and door openings. (Tier 2: Sec. 4.8.6.2)	C
Stud Tracks	Stud tracks shall be fastened to structural framing at a spacing equal to or less than 24 inches on center. (Tier 2: Sec. 4.8.6.1)	C

Parapets, Cornices, Ornamentation, and Appendages

Appendages	Cornices, parapets, signs, and other appendages that extend above the highest anchorage level or cantilever from exterior wall faces and other exterior wall ornamentation shall be reinforced and anchored to the structural system at a spacing equal to or less than 10 feet for Life Safety and 6 feet for Immediate Occupancy. This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. f4.8.8.4)	NC
Concrete Parapets	Concrete parapets with height-to-thickness ratios greater than 2.5 shall have vertical reinforcement. (Tier 2: Sec. 4.8.8.3)	NA

Partitions

Drift Allowance	Rigid cementitious partitions shall be detailed to accommodate a drift ratio of 0.02 in steel moment frame, concrete moment frame, and wood frame buildings. Rigid cementitious partitions shall be detailed to accommodate a drift ratio of 0.005 in other buildings. (Tier 2: Sec. 4.8.1.2)	NA
Lateral Bracing for Tops	The tops of framed or panelized partitions that only extend to the ceiling line shall have lateral bracing to the building structure at a spacing equal to or less than 6 feet. (Tier 2: Sec. 4.8.1.4)	NA
Seismic Control Joints	Partitions at structural separations shall have seismic or control joints. (Tier 2: Sec. 4.8.1.3)	NA

		Compliance
Piping		
C-Clamps	One-sided C-clamps that support piping greater than 2.5 inches in diameter shall be restrained. (Tier 2: Sec. 4.8.13.5)	C
Fluid and Gas Piping Anchorage and Bracing	Fluid and gas piping shall be anchored and braced to the structure to prevent breakage in piping. (Tier 2: Sec 4.8.13.3)	C
Shut-Off Valves	Shut-off devices shall be present at building utility interfaces to shut off the flow of gas and high-temperature energy in the event of earthquake-induced failure. (Tier 2: Sec. 4.8.13.4)	C

3.9.2 Intermediate Nonstructural Component Checklist

		Compliance
Ceiling Systems		
Integrated Ceilings	Integrated suspended ceilings at exists and corridors or weighing more than 2 pounds per square foot shall be laterally restrained with a minimum of four diagonal wires or rigid members attached to the structure above at a spacing equal to or less than 12 feet. (Tier 2: Sec. 4.8.2.3)	NA
Lay-In Tiles	Lay-in tiles used in ceiling panels located at exits and corridors shall be secured with clips. (Tier 2: Sec. 4.8.2.2)	C
Suspended Lath and Plaster	Ceilings consisting of suspended lath and plaster or gypsum board shall be attached to resist seismic forced for every 12 square feet of area. (Tier 2: Sec. 4.8.2.4)	C
Cladding and Glazing		
Glazing	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall have safety glazing. Such glazing located over 10 feet above an exterior walking surface shall be laminated, annealed, or laminated heat strengthened safety glass that will remain in the frame when cracked (Tier 2: Sec. 4.8.4.8)	NA
Laminated Safety Glass	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall have safety glazing. Such glazing located over 10 feet above an exterior walking surface shall be laminated annealed or laminated heat-strengthened safety glass or other glazing system that will remain in the frame when glass is cracked. (Tier 2: Sec. 4.8.4.8)	NA
Ducts		
Stair and Smoke Duct Bracing	Stair pressurization and smoke control ducts shall be braced and shall have flexible connections at seismic joints. (Tier 2: Sec. 4.8.14.1)	NA
Light Fixtures		
Independent Support	Light fixtures in suspended grid ceilings shall be supported independently of the ceiling suspension system by a minimum of two wires at diagonally opposite. (Tier 2: Sec. 4.8.3.2)	C

		Compliance
Masonry Chimneys		
Anchorage	Masonry chimneys shall be anchored at each floor level and the roof. (Tier 2: Sec. 4.8.9.2)This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. 4.8.8.4)	NA
Mechanical and Electrical Equipment		
Vibration Isolators Restrained	Equipment mounted on vibration isolators shall be equipped with restraints or snubbers. (Tier 2: Sec. 4.8.12.4)	NA
Parapets, Cornices, Ornamentation, and Appendages		
Appendages	Cornices, parapets, signs, and other appendages that extend above the highest point of anchorage to the structure or cantilever from exterior wall faces and other exterior wall ornamentation shall be reinforced and anchored to the structural system at a spacing equal to or less than 10 feet for Life Safety and 6 feet for Immediate Occupancy. This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. 4.8.8.4)	NC
Concrete Parapets	Concrete parapets with height-to-thickness ratios greater than 2.5 shall have vertical reinforcement. (Tier 2: Sec. 4.8.8.3)	NA

ASCE31 Tier 1 Seismic Screening
Structural and Non-Structural Findings

Effluent Pump Station (EPS) Structure

3.7.13 Reinforced Masonry Bearing Walls with Flexible Diaphragms

Building System

		Compliance
ADJACENT BUILDINGS	The clear distance between the building being evaluated and any adjacent building shall be greater than 4 percent of the height of the shorter building for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.1.2)	C
DETERIORATION OF WOOD	There shall be no signs of decay, shrinkage, splitting, fire damage, or sagging in any of the wood members, and none of the metal connection hardware shall be deteriorated, broken, or loose. (Tier 2: Sec. 4.3.3.1)	NC
GEOMETRY	There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30 percent in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines. (Tier 2: Sec. 4.3.2.3)	NA
LOAD PATH	The structure shall contain a minimum of one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)	C
MASONRY JOINTS	The mortar shall not be easily scraped away from the joints by hand with a metal tool, and there shall be no areas of eroded mortar. (Tier 2: Sec. 4.3.3.8)	NC
MASONRY UNITS	There shall be no visible deterioration of masonry units. (Tier 2: Sec. 4.3.3.7)	NC
MASS	There shall be no change in effective mass more than 50 percent from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses, and mezzanines need not be considered. (Tier 2: Sec. 4.3.2.5)	NA
MEZZANINES	Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.3)	NA

		Compliance
REINFORCED MASONRY WALL CRACKS	All existing diagonal cracks in wall elements shall be less than 1/8 inch for Life Safety and 1/16 inch for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern. (Tier 2: Sec. 4.3.3.10)	NC
SOFT STORY	The stiffness of the lateral-force-resisting system in any story shall not be less than 70 percent of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80 percent of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2)	NA
VERTICAL DISCONTINUITIES	All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)	NA
WEAK STORY	The strength of the lateral-force-resisting system in any story shall not be less than 80 percent of the strength in an adjacent story, above or below, for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)	NA

Connections

FOUNDATION DOWELS	Wall reinforcement shall be doweled into the foundation for Life Safety, and the dowels shall be able to develop the lesser of the strength of the walls or the uplift capacity of the foundation for Immediate Occupancy. (Tier 2: Sec. 4.6.3.5)	NC
GIRDER/COLUMN CONNECTION	There shall be a positive connection utilizing plates, connection hardware, or straps between the girder and the column support. (Tier 2: Sec. 4.6.4.1)	NC
TRANSFER TO SHEAR WALLS	Diaphragms shall be connected for transfer of loads to the shear walls for Life Safety and the connections shall be able to develop the lesser of the shear strength of the walls or diaphragms for Immediate Occupancy. (Tier 2: Sec. 4.6.2.1)	NC
WALL ANCHORAGE	Exterior concrete or masonry walls that are dependent on the diaphragm for lateral support shall be anchored for out-of-plane forces at each diaphragm level with steel anchors, reinforcing dowels, or straps that are developed into the diaphragm. Connections shall have adequate strength to resist the connection force calculated in the Quick Check procedure of Section 3.5.3.7. (Tier 2: Sec. 4.6.1.1)	NC

Effluent Pump Station (EPS) Structure

		Compliance
WOOD LEDGERS	The connection between the wall panels and the diaphragm shall not induce cross-grain bending or tension in the wood ledgers. (Tier 2: Sec. 4.6.1.2)	NC

Lateral Force Resisting System

REDUNDANCY	The number of lines of shear walls in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.1.1)	C
REINFORCING STEEL	The total vertical and horizontal reinforcing steel ratio in reinforced masonry walls shall be greater than 0.002 for Life Safety and Immediate Occupancy of the wall with the minimum of 0.0007 for Life Safety and Immediate Occupancy in either of the two directions; the spacing of reinforcing steel shall be less than 48 inches for Life Safety and Immediate Occupancy; and all vertical bars shall extend to the top of the walls. (Tier 2: Sec. 4.4.2.4.2)	NC
SHEAR STRESS CHECK	The shear stress in the reinforced masonry shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 70 psi for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.4.1)	NC

		Compliance

3.7.13S Reinforced Masonry Bearing Walls with Flexible Diaphragms

Connections

STIFFNESS OF WALL ANCHORS	Anchors of concrete or masonry walls to wood structural elements shall be installed taut and shall be stiff enough to limit the relative movement between the wall and the diaphragm to no greater than 1/8 inch prior to engagement of the anchors. (Tier 2: Sec. 4.6.1.4)	NC

Diaphragms

CROSS TIES	There shall be continuous cross ties between diaphragm chords. (Tier 2: Sec. 4.5.1.2)	NC
DIAPHRAGM REINFORCEMENT AT OPENINGS	There shall be reinforcing around all diaphragm openings larger than 50 percent of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)	NC
NON-CONCRETE FILLED DIAPHRAGMS	Untopped metal deck diaphragms or metal deck diaphragms with fill other than concrete shall consist of horizontal spans of less than 40 feet and shall have span/depth ratios less than 4-to-l. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.3.1)	NA
OPENINGS AT EXTERIOR MASONRY SHEAR WALLS	Diaphragm openings immediately adjacent to exterior masonry shear walls shall not be greater than 8 feet long for Life Safety and 4 feet long for Immediate Occupancy. (Tier 2: Sec. 4.5.1.6)	NA
OPENINGS AT SHEAR WALLS	Diaphragm openings immediately adjacent to the shear walls shall be less than 25 percent of the wall length for Life Safety and 15 percent of the wall length for Immediate Occupancy. (Tier 2: Sec. 4.5.1.4)	NA
OTHER DIAPHRAGMS	The diaphragm shall not consist of a system other than wood, metal deck, concrete, or horizontal bracing. (Tier 2: Sec. 4.5.7.1)	C
PLAN IRREGULARITIES	There shall be tensile capacity to develop the strength of the diaphragm at re-entrant comers or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)	NA
SPANS	All wood diaphragms with spans greater than 24 feet for Life Safety and 12 feet for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing. (Tier 2: Sec. 4.5.2.2)	NC

		Compliance
STRAIGHT SHEATHING	All straight sheathed diaphragms shall have aspect ratios less than 2- to-1 for Life Safety and 1-to-1 for Immediate Occupancy in the direction being considered. (Tier 2: Sec. 4.5.2.1)	NC
UNBLOCKED DIAPHRAGMS	All diagonally sheathed or unblocked wood structural panel diaphragms shall have horizontal spans less than 40 feet for Life Safety and 30 feet for Immediate Occupancy and shall have aspect ratios less than or equal to 4-to-1 for Life Safety and 3-to-l for Immediate Occupancy. (Tier 2: Sec. 4.5.2.3)	NC

Lateral Force Resisting System

PROPORTIONS	The height-to-thickness ratio of the shear walls at each story shall be less than 30. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.4.4)	NC
REINFORCING AT OPENINGS	All wall openings that interrupt rebar shall have trim reinforcing on all sides. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.4.3)	C

Effluent Pump Station (EPS) Structure

3.9.1 Basic Nonstructural Component Checklist

		Compliance
Building Contents and Furnishing		
Tall Narrow Contents	Contents over 4 feet in height with a height-to-depth or height-to-width ratio greater than 3-to-1 shall be anchored to the floor slab or adjacent structural walls. A height-to-depth or height-to-width ratio of up to 4-to-1 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.11.1)	NA
Ceiling Systems		
Integrated Ceilings	Integrated suspended ceilings at exits and corridors or weighing more than 2 lb/ft^2 shall be laterally restrained by a minimum of 4 diagonal wires or rigid members attached to the structure above at a spacing equal to or less than 12 ft (Tier 2: Sec. 4.8.2.1)	NA
Lay-In Tiles	Lay-in tiles used in ceiling panels located at exits and corridors shall be secured with clips. (Tier 2: Sec. 4.8.2.2)	NA
Supporting Partitions	The integrated suspended ceiling system shall not be used to laterally support the tops of gypsum board, masonry, or hollow clay tile partitions. Gypsum board partitions need not be evaluated where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.2.1)	NA
Suspended Lath and Plaster	Ceilings consisting of suspended lath and plaster or gypsum board shall be attached for each 10 square feet of area (Tier 2: Sec. 4.8.2.4)	NA
Cladding and Glazing		
Bearing Connections	Where bearing connections are required, there shall be a minimum of two bearing connections for each wall panel. (Tier 2: Sec. 4.8.4.5)	NA
Cladding Anchorage	Cladding components weighing more than 10 psf shall be mechanically anchored to the exterior wall framing at a spacing equal to or less than 4 feet. A spacing of up to 6 feet is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2 (Tier 2: Sec. 4.8.4.1)	NA
Cladding Isolation	For moment frame buildings of steel or concrete, panel connections shall be detailed to accommodate a drift ratio of 0.02 for Life Safety and 0.01for Immediate Occupancy (Tier 2: Sec. 4.8.4.2)	NA

		Compliance
Connections Out of Plane	Exterior cladding panels shall be anchored out-of-plane with a minimum of 4 connections for each wall panel. Two connections per wall panel are permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.7)	NA
Damage	There shall be no damage to exterior wall cladding. (Tier 4.8.4.8)	NA
Deterioration in Connections	There shall be no evidence of deterioration, damage or corrosion in any of the connection elements. (Tier 2: Sec. 4.8.4.2)	NA
Drift Isolation	For moment frame buildings of steel or concrete, panel connections shall be detailed to accommodate a story drift ratio of 0.02. Panel connection detailing for a story drift ratio of 0.01 is permitted where only the Basic nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.3)	NA
Glazing	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall be laminated, annealed, or heat strengthened safety glass that will remain in the frame when cracked (Tier 2: Sec. 4.8.4.9)	NA
Inserts	Where inserts are used in concrete connections, the inserts shall be anchored to reinforcing steel or other positive anchorage. (Tier 2: Sec. 4.8.4.6)	NA
Multi-Story Panels Drift	For multi-story panels attached at each floor level, panel connections shall be detailed to accommodate a story drift ratio of 0.02 and 0.01 for immediate occupancy. Panel connection detailing for a story drift ratio (Tier 2: Sec. 4.8.4.4)	NA
Panel Connections	Exterior cladding panels shall be anchored with a minimum of 2 connections for each wall panel for Life Safety and 4 connections for Immediate Occupancy. (Tier 2: Sec. 4.8.4.6)	NA

Hazardous Materials Storage and Distribution

Toxic Substances Lateral Bracing and Anchorage	Toxic and hazardous substances stored in breakable containers shall be restrained from falling by latched doors, shelf lips, wires, or other methods. (Tier 2: Sec 4.8.15.1)	NA

		Compliance
Light Fixtures		
Emergency Lighting Anchorage	Emergency lighting shall be anchored or braced to prevent falling or swaying during an earthquake. (Tier 2: Sec. 4.8.3.2)	C
Independent Support	Light fixtures in suspended grid ceilings shall be supported independently of the ceiling suspension system by a minimum of two wires at diagonally opposite corners of the fixtures (Tier 2: Sec. 4.8.3.1)	NA
Masonry Chimneys		
Urm Chimneys	No reinforced masonry chimney shall extend above the roof surface more than twice the least dimension of the chimney. A height above the roof surface of up to three times the least dimension of the chimney is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.9.1)	NA
Masonry Veneer		
Deterioration	There shall be no evidence of deterioration, damage or corrosion in any of the connection elements. (Tier 2: Sec. 4.8.5.4)	NA
Shelf Angles	Masonry veneer shall be supported by shelf angles or other elements at each floor 30 feet or more above ground for Life Safety and at each floor above the first floor for Immediate Occupancy. (Tier 2: Sec. 4.8.5.1)	NA
Ties	Masonry veneer shall be connected to the back-up with corrosion-resistant ties. The ties shall have a spacing equal to or less than 24 inches with a minimum of one tie for every 2-2/3 square feet. A spacing of up to 36 inches is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2. (Tier 2: Sec. 4.8.5.2)	NA
Weakened Planes	Masonry veneer shall be anchored to the back-up adjacent to weakened planes, such as at the locations of flashing. (Tier 2: Sec. 4.8.5.3)	NA
Mechanical and Electrical Equipment		
Attached Equipment	Equipment weighting over 20 lb that is attached to ceilings, walls, or other supports 4 feet above the floor level shall be mounted. (Tier 2: Sec 4.8.12.2)	C

		Compliance
Deterioration	There shall be no evidence of deterioration, damage, or corrosion in any of the anchorage or supports of mechanical or electrical equipment. (Tier 2: Sec. 4.8.12.3)	NC
Emergency Power Mounting	Equipment used as part of an emergency power system shall be mounted to maintain continued operation after an earthquake. (Tier 2: Sec. 4.8.12.1)	C
Hazardous Material Equipment	HVAC or other equipment containing hazardous material shall not have damaged supply lines or unbraced isolation supports. (Tier 2: Sec. 4.8.12.2)	C

Parapets, Cornices, Ornamentation, and Appendages

Canopies	Canopies located at building exits shall be anchored to the structural framing at a spacing of 6 feet or less. An anchorage spacing of up to 10 feet is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.8.2)	NA
Urm Parapets	There shall be no laterally unsupported unreinforced masonry parapets or cornices with height-to-thickness ratios greater than 1.5. A height-to-thickness ratio of up to 2.5 is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2. (Tier 2: Sec. 4.8.8.1)	NA

Partitions

Unreinforced Masonry Bracing	Unreinforced masonry or hollow clay tile partitions shall be braded at a spacing equal to or less than 10 feet in levels of low or moderate seismicity and 6 feet in levels of high seismicity. (Tier 2: Sec. 4.8.1.1)	NA

Piping

Fire Suppression Piping	Fire suppression piping shall be anchored and braced in accordance with NFPA-13 (NFPA, 1996). (Tier 2: Sec. 4.8.13.1)	NC
Flexible Couplings	Fluid, gas, and fire suppression piping shall have flexible couplings. (Tier 2: Sec. 4.8.13.2)	NC

Effluent Pump Station (EPS) Structure

Compliance

Stairs

Stair Details	In moment frame structures, the connection between the stairs and the structure shall not rely on shallow anchors in concrete. Alternatively, the stair details shall be capable of accommodating the drift calculated using the Quick Check procedure of Section 3.5.3.1 without including tension in the anchors. (Tier 2: Sec. 4.8.10.2)	NA
Urm Walls	Walls around stair enclosures shall not consist of unbraced hollow clay tile or unreinforced masonry with a height-to-thickness ratio greater than 12-to-1. A height-to-thickness ratio of up to 15-to-1 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.10.1)	NA

Effluent Pump Station (EPS) Structure

3.9.1S Supplemental Nonstructural Component Checklist

		Compliance
Building Contents and Furnishing		
Access Floor Anchorage	Access floors over 9 inches in height shall be braced. (Tier 2: Sec. 4.8.11.4)	NA
Drawers	Cabinet drawers shall have latches to keep them closed during an earthquake (Tier 2: Sec 4.8.11.3)	NA
Equipment Bracing and Anchorage to Access Floors	Equipment and computers supported on access floor systems shall be either attached to the structure or fastened to a laterally braced floor system. (Tier 2: Sec. 4.8.11.5)	NA
File Cabinets	File cabinets arranged in groups shall be attached to one another. (Tier 2: Sec. 4.8.11.2)	NC
File Cabinets Attachments, Doors, and Drawer Locks	Cabinet doors and drawers shall have latches to keep them closed during an earthquake. (Tier 2: Sec. 4.8.11.3)	NC
Ceiling Systems		
Edges Separation	The edges of integrated suspended ceilings shall be separated from enclosing walls by a minimum of 1/2 inch. (Tier 2: Sec. 4.8.2.5)	NA
Seismic Joint	The ceiling system shall not extend continuously across any seismic joint. (Tier 2: Sec. 4.8.2.6)	NA
Cladding and Glazing		
Safety Glass	All exterior glazing shall be laminated, annealed or laminated heat-strengthened safety glass or other glazing system that will remain in the frame when glass is cracked. (Tier 2: Sec. 4.8.4.9)	NA
Concrete Block and Masonry Back-Up Systems		
Anchorage	Back-up shall have a positive anchorage to the structural framing at a spacing equal to or less than 4 feet along the floors and roof. (Tier 2: Sec. 4.8.7.1)	NA
Concrete Block	Concrete block shall qualify as reinforced masonry (Tier 2: Sec. 4.8.7.1)	NA

		Compliance
Urm Back-Up	There shall be no unreinforced masonry back-up. (Tier 2: Sec. 4.8.7.2)	NA
Ducts		
Duct Bracing	Rectangular ductwork exceeding 6 square feet in cross-sectional area, and round ducts exceeding 28 inches in diameter, shall be braced. Maximum spacing of transverse bracing shall not exceed 30 feet. Maximum spacing of longitudinal bracing shall not exceed 60 feet. Intermediate supports shall not be considered part of the lateral-force resisting system. (Tier 2: Sec. 4.8.14.2)	NC
Duct Supports	Ducts shall not be supported by piping or electrical conduit. (Tier 2: Sec. 4.8.14.3)	C
Stair and Smoke Duct Bracing	Stair pressurization and smoke flow of gas and high temperature energy in the event of an earthquake-induced failure. (Tier 2: Sec. 4.8.13.4)	NA
Elevators		
Brackets	The brackets that tie the car rails and the counterweight rail to the building structure shall be sized in accordance with ASME A17.1. (Tier 2: Sec. 4.8.16.7)	NA
Counterweight Rails	All counterweight rails and divider beams shall be sized in accordance with ASME A17.1. (Tier 2: Sec. 4.8.16.6)	NA
Go-Slow Elevators	The building shall have a go-slow elevator system. (Tier 2: Sec. 4.8.16.9)	NA
Retainer Guards	Cable retainer guards on sheaves and drums shall be present to inhibit the displacement of cables. (Tier 2: Sec. 4.8.16.4)	NA
Retainer Plate	A retainer plate shall be present at the top and bottom of both car and counterweight. (Tier 2: Sec. 4.8.16.5)	NA
Seismic Switch	All elevators shall be equipped with seismic switches that will terminate operations when the ground motion exceeds 0.10g. (Tier 2: Sec. 4.8.16.2)	NA
Shaft Walls	All elevator shaft walls shall be anchored and reinforced to prevent toppling into the shaft during strong shaking. (Tier 2: Sec. 4.8.16.3)	NA

		Compliance
Spreader Bracket	Spreader brackets shall not be used to resist seismic forces. (Tier 2: Sec. 4.8.16.8)	NA
Support System	All elements of the elevator system shall be anchored. (Tier 2: Sec. 4.8.16.1)	NA
Hazardous Materials Storage and Distribution		
Gas Cylinder Restraints	Compressed gas-cylinders shall be restrained. (Tier 2: Sec. 4.8.15.2)	NA
Hazardous Materials Shutoff Valves	Piping containing hazardous materials shall have shut-off valves or other devices to prevent major spills or leaks. (Tier 2: Sec. 4.8.16.4)	C
Light Fixtures		
Lens Covers	Lens covers on light fixtures shall be attached or supplied with safety devices. (Tier 2: Sec. 4.8.3.4)	C
Pendant Supports	Light fixtures on pendant supports shall be attached at a spacing equal to or less than 6 feet and, if rigidly, supported, shall be free to move with the structure to which they are attached without damaging adjoining materials. (Tier 2: Sec. 4.8.3.3)	NA
Masonry Veneer		
Mortar	The mortar in masonry veneer shall not be easily scraped away from the joints by hand with a metal tool, and there shall not be significant areas of eroded mortar. (Tier 2: Sec. 4.8.5.5)	NA
Stone Cracks	There shall be no visible cracks or signs of visible distortion in the stone. (Tier 2: Sec. 4.8.5.7)	NA
Weep Holes	In veneer braced by stud walls, functioning weep holes and base flashing shall be present. (Tier 2: Sec. 4.8.5.6)	NA
Mechanical and Electrical Equipment		
Door Drift Allowance	Mechanically operated doors shall be detailed to operate at a story drift ratio of 0.01. (Tier 2: Sec. 4.8.12.8)	NA
Electrical Equipment Bracing	Electrical equipment and associated wiring shall be laterally braced to the structural system. (Tier 2: Sec. 4.8.12.7)	NA

Effluent Pump Station (EPS) Structure

		Compliance
Heavy Equipment Anchorage	Equipment weighing over 100 pounds shall be anchored to the structure or foundation. (Tier 2: Sec. 4.8.12.6)	C
Vibration Isolators Restrained	Equipment mounted on vibration isolators shall be equipped with restraints or snubbers. (Tier 2: Sec. 4.8.12.4)	NC

Metal Stud Back-Up Systems

Openings	Steel studs shall frame window and door openings. (Tier 2: Sec. 4.8.6.2)	C
Stud Tracks	Stud tracks shall be fastened to structural framing at a spacing equal to or less than 24 inches on center. (Tier 2: Sec. 4.8.6.1)	C

Parapets, Cornices, Ornamentation, and Appendages

Appendages	Cornices, parapets, signs, and other appendages that extend above the highest anchorage level or cantilever from exterior wall faces and other exterior wall ornamentation shall be reinforced and anchored to the structural system at a spacing equal to or less than 10 feet for Life Safety and 6 feet for Immediate Occupancy. This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. f4.8.8.4)	NA
Concrete Parapets	Concrete parapets with height-to-thickness ratios greater than 2.5 shall have vertical reinforcement. (Tier 2: Sec. 4.8.8.3)	NA

Partitions

Drift Allowance	Rigid cementitious partitions shall be detailed to accommodate a drift ratio of 0.02 in steel moment frame, concrete moment frame, and wood frame buildings. Rigid cementitious partitions shall be detailed to accommodate a drift ratio of 0.005 in other buildings. (Tier 2: Sec. 4.8.1.2)	NA
Lateral Bracing for Tops	The tops of framed or panelized partitions that only extend to the ceiling line shall have lateral bracing to the building structure at a spacing equal to or less than 6 feet. (Tier 2: Sec. 4.8.1.4)	NA
Seismic Control Joints	Partitions at structural separations shall have seismic or control joints. (Tier 2: Sec. 4.8.1.3)	NA

Effluent Pump Station (EPS) Structure

Piping

		Compliance
C-Clamps	One-sided C-clamps that support piping greater than 2.5 inches in diameter shall be restrained. (Tier 2: Sec. 4.8.13.5)	C
Fluid and Gas Piping Anchorage and Bracing	Fluid and gas piping shall be anchored and braced to the structure to prevent breakage in piping. (Tier 2: Sec 4.8.13.3)	C
Shut-Off Valves	Shut-off devices shall be present at building utility interfaces to shut off the flow of gas and high-temperature energy in the event of earthquake-induced failure. (Tier 2: Sec. 4.8.13.4)	C

3.9.2 Intermediate Nonstructural Component Checklist

		Compliance
Ceiling Systems		
Integrated Ceilings	Integrated suspended ceilings at exists and corridors or weighing more than 2 pounds per square foot shall be laterally restrained with a minimum of four diagonal wires or rigid members attached to the structure above at a spacing equal to or less than 12 feet. (Tier 2: Sec. 4.8.2.3)	NA
Lay-In Tiles	Lay-in tiles used in ceiling panels located at exits and corridors shall be secured with clips. (Tier 2: Sec. 4.8.2.2)	NA
Suspended Lath and Plaster	Ceilings consisting of suspended lath and plaster or gypsum board shall be attached to resist seismic forced for every 12 square feet of area. (Tier 2: Sec. 4.8.2.4)	NA
Cladding and Glazing		
Glazing	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall have safety glazing. Such glazing located over 10 feet above an exterior walking surface shall be laminated, annealed, or laminated heat strengthened safety glass that will remain in the frame when cracked (Tier 2: Sec. 4.8.4.8)	NA
Laminated Safety Glass	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall have safety glazing. Such glazing located over 10 feet above an exterior walking surface shall be laminated annealed or laminated heat-strengthened safety glass or other glazing system that will remain in the frame when glass is cracked. (Tier 2: Sec. 4.8.4.8)	NA
Ducts		
Stair and Smoke Duct Bracing	Stair pressurization and smoke control ducts shall be braced and shall have flexible connections at seismic joints. (Tier 2: Sec. 4.8.14.1)	NA
Light Fixtures		
Independent Support	Light fixtures in suspended grid ceilings shall be supported independently of the ceiling suspension system by a minimum of two wires at diagonally opposite. (Tier 2: Sec. 4.8.3.2)	NA

Effluent Pump Station (EPS) Structure

		Compliance
Masonry Chimneys		
Anchorage	Masonry chimneys shall be anchored at each floor level and the roof. (Tier 2: Sec. 4.8.9.2)This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. 4.8.8.4)	NA
Mechanical and Electrical Equipment		
Vibration Isolators Restrained	Equipment mounted on vibration isolators shall be equipped with restraints or snubbers. (Tier 2: Sec. 4.8.12.4)	NC
Parapets, Cornices, Ornamentation, and Appendages		
Appendages	Cornices, parapets, signs, and other appendages that extend above the highest point of anchorage to the structure or cantilever from exterior wall faces and other exterior wall ornamentation shall be reinforced and anchored to the structural system at a spacing equal to or less than 10 feet for Life Safety and 6 feet for Immediate Occupancy. This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. 4.8.8.4)	NA
Concrete Parapets	Concrete parapets with height-to-thickness ratios greater than 2.5 shall have vertical reinforcement. (Tier 2: Sec. 4.8.8.3)	NA

ASCE31 Tier 1 Seismic Screening
Structural and Non-Structural Findings

Co-Generation Building

Compliance

3.7.13 Reinforced Masonry Bearing Walls with Flexible Diaphragms

Building System

		Compliance
ADJACENT BUILDINGS	The clear distance between the building being evaluated and any adjacent building shall be greater than 4 percent of the height of the shorter building for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.1.2)	C
DETERIORATION OF WOOD	There shall be no signs of decay, shrinkage, splitting, fire damage, or sagging in any of the wood members, and none of the metal connection hardware shall be deteriorated, broken, or loose. (Tier 2: Sec. 4.3.3.1)	NC
GEOMETRY	There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30 percent in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines. (Tier 2: Sec. 4.3.2.3)	NA
LOAD PATH	The structure shall contain a minimum of one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)	C
MASONRY JOINTS	The mortar shall not be easily scraped away from the joints by hand with a metal tool, and there shall be no areas of eroded mortar. (Tier 2: Sec. 4.3.3.8)	C
MASONRY UNITS	There shall be no visible deterioration of masonry units. (Tier 2: Sec. 4.3.3.7)	NC
MASS	There shall be no change in effective mass more than 50 percent from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses, and mezzanines need not be considered. (Tier 2: Sec. 4.3.2.5)	C
MEZZANINES	Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.3)	C

		Compliance
REINFORCED MASONRY WALL CRACKS	All existing diagonal cracks in wall elements shall be less than 1/8 inch for Life Safety and 1/16 inch for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern. (Tier 2: Sec. 4.3.3.10)	C
SOFT STORY	The stiffness of the lateral-force-resisting system in any story shall not be less than 70 percent of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80 percent of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2)	C
VERTICAL DISCONTINUITIES	All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)	C
WEAK STORY	The strength of the lateral-force-resisting system in any story shall not be less than 80 percent of the strength in an adjacent story, above or below, for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)	C
Connections		
FOUNDATION DOWELS	Wall reinforcement shall be doweled into the foundation for Life Safety, and the dowels shall be able to develop the lesser of the strength of the walls or the uplift capacity of the foundation for Immediate Occupancy. (Tier 2: Sec. 4.6.3.5)	C
GIRDER/COLUMN CONNECTION	There shall be a positive connection utilizing plates, connection hardware, or straps between the girder and the column support. (Tier 2: Sec. 4.6.4.1)	C
TRANSFER TO SHEAR WALLS	Diaphragms shall be connected for transfer of loads to the shear walls for Life Safety and the connections shall be able to develop the lesser of the shear strength of the walls or diaphragms for Immediate Occupancy. (Tier 2: Sec. 4.6.2.1)	C
WALL ANCHORAGE	Exterior concrete or masonry walls that are dependent on the diaphragm for lateral support shall be anchored for out-of-plane forces at each diaphragm level with steel anchors, reinforcing dowels, or straps that are developed into the diaphragm. Connections shall have adequate strength to resist the connection force calculated in the Quick Check procedure of Section 3.5.3.7. (Tier 2: Sec. 4.6.1.1)	C

		Compliance
WOOD LEDGERS	The connection between the wall panels and the diaphragm shall not induce cross-grain bending or tension in the wood ledgers. (Tier 2: Sec. 4.6.1.2)	C

Lateral Force Resisting System

REDUNDANCY	The number of lines of shear walls in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.1.1)	C
REINFORCING STEEL	The total vertical and horizontal reinforcing steel ratio in reinforced masonry walls shall be greater than 0.002 for Life Safety and Immediate Occupancy of the wall with the minimum of 0.0007 for Life Safety and Immediate Occupancy in either of the two directions; the spacing of reinforcing steel shall be less than 48 inches for Life Safety and Immediate Occupancy; and all vertical bars shall extend to the top of the walls. (Tier 2: Sec. 4.4.2.4.2)	NC
SHEAR STRESS CHECK	The shear stress in the reinforced masonry shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 70 psi for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.4.1)	C

3.7.13S Reinforced Masonry Bearing Walls with Flexible Diaphragms

Connections

		Compliance
STIFFNESS OF WALL ANCHORS	Anchors of concrete or masonry walls to wood structural elements shall be installed taut and shall be stiff enough to limit the relative movement between the wall and the diaphragm to no greater than 1/8 inch prior to engagement of the anchors. (Tier 2: Sec. 4.6.1.4)	C

Diaphragms

		Compliance
CROSS TIES	There shall be continuous cross ties between diaphragm chords. (Tier 2: Sec. 4.5.1.2)	NC
DIAPHRAGM REINFORCEMENT AT OPENINGS	There shall be reinforcing around all diaphragm openings larger than 50 percent of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)	C
NON-CONCRETE FILLED DIAPHRAGMS	Untopped metal deck diaphragms or metal deck diaphragms with fill other than concrete shall consist of horizontal spans of less than 40 feet and shall have span/depth ratios less than 4-to-l. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.3.1)	C
OPENINGS AT EXTERIOR MASONRY SHEAR WALLS	Diaphragm openings immediately adjacent to exterior masonry shear walls shall not be greater than 8 feet long for Life Safety and 4 feet long for Immediate Occupancy. (Tier 2: Sec. 4.5.1.6)	C
OPENINGS AT SHEAR WALLS	Diaphragm openings immediately adjacent to the shear walls shall be less than 25 percent of the wall length for Life Safety and 15 percent of the wall length for Immediate Occupancy. (Tier 2: Sec. 4.5.1.4)	C
OTHER DIAPHRAGMS	The diaphragm shall not consist of a system other than wood, metal deck, concrete, or horizontal bracing. (Tier 2: Sec. 4.5.7.1)	C
PLAN IRREGULARITIES	There shall be tensile capacity to develop the strength of the diaphragm at re-entrant comers or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)	NA
SPANS	All wood diaphragms with spans greater than 24 feet for Life Safety and 12 feet for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing. (Tier 2: Sec. 4.5.2.2)	C

		Compliance
STRAIGHT SHEATHING	All straight sheathed diaphragms shall have aspect ratios less than 2- to-1 for Life Safety and 1-to-1 for Immediate Occupancy in the direction being considered. (Tier 2: Sec. 4.5.2.1)	C
UNBLOCKED DIAPHRAGMS	All diagonally sheathed or unblocked wood structural panel diaphragms shall have horizontal spans less than 40 feet for Life Safety and 30 feet for Immediate Occupancy and shall have aspect ratios less than or equal to 4-to-1 for Life Safety and 3-to-l for Immediate Occupancy. (Tier 2: Sec. 4.5.2.3)	NC

Lateral Force Resisting System

PROPORTIONS	The height-to-thickness ratio of the shear walls at each story shall be less than 30. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.4.4)	C
REINFORCING AT OPENINGS	All wall openings that interrupt rebar shall have trim reinforcing on all sides. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.4.3)	C

3.9.1 Basic Nonstructural Component Checklist

		Compliance
Building Contents and Furnishing		
Tall Narrow Contents	Contents over 4 feet in height with a height-to-depth or height-to-width ratio greater than 3-to-1 shall be anchored to the floor slab or adjacent structural walls. A height-to-depth or height-to-width ratio of up to 4-to-1 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.11.1)	C
Ceiling Systems		
Integrated Ceilings	Integrated suspended ceilings at exits and corridors or weighing more than 2 lb/ft^2 shall be laterally restrained by a minimum of 4 diagonal wires or rigid members attached to the structure above at a spacing equal to or less than 12 ft (Tier 2: Sec. 4.8.2.1)	NA
Lay-In Tiles	Lay-in tiles used in ceiling panels located at exits and corridors shall be secured with clips. (Tier 2: Sec. 4.8.2.2)	C
Supporting Partitions	The integrated suspended ceiling system shall not be used to laterally support the tops of gypsum board, masonry, or hollow clay tile partitions. Gypsum board partitions need not be evaluated where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.2.1)	C
Suspended Lath and Plaster	Ceilings consisting of suspended lath and plaster or gypsum board shall be attached for each 10 square feet of area (Tier 2: Sec. 4.8.2.4)	C
Cladding and Glazing		
Bearing Connections	Where bearing connections are required, there shall be a minimum of two bearing connections for each wall panel. (Tier 2: Sec. 4.8.4.5)	NA
Cladding Anchorage	Cladding components weighing more than 10 psf shall be mechanically anchored to the exterior wall framing at a spacing equal to or less than 4 feet. A spacing of up to 6 feet is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2 (Tier 2: Sec. 4.8.4.1)	NA
Cladding Isolation	For moment frame buildings of steel or concrete, panel connections shall be detailed to accommodate a drift ratio of 0.02 for Life Safety and 0.01for Immediate Occupancy (Tier 2: Sec. 4.8.4.2)	NA

		Compliance
Connections Out of Plane	Exterior cladding panels shall be anchored out-of-plane with a minimum of 4 connections for each wall panel. Two connections per wall panel are permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.7)	NA
Damage	There shall be no damage to exterior wall cladding. (Tier 4.8.4.8)	NA
Deterioration in Connections	There shall be no evidence of deterioration, damage or corrosion in any of the connection elements. (Tier 2: Sec. 4.8.4.2)	NA
Drift Isolation	For moment frame buildings of steel or concrete, panel connections shall be detailed to accommodate a story drift ratio of 0.02. Panel connection detailing for a story drift ratio of 0.01 is permitted where only the Basic nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.3)	NA
Glazing	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall be laminated, annealed, or heat strengthened safety glass that will remain in the frame when cracked (Tier 2: Sec. 4.8.4.9)	NA
Inserts	Where inserts are used in concrete connections, the inserts shall be anchored to reinforcing steel or other positive anchorage. (Tier 2: Sec. 4.8.4.6)	NA
Multi-Story Panels Drift	For multi-story panels attached at each floor level, panel connections shall be detailed to accommodate a story drift ratio of 0.02 and 0.01 for immediate occupancy. Panel connection detailing for a story drift ratio (Tier 2: Sec. 4.8.4.4)	NA
Panel Connections	Exterior cladding panels shall be anchored with a minimum of 2 connections for each wall panel for Life Safety and 4 connections for Immediate Occupancy. (Tier 2: Sec. 4.8.4.6)	NA

Hazardous Materials Storage and Distribution

Toxic Substances Lateral Bracing and Anchorage	Toxic and hazardous substances stored in breakable containers shall be restrained from falling by latched doors, shelf lips, wires, or other methods. (Tier 2: Sec 4.8.15.1)	C

		Compliance
Light Fixtures		
Emergency Lighting Anchorage	Emergency lighting shall be anchored or braced to prevent falling or swaying during an earthquake. (Tier 2: Sec. 4.8.3.2)	C
Independent Support	Light fixtures in suspended grid ceilings shall be supported independently of the ceiling suspension system by a minimum of two wires at diagonally opposite corners of the fixtures (Tier 2: Sec. 4.8.3.1)	C
Masonry Chimneys		
Urm Chimneys	No reinforced masonry chimney shall extend above the roof surface more than twice the least dimension of the chimney. A height above the roof surface of up to three times the least dimension of the chimney is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.9.1)	NA
Masonry Veneer		
Deterioration	There shall be no evidence of deterioration, damage or corrosion in any of the connection elements. (Tier 2: Sec. 4.8.5.4)	NA
Shelf Angles	Masonry veneer shall be supported by shelf angles or other elements at each floor 30 feet or more above ground for Life Safety and at each floor above the first floor for Immediate Occupancy. (Tier 2: Sec. 4.8.5.1)	NA
Ties	Masonry veneer shall be connected to the back-up with corrosion-resistant ties. The ties shall have a spacing equal to or less than 24 inches with a minimum of one tie for every 2-2/3 square feet. A spacing of up to 36 inches is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2. (Tier 2: Sec. 4.8.5.2)	NA
Weakened Planes	Masonry veneer shall be anchored to the back-up adjacent to weakened planes, such as at the locations of flashing. (Tier 2: Sec. 4.8.5.3)	NA
Mechanical and Electrical Equipment		
Attached Equipment	Equipment weighting over 20 lb that is attached to ceilings, walls, or other supports 4 feet above the floor level shall be mounted. (Tier 2: Sec 4.8.12.2)	C

		Compliance
Deterioration	There shall be no evidence of deterioration, damage, or corrosion in any of the anchorage or supports of mechanical or electrical equipment. (Tier 2: Sec. 4.8.12.3)	NC
Emergency Power Mounting	Equipment used as part of an emergency power system shall be mounted to maintain continued operation after an earthquake. (Tier 2: Sec. 4.8.12.1)	C
Hazardous Material Equipment	HVAC or other equipment containing hazardous material shall not have damaged supply lines or unbraced isolation supports. (Tier 2: Sec. 4.8.12.2)	NA

Parapets, Cornices, Ornamentation, and Appendages

Canopies	Canopies located at building exits shall be anchored to the structural framing at a spacing of 6 feet or less. An anchorage spacing of up to 10 feet is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.8.2)	NA
Urm Parapets	There shall be no laterally unsupported unreinforced masonry parapets or cornices with height-to-thickness ratios greater than 1.5. A height-to-thickness ratio of up to 2.5 is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2. (Tier 2: Sec. 4.8.8.1)	NC

Partitions

Unreinforced Masonry Bracing	Unreinforced masonry or hollow clay tile partitions shall be braded at a spacing equal to or less than 10 feet in levels of low or moderate seismicity and 6 feet in levels of high seismicity. (Tier 2: Sec. 4.8.1.1)	NA

Piping

Fire Suppression Piping	Fire suppression piping shall be anchored and braced in accordance with NFPA-13 (NFPA, 1996). (Tier 2: Sec. 4.8.13.1)	NC
Flexible Couplings	Fluid, gas, and fire suppression piping shall have flexible couplings. (Tier 2: Sec. 4.8.13.2)	NC

		Compliance
Stairs		
Stair Details	In moment frame structures, the connection between the stairs and the structure shall not rely on shallow anchors in concrete. Alternatively, the stair details shall be capable of accommodating the drift calculated using the Quick Check procedure of Section 3.5.3.1 without including tension in the anchors. (Tier 2: Sec. 4.8.10.2)	NA
Urm Walls	Walls around stair enclosures shall not consist of unbraced hollow clay tile or unreinforced masonry with a height-to-thickness ratio greater than 12-to-1. A height-to-thickness ratio of up to 15-to-1 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.10.1)	NA

Compliance

3.9.1S Supplemental Nonstructural Component Checklist

Building Contents and Furnishing

Access Floor Anchorage	Access floors over 9 inches in height shall be braced. (Tier 2: Sec. 4.8.11.4)	NA
Drawers	Cabinet drawers shall have latches to keep them closed during an earthquake (Tier 2: Sec 4.8.11.3)	NC
Equipment Bracing and Anchorage to Access Floors	Equipment and computers supported on access floor systems shall be either attached to the structure or fastened to a laterally braced floor system. (Tier 2: Sec. 4.8.11.5)	NA
File Cabinets	File cabinets arranged in groups shall be attached to one another. (Tier 2: Sec. 4.8.11.2)	NC
File Cabinets Attachments, Doors, and Drawer Locks	Cabinet doors and drawers shall have latches to keep them closed during an earthquake. (Tier 2: Sec. 4.8.11.3)	NC

Ceiling Systems

Edges Separation	The edges of integrated suspended ceilings shall be separated from enclosing walls by a minimum of 1/2 inch. (Tier 2: Sec. 4.8.2.5)	C
Seismic Joint	The ceiling system shall not extend continuously across any seismic joint. (Tier 2: Sec. 4.8.2.6)	C

Cladding and Glazing

Safety Glass	All exterior glazing shall be laminated, annealed or laminated heat-strengthened safety glass or other glazing system that will remain in the frame when glass is cracked. (Tier 2: Sec. 4.8.4.9)	NA

Concrete Block and Masonry Back-Up Systems

Anchorage	Back-up shall have a positive anchorage to the structural framing at a spacing equal to or less than 4 feet along the floors and roof. (Tier 2: Sec. 4.8.7.1)	C
Concrete Block	Concrete block shall qualify as reinforced masonry (Tier 2: Sec. 4.8.7.1)	C

		Compliance
Urm Back-Up	There shall be no unreinforced masonry back-up. (Tier 2: Sec. 4.8.7.2)	C
Ducts		
Duct Bracing	Rectangular ductwork exceeding 6 square feet in cross-sectional area, and round ducts exceeding 28 inches in diameter, shall be braced. Maximum spacing of transverse bracing shall not exceed 30 feet. Maximum spacing of longitudinal bracing shall not exceed 60 feet. Intermediate supports shall not be considered part of the lateral-force resisting system. (Tier 2: Sec. 4.8.14.2)	NC
Duct Supports	Ducts shall not be supported by piping or electrical conduit. (Tier 2: Sec. 4.8.14.3)	C
Stair and Smoke Duct Bracing	Stair pressurization and smoke flow of gas and high temperature energy in the event of an earthquake-induced failure. (Tier 2: Sec. 4.8.13.4)	NA
Elevators		
Brackets	The brackets that tie the car rails and the counterweight rail to the building structure shall be sized in accordance with ASME A17.1. (Tier 2: Sec. 4.8.16.7)	NA
Counterweight Rails	All counterweight rails and divider beams shall be sized in accordance with ASME A17.1. (Tier 2: Sec. 4.8.16.6)	NA
Go-Slow Elevators	The building shall have a go-slow elevator system. (Tier 2: Sec. 4.8.16.9)	NA
Retainer Guards	Cable retainer guards on sheaves and drums shall be present to inhibit the displacement of cables. (Tier 2: Sec. 4.8.16.4)	NA
Retainer Plate	A retainer plate shall be present at the top and bottom of both car and counterweight. (Tier 2: Sec. 4.8.16.5)	NA
Seismic Switch	All elevators shall be equipped with seismic switches that will terminate operations when the ground motion exceeds 0.10g. (Tier 2: Sec. 4.8.16.2)	NA
Shaft Walls	All elevator shaft walls shall be anchored and reinforced to prevent toppling into the shaft during strong shaking. (Tier 2: Sec. 4.8.16.3)	NA

		Compliance
Spreader Bracket	Spreader brackets shall not be used to resist seismic forces. (Tier 2: Sec. 4.8.16.8)	NA
Support System	All elements of the elevator system shall be anchored. (Tier 2: Sec. 4.8.16.1)	NA
Hazardous Materials Storage and Distribution		
Gas Cylinder Restraints	Compressed gas-cylinders shall be restrained. (Tier 2: Sec. 4.8.15.2)	C
Hazardous Materials Shutoff Valves	Piping containing hazardous materials shall have shut-off valves or other devices to prevent major spills or leaks. (Tier 2: Sec. 4.8.16.4)	C
Light Fixtures		
Lens Covers	Lens covers on light fixtures shall be attached or supplied with safety devices. (Tier 2: Sec. 4.8.3.4)	C
Pendant Supports	Light fixtures on pendant supports shall be attached at a spacing equal to or less than 6 feet and, if rigidly, supported, shall be free to move with the structure to which they are attached without damaging adjoining materials. (Tier 2: Sec. 4.8.3.3)	C
Masonry Veneer		
Mortar	The mortar in masonry veneer shall not be easily scraped away from the joints by hand with a metal tool, and there shall not be significant areas of eroded mortar. (Tier 2: Sec. 4.8.5.5)	NA
Stone Cracks	There shall be no visible cracks or signs of visible distortion in the stone. (Tier 2: Sec. 4.8.5.7)	NA
Weep Holes	In veneer braced by stud walls, functioning weep holes and base flashing shall be present. (Tier 2: Sec. 4.8.5.6)	NA
Mechanical and Electrical Equipment		
Door Drift Allowance	Mechanically operated doors shall be detailed to operate at a story drift ratio of 0.01. (Tier 2: Sec. 4.8.12.8)	NA
Electrical Equipment Bracing	Electrical equipment and associated wiring shall be laterally braced to the structural system. (Tier 2: Sec. 4.8.12.7)	NC

		Compliance
Heavy Equipment Anchorage	Equipment weighing over 100 pounds shall be anchored to the structure or foundation. (Tier 2: Sec. 4.8.12.6)	C
Vibration Isolators Restrained	Equipment mounted on vibration isolators shall be equipped with restraints or snubbers. (Tier 2: Sec. 4.8.12.4)	NC

Metal Stud Back-Up Systems

Openings	Steel studs shall frame window and door openings. (Tier 2: Sec. 4.8.6.2)	C
Stud Tracks	Stud tracks shall be fastened to structural framing at a spacing equal to or less than 24 inches on center. (Tier 2: Sec. 4.8.6.1)	C

Parapets, Cornices, Ornamentation, and Appendages

Appendages	Cornices, parapets, signs, and other appendages that extend above the highest anchorage level or cantilever from exterior wall faces and other exterior wall ornamentation shall be reinforced and anchored to the structural system at a spacing equal to or less than 10 feet for Life Safety and 6 feet for Immediate Occupancy. This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. f4.8.8.4)	NC
Concrete Parapets	Concrete parapets with height-to-thickness ratios greater than 2.5 shall have vertical reinforcement. (Tier 2: Sec. 4.8.8.3)	NA

Partitions

Drift Allowance	Rigid cementitious partitions shall be detailed to accommodate a drift ratio of 0.02 in steel moment frame, concrete moment frame, and wood frame buildings. Rigid cementitious partitions shall be detailed to accommodate a drift ratio of 0.005 in other buildings. (Tier 2: Sec. 4.8.1.2)	NA
Lateral Bracing for Tops	The tops of framed or panelized partitions that only extend to the ceiling line shall have lateral bracing to the building structure at a spacing equal to or less than 6 feet. (Tier 2: Sec. 4.8.1.4)	NA
Seismic Control Joints	Partitions at structural separations shall have seismic or control joints. (Tier 2: Sec. 4.8.1.3)	NA

Co-Generation Building

Piping		Compliance
C-Clamps	One-sided C-clamps that support piping greater than 2.5 inches in diameter shall be restrained. (Tier 2: Sec. 4.8.13.5)	C
Fluid and Gas Piping Anchorage and Bracing	Fluid and gas piping shall be anchored and braced to the structure to prevent breakage in piping. (Tier 2: Sec 4.8.13.3)	C
Shut-Off Valves	Shut-off devices shall be present at building utility interfaces to shut off the flow of gas and high-temperature energy in the event of earthquake-induced failure. (Tier 2: Sec. 4.8.13.4)	C

Compliance

3.9.2 Intermediate Nonstructural Component Checklist

Ceiling Systems		
Integrated Ceilings	Integrated suspended ceilings at exists and corridors or weighing more than 2 pounds per square foot shall be laterally restrained with a minimum of four diagonal wires or rigid members attached to the structure above at a spacing equal to or less than 12 feet. (Tier 2: Sec. 4.8.2.3)	NA
Lay-In Tiles	Lay-in tiles used in ceiling panels located at exits and corridors shall be secured with clips. (Tier 2: Sec. 4.8.2.2)	C
Suspended Lath and Plaster	Ceilings consisting of suspended lath and plaster or gypsum board shall be attached to resist seismic forced for every 12 square feet of area. (Tier 2: Sec. 4.8.2.4)	C
Cladding and Glazing		
Glazing	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall have safety glazing. Such glazing located over 10 feet above an exterior walking surface shall be laminated, annealed, or laminated heat strengthened safety glass that will remain in the frame when cracked (Tier 2: Sec. 4.8.4.8)	NA
Laminated Safety Glass	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall have safety glazing. Such glazing located over 10 feet above an exterior walking surface shall be laminated annealed or laminated heat-strengthened safety glass or other glazing system that will remain in the frame when glass is cracked. (Tier 2: Sec. 4.8.4.8)	NA
Ducts		
Stair and Smoke Duct Bracing	Stair pressurization and smoke control ducts shall be braced and shall have flexible connections at seismic joints. (Tier 2: Sec. 4.8.14.1)	NA
Light Fixtures		
Independent Support	Light fixtures in suspended grid ceilings shall be supported independently of the ceiling suspension system by a minimum of two wires at diagonally opposite. (Tier 2: Sec. 4.8.3.2)	C

		Compliance
Masonry Chimneys		
Anchorage	Masonry chimneys shall be anchored at each floor level and the roof. (Tier 2: Sec. 4.8.9.2)This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. 4.8.8.4)	NA
Mechanical and Electrical Equipment		
Vibration Isolators Restrained	Equipment mounted on vibration isolators shall be equipped with restraints or snubbers. (Tier 2: Sec. 4.8.12.4)	NA
Parapets, Cornices, Ornamentation, and Appendages		
Appendages	Cornices, parapets, signs, and other appendages that extend above the highest point of anchorage to the structure or cantilever from exterior wall faces and other exterior wall ornamentation shall be reinforced and anchored to the structural system at a spacing equal to or less than 10 feet for Life Safety and 6 feet for Immediate Occupancy. This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. 4.8.8.4)	NA
Concrete Parapets	Concrete parapets with height-to-thickness ratios greater than 2.5 shall have vertical reinforcement. (Tier 2: Sec. 4.8.8.3)	NA

ASCE31 Tier 1 Seismic Screening
Structural and Non-Structural Findings

Maintenance Building

3.7.13 Reinforced Masonry Bearing Walls with Flexible Diaphragms

Building System

		Compliance
ADJACENT BUILDINGS	The clear distance between the building being evaluated and any adjacent building shall be greater than 4 percent of the height of the shorter building for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.1.2)	C
DETERIORATION OF WOOD	There shall be no signs of decay, shrinkage, splitting, fire damage, or sagging in any of the wood members, and none of the metal connection hardware shall be deteriorated, broken, or loose. (Tier 2: Sec. 4.3.3.1)	NC
GEOMETRY	There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30 percent in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines. (Tier 2: Sec. 4.3.2.3)	NA
LOAD PATH	The structure shall contain a minimum of one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)	C
MASONRY JOINTS	The mortar shall not be easily scraped away from the joints by hand with a metal tool, and there shall be no areas of eroded mortar. (Tier 2: Sec. 4.3.3.8)	C
MASONRY UNITS	There shall be no visible deterioration of masonry units. (Tier 2: Sec. 4.3.3.7)	C
MASS	There shall be no change in effective mass more than 50 percent from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses, and mezzanines need not be considered. (Tier 2: Sec. 4.3.2.5)	NA
MEZZANINES	Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.3)	NA

		Compliance
REINFORCED MASONRY WALL CRACKS	All existing diagonal cracks in wall elements shall be less than 1/8 inch for Life Safety and 1/16 inch for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern. (Tier 2: Sec. 4.3.3.10)	C
SOFT STORY	The stiffness of the lateral-force-resisting system in any story shall not be less than 70 percent of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80 percent of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2)	NA
VERTICAL DISCONTINUITIES	All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)	C
WEAK STORY	The strength of the lateral-force-resisting system in any story shall not be less than 80 percent of the strength in an adjacent story, above or below, for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)	NA

Connections

FOUNDATION DOWELS	Wall reinforcement shall be doweled into the foundation for Life Safety, and the dowels shall be able to develop the lesser of the strength of the walls or the uplift capacity of the foundation for Immediate Occupancy. (Tier 2: Sec. 4.6.3.5)	NC
GIRDER/COLUMN CONNECTION	There shall be a positive connection utilizing plates, connection hardware, or straps between the girder and the column support. (Tier 2: Sec. 4.6.4.1)	NC
TRANSFER TO SHEAR WALLS	Diaphragms shall be connected for transfer of loads to the shear walls for Life Safety and the connections shall be able to develop the lesser of the shear strength of the walls or diaphragms for Immediate Occupancy. (Tier 2: Sec. 4.6.2.1)	NC
WALL ANCHORAGE	Exterior concrete or masonry walls that are dependent on the diaphragm for lateral support shall be anchored for out-of-plane forces at each diaphragm level with steel anchors, reinforcing dowels, or straps that are developed into the diaphragm. Connections shall have adequate strength to resist the connection force calculated in the Quick Check procedure of Section 3.5.3.7. (Tier 2: Sec. 4.6.1.1)	NC

		Compliance
WOOD LEDGERS	The connection between the wall panels and the diaphragm shall not induce cross-grain bending or tension in the wood ledgers. (Tier 2: Sec. 4.6.1.2)	NC

Lateral Force Resisting System

REDUNDANCY	The number of lines of shear walls in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.1.1)	NC
REINFORCING STEEL	The total vertical and horizontal reinforcing steel ratio in reinforced masonry walls shall be greater than 0.002 for Life Safety and Immediate Occupancy of the wall with the minimum of 0.0007 for Life Safety and Immediate Occupancy in either of the two directions; the spacing of reinforcing steel shall be less than 48 inches for Life Safety and Immediate Occupancy; and all vertical bars shall extend to the top of the walls. (Tier 2: Sec. 4.4.2.4.2)	C
SHEAR STRESS CHECK	The shear stress in the reinforced masonry shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 70 psi for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.4.1)	NC

3.7.13S Reinforced Masonry Bearing Walls with Flexible Diaphragms

Connections

STIFFNESS OF WALL ANCHORS	Anchors of concrete or masonry walls to wood structural elements shall be installed taut and shall be stiff enough to limit the relative movement between the wall and the diaphragm to no greater than 1/8 inch prior to engagement of the anchors. (Tier 2: Sec. 4.6.1.4)	NC

Diaphragms

CROSS TIES	There shall be continuous cross ties between diaphragm chords. (Tier 2: Sec. 4.5.1.2)	NC
DIAPHRAGM REINFORCEMENT AT OPENINGS	There shall be reinforcing around all diaphragm openings larger than 50 percent of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)	NC
NON-CONCRETE FILLED DIAPHRAGMS	Untopped metal deck diaphragms or metal deck diaphragms with fill other than concrete shall consist of horizontal spans of less than 40 feet and shall have span/depth ratios less than 4-to-l. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.3.1)	NA
OPENINGS AT EXTERIOR MASONRY SHEAR WALLS	Diaphragm openings immediately adjacent to exterior masonry shear walls shall not be greater than 8 feet long for Life Safety and 4 feet long for Immediate Occupancy. (Tier 2: Sec. 4.5.1.6)	NC
OPENINGS AT SHEAR WALLS	Diaphragm openings immediately adjacent to the shear walls shall be less than 25 percent of the wall length for Life Safety and 15 percent of the wall length for Immediate Occupancy. (Tier 2: Sec. 4.5.1.4)	NC
OTHER DIAPHRAGMS	The diaphragm shall not consist of a system other than wood, metal deck, concrete, or horizontal bracing. (Tier 2: Sec. 4.5.7.1)	C
PLAN IRREGULARITIES	There shall be tensile capacity to develop the strength of the diaphragm at re-entrant comers or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)	NA
SPANS	All wood diaphragms with spans greater than 24 feet for Life Safety and 12 feet for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing. (Tier 2: Sec. 4.5.2.2)	NC

		Compliance
STRAIGHT SHEATHING	All straight sheathed diaphragms shall have aspect ratios less than 2- to-1 for Life Safety and 1-to-1 for Immediate Occupancy in the direction being considered. (Tier 2: Sec. 4.5.2.1)	NC
UNBLOCKED DIAPHRAGMS	All diagonally sheathed or unblocked wood structural panel diaphragms shall have horizontal spans less than 40 feet for Life Safety and 30 feet for Immediate Occupancy and shall have aspect ratios less than or equal to 4-to-1 for Life Safety and 3-to-l for Immediate Occupancy. (Tier 2: Sec. 4.5.2.3)	NC

Lateral Force Resisting System

PROPORTIONS	The height-to-thickness ratio of the shear walls at each story shall be less than 30. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.4.4)	NC
REINFORCING AT OPENINGS	All wall openings that interrupt rebar shall have trim reinforcing on all sides. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.4.3)	NC

Compliance

3.9.1 Basic Nonstructural Component Checklist

Building Contents and Furnishing

Tall Narrow Contents	Contents over 4 feet in height with a height-to-depth or height-to-width ratio greater than 3-to-1 shall be anchored to the floor slab or adjacent structural walls. A height-to-depth or height-to-width ratio of up to 4-to-1 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.11.1)	C

Ceiling Systems

Integrated Ceilings	Integrated suspended ceilings at exits and corridors or weighing more than 2 lb/ft^2 shall be laterally restrained by a minimum of 4 diagonal wires or rigid members attached to the structure above at a spacing equal to or less than 12 ft (Tier 2: Sec. 4.8.2.1)	C
Lay-In Tiles	Lay-in tiles used in ceiling panels located at exits and corridors shall be secured with clips. (Tier 2: Sec. 4.8.2.2)	C
Supporting Partitions	The integrated suspended ceiling system shall not be used to laterally support the tops of gypsum board, masonry, or hollow clay tile partitions. Gypsum board partitions need not be evaluated where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.2.1)	C
Suspended Lath and Plaster	Ceilings consisting of suspended lath and plaster or gypsum board shall be attached for each 10 square feet of area (Tier 2: Sec. 4.8.2.4)	NA

Cladding and Glazing

Bearing Connections	Where bearing connections are required, there shall be a minimum of two bearing connections for each wall panel. (Tier 2: Sec. 4.8.4.5)	NA
Cladding Anchorage	Cladding components weighing more than 10 psf shall be mechanically anchored to the exterior wall framing at a spacing equal to or less than 4 feet. A spacing of up to 6 feet is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2 (Tier 2: Sec. 4.8.4.1)	NA
Cladding Isolation	For moment frame buildings of steel or concrete, panel connections shall be detailed to accommodate a drift ratio of 0.02 for Life Safety and 0.01for Immediate Occupancy (Tier 2: Sec. 4.8.4.2)	NA

		Compliance
Connections Out of Plane	Exterior cladding panels shall be anchored out-of-plane with a minimum of 4 connections for each wall panel. Two connections per wall panel are permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.7)	NA
Damage	There shall be no damage to exterior wall cladding. (Tier 4.8.4.8)	NA
Deterioration in Connections	There shall be no evidence of deterioration, damage or corrosion in any of the connection elements. (Tier 2: Sec. 4.8.4.2)	NA
Drift Isolation	For moment frame buildings of steel or concrete, panel connections shall be detailed to accommodate a story drift ratio of 0.02. Panel connection detailing for a story drift ratio of 0.01 is permitted where only the Basic nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.3)	NA
Glazing	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall be laminated, annealed, or heat strengthened safety glass that will remain in the frame when cracked (Tier 2: Sec. 4.8.4.9)	NA
Inserts	Where inserts are used in concrete connections, the inserts shall be anchored to reinforcing steel or other positive anchorage. (Tier 2: Sec. 4.8.4.6)	NA
Multi-Story Panels Drift	For multi-story panels attached at each floor level, panel connections shall be detailed to accommodate a story drift ratio of 0.02 and 0.01 for immediate occupancy. Panel connection detailing for a story drift ratio (Tier 2: Sec. 4.8.4.4)	NA
Panel Connections	Exterior cladding panels shall be anchored with a minimum of 2 connections for each wall panel for Life Safety and 4 connections for Immediate Occupancy. (Tier 2: Sec. 4.8.4.6)	NA

Hazardous Materials Storage and Distribution

Toxic Substances Lateral Bracing and Anchorage	Toxic and hazardous substances stored in breakable containers shall be restrained from falling by latched doors, shelf lips, wires, or other methods. (Tier 2: Sec 4.8.15.1)	NA

Maintenance Building

		Compliance
Light Fixtures		
Emergency Lighting Anchorage	Emergency lighting shall be anchored or braced to prevent falling or swaying during an earthquake. (Tier 2: Sec. 4.8.3.2)	C
Independent Support	Light fixtures in suspended grid ceilings shall be supported independently of the ceiling suspension system by a minimum of two wires at diagonally opposite corners of the fixtures (Tier 2: Sec. 4.8.3.1)	NA
Masonry Chimneys		
Urm Chimneys	No reinforced masonry chimney shall extend above the roof surface more than twice the least dimension of the chimney. A height above the roof surface of up to three times the least dimension of the chimney is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.9.1)	NA
Masonry Veneer		
Deterioration	There shall be no evidence of deterioration, damage or corrosion in any of the connection elements. (Tier 2: Sec. 4.8.5.4)	NA
Shelf Angles	Masonry veneer shall be supported by shelf angles or other elements at each floor 30 feet or more above ground for Life Safety and at each floor above the first floor for Immediate Occupancy. (Tier 2: Sec. 4.8.5.1)	NA
Ties	Masonry veneer shall be connected to the back-up with corrosion-resistant ties. The ties shall have a spacing equal to or less than 24 inches with a minimum of one tie for every 2-2/3 square feet. A spacing of up to 36 inches is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2. (Tier 2: Sec. 4.8.5.2)	NA
Weakened Planes	Masonry veneer shall be anchored to the back-up adjacent to weakened planes, such as at the locations of flashing. (Tier 2: Sec. 4.8.5.3)	NA
Mechanical and Electrical Equipment		
Attached Equipment	Equipment weighting over 20 lb that is attached to ceilings, walls, or other supports 4 feet above the floor level shall be mounted. (Tier 2: Sec 4.8.12.2)	C

Maintenance Building

		Compliance
Deterioration	There shall be no evidence of deterioration, damage, or corrosion in any of the anchorage or supports of mechanical or electrical equipment. (Tier 2: Sec. 4.8.12.3)	NC
Emergency Power Mounting	Equipment used as part of an emergency power system shall be mounted to maintain continued operation after an earthquake. (Tier 2: Sec. 4.8.12.1)	C
Hazardous Material Equipment	HVAC or other equipment containing hazardous material shall not have damaged supply lines or unbraced isolation supports. (Tier 2: Sec. 4.8.12.2)	C

Parapets, Cornices, Ornamentation, and Appendages

Canopies	Canopies located at building exits shall be anchored to the structural framing at a spacing of 6 feet or less. An anchorage spacing of up to 10 feet is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.8.2)	NA
Urm Parapets	There shall be no laterally unsupported unreinforced masonry parapets or cornices with height-to-thickness ratios greater than 1.5. A height-to-thickness ratio of up to 2.5 is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2. (Tier 2: Sec. 4.8.8.1)	NA

Partitions

Unreinforced Masonry Bracing	Unreinforced masonry or hollow clay tile partitions shall be braded at a spacing equal to or less than 10 feet in levels of low or moderate seismicity and 6 feet in levels of high seismicity. (Tier 2: Sec. 4.8.1.1)	NA

Piping

Fire Suppression Piping	Fire suppression piping shall be anchored and braced in accordance with NFPA-13 (NFPA, 1996). (Tier 2: Sec. 4.8.13.1)	NC
Flexible Couplings	Fluid, gas, and fire suppression piping shall have flexible couplings. (Tier 2: Sec. 4.8.13.2)	NC

Maintenance Building

Compliance

Stairs

Stair Details	In moment frame structures, the connection between the stairs and the structure shall not rely on shallow anchors in concrete. Alternatively, the stair details shall be capable of accommodating the drift calculated using the Quick Check procedure of Section 3.5.3.1 without including tension in the anchors. (Tier 2: Sec. 4.8.10.2)	NA
Urm Walls	Walls around stair enclosures shall not consist of unbraced hollow clay tile or unreinforced masonry with a height-to-thickness ratio greater than 12-to-1. A height-to-thickness ratio of up to 15-to-1 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.10.1)	NA

3.9.1S Supplemental Nonstructural Component Checklist

		Compliance
Building Contents and Furnishing		
Access Floor Anchorage	Access floors over 9 inches in height shall be braced. (Tier 2: Sec. 4.8.11.4)	NA
Drawers	Cabinet drawers shall have latches to keep them closed during an earthquake (Tier 2: Sec 4.8.11.3)	NC
Equipment Bracing and Anchorage to Access Floors	Equipment and computers supported on access floor systems shall be either attached to the structure or fastened to a laterally braced floor system. (Tier 2: Sec. 4.8.11.5)	NA
File Cabinets	File cabinets arranged in groups shall be attached to one another. (Tier 2: Sec. 4.8.11.2)	NC
File Cabinets Attachments, Doors, and Drawer Locks	Cabinet doors and drawers shall have latches to keep them closed during an earthquake. (Tier 2: Sec. 4.8.11.3)	NC
Ceiling Systems		
Edges Separation	The edges of integrated suspended ceilings shall be separated from enclosing walls by a minimum of 1/2 inch. (Tier 2: Sec. 4.8.2.5)	C
Seismic Joint	The ceiling system shall not extend continuously across any seismic joint. (Tier 2: Sec. 4.8.2.6)	NA
Cladding and Glazing		
Safety Glass	All exterior glazing shall be laminated, annealed or laminated heat-strengthened safety glass or other glazing system that will remain in the frame when glass is cracked. (Tier 2: Sec. 4.8.4.9)	NA
Concrete Block and Masonry Back-Up Systems		
Anchorage	Back-up shall have a positive anchorage to the structural framing at a spacing equal to or less than 4 feet along the floors and roof. (Tier 2: Sec. 4.8.7.1)	NA
Concrete Block	Concrete block shall qualify as reinforced masonry (Tier 2: Sec. 4.8.7.1)	NA

		Compliance
Urm Back-Up	There shall be no unreinforced masonry back-up. (Tier 2: Sec. 4.8.7.2)	NA
Ducts		
Duct Bracing	Rectangular ductwork exceeding 6 square feet in cross-sectional area, and round ducts exceeding 28 inches in diameter, shall be braced. Maximum spacing of transverse bracing shall not exceed 30 feet. Maximum spacing of longitudinal bracing shall not exceed 60 feet. Intermediate supports shall not be considered part of the lateral-force resisting system. (Tier 2: Sec. 4.8.14.2)	NA
Duct Supports	Ducts shall not be supported by piping or electrical conduit. (Tier 2: Sec. 4.8.14.3)	C
Stair and Smoke Duct Bracing	Stair pressurization and smoke flow of gas and high temperature energy in the event of an earthquake-induced failure. (Tier 2: Sec. 4.8.13.4)	NA
Elevators		
Brackets	The brackets that tie the car rails and the counterweight rail to the building structure shall be sized in accordance with ASME A17.1. (Tier 2: Sec. 4.8.16.7)	NA
Counterweight Rails	All counterweight rails and divider beams shall be sized in accordance with ASME A17.1. (Tier 2: Sec. 4.8.16.6)	NA
Go-Slow Elevators	The building shall have a go-slow elevator system. (Tier 2: Sec. 4.8.16.9)	NA
Retainer Guards	Cable retainer guards on sheaves and drums shall be present to inhibit the displacement of cables. (Tier 2: Sec. 4.8.16.4)	NA
Retainer Plate	A retainer plate shall be present at the top and bottom of both car and counterweight. (Tier 2: Sec. 4.8.16.5)	NA
Seismic Switch	All elevators shall be equipped with seismic switches that will terminate operations when the ground motion exceeds 0.10g. (Tier 2: Sec. 4.8.16.2)	NA
Shaft Walls	All elevator shaft walls shall be anchored and reinforced to prevent toppling into the shaft during strong shaking. (Tier 2: Sec. 4.8.16.3)	NA

		Compliance
Spreader Bracket	Spreader brackets shall not be used to resist seismic forces. (Tier 2: Sec. 4.8.16.8)	NA
Support System	All elements of the elevator system shall be anchored. (Tier 2: Sec. 4.8.16.1)	NA
Hazardous Materials Storage and Distribution		
Gas Cylinder Restraints	Compressed gas-cylinders shall be restrained. (Tier 2: Sec. 4.8.15.2)	NA
Hazardous Materials Shutoff Valves	Piping containing hazardous materials shall have shut-off valves or other devices to prevent major spills or leaks. (Tier 2: Sec. 4.8.16.4)	NA
Light Fixtures		
Lens Covers	Lens covers on light fixtures shall be attached or supplied with safety devices. (Tier 2: Sec. 4.8.3.4)	C
Pendant Supports	Light fixtures on pendant supports shall be attached at a spacing equal to or less than 6 feet and, if rigidly, supported, shall be free to move with the structure to which they are attached without damaging adjoining materials. (Tier 2: Sec. 4.8.3.3)	C
Masonry Veneer		
Mortar	The mortar in masonry veneer shall not be easily scraped away from the joints by hand with a metal tool, and there shall not be significant areas of eroded mortar. (Tier 2: Sec. 4.8.5.5)	NA
Stone Cracks	There shall be no visible cracks or signs of visible distortion in the stone. (Tier 2: Sec. 4.8.5.7)	NA
Weep Holes	In veneer braced by stud walls, functioning weep holes and base flashing shall be present. (Tier 2: Sec. 4.8.5.6)	NA
Mechanical and Electrical Equipment		
Door Drift Allowance	Mechanically operated doors shall be detailed to operate at a story drift ratio of 0.01. (Tier 2: Sec. 4.8.12.8)	NA
Electrical Equipment Bracing	Electrical equipment and associated wiring shall be laterally braced to the structural system. (Tier 2: Sec. 4.8.12.7)	C

		Compliance
Heavy Equipment Anchorage	Equipment weighing over 100 pounds shall be anchored to the structure or foundation. (Tier 2: Sec. 4.8.12.6)	C
Vibration Isolators Restrained	Equipment mounted on vibration isolators shall be equipped with restraints or snubbers. (Tier 2: Sec. 4.8.12.4)	NA

Metal Stud Back-Up Systems

Openings	Steel studs shall frame window and door openings. (Tier 2: Sec. 4.8.6.2)	C
Stud Tracks	Stud tracks shall be fastened to structural framing at a spacing equal to or less than 24 inches on center. (Tier 2: Sec. 4.8.6.1)	C

Parapets, Cornices, Ornamentation, and Appendages

Appendages	Cornices, parapets, signs, and other appendages that extend above the highest anchorage level or cantilever from exterior wall faces and other exterior wall ornamentation shall be reinforced and anchored to the structural system at a spacing equal to or less than 10 feet for Life Safety and 6 feet for Immediate Occupancy. This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. f4.8.8.4)	NA
Concrete Parapets	Concrete parapets with height-to-thickness ratios greater than 2.5 shall have vertical reinforcement. (Tier 2: Sec. 4.8.8.3)	NA

Partitions

Drift Allowance	Rigid cementitious partitions shall be detailed to accommodate a drift ratio of 0.02 in steel moment frame, concrete moment frame, and wood frame buildings. Rigid cementitious partitions shall be detailed to accommodate a drift ratio of 0.005 in other buildings. (Tier 2: Sec. 4.8.1.2)	NA
Lateral Bracing for Tops	The tops of framed or panelized partitions that only extend to the ceiling line shall have lateral bracing to the building structure at a spacing equal to or less than 6 feet. (Tier 2: Sec. 4.8.1.4)	NA
Seismic Control Joints	Partitions at structural separations shall have seismic or control joints. (Tier 2: Sec. 4.8.1.3)	NA

		Compliance
Piping		
C-Clamps	One-sided C-clamps that support piping greater than 2.5 inches in diameter shall be restrained. (Tier 2: Sec. 4.8.13.5)	C
Fluid and Gas Piping Anchorage and Bracing	Fluid and gas piping shall be anchored and braced to the structure to prevent breakage in piping. (Tier 2: Sec 4.8.13.3)	C
Shut-Off Valves	Shut-off devices shall be present at building utility interfaces to shut off the flow of gas and high-temperature energy in the event of earthquake-induced failure. (Tier 2: Sec. 4.8.13.4)	C

Compliance

3.9.2 Intermediate Nonstructural Component Checklist

Ceiling Systems		
Integrated Ceilings	Integrated suspended ceilings at exists and corridors or weighing more than 2 pounds per square foot shall be laterally restrained with a minimum of four diagonal wires or rigid members attached to the structure above at a spacing equal to or less than 12 feet. (Tier 2: Sec. 4.8.2.3)	C
Lay-In Tiles	Lay-in tiles used in ceiling panels located at exits and corridors shall be secured with clips. (Tier 2: Sec. 4.8.2.2)	C
Suspended Lath and Plaster	Ceilings consisting of suspended lath and plaster or gypsum board shall be attached to resist seismic forced for every 12 square feet of area. (Tier 2: Sec. 4.8.2.4)	C
Cladding and Glazing		
Glazing	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall have safety glazing. Such glazing located over 10 feet above an exterior walking surface shall be laminated, annealed, or laminated heat strengthened safety glass that will remain in the frame when cracked (Tier 2: Sec. 4.8.4.8)	NA
Laminated Safety Glass	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall have safety glazing. Such glazing located over 10 feet above an exterior walking surface shall be laminated annealed or laminated heat-strengthened safety glass or other glazing system that will remain in the frame when glass is cracked. (Tier 2: Sec. 4.8.4.8)	NA
Ducts		
Stair and Smoke Duct Bracing	Stair pressurization and smoke control ducts shall be braced and shall have flexible connections at seismic joints. (Tier 2: Sec. 4.8.14.1)	NA
Light Fixtures		
Independent Support	Light fixtures in suspended grid ceilings shall be supported independently of the ceiling suspension system by a minimum of two wires at diagonally opposite. (Tier 2: Sec. 4.8.3.2)	NA

Maintenance Building

Compliance

Masonry Chimneys

Anchorage	Masonry chimneys shall be anchored at each floor level and the roof. (Tier 2: Sec. 4.8.9.2)This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. 4.8.8.4)	NA

Mechanical and Electrical Equipment

Vibration Isolators Restrained	Equipment mounted on vibration isolators shall be equipped with restraints or snubbers. (Tier 2: Sec. 4.8.12.4)	NA

Parapets, Cornices, Ornamentation, and Appendages

Appendages	Cornices, parapets, signs, and other appendages that extend above the highest point of anchorage to the structure or cantilever from exterior wall faces and other exterior wall ornamentation shall be reinforced and anchored to the structural system at a spacing equal to or less than 10 feet for Life Safety and 6 feet for Immediate Occupancy. This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. 4.8.8.4)	NA
Concrete Parapets	Concrete parapets with height-to-thickness ratios greater than 2.5 shall have vertical reinforcement. (Tier 2: Sec. 4.8.8.3)	NA

ASCE31 Tier 1 Seismic Screening
Structural and Non-Structural Findings

Collection System Maintenance Building

3.7.13 Reinforced Masonry Bearing Walls with Flexible Diaphragms

Building System

		Compliance
ADJACENT BUILDINGS	The clear distance between the building being evaluated and any adjacent building shall be greater than 4 percent of the height of the shorter building for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.1.2)	C
DETERIORATION OF WOOD	There shall be no signs of decay, shrinkage, splitting, fire damage, or sagging in any of the wood members, and none of the metal connection hardware shall be deteriorated, broken, or loose. (Tier 2: Sec. 4.3.3.1)	C
GEOMETRY	There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30 percent in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines. (Tier 2: Sec. 4.3.2.3)	C
LOAD PATH	The structure shall contain a minimum of one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)	C
MASONRY JOINTS	The mortar shall not be easily scraped away from the joints by hand with a metal tool, and there shall be no areas of eroded mortar. (Tier 2: Sec. 4.3.3.8)	C
MASONRY UNITS	There shall be no visible deterioration of masonry units. (Tier 2: Sec. 4.3.3.7)	C
MASS	There shall be no change in effective mass more than 50 percent from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses, and mezzanines need not be considered. (Tier 2: Sec. 4.3.2.5)	NA
MEZZANINES	Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.3)	NA

		Compliance
REINFORCED MASONRY WALL CRACKS	All existing diagonal cracks in wall elements shall be less than 1/8 inch for Life Safety and 1/16 inch for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern. (Tier 2: Sec. 4.3.3.10)	C
SOFT STORY	The stiffness of the lateral-force-resisting system in any story shall not be less than 70 percent of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80 percent of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2)	NA
VERTICAL DISCONTINUITIES	All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)	C
WEAK STORY	The strength of the lateral-force-resisting system in any story shall not be less than 80 percent of the strength in an adjacent story, above or below, for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)	NA

Connections

FOUNDATION DOWELS	Wall reinforcement shall be doweled into the foundation for Life Safety, and the dowels shall be able to develop the lesser of the strength of the walls or the uplift capacity of the foundation for Immediate Occupancy. (Tier 2: Sec. 4.6.3.5)	C
GIRDER/COLUMN CONNECTION	There shall be a positive connection utilizing plates, connection hardware, or straps between the girder and the column support. (Tier 2: Sec. 4.6.4.1)	C
TRANSFER TO SHEAR WALLS	Diaphragms shall be connected for transfer of loads to the shear walls for Life Safety and the connections shall be able to develop the lesser of the shear strength of the walls or diaphragms for Immediate Occupancy. (Tier 2: Sec. 4.6.2.1)	C
WALL ANCHORAGE	Exterior concrete or masonry walls that are dependent on the diaphragm for lateral support shall be anchored for out-of-plane forces at each diaphragm level with steel anchors, reinforcing dowels, or straps that are developed into the diaphragm. Connections shall have adequate strength to resist the connection force calculated in the Quick Check procedure of Section 3.5.3.7. (Tier 2: Sec. 4.6.1.1)	C

		Compliance
WOOD LEDGERS	The connection between the wall panels and the diaphragm shall not induce cross-grain bending or tension in the wood ledgers. (Tier 2: Sec. 4.6.1.2)	NC

Lateral Force Resisting System

REDUNDANCY	The number of lines of shear walls in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.1.1)	C
REINFORCING STEEL	The total vertical and horizontal reinforcing steel ratio in reinforced masonry walls shall be greater than 0.002 for Life Safety and Immediate Occupancy of the wall with the minimum of 0.0007 for Life Safety and Immediate Occupancy in either of the two directions; the spacing of reinforcing steel shall be less than 48 inches for Life Safety and Immediate Occupancy; and all vertical bars shall extend to the top of the walls. (Tier 2: Sec. 4.4.2.4.2)	NC
SHEAR STRESS CHECK	The shear stress in the reinforced masonry shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 70 psi for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.4.1)	NC

3.7.13S Reinforced Masonry Bearing Walls with Flexible Diaphragms

Connections

STIFFNESS OF WALL ANCHORS	Anchors of concrete or masonry walls to wood structural elements shall be installed taut and shall be stiff enough to limit the relative movement between the wall and the diaphragm to no greater than 1/8 inch prior to engagement of the anchors. (Tier 2: Sec. 4.6.1.4)	C

Diaphragms

CROSS TIES	There shall be continuous cross ties between diaphragm chords. (Tier 2: Sec. 4.5.1.2)	C
DIAPHRAGM REINFORCEMENT AT OPENINGS	There shall be reinforcing around all diaphragm openings larger than 50 percent of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)	C
NON-CONCRETE FILLED DIAPHRAGMS	Untopped metal deck diaphragms or metal deck diaphragms with fill other than concrete shall consist of horizontal spans of less than 40 feet and shall have span/depth ratios less than 4-to-l. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.3.1)	NA
OPENINGS AT EXTERIOR MASONRY SHEAR WALLS	Diaphragm openings immediately adjacent to exterior masonry shear walls shall not be greater than 8 feet long for Life Safety and 4 feet long for Immediate Occupancy. (Tier 2: Sec. 4.5.1.6)	NA
OPENINGS AT SHEAR WALLS	Diaphragm openings immediately adjacent to the shear walls shall be less than 25 percent of the wall length for Life Safety and 15 percent of the wall length for Immediate Occupancy. (Tier 2: Sec. 4.5.1.4)	C
OTHER DIAPHRAGMS	The diaphragm shall not consist of a system other than wood, metal deck, concrete, or horizontal bracing. (Tier 2: Sec. 4.5.7.1)	C
PLAN IRREGULARITIES	There shall be tensile capacity to develop the strength of the diaphragm at re-entrant comers or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)	NA
SPANS	All wood diaphragms with spans greater than 24 feet for Life Safety and 12 feet for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing. (Tier 2: Sec. 4.5.2.2)	C

		Compliance
STRAIGHT SHEATHING	All straight sheathed diaphragms shall have aspect ratios less than 2- to-1 for Life Safety and 1-to-1 for Immediate Occupancy in the direction being considered. (Tier 2: Sec. 4.5.2.1)	NC
UNBLOCKED DIAPHRAGMS	All diagonally sheathed or unblocked wood structural panel diaphragms shall have horizontal spans less than 40 feet for Life Safety and 30 feet for Immediate Occupancy and shall have aspect ratios less than or equal to 4-to-1 for Life Safety and 3-to-l for Immediate Occupancy. (Tier 2: Sec. 4.5.2.3)	NC

Lateral Force Resisting System

PROPORTIONS	The height-to-thickness ratio of the shear walls at each story shall be less than 30. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.4.4)	C
REINFORCING AT OPENINGS	All wall openings that interrupt rebar shall have trim reinforcing on all sides. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.4.3)	NC

Compliance

3.9.1 Basic Nonstructural Component Checklist

Building Contents and Furnishing		
Tall Narrow Contents	Contents over 4 feet in height with a height-to-depth or height-to-width ratio greater than 3-to-1 shall be anchored to the floor slab or adjacent structural walls. A height-to-depth or height-to-width ratio of up to 4-to-1 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.11.1)	C
Ceiling Systems		
Integrated Ceilings	Integrated suspended ceilings at exits and corridors or weighing more than 2 lb/ft^2 shall be laterally restrained by a minimum of 4 diagonal wires or rigid members attached to the structure above at a spacing equal to or less than 12 ft (Tier 2: Sec. 4.8.2.1)	C
Lay-In Tiles	Lay-in tiles used in ceiling panels located at exits and corridors shall be secured with clips. (Tier 2: Sec. 4.8.2.2)	C
Supporting Partitions	The integrated suspended ceiling system shall not be used to laterally support the tops of gypsum board, masonry, or hollow clay tile partitions. Gypsum board partitions need not be evaluated where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.2.1)	C
Suspended Lath and Plaster	Ceilings consisting of suspended lath and plaster or gypsum board shall be attached for each 10 square feet of area (Tier 2: Sec. 4.8.2.4)	NA
Cladding and Glazing		
Bearing Connections	Where bearing connections are required, there shall be a minimum of two bearing connections for each wall panel. (Tier 2: Sec. 4.8.4.5)	NA
Cladding Anchorage	Cladding components weighing more than 10 psf shall be mechanically anchored to the exterior wall framing at a spacing equal to or less than 4 feet. A spacing of up to 6 feet is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2 (Tier 2: Sec. 4.8.4.1)	NA
Cladding Isolation	For moment frame buildings of steel or concrete, panel connections shall be detailed to accommodate a drift ratio of 0.02 for Life Safety and 0.01for Immediate Occupancy (Tier 2: Sec. 4.8.4.2)	NA

		Compliance
Connections Out of Plane	Exterior cladding panels shall be anchored out-of-plane with a minimum of 4 connections for each wall panel. Two connections per wall panel are permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.7)	NA
Damage	There shall be no damage to exterior wall cladding. (Tier 4.8.4.8)	NA
Deterioration in Connections	There shall be no evidence of deterioration, damage or corrosion in any of the connection elements. (Tier 2: Sec. 4.8.4.2)	NA
Drift Isolation	For moment frame buildings of steel or concrete, panel connections shall be detailed to accommodate a story drift ratio of 0.02. Panel connection detailing for a story drift ratio of 0.01 is permitted where only the Basic nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.3)	NA
Glazing	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall be laminated, annealed, or heat strengthened safety glass that will remain in the frame when cracked (Tier 2: Sec. 4.8.4.9)	NA
Inserts	Where inserts are used in concrete connections, the inserts shall be anchored to reinforcing steel or other positive anchorage. (Tier 2: Sec. 4.8.4.6)	NA
Multi-Story Panels Drift	For multi-story panels attached at each floor level, panel connections shall be detailed to accommodate a story drift ratio of 0.02 and 0.01 for immediate occupancy. Panel connection detailing for a story drift ratio (Tier 2: Sec. 4.8.4.4)	NA
Panel Connections	Exterior cladding panels shall be anchored with a minimum of 2 connections for each wall panel for Life Safety and 4 connections for Immediate Occupancy. (Tier 2: Sec. 4.8.4.6)	NA

Hazardous Materials Storage and Distribution

Toxic Substances Lateral Bracing and Anchorage	Toxic and hazardous substances stored in breakable containers shall be restrained from falling by latched doors, shelf lips, wires, or other methods. (Tier 2: Sec 4.8.15.1)	NA

Light Fixtures

Emergency Lighting Anchorage	Emergency lighting shall be anchored or braced to prevent falling or swaying during an earthquake. (Tier 2: Sec. 4.8.3.2)	NC
Independent Support	Light fixtures in suspended grid ceilings shall be supported independently of the ceiling suspension system by a minimum of two wires at diagonally opposite corners of the fixtures (Tier 2: Sec. 4.8.3.1)	C

Masonry Chimneys

Urm Chimneys	No reinforced masonry chimney shall extend above the roof surface more than twice the least dimension of the chimney. A height above the roof surface of up to three times the least dimension of the chimney is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.9.1)	NA

Masonry Veneer

Deterioration	There shall be no evidence of deterioration, damage or corrosion in any of the connection elements. (Tier 2: Sec. 4.8.5.4)	NA
Shelf Angles	Masonry veneer shall be supported by shelf angles or other elements at each floor 30 feet or more above ground for Life Safety and at each floor above the first floor for Immediate Occupancy. (Tier 2: Sec. 4.8.5.1)	NA
Ties	Masonry veneer shall be connected to the back-up with corrosion-resistant ties. The ties shall have a spacing equal to or less than 24 inches with a minimum of one tie for every 2-2/3 square feet. A spacing of up to 36 inches is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2. (Tier 2: Sec. 4.8.5.2)	NA
Weakened Planes	Masonry veneer shall be anchored to the back-up adjacent to weakened planes, such as at the locations of flashing. (Tier 2: Sec. 4.8.5.3)	NA

Mechanical and Electrical Equipment

Attached Equipment	Equipment weighting over 20 lb that is attached to ceilings, walls, or other supports 4 feet above the floor level shall be mounted. (Tier 2: Sec 4.8.12.2)	NA

		Compliance
Deterioration	There shall be no evidence of deterioration, damage, or corrosion in any of the anchorage or supports of mechanical or electrical equipment. (Tier 2: Sec. 4.8.12.3)	NA
Emergency Power Mounting	Equipment used as part of an emergency power system shall be mounted to maintain continued operation after an earthquake. (Tier 2: Sec. 4.8.12.1)	NA
Hazardous Material Equipment	HVAC or other equipment containing hazardous material shall not have damaged supply lines or unbraced isolation supports. (Tier 2: Sec. 4.8.12.2)	NA

Parapets, Cornices, Ornamentation, and Appendages

Canopies	Canopies located at building exits shall be anchored to the structural framing at a spacing of 6 feet or less. An anchorage spacing of up to 10 feet is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.8.2)	NA
Urm Parapets	There shall be no laterally unsupported unreinforced masonry parapets or cornices with height-to-thickness ratios greater than 1.5. A height-to-thickness ratio of up to 2.5 is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2. (Tier 2: Sec. 4.8.8.1)	NA

Partitions

Unreinforced Masonry Bracing	Unreinforced masonry or hollow clay tile partitions shall be braded at a spacing equal to or less than 10 feet in levels of low or moderate seismicity and 6 feet in levels of high seismicity. (Tier 2: Sec. 4.8.1.1)	NA

Piping

Fire Suppression Piping	Fire suppression piping shall be anchored and braced in accordance with NFPA-13 (NFPA, 1996). (Tier 2: Sec. 4.8.13.1)	NC
Flexible Couplings	Fluid, gas, and fire suppression piping shall have flexible couplings. (Tier 2: Sec. 4.8.13.2)	NC

		Compliance
Stairs		
Stair Details	In moment frame structures, the connection between the stairs and the structure shall not rely on shallow anchors in concrete. Alternatively, the stair details shall be capable of accommodating the drift calculated using the Quick Check procedure of Section 3.5.3.1 without including tension in the anchors. (Tier 2: Sec. 4.8.10.2)	NA
Urm Walls	Walls around stair enclosures shall not consist of unbraced hollow clay tile or unreinforced masonry with a height-to-thickness ratio greater than 12-to-1. A height-to-thickness ratio of up to 15-to-1 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.10.1)	NA

Collection System Maintenance Building

Compliance

3.9.1S Supplemental Nonstructural Component Checklist

Building Contents and Furnishing

Access Floor Anchorage	Access floors over 9 inches in height shall be braced. (Tier 2: Sec. 4.8.11.4)	NA
Drawers	Cabinet drawers shall have latches to keep them closed during an earthquake (Tier 2: Sec 4.8.11.3)	NC
Equipment Bracing and Anchorage to Access Floors	Equipment and computers supported on access floor systems shall be either attached to the structure or fastened to a laterally braced floor system. (Tier 2: Sec. 4.8.11.5)	NA
File Cabinets	File cabinets arranged in groups shall be attached to one another. (Tier 2: Sec. 4.8.11.2)	NC
File Cabinets Attachments, Doors, and Drawer Locks	Cabinet doors and drawers shall have latches to keep them closed during an earthquake. (Tier 2: Sec. 4.8.11.3)	NC

Ceiling Systems

Edges Separation	The edges of integrated suspended ceilings shall be separated from enclosing walls by a minimum of 1/2 inch. (Tier 2: Sec. 4.8.2.5)	C
Seismic Joint	The ceiling system shall not extend continuously across any seismic joint. (Tier 2: Sec. 4.8.2.6)	C

Cladding and Glazing

Safety Glass	All exterior glazing shall be laminated, annealed or laminated heat-strengthened safety glass or other glazing system that will remain in the frame when glass is cracked. (Tier 2: Sec. 4.8.4.9)	NA

Concrete Block and Masonry Back-Up Systems

Anchorage	Back-up shall have a positive anchorage to the structural framing at a spacing equal to or less than 4 feet along the floors and roof. (Tier 2: Sec. 4.8.7.1)	NA
Concrete Block	Concrete block shall qualify as reinforced masonry (Tier 2: Sec. 4.8.7.1)	NA

		Compliance
Urm Back-Up	There shall be no unreinforced masonry back-up. (Tier 2: Sec. 4.8.7.2)	NA
Ducts		
Duct Bracing	Rectangular ductwork exceeding 6 square feet in cross-sectional area, and round ducts exceeding 28 inches in diameter, shall be braced. Maximum spacing of transverse bracing shall not exceed 30 feet. Maximum spacing of longitudinal bracing shall not exceed 60 feet. Intermediate supports shall not be considered part of the lateral-force resisting system. (Tier 2: Sec. 4.8.14.2)	NC
Duct Supports	Ducts shall not be supported by piping or electrical conduit. (Tier 2: Sec. 4.8.14.3)	C
Stair and Smoke Duct Bracing	Stair pressurization and smoke flow of gas and high temperature energy in the event of an earthquake-induced failure. (Tier 2: Sec. 4.8.13.4)	NA
Elevators		
Brackets	The brackets that tie the car rails and the counterweight rail to the building structure shall be sized in accordance with ASME A17.1. (Tier 2: Sec. 4.8.16.7)	NA
Counterweight Rails	All counterweight rails and divider beams shall be sized in accordance with ASME A17.1. (Tier 2: Sec. 4.8.16.6)	NA
Go-Slow Elevators	The building shall have a go-slow elevator system. (Tier 2: Sec. 4.8.16.9)	NA
Retainer Guards	Cable retainer guards on sheaves and drums shall be present to inhibit the displacement of cables. (Tier 2: Sec. 4.8.16.4)	NA
Retainer Plate	A retainer plate shall be present at the top and bottom of both car and counterweight. (Tier 2: Sec. 4.8.16.5)	NA
Seismic Switch	All elevators shall be equipped with seismic switches that will terminate operations when the ground motion exceeds 0.10g. (Tier 2: Sec. 4.8.16.2)	NA
Shaft Walls	All elevator shaft walls shall be anchored and reinforced to prevent toppling into the shaft during strong shaking. (Tier 2: Sec. 4.8.16.3)	NA

		Compliance
Spreader Bracket	Spreader brackets shall not be used to resist seismic forces. (Tier 2: Sec. 4.8.16.8)	NA
Support System	All elements of the elevator system shall be anchored. (Tier 2: Sec. 4.8.16.1)	NA
Hazardous Materials Storage and Distribution		
Gas Cylinder Restraints	Compressed gas-cylinders shall be restrained. (Tier 2: Sec. 4.8.15.2)	C
Hazardous Materials Shutoff Valves	Piping containing hazardous materials shall have shut-off valves or other devices to prevent major spills or leaks. (Tier 2: Sec. 4.8.16.4)	C
Light Fixtures		
Lens Covers	Lens covers on light fixtures shall be attached or supplied with safety devices. (Tier 2: Sec. 4.8.3.4)	C
Pendant Supports	Light fixtures on pendant supports shall be attached at a spacing equal to or less than 6 feet and, if rigidly, supported, shall be free to move with the structure to which they are attached without damaging adjoining materials. (Tier 2: Sec. 4.8.3.3)	C
Masonry Veneer		
Mortar	The mortar in masonry veneer shall not be easily scraped away from the joints by hand with a metal tool, and there shall not be significant areas of eroded mortar. (Tier 2: Sec. 4.8.5.5)	NA
Stone Cracks	There shall be no visible cracks or signs of visible distortion in the stone. (Tier 2: Sec. 4.8.5.7)	NA
Weep Holes	In veneer braced by stud walls, functioning weep holes and base flashing shall be present. (Tier 2: Sec. 4.8.5.6)	NA
Mechanical and Electrical Equipment		
Door Drift Allowance	Mechanically operated doors shall be detailed to operate at a story drift ratio of 0.01. (Tier 2: Sec. 4.8.12.8)	NA
Electrical Equipment Bracing	Electrical equipment and associated wiring shall be laterally braced to the structural system. (Tier 2: Sec. 4.8.12.7)	NC

		Compliance
Heavy Equipment Anchorage	Equipment weighing over 100 pounds shall be anchored to the structure or foundation. (Tier 2: Sec. 4.8.12.6)	NA
Vibration Isolators Restrained	Equipment mounted on vibration isolators shall be equipped with restraints or snubbers. (Tier 2: Sec. 4.8.12.4)	NA

Metal Stud Back-Up Systems

Openings	Steel studs shall frame window and door openings. (Tier 2: Sec. 4.8.6.2)	C
Stud Tracks	Stud tracks shall be fastened to structural framing at a spacing equal to or less than 24 inches on center. (Tier 2: Sec. 4.8.6.1)	C

Parapets, Cornices, Ornamentation, and Appendages

Appendages	Cornices, parapets, signs, and other appendages that extend above the highest anchorage level or cantilever from exterior wall faces and other exterior wall ornamentation shall be reinforced and anchored to the structural system at a spacing equal to or less than 10 feet for Life Safety and 6 feet for Immediate Occupancy. This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. f4.8.8.4)	NA
Concrete Parapets	Concrete parapets with height-to-thickness ratios greater than 2.5 shall have vertical reinforcement. (Tier 2: Sec. 4.8.8.3)	NA

Partitions

Drift Allowance	Rigid cementitious partitions shall be detailed to accommodate a drift ratio of 0.02 in steel moment frame, concrete moment frame, and wood frame buildings. Rigid cementitious partitions shall be detailed to accommodate a drift ratio of 0.005 in other buildings. (Tier 2: Sec. 4.8.1.2)	NA
Lateral Bracing for Tops	The tops of framed or panelized partitions that only extend to the ceiling line shall have lateral bracing to the building structure at a spacing equal to or less than 6 feet. (Tier 2: Sec. 4.8.1.4)	NA
Seismic Control Joints	Partitions at structural separations shall have seismic or control joints. (Tier 2: Sec. 4.8.1.3)	NA

		Compliance
Piping		
C-Clamps	One-sided C-clamps that support piping greater than 2.5 inches in diameter shall be restrained. (Tier 2: Sec. 4.8.13.5)	C
Fluid and Gas Piping Anchorage and Bracing	Fluid and gas piping shall be anchored and braced to the structure to prevent breakage in piping. (Tier 2: Sec 4.8.13.3)	C
Shut-Off Valves	Shut-off devices shall be present at building utility interfaces to shut off the flow of gas and high-temperature energy in the event of earthquake-induced failure. (Tier 2: Sec. 4.8.13.4)	C

3.9.2 Intermediate Nonstructural Component Checklist

		Compliance
Ceiling Systems		
Integrated Ceilings	Integrated suspended ceilings at exists and corridors or weighing more than 2 pounds per square foot shall be laterally restrained with a minimum of four diagonal wires or rigid members attached to the structure above at a spacing equal to or less than 12 feet. (Tier 2: Sec. 4.8.2.3)	C
Lay-In Tiles	Lay-in tiles used in ceiling panels located at exits and corridors shall be secured with clips. (Tier 2: Sec. 4.8.2.2)	C
Suspended Lath and Plaster	Ceilings consisting of suspended lath and plaster or gypsum board shall be attached to resist seismic forced for every 12 square feet of area. (Tier 2: Sec. 4.8.2.4)	NA
Cladding and Glazing		
Glazing	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall have safety glazing. Such glazing located over 10 feet above an exterior walking surface shall be laminated, annealed, or laminated heat strengthened safety glass that will remain in the frame when cracked (Tier 2: Sec. 4.8.4.8)	NA
Laminated Safety Glass	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall have safety glazing. Such glazing located over 10 feet above an exterior walking surface shall be laminated annealed or laminated heat-strengthened safety glass or other glazing system that will remain in the frame when glass is cracked. (Tier 2: Sec. 4.8.4.8)	NA
Ducts		
Stair and Smoke Duct Bracing	Stair pressurization and smoke control ducts shall be braced and shall have flexible connections at seismic joints. (Tier 2: Sec. 4.8.14.1)	NA
Light Fixtures		
Independent Support	Light fixtures in suspended grid ceilings shall be supported independently of the ceiling suspension system by a minimum of two wires at diagonally opposite. (Tier 2: Sec. 4.8.3.2)	NA

		Compliance
Masonry Chimneys		
Anchorage	Masonry chimneys shall be anchored at each floor level and the roof. (Tier 2: Sec. 4.8.9.2)This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. 4.8.8.4)	NA
Mechanical and Electrical Equipment		
Vibration Isolators Restrained	Equipment mounted on vibration isolators shall be equipped with restraints or snubbers. (Tier 2: Sec. 4.8.12.4)	NA
Parapets, Cornices, Ornamentation, and Appendages		
Appendages	Cornices, parapets, signs, and other appendages that extend above the highest point of anchorage to the structure or cantilever from exterior wall faces and other exterior wall ornamentation shall be reinforced and anchored to the structural system at a spacing equal to or less than 10 feet for Life Safety and 6 feet for Immediate Occupancy. This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. 4.8.8.4)	NA
Concrete Parapets	Concrete parapets with height-to-thickness ratios greater than 2.5 shall have vertical reinforcement. (Tier 2: Sec. 4.8.8.3)	NA

ASCE31 Tier 1 Seismic Screening
Structural and Non-Structural Findings

Chemical Handling Building

3.7.13 Reinforced Masonry Bearing Walls with Flexible Diaphragms

Building System

		Compliance
ADJACENT BUILDINGS	The clear distance between the building being evaluated and any adjacent building shall be greater than 4 percent of the height of the shorter building for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.1.2)	C
DETERIORATION OF WOOD	There shall be no signs of decay, shrinkage, splitting, fire damage, or sagging in any of the wood members, and none of the metal connection hardware shall be deteriorated, broken, or loose. (Tier 2: Sec. 4.3.3.1)	C
GEOMETRY	There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30 percent in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines. (Tier 2: Sec. 4.3.2.3)	C
LOAD PATH	The structure shall contain a minimum of one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)	C
MASONRY JOINTS	The mortar shall not be easily scraped away from the joints by hand with a metal tool, and there shall be no areas of eroded mortar. (Tier 2: Sec. 4.3.3.8)	C
MASONRY UNITS	There shall be no visible deterioration of masonry units. (Tier 2: Sec. 4.3.3.7)	C
MASS	There shall be no change in effective mass more than 50 percent from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses, and mezzanines need not be considered. (Tier 2: Sec. 4.3.2.5)	NA
MEZZANINES	Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.3)	NA

		Compliance
REINFORCED MASONRY WALL CRACKS	All existing diagonal cracks in wall elements shall be less than 1/8 inch for Life Safety and 1/16 inch for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern. (Tier 2: Sec. 4.3.3.10)	C
SOFT STORY	The stiffness of the lateral-force-resisting system in any story shall not be less than 70 percent of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80 percent of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2)	NA
VERTICAL DISCONTINUITIES	All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)	C
WEAK STORY	The strength of the lateral-force-resisting system in any story shall not be less than 80 percent of the strength in an adjacent story, above or below, for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)	NA

Connections

FOUNDATION DOWELS	Wall reinforcement shall be doweled into the foundation for Life Safety, and the dowels shall be able to develop the lesser of the strength of the walls or the uplift capacity of the foundation for Immediate Occupancy. (Tier 2: Sec. 4.6.3.5)	C
GIRDER/COLUMN CONNECTION	There shall be a positive connection utilizing plates, connection hardware, or straps between the girder and the column support. (Tier 2: Sec. 4.6.4.1)	C
TRANSFER TO SHEAR WALLS	Diaphragms shall be connected for transfer of loads to the shear walls for Life Safety and the connections shall be able to develop the lesser of the shear strength of the walls or diaphragms for Immediate Occupancy. (Tier 2: Sec. 4.6.2.1)	C
WALL ANCHORAGE	Exterior concrete or masonry walls that are dependent on the diaphragm for lateral support shall be anchored for out-of-plane forces at each diaphragm level with steel anchors, reinforcing dowels, or straps that are developed into the diaphragm. Connections shall have adequate strength to resist the connection force calculated in the Quick Check procedure of Section 3.5.3.7. (Tier 2: Sec. 4.6.1.1)	C

Chemical Handling Building

		Compliance
WOOD LEDGERS	The connection between the wall panels and the diaphragm shall not induce cross-grain bending or tension in the wood ledgers. (Tier 2: Sec. 4.6.1.2)	NC

Lateral Force Resisting System

REDUNDANCY	The number of lines of shear walls in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.1.1)	C
REINFORCING STEEL	The total vertical and horizontal reinforcing steel ratio in reinforced masonry walls shall be greater than 0.002 for Life Safety and Immediate Occupancy of the wall with the minimum of 0.0007 for Life Safety and Immediate Occupancy in either of the two directions; the spacing of reinforcing steel shall be less than 48 inches for Life Safety and Immediate Occupancy; and all vertical bars shall extend to the top of the walls. (Tier 2: Sec. 4.4.2.4.2)	NC
SHEAR STRESS CHECK	The shear stress in the reinforced masonry shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 70 psi for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.4.1)	C

Compliance

3.7.13S Reinforced Masonry Bearing Walls with Flexible Diaphragms

Connections

STIFFNESS OF WALL ANCHORS	Anchors of concrete or masonry walls to wood structural elements shall be installed taut and shall be stiff enough to limit the relative movement between the wall and the diaphragm to no greater than 1/8 inch prior to engagement of the anchors. (Tier 2: Sec. 4.6.1.4)	C

Diaphragms

CROSS TIES	There shall be continuous cross ties between diaphragm chords. (Tier 2: Sec. 4.5.1.2)	C
DIAPHRAGM REINFORCEMENT AT OPENINGS	There shall be reinforcing around all diaphragm openings larger than 50 percent of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)	C
NON-CONCRETE FILLED DIAPHRAGMS	Untopped metal deck diaphragms or metal deck diaphragms with fill other than concrete shall consist of horizontal spans of less than 40 feet and shall have span/depth ratios less than 4-to-l. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.3.1)	NA
OPENINGS AT EXTERIOR MASONRY SHEAR WALLS	Diaphragm openings immediately adjacent to exterior masonry shear walls shall not be greater than 8 feet long for Life Safety and 4 feet long for Immediate Occupancy. (Tier 2: Sec. 4.5.1.6)	NA
OPENINGS AT SHEAR WALLS	Diaphragm openings immediately adjacent to the shear walls shall be less than 25 percent of the wall length for Life Safety and 15 percent of the wall length for Immediate Occupancy. (Tier 2: Sec. 4.5.1.4)	NA
OTHER DIAPHRAGMS	The diaphragm shall not consist of a system other than wood, metal deck, concrete, or horizontal bracing. (Tier 2: Sec. 4.5.7.1)	C
PLAN IRREGULARITIES	There shall be tensile capacity to develop the strength of the diaphragm at re-entrant comers or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)	NA
SPANS	All wood diaphragms with spans greater than 24 feet for Life Safety and 12 feet for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing. (Tier 2: Sec. 4.5.2.2)	C

		Compliance
STRAIGHT SHEATHING	All straight sheathed diaphragms shall have aspect ratios less than 2- to-1 for Life Safety and 1-to-1 for Immediate Occupancy in the direction being considered. (Tier 2: Sec. 4.5.2.1)	NC
UNBLOCKED DIAPHRAGMS	All diagonally sheathed or unblocked wood structural panel diaphragms shall have horizontal spans less than 40 feet for Life Safety and 30 feet for Immediate Occupancy and shall have aspect ratios less than or equal to 4-to-1 for Life Safety and 3-to-l for Immediate Occupancy. (Tier 2: Sec. 4.5.2.3)	NA

Lateral Force Resisting System

PROPORTIONS	The height-to-thickness ratio of the shear walls at each story shall be less than 30. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.4.4)	C
REINFORCING AT OPENINGS	All wall openings that interrupt rebar shall have trim reinforcing on all sides. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.4.3)	C

Chemical Handling Building

Compliance

3.9.1 Basic Nonstructural Component Checklist

Building Contents and Furnishing

Tall Narrow Contents	Contents over 4 feet in height with a height-to-depth or height-to-width ratio greater than 3-to-1 shall be anchored to the floor slab or adjacent structural walls. A height-to-depth or height-to-width ratio of up to 4-to-1 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.11.1)	NC

Ceiling Systems

Integrated Ceilings	Integrated suspended ceilings at exits and corridors or weighing more than 2 lb/ft^2 shall be laterally restrained by a minimum of 4 diagonal wires or rigid members attached to the structure above at a spacing equal to or less than 12 ft (Tier 2: Sec. 4.8.2.1)	NA
Lay-In Tiles	Lay-in tiles used in ceiling panels located at exits and corridors shall be secured with clips. (Tier 2: Sec. 4.8.2.2)	NA
Supporting Partitions	The integrated suspended ceiling system shall not be used to laterally support the tops of gypsum board, masonry, or hollow clay tile partitions. Gypsum board partitions need not be evaluated where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.2.1)	NA
Suspended Lath and Plaster	Ceilings consisting of suspended lath and plaster or gypsum board shall be attached for each 10 square feet of area (Tier 2: Sec. 4.8.2.4)	NA

Cladding and Glazing

Bearing Connections	Where bearing connections are required, there shall be a minimum of two bearing connections for each wall panel. (Tier 2: Sec. 4.8.4.5)	NA
Cladding Anchorage	Cladding components weighing more than 10 psf shall be mechanically anchored to the exterior wall framing at a spacing equal to or less than 4 feet. A spacing of up to 6 feet is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2 (Tier 2: Sec. 4.8.4.1)	NA
Cladding Isolation	For moment frame buildings of steel or concrete, panel connections shall be detailed to accommodate a drift ratio of 0.02 for Life Safety and 0.01for Immediate Occupancy (Tier 2: Sec. 4.8.4.2)	NA

		Compliance
Connections Out of Plane	Exterior cladding panels shall be anchored out-of-plane with a minimum of 4 connections for each wall panel. Two connections per wall panel are permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.7)	NA
Damage	There shall be no damage to exterior wall cladding. (Tier 4.8.4.8)	NA
Deterioration in Connections	There shall be no evidence of deterioration, damage or corrosion in any of the connection elements. (Tier 2: Sec. 4.8.4.2)	NA
Drift Isolation	For moment frame buildings of steel or concrete, panel connections shall be detailed to accommodate a story drift ratio of 0.02. Panel connection detailing for a story drift ratio of 0.01 is permitted where only the Basic nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.3)	NA
Glazing	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall be laminated, annealed, or heat strengthened safety glass that will remain in the frame when cracked (Tier 2: Sec. 4.8.4.9)	NA
Inserts	Where inserts are used in concrete connections, the inserts shall be anchored to reinforcing steel or other positive anchorage. (Tier 2: Sec. 4.8.4.6)	NA
Multi-Story Panels Drift	For multi-story panels attached at each floor level, panel connections shall be detailed to accommodate a story drift ratio of 0.02 and 0.01 for immediate occupancy. Panel connection detailing for a story drift ratio (Tier 2: Sec. 4.8.4.4)	NA
Panel Connections	Exterior cladding panels shall be anchored with a minimum of 2 connections for each wall panel for Life Safety and 4 connections for Immediate Occupancy. (Tier 2: Sec. 4.8.4.6)	NA

Hazardous Materials Storage and Distribution

Toxic Substances Lateral Bracing and Anchorage	Toxic and hazardous substances stored in breakable containers shall be restrained from falling by latched doors, shelf lips, wires, or other methods. (Tier 2: Sec 4.8.15.1)	NA

Light Fixtures

Emergency Lighting Anchorage	Emergency lighting shall be anchored or braced to prevent falling or swaying during an earthquake. (Tier 2: Sec. 4.8.3.2)	C
Independent Support	Light fixtures in suspended grid ceilings shall be supported independently of the ceiling suspension system by a minimum of two wires at diagonally opposite corners of the fixtures (Tier 2: Sec. 4.8.3.1)	NA

Masonry Chimneys

Urm Chimneys	No reinforced masonry chimney shall extend above the roof surface more than twice the least dimension of the chimney. A height above the roof surface of up to three times the least dimension of the chimney is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.9.1)	NA

Masonry Veneer

Deterioration	There shall be no evidence of deterioration, damage or corrosion in any of the connection elements. (Tier 2: Sec. 4.8.5.4)	NA
Shelf Angles	Masonry veneer shall be supported by shelf angles or other elements at each floor 30 feet or more above ground for Life Safety and at each floor above the first floor for Immediate Occupancy. (Tier 2: Sec. 4.8.5.1)	NA
Ties	Masonry veneer shall be connected to the back-up with corrosion-resistant ties. The ties shall have a spacing equal to or less than 24 inches with a minimum of one tie for every 2-2/3 square feet. A spacing of up to 36 inches is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2. (Tier 2: Sec. 4.8.5.2)	NA
Weakened Planes	Masonry veneer shall be anchored to the back-up adjacent to weakened planes, such as at the locations of flashing. (Tier 2: Sec. 4.8.5.3)	NA

Mechanical and Electrical Equipment

Attached Equipment	Equipment weighting over 20 lb that is attached to ceilings, walls, or other supports 4 feet above the floor level shall be mounted. (Tier 2: Sec 4.8.12.2)	C

		Compliance
Deterioration	There shall be no evidence of deterioration, damage, or corrosion in any of the anchorage or supports of mechanical or electrical equipment. (Tier 2: Sec. 4.8.12.3)	NC
Emergency Power Mounting	Equipment used as part of an emergency power system shall be mounted to maintain continued operation after an earthquake. (Tier 2: Sec. 4.8.12.1)	NA
Hazardous Material Equipment	HVAC or other equipment containing hazardous material shall not have damaged supply lines or unbraced isolation supports. (Tier 2: Sec. 4.8.12.2)	NA

Parapets, Cornices, Ornamentation, and Appendages

Canopies	Canopies located at building exits shall be anchored to the structural framing at a spacing of 6 feet or less. An anchorage spacing of up to 10 feet is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.8.2)	NA
Urm Parapets	There shall be no laterally unsupported unreinforced masonry parapets or cornices with height-to-thickness ratios greater than 1.5. A height-to-thickness ratio of up to 2.5 is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2. (Tier 2: Sec. 4.8.8.1)	NA

Partitions

Unreinforced Masonry Bracing	Unreinforced masonry or hollow clay tile partitions shall be braded at a spacing equal to or less than 10 feet in levels of low or moderate seismicity and 6 feet in levels of high seismicity. (Tier 2: Sec. 4.8.1.1)	NA

Piping

Fire Suppression Piping	Fire suppression piping shall be anchored and braced in accordance with NFPA-13 (NFPA, 1996). (Tier 2: Sec. 4.8.13.1)	NC
Flexible Couplings	Fluid, gas, and fire suppression piping shall have flexible couplings. (Tier 2: Sec. 4.8.13.2)	NC

Chemical Handling Building

Compliance

Stairs

Stair Details	In moment frame structures, the connection between the stairs and the structure shall not rely on shallow anchors in concrete. Alternatively, the stair details shall be capable of accommodating the drift calculated using the Quick Check procedure of Section 3.5.3.1 without including tension in the anchors. (Tier 2: Sec. 4.8.10.2)	NA
Urm Walls	Walls around stair enclosures shall not consist of unbraced hollow clay tile or unreinforced masonry with a height-to-thickness ratio greater than 12-to-1. A height-to-thickness ratio of up to 15-to-1 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.10.1)	NA

Chemical Handling Building

Compliance

3.9.1S Supplemental Nonstructural Component Checklist

Building Contents and Furnishing		
Access Floor Anchorage	Access floors over 9 inches in height shall be braced. (Tier 2: Sec. 4.8.11.4)	NA
Drawers	Cabinet drawers shall have latches to keep them closed during an earthquake (Tier 2: Sec 4.8.11.3)	NC
Equipment Bracing and Anchorage to Access Floors	Equipment and computers supported on access floor systems shall be either attached to the structure or fastened to a laterally braced floor system. (Tier 2: Sec. 4.8.11.5)	NA
File Cabinets	File cabinets arranged in groups shall be attached to one another. (Tier 2: Sec. 4.8.11.2)	NC
File Cabinets Attachments, Doors, and Drawer Locks	Cabinet doors and drawers shall have latches to keep them closed during an earthquake. (Tier 2: Sec. 4.8.11.3)	NC
Ceiling Systems		
Edges Separation	The edges of integrated suspended ceilings shall be separated from enclosing walls by a minimum of 1/2 inch. (Tier 2: Sec. 4.8.2.5)	NA
Seismic Joint	The ceiling system shall not extend continuously across any seismic joint. (Tier 2: Sec. 4.8.2.6)	NA
Cladding and Glazing		
Safety Glass	All exterior glazing shall be laminated, annealed or laminated heat-strengthened safety glass or other glazing system that will remain in the frame when glass is cracked. (Tier 2: Sec. 4.8.4.9)	NA
Concrete Block and Masonry Back-Up Systems		
Anchorage	Back-up shall have a positive anchorage to the structural framing at a spacing equal to or less than 4 feet along the floors and roof. (Tier 2: Sec. 4.8.7.1)	NA
Concrete Block	Concrete block shall qualify as reinforced masonry (Tier 2: Sec. 4.8.7.1)	NA

		Compliance
Urm Back-Up	There shall be no unreinforced masonry back-up. (Tier 2: Sec. 4.8.7.2)	NA
Ducts		
Duct Bracing	Rectangular ductwork exceeding 6 square feet in cross-sectional area, and round ducts exceeding 28 inches in diameter, shall be braced. Maximum spacing of transverse bracing shall not exceed 30 feet. Maximum spacing of longitudinal bracing shall not exceed 60 feet. Intermediate supports shall not be considered part of the lateral-force resisting system. (Tier 2: Sec. 4.8.14.2)	NA
Duct Supports	Ducts shall not be supported by piping or electrical conduit. (Tier 2: Sec. 4.8.14.3)	C
Stair and Smoke Duct Bracing	Stair pressurization and smoke flow of gas and high temperature energy in the event of an earthquake-induced failure. (Tier 2: Sec. 4.8.13.4)	NA
Elevators		
Brackets	The brackets that tie the car rails and the counterweight rail to the building structure shall be sized in accordance with ASME A17.1. (Tier 2: Sec. 4.8.16.7)	NA
Counterweight Rails	All counterweight rails and divider beams shall be sized in accordance with ASME A17.1. (Tier 2: Sec. 4.8.16.6)	NA
Go-Slow Elevators	The building shall have a go-slow elevator system. (Tier 2: Sec. 4.8.16.9)	NA
Retainer Guards	Cable retainer guards on sheaves and drums shall be present to inhibit the displacement of cables. (Tier 2: Sec. 4.8.16.4)	NA
Retainer Plate	A retainer plate shall be present at the top and bottom of both car and counterweight. (Tier 2: Sec. 4.8.16.5)	NA
Seismic Switch	All elevators shall be equipped with seismic switches that will terminate operations when the ground motion exceeds 0.10g. (Tier 2: Sec. 4.8.16.2)	NA
Shaft Walls	All elevator shaft walls shall be anchored and reinforced to prevent toppling into the shaft during strong shaking. (Tier 2: Sec. 4.8.16.3)	NA

		Compliance
Spreader Bracket	Spreader brackets shall not be used to resist seismic forces. (Tier 2: Sec. 4.8.16.8)	NA
Support System	All elements of the elevator system shall be anchored. (Tier 2: Sec. 4.8.16.1)	NA

Hazardous Materials Storage and Distribution

Gas Cylinder Restraints	Compressed gas-cylinders shall be restrained. (Tier 2: Sec. 4.8.15.2)	NA
Hazardous Materials Shutoff Valves	Piping containing hazardous materials shall have shut-off valves or other devices to prevent major spills or leaks. (Tier 2: Sec. 4.8.16.4)	NA

Light Fixtures

Lens Covers	Lens covers on light fixtures shall be attached or supplied with safety devices. (Tier 2: Sec. 4.8.3.4)	C
Pendant Supports	Light fixtures on pendant supports shall be attached at a spacing equal to or less than 6 feet and, if rigidly, supported, shall be free to move with the structure to which they are attached without damaging adjoining materials. (Tier 2: Sec. 4.8.3.3)	C

Masonry Veneer

Mortar	The mortar in masonry veneer shall not be easily scraped away from the joints by hand with a metal tool, and there shall not be significant areas of eroded mortar. (Tier 2: Sec. 4.8.5.5)	NA
Stone Cracks	There shall be no visible cracks or signs of visible distortion in the stone. (Tier 2: Sec. 4.8.5.7)	NA
Weep Holes	In veneer braced by stud walls, functioning weep holes and base flashing shall be present. (Tier 2: Sec. 4.8.5.6)	NA

Mechanical and Electrical Equipment

Door Drift Allowance	Mechanically operated doors shall be detailed to operate at a story drift ratio of 0.01. (Tier 2: Sec. 4.8.12.8)	NA
Electrical Equipment Bracing	Electrical equipment and associated wiring shall be laterally braced to the structural system. (Tier 2: Sec. 4.8.12.7)	NC

		Compliance
Heavy Equipment Anchorage	Equipment weighing over 100 pounds shall be anchored to the structure or foundation. (Tier 2: Sec. 4.8.12.6)	C
Vibration Isolators Restrained	Equipment mounted on vibration isolators shall be equipped with restraints or snubbers. (Tier 2: Sec. 4.8.12.4)	NA

Metal Stud Back-Up Systems

Openings	Steel studs shall frame window and door openings. (Tier 2: Sec. 4.8.6.2)	C
Stud Tracks	Stud tracks shall be fastened to structural framing at a spacing equal to or less than 24 inches on center. (Tier 2: Sec. 4.8.6.1)	C

Parapets, Cornices, Ornamentation, and Appendages

Appendages	Cornices, parapets, signs, and other appendages that extend above the highest anchorage level or cantilever from exterior wall faces and other exterior wall ornamentation shall be reinforced and anchored to the structural system at a spacing equal to or less than 10 feet for Life Safety and 6 feet for Immediate Occupancy. This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. f4.8.8.4)	NA
Concrete Parapets	Concrete parapets with height-to-thickness ratios greater than 2.5 shall have vertical reinforcement. (Tier 2: Sec. 4.8.8.3)	NA

Partitions

Drift Allowance	Rigid cementitious partitions shall be detailed to accommodate a drift ratio of 0.02 in steel moment frame, concrete moment frame, and wood frame buildings. Rigid cementitious partitions shall be detailed to accommodate a drift ratio of 0.005 in other buildings. (Tier 2: Sec. 4.8.1.2)	NA
Lateral Bracing for Tops	The tops of framed or panelized partitions that only extend to the ceiling line shall have lateral bracing to the building structure at a spacing equal to or less than 6 feet. (Tier 2: Sec. 4.8.1.4)	NA
Seismic Control Joints	Partitions at structural separations shall have seismic or control joints. (Tier 2: Sec. 4.8.1.3)	NA

Chemical Handling Building

		Compliance
Piping		
C-Clamps	One-sided C-clamps that support piping greater than 2.5 inches in diameter shall be restrained. (Tier 2: Sec. 4.8.13.5)	C
Fluid and Gas Piping Anchorage and Bracing	Fluid and gas piping shall be anchored and braced to the structure to prevent breakage in piping. (Tier 2: Sec 4.8.13.3)	C
Shut-Off Valves	Shut-off devices shall be present at building utility interfaces to shut off the flow of gas and high-temperature energy in the event of earthquake-induced failure. (Tier 2: Sec. 4.8.13.4)	C

Chemical Handling Building

Compliance

3.9.2 Intermediate Nonstructural Component Checklist

Ceiling Systems		
Integrated Ceilings	Integrated suspended ceilings at exists and corridors or weighing more than 2 pounds per square foot shall be laterally restrained with a minimum of four diagonal wires or rigid members attached to the structure above at a spacing equal to or less than 12 feet. (Tier 2: Sec. 4.8.2.3)	NA
Lay-In Tiles	Lay-in tiles used in ceiling panels located at exits and corridors shall be secured with clips. (Tier 2: Sec. 4.8.2.2)	NA
Suspended Lath and Plaster	Ceilings consisting of suspended lath and plaster or gypsum board shall be attached to resist seismic forced for every 12 square feet of area. (Tier 2: Sec. 4.8.2.4)	NA
Cladding and Glazing		
Glazing	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall have safety glazing. Such glazing located over 10 feet above an exterior walking surface shall be laminated, annealed, or laminated heat strengthened safety glass that will remain in the frame when cracked (Tier 2: Sec. 4.8.4.8)	NA
Laminated Safety Glass	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall have safety glazing. Such glazing located over 10 feet above an exterior walking surface shall be laminated annealed or laminated heat-strengthened safety glass or other glazing system that will remain in the frame when glass is cracked. (Tier 2: Sec. 4.8.4.8)	NA
Ducts		
Stair and Smoke Duct Bracing	Stair pressurization and smoke control ducts shall be braced and shall have flexible connections at seismic joints. (Tier 2: Sec. 4.8.14.1)	NA
Light Fixtures		
Independent Support	Light fixtures in suspended grid ceilings shall be supported independently of the ceiling suspension system by a minimum of two wires at diagonally opposite. (Tier 2: Sec. 4.8.3.2)	NA

		Compliance
Masonry Chimneys		
Anchorage	Masonry chimneys shall be anchored at each floor level and the roof. (Tier 2: Sec. 4.8.9.2)This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. 4.8.8.4)	NA
Mechanical and Electrical Equipment		
Vibration Isolators Restrained	Equipment mounted on vibration isolators shall be equipped with restraints or snubbers. (Tier 2: Sec. 4.8.12.4)	NA
Parapets, Cornices, Ornamentation, and Appendages		
Appendages	Cornices, parapets, signs, and other appendages that extend above the highest point of anchorage to the structure or cantilever from exterior wall faces and other exterior wall ornamentation shall be reinforced and anchored to the structural system at a spacing equal to or less than 10 feet for Life Safety and 6 feet for Immediate Occupancy. This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. 4.8.8.4)	NA
Concrete Parapets	Concrete parapets with height-to-thickness ratios greater than 2.5 shall have vertical reinforcement. (Tier 2: Sec. 4.8.8.3)	NA

ASCE31 Tier 1 Seismic Screening
Structural and Non-Structural Findings

Vacuum Filter Building

3.7.13 Reinforced Masonry Bearing Walls with Flexible Diaphragms

Building System

		Compliance
ADJACENT BUILDINGS	The clear distance between the building being evaluated and any adjacent building shall be greater than 4 percent of the height of the shorter building for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.1.2)	C
DETERIORATION OF WOOD	There shall be no signs of decay, shrinkage, splitting, fire damage, or sagging in any of the wood members, and none of the metal connection hardware shall be deteriorated, broken, or loose. (Tier 2: Sec. 4.3.3.1)	NC
GEOMETRY	There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30 percent in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines. (Tier 2: Sec. 4.3.2.3)	NA
LOAD PATH	The structure shall contain a minimum of one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)	C
MASONRY JOINTS	The mortar shall not be easily scraped away from the joints by hand with a metal tool, and there shall be no areas of eroded mortar. (Tier 2: Sec. 4.3.3.8)	NC
MASONRY UNITS	There shall be no visible deterioration of masonry units. (Tier 2: Sec. 4.3.3.7)	NC
MASS	There shall be no change in effective mass more than 50 percent from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses, and mezzanines need not be considered. (Tier 2: Sec. 4.3.2.5)	NA
MEZZANINES	Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.3)	NA

		Compliance
REINFORCED MASONRY WALL CRACKS	All existing diagonal cracks in wall elements shall be less than 1/8 inch for Life Safety and 1/16 inch for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern. (Tier 2: Sec. 4.3.3.10)	NC
SOFT STORY	The stiffness of the lateral-force-resisting system in any story shall not be less than 70 percent of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80 percent of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2)	NA
VERTICAL DISCONTINUITIES	All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)	C
WEAK STORY	The strength of the lateral-force-resisting system in any story shall not be less than 80 percent of the strength in an adjacent story, above or below, for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)	NA

Connections

FOUNDATION DOWELS	Wall reinforcement shall be doweled into the foundation for Life Safety, and the dowels shall be able to develop the lesser of the strength of the walls or the uplift capacity of the foundation for Immediate Occupancy. (Tier 2: Sec. 4.6.3.5)	NC
GIRDER/COLUMN CONNECTION	There shall be a positive connection utilizing plates, connection hardware, or straps between the girder and the column support. (Tier 2: Sec. 4.6.4.1)	NC
TRANSFER TO SHEAR WALLS	Diaphragms shall be connected for transfer of loads to the shear walls for Life Safety and the connections shall be able to develop the lesser of the shear strength of the walls or diaphragms for Immediate Occupancy. (Tier 2: Sec. 4.6.2.1)	NC
WALL ANCHORAGE	Exterior concrete or masonry walls that are dependent on the diaphragm for lateral support shall be anchored for out-of-plane forces at each diaphragm level with steel anchors, reinforcing dowels, or straps that are developed into the diaphragm. Connections shall have adequate strength to resist the connection force calculated in the Quick Check procedure of Section 3.5.3.7. (Tier 2: Sec. 4.6.1.1)	NC

		Compliance
WOOD LEDGERS	The connection between the wall panels and the diaphragm shall not induce cross-grain bending or tension in the wood ledgers. (Tier 2: Sec. 4.6.1.2)	NC

Lateral Force Resisting System

REDUNDANCY	The number of lines of shear walls in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.1.1)	NC
REINFORCING STEEL	The total vertical and horizontal reinforcing steel ratio in reinforced masonry walls shall be greater than 0.002 for Life Safety and Immediate Occupancy of the wall with the minimum of 0.0007 for Life Safety and Immediate Occupancy in either of the two directions; the spacing of reinforcing steel shall be less than 48 inches for Life Safety and Immediate Occupancy; and all vertical bars shall extend to the top of the walls. (Tier 2: Sec. 4.4.2.4.2)	NC
SHEAR STRESS CHECK	The shear stress in the reinforced masonry shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 70 psi for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.4.1)	NC

3.7.13S Reinforced Masonry Bearing Walls with Flexible Diaphragms

		Compliance
Connections		
STIFFNESS OF WALL ANCHORS	Anchors of concrete or masonry walls to wood structural elements shall be installed taut and shall be stiff enough to limit the relative movement between the wall and the diaphragm to no greater than 1/8 inch prior to engagement of the anchors. (Tier 2: Sec. 4.6.1.4)	NC
Diaphragms		
CROSS TIES	There shall be continuous cross ties between diaphragm chords. (Tier 2: Sec. 4.5.1.2)	NC
DIAPHRAGM REINFORCEMENT AT OPENINGS	There shall be reinforcing around all diaphragm openings larger than 50 percent of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)	NC
NON-CONCRETE FILLED DIAPHRAGMS	Untopped metal deck diaphragms or metal deck diaphragms with fill other than concrete shall consist of horizontal spans of less than 40 feet and shall have span/depth ratios less than 4-to-l. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.3.1)	NA
OPENINGS AT EXTERIOR MASONRY SHEAR WALLS	Diaphragm openings immediately adjacent to exterior masonry shear walls shall not be greater than 8 feet long for Life Safety and 4 feet long for Immediate Occupancy. (Tier 2: Sec. 4.5.1.6)	NC
OPENINGS AT SHEAR WALLS	Diaphragm openings immediately adjacent to the shear walls shall be less than 25 percent of the wall length for Life Safety and 15 percent of the wall length for Immediate Occupancy. (Tier 2: Sec. 4.5.1.4)	NC
OTHER DIAPHRAGMS	The diaphragm shall not consist of a system other than wood, metal deck, concrete, or horizontal bracing. (Tier 2: Sec. 4.5.7.1)	C
PLAN IRREGULARITIES	There shall be tensile capacity to develop the strength of the diaphragm at re-entrant comers or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)	NA
SPANS	All wood diaphragms with spans greater than 24 feet for Life Safety and 12 feet for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing. (Tier 2: Sec. 4.5.2.2)	NC

Vacuum Filter Building

		Compliance
STRAIGHT SHEATHING	All straight sheathed diaphragms shall have aspect ratios less than 2- to-1 for Life Safety and 1-to-1 for Immediate Occupancy in the direction being considered. (Tier 2: Sec. 4.5.2.1)	NC
UNBLOCKED DIAPHRAGMS	All diagonally sheathed or unblocked wood structural panel diaphragms shall have horizontal spans less than 40 feet for Life Safety and 30 feet for Immediate Occupancy and shall have aspect ratios less than or equal to 4-to-1 for Life Safety and 3-to-l for Immediate Occupancy. (Tier 2: Sec. 4.5.2.3)	NC

Lateral Force Resisting System

PROPORTIONS	The height-to-thickness ratio of the shear walls at each story shall be less than 30. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.4.4)	NC
REINFORCING AT OPENINGS	All wall openings that interrupt rebar shall have trim reinforcing on all sides. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.4.3)	NC

		Compliance
3.9.1 Basic Nonstructural Component Checklist		
Building Contents and Furnishing		
Tall Narrow Contents	Contents over 4 feet in height with a height-to-depth or height-to-width ratio greater than 3-to-1 shall be anchored to the floor slab or adjacent structural walls. A height-to-depth or height-to-width ratio of up to 4-to-1 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.11.1)	NC
Ceiling Systems		
Integrated Ceilings	Integrated suspended ceilings at exits and corridors or weighing more than 2 lb/ft^2 shall be laterally restrained by a minimum of 4 diagonal wires or rigid members attached to the structure above at a spacing equal to or less than 12 ft (Tier 2: Sec. 4.8.2.1)	NA
Lay-In Tiles	Lay-in tiles used in ceiling panels located at exits and corridors shall be secured with clips. (Tier 2: Sec. 4.8.2.2)	NA
Supporting Partitions	The integrated suspended ceiling system shall not be used to laterally support the tops of gypsum board, masonry, or hollow clay tile partitions. Gypsum board partitions need not be evaluated where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.2.1)	NA
Suspended Lath and Plaster	Ceilings consisting of suspended lath and plaster or gypsum board shall be attached for each 10 square feet of area (Tier 2: Sec. 4.8.2.4)	NA
Cladding and Glazing		
Bearing Connections	Where bearing connections are required, there shall be a minimum of two bearing connections for each wall panel. (Tier 2: Sec. 4.8.4.5)	NA
Cladding Anchorage	Cladding components weighing more than 10 psf shall be mechanically anchored to the exterior wall framing at a spacing equal to or less than 4 feet. A spacing of up to 6 feet is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2 (Tier 2: Sec. 4.8.4.1)	NA
Cladding Isolation	For moment frame buildings of steel or concrete, panel connections shall be detailed to accommodate a drift ratio of 0.02 for Life Safety and 0.01for Immediate Occupancy (Tier 2: Sec. 4.8.4.2)	NA

		Compliance
Connections Out of Plane	Exterior cladding panels shall be anchored out-of-plane with a minimum of 4 connections for each wall panel. Two connections per wall panel are permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.7)	NA
Damage	There shall be no damage to exterior wall cladding. (Tier 4.8.4.8)	NA
Deterioration in Connections	There shall be no evidence of deterioration, damage or corrosion in any of the connection elements. (Tier 2: Sec. 4.8.4.2)	NA
Drift Isolation	For moment frame buildings of steel or concrete, panel connections shall be detailed to accommodate a story drift ratio of 0.02. Panel connection detailing for a story drift ratio of 0.01 is permitted where only the Basic nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.3)	NA
Glazing	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall be laminated, annealed, or heat strengthened safety glass that will remain in the frame when cracked (Tier 2: Sec. 4.8.4.9)	NA
Inserts	Where inserts are used in concrete connections, the inserts shall be anchored to reinforcing steel or other positive anchorage. (Tier 2: Sec. 4.8.4.6)	NA
Multi-Story Panels Drift	For multi-story panels attached at each floor level, panel connections shall be detailed to accommodate a story drift ratio of 0.02 and 0.01 for immediate occupancy. Panel connection detailing for a story drift ratio (Tier 2: Sec. 4.8.4.4)	NA
Panel Connections	Exterior cladding panels shall be anchored with a minimum of 2 connections for each wall panel for Life Safety and 4 connections for Immediate Occupancy. (Tier 2: Sec. 4.8.4.6)	NA

Hazardous Materials Storage and Distribution

Toxic Substances Lateral Bracing and Anchorage	Toxic and hazardous substances stored in breakable containers shall be restrained from falling by latched doors, shelf lips, wires, or other methods. (Tier 2: Sec 4.8.15.1)	NA

		Compliance
Light Fixtures		
Emergency Lighting Anchorage	Emergency lighting shall be anchored or braced to prevent falling or swaying during an earthquake. (Tier 2: Sec. 4.8.3.2)	C
Independent Support	Light fixtures in suspended grid ceilings shall be supported independently of the ceiling suspension system by a minimum of two wires at diagonally opposite corners of the fixtures (Tier 2: Sec. 4.8.3.1)	NA
Masonry Chimneys		
Urm Chimneys	No reinforced masonry chimney shall extend above the roof surface more than twice the least dimension of the chimney. A height above the roof surface of up to three times the least dimension of the chimney is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.9.1)	NA
Masonry Veneer		
Deterioration	There shall be no evidence of deterioration, damage or corrosion in any of the connection elements. (Tier 2: Sec. 4.8.5.4)	NA
Shelf Angles	Masonry veneer shall be supported by shelf angles or other elements at each floor 30 feet or more above ground for Life Safety and at each floor above the first floor for Immediate Occupancy. (Tier 2: Sec. 4.8.5.1)	NA
Ties	Masonry veneer shall be connected to the back-up with corrosion-resistant ties. The ties shall have a spacing equal to or less than 24 inches with a minimum of one tie for every 2-2/3 square feet. A spacing of up to 36 inches is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2. (Tier 2: Sec. 4.8.5.2)	NA
Weakened Planes	Masonry veneer shall be anchored to the back-up adjacent to weakened planes, such as at the locations of flashing. (Tier 2: Sec. 4.8.5.3)	NA
Mechanical and Electrical Equipment		
Attached Equipment	Equipment weighting over 20 lb that is attached to ceilings, walls, or other supports 4 feet above the floor level shall be mounted. (Tier 2: Sec 4.8.12.2)	C

		Compliance
Deterioration	There shall be no evidence of deterioration, damage, or corrosion in any of the anchorage or supports of mechanical or electrical equipment. (Tier 2: Sec. 4.8.12.3)	NC
Emergency Power Mounting	Equipment used as part of an emergency power system shall be mounted to maintain continued operation after an earthquake. (Tier 2: Sec. 4.8.12.1)	NA
Hazardous Material Equipment	HVAC or other equipment containing hazardous material shall not have damaged supply lines or unbraced isolation supports. (Tier 2: Sec. 4.8.12.2)	NA
Parapets, Cornices, Ornamentation, and Appendages		
Canopies	Canopies located at building exits shall be anchored to the structural framing at a spacing of 6 feet or less. An anchorage spacing of up to 10 feet is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.8.2)	NA
Urm Parapets	There shall be no laterally unsupported unreinforced masonry parapets or cornices with height-to-thickness ratios greater than 1.5. A height-to-thickness ratio of up to 2.5 is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2. (Tier 2: Sec. 4.8.8.1)	NA
Partitions		
Unreinforced Masonry Bracing	Unreinforced masonry or hollow clay tile partitions shall be braded at a spacing equal to or less than 10 feet in levels of low or moderate seismicity and 6 feet in levels of high seismicity. (Tier 2: Sec. 4.8.1.1)	NA
Piping		
Fire Suppression Piping	Fire suppression piping shall be anchored and braced in accordance with NFPA-13 (NFPA, 1996). (Tier 2: Sec. 4.8.13.1)	NC
Flexible Couplings	Fluid, gas, and fire suppression piping shall have flexible couplings. (Tier 2: Sec. 4.8.13.2)	NC

		Compliance
Stairs		
Stair Details	In moment frame structures, the connection between the stairs and the structure shall not rely on shallow anchors in concrete. Alternatively, the stair details shall be capable of accommodating the drift calculated using the Quick Check procedure of Section 3.5.3.1 without including tension in the anchors. (Tier 2: Sec. 4.8.10.2)	NA
Urm Walls	Walls around stair enclosures shall not consist of unbraced hollow clay tile or unreinforced masonry with a height-to-thickness ratio greater than 12-to-1. A height-to-thickness ratio of up to 15-to-1 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.10.1)	NA

		Compliance

3.9.1S Supplemental Nonstructural Component Checklist

Building Contents and Furnishing

Access Floor Anchorage	Access floors over 9 inches in height shall be braced. (Tier 2: Sec. 4.8.11.4)	NA
Drawers	Cabinet drawers shall have latches to keep them closed during an earthquake (Tier 2: Sec 4.8.11.3)	NA
Equipment Bracing and Anchorage to Access Floors	Equipment and computers supported on access floor systems shall be either attached to the structure or fastened to a laterally braced floor system. (Tier 2: Sec. 4.8.11.5)	NA
File Cabinets	File cabinets arranged in groups shall be attached to one another. (Tier 2: Sec. 4.8.11.2)	NC
File Cabinets Attachments, Doors, and Drawer Locks	Cabinet doors and drawers shall have latches to keep them closed during an earthquake. (Tier 2: Sec. 4.8.11.3)	NC

Ceiling Systems

Edges Separation	The edges of integrated suspended ceilings shall be separated from enclosing walls by a minimum of 1/2 inch. (Tier 2: Sec. 4.8.2.5)	NA
Seismic Joint	The ceiling system shall not extend continuously across any seismic joint. (Tier 2: Sec. 4.8.2.6)	NA

Cladding and Glazing

Safety Glass	All exterior glazing shall be laminated, annealed or laminated heat-strengthened safety glass or other glazing system that will remain in the frame when glass is cracked. (Tier 2: Sec. 4.8.4.9)	NA

Concrete Block and Masonry Back-Up Systems

Anchorage	Back-up shall have a positive anchorage to the structural framing at a spacing equal to or less than 4 feet along the floors and roof. (Tier 2: Sec. 4.8.7.1)	NA
Concrete Block	Concrete block shall qualify as reinforced masonry (Tier 2: Sec. 4.8.7.1)	NA

		Compliance
Urm Back-Up	There shall be no unreinforced masonry back-up. (Tier 2: Sec. 4.8.7.2)	NA

Ducts

Duct Bracing	Rectangular ductwork exceeding 6 square feet in cross-sectional area, and round ducts exceeding 28 inches in diameter, shall be braced. Maximum spacing of transverse bracing shall not exceed 30 feet. Maximum spacing of longitudinal bracing shall not exceed 60 feet. Intermediate supports shall not be considered part of the lateral-force resisting system. (Tier 2: Sec. 4.8.14.2)	NA
Duct Supports	Ducts shall not be supported by piping or electrical conduit. (Tier 2: Sec. 4.8.14.3)	NA
Stair and Smoke Duct Bracing	Stair pressurization and smoke flow of gas and high temperature energy in the event of an earthquake-induced failure. (Tier 2: Sec. 4.8.13.4)	C

Elevators

Brackets	The brackets that tie the car rails and the counterweight rail to the building structure shall be sized in accordance with ASME A17.1. (Tier 2: Sec. 4.8.16.7)	NA
Counterweight Rails	All counterweight rails and divider beams shall be sized in accordance with ASME A17.1. (Tier 2: Sec. 4.8.16.6)	NA
Go-Slow Elevators	The building shall have a go-slow elevator system. (Tier 2: Sec. 4.8.16.9)	NA
Retainer Guards	Cable retainer guards on sheaves and drums shall be present to inhibit the displacement of cables. (Tier 2: Sec. 4.8.16.4)	NA
Retainer Plate	A retainer plate shall be present at the top and bottom of both car and counterweight. (Tier 2: Sec. 4.8.16.5)	NA
Seismic Switch	All elevators shall be equipped with seismic switches that will terminate operations when the ground motion exceeds 0.10g. (Tier 2: Sec. 4.8.16.2)	NA
Shaft Walls	All elevator shaft walls shall be anchored and reinforced to prevent toppling into the shaft during strong shaking. (Tier 2: Sec. 4.8.16.3)	NA

		Compliance
Spreader Bracket	Spreader brackets shall not be used to resist seismic forces. (Tier 2: Sec. 4.8.16.8)	NA
Support System	All elements of the elevator system shall be anchored. (Tier 2: Sec. 4.8.16.1)	NA
Hazardous Materials Storage and Distribution		
Gas Cylinder Restraints	Compressed gas-cylinders shall be restrained. (Tier 2: Sec. 4.8.15.2)	NA
Hazardous Materials Shutoff Valves	Piping containing hazardous materials shall have shut-off valves or other devices to prevent major spills or leaks. (Tier 2: Sec. 4.8.16.4)	NA
Light Fixtures		
Lens Covers	Lens covers on light fixtures shall be attached or supplied with safety devices. (Tier 2: Sec. 4.8.3.4)	C
Pendant Supports	Light fixtures on pendant supports shall be attached at a spacing equal to or less than 6 feet and, if rigidly, supported, shall be free to move with the structure to which they are attached without damaging adjoining materials. (Tier 2: Sec. 4.8.3.3)	C
Masonry Veneer		
Mortar	The mortar in masonry veneer shall not be easily scraped away from the joints by hand with a metal tool, and there shall not be significant areas of eroded mortar. (Tier 2: Sec. 4.8.5.5)	NA
Stone Cracks	There shall be no visible cracks or signs of visible distortion in the stone. (Tier 2: Sec. 4.8.5.7)	NA
Weep Holes	In veneer braced by stud walls, functioning weep holes and base flashing shall be present. (Tier 2: Sec. 4.8.5.6)	NA
Mechanical and Electrical Equipment		
Door Drift Allowance	Mechanically operated doors shall be detailed to operate at a story drift ratio of 0.01. (Tier 2: Sec. 4.8.12.8)	NA
Electrical Equipment Bracing	Electrical equipment and associated wiring shall be laterally braced to the structural system. (Tier 2: Sec. 4.8.12.7)	NA

		Compliance
Heavy Equipment Anchorage	Equipment weighing over 100 pounds shall be anchored to the structure or foundation. (Tier 2: Sec. 4.8.12.6)	NC
Vibration Isolators Restrained	Equipment mounted on vibration isolators shall be equipped with restraints or snubbers. (Tier 2: Sec. 4.8.12.4)	NA

Metal Stud Back-Up Systems

Openings	Steel studs shall frame window and door openings. (Tier 2: Sec. 4.8.6.2)	C
Stud Tracks	Stud tracks shall be fastened to structural framing at a spacing equal to or less than 24 inches on center. (Tier 2: Sec. 4.8.6.1)	C

Parapets, Cornices, Ornamentation, and Appendages

Appendages	Cornices, parapets, signs, and other appendages that extend above the highest anchorage level or cantilever from exterior wall faces and other exterior wall ornamentation shall be reinforced and anchored to the structural system at a spacing equal to or less than 10 feet for Life Safety and 6 feet for Immediate Occupancy. This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. f4.8.8.4)	NA
Concrete Parapets	Concrete parapets with height-to-thickness ratios greater than 2.5 shall have vertical reinforcement. (Tier 2: Sec. 4.8.8.3)	NA

Partitions

Drift Allowance	Rigid cementitious partitions shall be detailed to accommodate a drift ratio of 0.02 in steel moment frame, concrete moment frame, and wood frame buildings. Rigid cementitious partitions shall be detailed to accommodate a drift ratio of 0.005 in other buildings. (Tier 2: Sec. 4.8.1.2)	NA
Lateral Bracing for Tops	The tops of framed or panelized partitions that only extend to the ceiling line shall have lateral bracing to the building structure at a spacing equal to or less than 6 feet. (Tier 2: Sec. 4.8.1.4)	NA
Seismic Control Joints	Partitions at structural separations shall have seismic or control joints. (Tier 2: Sec. 4.8.1.3)	C

		Compliance
Piping		
C-Clamps	One-sided C-clamps that support piping greater than 2.5 inches in diameter shall be restrained. (Tier 2: Sec. 4.8.13.5)	C
Fluid and Gas Piping Anchorage and Bracing	Fluid and gas piping shall be anchored and braced to the structure to prevent breakage in piping. (Tier 2: Sec 4.8.13.3)	C
Shut-Off Valves	Shut-off devices shall be present at building utility interfaces to shut off the flow of gas and high-temperature energy in the event of earthquake-induced failure. (Tier 2: Sec. 4.8.13.4)	

3.9.2 Intermediate Nonstructural Component Checklist

		Compliance
Ceiling Systems		
Integrated Ceilings	Integrated suspended ceilings at exists and corridors or weighing more than 2 pounds per square foot shall be laterally restrained with a minimum of four diagonal wires or rigid members attached to the structure above at a spacing equal to or less than 12 feet. (Tier 2: Sec. 4.8.2.3)	NA
Lay-In Tiles	Lay-in tiles used in ceiling panels located at exits and corridors shall be secured with clips. (Tier 2: Sec. 4.8.2.2)	NA
Suspended Lath and Plaster	Ceilings consisting of suspended lath and plaster or gypsum board shall be attached to resist seismic forced for every 12 square feet of area. (Tier 2: Sec. 4.8.2.4)	NA
Cladding and Glazing		
Glazing	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall have safety glazing. Such glazing located over 10 feet above an exterior walking surface shall be laminated, annealed, or laminated heat strengthened safety glass that will remain in the frame when cracked (Tier 2: Sec. 4.8.4.8)	NA
Laminated Safety Glass	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall have safety glazing. Such glazing located over 10 feet above an exterior walking surface shall be laminated annealed or laminated heat-strengthened safety glass or other glazing system that will remain in the frame when glass is cracked. (Tier 2: Sec. 4.8.4.8)	NA
Ducts		
Stair and Smoke Duct Bracing	Stair pressurization and smoke control ducts shall be braced and shall have flexible connections at seismic joints. (Tier 2: Sec. 4.8.14.1)	NA
Light Fixtures		
Independent Support	Light fixtures in suspended grid ceilings shall be supported independently of the ceiling suspension system by a minimum of two wires at diagonally opposite. (Tier 2: Sec. 4.8.3.2)	NA

 Compliance

Masonry Chimneys

Anchorage	Masonry chimneys shall be anchored at each floor level and the roof. (Tier 2: Sec. 4.8.9.2)This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. 4.8.8.4)	NA

Mechanical and Electrical Equipment

Vibration Isolators Restrained	Equipment mounted on vibration isolators shall be equipped with restraints or snubbers. (Tier 2: Sec. 4.8.12.4)	NA

Parapets, Cornices, Ornamentation, and Appendages

Appendages	Cornices, parapets, signs, and other appendages that extend above the highest point of anchorage to the structure or cantilever from exterior wall faces and other exterior wall ornamentation shall be reinforced and anchored to the structural system at a spacing equal to or less than 10 feet for Life Safety and 6 feet for Immediate Occupancy. This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. 4.8.8.4)	NA
Concrete Parapets	Concrete parapets with height-to-thickness ratios greater than 2.5 shall have vertical reinforcement. (Tier 2: Sec. 4.8.8.3)	NA

ASCE31 Tier 1 Seismic Screening
Structural and Non-Structural Findings

Butler Building

3.7.5 Steel Light Frames

		Compliance
Buiding System		
TORSION	The estimated distance between the story center of mass and the story center of rigidity shall be less 20 percent of the building width in either plan dimension for Life Safety and Immediate Occupancy	NC
Building System		
DETERIORATION OF STEEL	There shall be no visible rusting, corrosion, cracking, or other deterioration in any of the steel elements or connections in the vertical-or lateral-force-resisting systems	NC
LOAD PATH	The structure shall contain a minimum of one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation	C
MEZZANINES	Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure	NA
VERTICAL DISCONTINUITIES	All vertical elements in the lateral-force-resisting system shall be continuous to the foundation	C
Connections		
ROOF PANELS	Metal, plastic, or cementitious roof panels shall be positively attached to the roof framing to resist sesimic forces for Life Safety and Immediate Occupancy	C
STEEL COLUMNS	The columns in lateral-force-resisting frames ahll be anchored to the building foundation for Life Safety, and the anchorage shall be able to develop the lesser of the tensile capacity of the column, the tensile capacity of the lowest level column splice (if any), or the uplift capacity of the foundation, for Immediate Occupancy	NA

		Compliance
TRANSFER OF STEEL FRAMES	Diaphragms shall be connected for transfer of load to the steel frames for Life Safety, and the connections shall be able to develop the lesser of the strength of the frames or the diaphragms for Immediate Occupancy	C
WALL PANELS	Metal, fiberglass, or cementitious wall panels shall be positively attached to the framing to resist seismic forces for Life Safety and Immediate Occupancy	C
WALL PANELS	Metal, fiberglass, or cementitious wall panels shall be positively attached to the foundation for Life Safety and Immediate Occupancy	C

Lateral-Force-Resisting System

AXIAL STRESS CHECK	The axial stress in the diagonals, calculated using the Quick Check procedure of Section 3.5.3.4, shall be less than 0.50Fy for Life Safety and for Immediate Occupancy	NC

Compliance

3.7.5S Steel Light Frames

Connections

UPLIFT AT PILE CAPS	Pile caps shall have reinforcement and piles shall be anchored to the pile caps for Life Safety, and the pile reinforcement and pile anchorage shall be able to develop the tensile capacity of the piles for Immediate Occupancy	NA

Diaphragms

DIAPHRAGM REINFORCEMENT AT OPENINGS	There shall be reinforcing around all diaphragm openings larger than 50 percent of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only	NA
OTHER DIAPHRAGMS	The diaphragm shall not consist of a system other than wood, metal deck, concrete, or horizontal bracing	C
PLAN IRREGULARITIES	There shall be tensile capacity to develop the strength of the diaphragm at re-entrant corners or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only	C

Lateral-Force-Resisting System

BEAM PENETRATIONS	All openings in frame-beam webs shall be less than 1/4 of the beam depth and shall be located in the center half of the beams. This statement shall apply to the Immediate Occupancy Performance Level only	NA
BOTTOM FLANGE BRACING	The bottom flanges of beams shall be braced out-of-plane. This statement shall apply to the Immediate Occupancy Performance Level only	NA
COMPACT MEMBERS	All frame elements shall meet section requirements set forth by Seismic Provisions for Structural Steel Building Table 1-91	NA
MOMENT-RESISTING CONNECTIONS	All moment connections shall be able to develop the strength of the adjoining members or panel zones	NA
OUT-OF-PLANE BRACING	Beam-column joints shall be braced out-of-plane. This statement shall apply to the Immediate Occupancy Performance Level only	NA

Compliance

3.9.1 Basic Nonstructural Component Checklist

Building Contents and Furnishing

Tall Narrow Contents	Contents over 4 feet in height with a height-to-depth or height-to-width ratio greater than 3-to-1 shall be anchored to the floor slab or adjacent structural walls. A height-to-depth or height-to-width ratio of up to 4-to-1 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.11.1)	NC

Ceiling Systems

Integrated Ceilings	Integrated suspended ceilings at exits and corridors or weighing more than 2 lb/ft^2 shall be laterally restrained by a minimum of 4 diagonal wires or rigid members attached to the structure above at a spacing equal to or less than 12 ft (Tier 2: Sec. 4.8.2.1)	NA
Lay-In Tiles	Lay-in tiles used in ceiling panels located at exits and corridors shall be secured with clips. (Tier 2: Sec. 4.8.2.2)	NA
Supporting Partitions	The integrated suspended ceiling system shall not be used to laterally support the tops of gypsum board, masonry, or hollow clay tile partitions. Gypsum board partitions need not be evaluated where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.2.1)	NA
Suspended Lath and Plaster	Ceilings consisting of suspended lath and plaster or gypsum board shall be attached for each 10 square feet of area (Tier 2: Sec. 4.8.2.4)	NA

Cladding and Glazing

Bearing Connections	Where bearing connections are required, there shall be a minimum of two bearing connections for each wall panel. (Tier 2: Sec. 4.8.4.5)	NA
Cladding Anchorage	Cladding components weighing more than 10 psf shall be mechanically anchored to the exterior wall framing at a spacing equal to or less than 4 feet. A spacing of up to 6 feet is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2 (Tier 2: Sec. 4.8.4.1)	NA
Cladding Isolation	For moment frame buildings of steel or concrete, panel connections shall be detailed to accommodate a drift ratio of 0.02 for Life Safety and 0.01for Immediate Occupancy (Tier 2: Sec. 4.8.4.2)	NA

		Compliance
Connections Out of Plane	Exterior cladding panels shall be anchored out-of-plane with a minimum of 4 connections for each wall panel. Two connections per wall panel are permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.7)	NA
Damage	There shall be no damage to exterior wall cladding. (Tier 4.8.4.8)	NA
Deterioration in Connections	There shall be no evidence of deterioration, damage or corrosion in any of the connection elements. (Tier 2: Sec. 4.8.4.2)	NA
Drift Isolation	For moment frame buildings of steel or concrete, panel connections shall be detailed to accommodate a story drift ratio of 0.02. Panel connection detailing for a story drift ratio of 0.01 is permitted where only the Basic nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.3)	NA
Glazing	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall be laminated, annealed, or heat strengthened safety glass that will remain in the frame when cracked (Tier 2: Sec. 4.8.4.9)	NA
Inserts	Where inserts are used in concrete connections, the inserts shall be anchored to reinforcing steel or other positive anchorage. (Tier 2: Sec. 4.8.4.6)	NA
Multi-Story Panels Drift	For multi-story panels attached at each floor level, panel connections shall be detailed to accommodate a story drift ratio of 0.02 and 0.01 for immediate occupancy. Panel connection detailing for a story drift ratio (Tier 2: Sec. 4.8.4.4)	NA
Panel Connections	Exterior cladding panels shall be anchored with a minimum of 2 connections for each wall panel for Life Safety and 4 connections for Immediate Occupancy. (Tier 2: Sec. 4.8.4.6)	NA

Hazardous Materials Storage and Distribution

Toxic Substances Lateral Bracing and Anchorage	Toxic and hazardous substances stored in breakable containers shall be restrained from falling by latched doors, shelf lips, wires, or other methods. (Tier 2: Sec 4.8.15.1)	NA

Light Fixtures

Emergency Lighting Anchorage	Emergency lighting shall be anchored or braced to prevent falling or swaying during an earthquake. (Tier 2: Sec. 4.8.3.2)	C
Independent Support	Light fixtures in suspended grid ceilings shall be supported independently of the ceiling suspension system by a minimum of two wires at diagonally opposite corners of the fixtures (Tier 2: Sec. 4.8.3.1)	NA

Masonry Chimneys

Urm Chimneys	No reinforced masonry chimney shall extend above the roof surface more than twice the least dimension of the chimney. A height above the roof surface of up to three times the least dimension of the chimney is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.9.1)	NA

Masonry Veneer

Deterioration	There shall be no evidence of deterioration, damage or corrosion in any of the connection elements. (Tier 2: Sec. 4.8.5.4)	NA
Shelf Angles	Masonry veneer shall be supported by shelf angles or other elements at each floor 30 feet or more above ground for Life Safety and at each floor above the first floor for Immediate Occupancy. (Tier 2: Sec. 4.8.5.1)	NA
Ties	Masonry veneer shall be connected to the back-up with corrosion-resistant ties. The ties shall have a spacing equal to or less than 24 inches with a minimum of one tie for every 2-2/3 square feet. A spacing of up to 36 inches is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2. (Tier 2: Sec. 4.8.5.2)	NA
Weakened Planes	Masonry veneer shall be anchored to the back-up adjacent to weakened planes, such as at the locations of flashing. (Tier 2: Sec. 4.8.5.3)	NA

Mechanical and Electrical Equipment

Attached Equipment	Equipment weighting over 20 lb that is attached to ceilings, walls, or other supports 4 feet above the floor level shall be mounted. (Tier 2: Sec 4.8.12.2)	NC

		Compliance
Deterioration	There shall be no evidence of deterioration, damage, or corrosion in any of the anchorage or supports of mechanical or electrical equipment. (Tier 2: Sec. 4.8.12.3)	NC
Emergency Power Mounting	Equipment used as part of an emergency power system shall be mounted to maintain continued operation after an earthquake. (Tier 2: Sec. 4.8.12.1)	NA
Hazardous Material Equipment	HVAC or other equipment containing hazardous material shall not have damaged supply lines or unbraced isolation supports. (Tier 2: Sec. 4.8.12.2)	NA

Parapets, Cornices, Ornamentation, and Appendages

Canopies	Canopies located at building exits shall be anchored to the structural framing at a spacing of 6 feet or less. An anchorage spacing of up to 10 feet is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.8.2)	NA
Urm Parapets	There shall be no laterally unsupported unreinforced masonry parapets or cornices with height-to-thickness ratios greater than 1.5. A height-to-thickness ratio of up to 2.5 is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2. (Tier 2: Sec. 4.8.8.1)	NA

Partitions

Unreinforced Masonry Bracing	Unreinforced masonry or hollow clay tile partitions shall be braded at a spacing equal to or less than 10 feet in levels of low or moderate seismicity and 6 feet in levels of high seismicity. (Tier 2: Sec. 4.8.1.1)	NA

Piping

Fire Suppression Piping	Fire suppression piping shall be anchored and braced in accordance with NFPA-13 (NFPA, 1996). (Tier 2: Sec. 4.8.13.1)	NA
Flexible Couplings	Fluid, gas, and fire suppression piping shall have flexible couplings. (Tier 2: Sec. 4.8.13.2)	NA

		Compliance
Stairs		
Stair Details	In moment frame structures, the connection between the stairs and the structure shall not rely on shallow anchors in concrete. Alternatively, the stair details shall be capable of accommodating the drift calculated using the Quick Check procedure of Section 3.5.3.1 without including tension in the anchors. (Tier 2: Sec. 4.8.10.2)	NA
Urm Walls	Walls around stair enclosures shall not consist of unbraced hollow clay tile or unreinforced masonry with a height-to-thickness ratio greater than 12-to-1. A height-to-thickness ratio of up to 15-to-1 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.10.1)	NA

3.9.1S Supplemental Nonstructural Component Checklist

Building Contents and Furnishing		
Access Floor Anchorage	Access floors over 9 inches in height shall be braced. (Tier 2: Sec. 4.8.11.4)	NA
Drawers	Cabinet drawers shall have latches to keep them closed during an earthquake (Tier 2: Sec 4.8.11.3)	NA
Equipment Bracing and Anchorage to Access Floors	Equipment and computers supported on access floor systems shall be either attached to the structure or fastened to a laterally braced floor system. (Tier 2: Sec. 4.8.11.5)	NA
File Cabinets	File cabinets arranged in groups shall be attached to one another. (Tier 2: Sec. 4.8.11.2)	NA
File Cabinets Attachments, Doors, and Drawer Locks	Cabinet doors and drawers shall have latches to keep them closed during an earthquake. (Tier 2: Sec. 4.8.11.3)	NA
Ceiling Systems		
Edges Separation	The edges of integrated suspended ceilings shall be separated from enclosing walls by a minimum of 1/2 inch. (Tier 2: Sec. 4.8.2.5)	NA
Seismic Joint	The ceiling system shall not extend continuously across any seismic joint. (Tier 2: Sec. 4.8.2.6)	NA
Cladding and Glazing		
Safety Glass	All exterior glazing shall be laminated, annealed or laminated heat-strengthened safety glass or other glazing system that will remain in the frame when glass is cracked. (Tier 2: Sec. 4.8.4.9)	NA
Concrete Block and Masonry Back-Up Systems		
Anchorage	Back-up shall have a positive anchorage to the structural framing at a spacing equal to or less than 4 feet along the floors and roof. (Tier 2: Sec. 4.8.7.1)	NA
Concrete Block	Concrete block shall qualify as reinforced masonry (Tier 2: Sec. 4.8.7.1)	NA

		Compliance
Urm Back-Up	There shall be no unreinforced masonry back-up. (Tier 2: Sec. 4.8.7.2)	NA
Ducts		
Duct Bracing	Rectangular ductwork exceeding 6 square feet in cross-sectional area, and round ducts exceeding 28 inches in diameter, shall be braced. Maximum spacing of transverse bracing shall not exceed 30 feet. Maximum spacing of longitudinal bracing shall not exceed 60 feet. Intermediate supports shall not be considered part of the lateral-force resisting system. (Tier 2: Sec. 4.8.14.2)	NA
Duct Supports	Ducts shall not be supported by piping or electrical conduit. (Tier 2: Sec. 4.8.14.3)	NA
Stair and Smoke Duct Bracing	Stair pressurization and smoke flow of gas and high temperature energy in the event of an earthquake-induced failure. (Tier 2: Sec. 4.8.13.4)	NA
Elevators		
Brackets	The brackets that tie the car rails and the counterweight rail to the building structure shall be sized in accordance with ASME A17.1. (Tier 2: Sec. 4.8.16.7)	NA
Counterweight Rails	All counterweight rails and divider beams shall be sized in accordance with ASME A17.1. (Tier 2: Sec. 4.8.16.6)	NA
Go-Slow Elevators	The building shall have a go-slow elevator system. (Tier 2: Sec. 4.8.16.9)	NA
Retainer Guards	Cable retainer guards on sheaves and drums shall be present to inhibit the displacement of cables. (Tier 2: Sec. 4.8.16.4)	NA
Retainer Plate	A retainer plate shall be present at the top and bottom of both car and counterweight. (Tier 2: Sec. 4.8.16.5)	NA
Seismic Switch	All elevators shall be equipped with seismic switches that will terminate operations when the ground motion exceeds 0.10g. (Tier 2: Sec. 4.8.16.2)	NA
Shaft Walls	All elevator shaft walls shall be anchored and reinforced to prevent toppling into the shaft during strong shaking. (Tier 2: Sec. 4.8.16.3)	NA

		Compliance
Spreader Bracket	Spreader brackets shall not be used to resist seismic forces. (Tier 2: Sec. 4.8.16.8)	NA
Support System	All elements of the elevator system shall be anchored. (Tier 2: Sec. 4.8.16.1)	NA
Hazardous Materials Storage and Distribution		
Gas Cylinder Restraints	Compressed gas-cylinders shall be restrained. (Tier 2: Sec. 4.8.15.2)	NA
Hazardous Materials Shutoff Valves	Piping containing hazardous materials shall have shut-off valves or other devices to prevent major spills or leaks. (Tier 2: Sec. 4.8.16.4)	NA
Light Fixtures		
Lens Covers	Lens covers on light fixtures shall be attached or supplied with safety devices. (Tier 2: Sec. 4.8.3.4)	C
Pendant Supports	Light fixtures on pendant supports shall be attached at a spacing equal to or less than 6 feet and, if rigidly, supported, shall be free to move with the structure to which they are attached without damaging adjoining materials. (Tier 2: Sec. 4.8.3.3)	NA
Masonry Veneer		
Mortar	The mortar in masonry veneer shall not be easily scraped away from the joints by hand with a metal tool, and there shall not be significant areas of eroded mortar. (Tier 2: Sec. 4.8.5.5)	NA
Stone Cracks	There shall be no visible cracks or signs of visible distortion in the stone. (Tier 2: Sec. 4.8.5.7)	NA
Weep Holes	In veneer braced by stud walls, functioning weep holes and base flashing shall be present. (Tier 2: Sec. 4.8.5.6)	NA
Mechanical and Electrical Equipment		
Door Drift Allowance	Mechanically operated doors shall be detailed to operate at a story drift ratio of 0.01. (Tier 2: Sec. 4.8.12.8)	NA
Electrical Equipment Bracing	Electrical equipment and associated wiring shall be laterally braced to the structural system. (Tier 2: Sec. 4.8.12.7)	NA

		Compliance
Heavy Equipment Anchorage	Equipment weighing over 100 pounds shall be anchored to the structure or foundation. (Tier 2: Sec. 4.8.12.6)	NC
Vibration Isolators Restrained	Equipment mounted on vibration isolators shall be equipped with restraints or snubbers. (Tier 2: Sec. 4.8.12.4)	NA

Metal Stud Back-Up Systems

Openings	Steel studs shall frame window and door openings. (Tier 2: Sec. 4.8.6.2)	C
Stud Tracks	Stud tracks shall be fastened to structural framing at a spacing equal to or less than 24 inches on center. (Tier 2: Sec. 4.8.6.1)	C

Parapets, Cornices, Ornamentation, and Appendages

Appendages	Cornices, parapets, signs, and other appendages that extend above the highest anchorage level or cantilever from exterior wall faces and other exterior wall ornamentation shall be reinforced and anchored to the structural system at a spacing equal to or less than 10 feet for Life Safety and 6 feet for Immediate Occupancy. This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. f4.8.8.4)	NA
Concrete Parapets	Concrete parapets with height-to-thickness ratios greater than 2.5 shall have vertical reinforcement. (Tier 2: Sec. 4.8.8.3)	NA

Partitions

Drift Allowance	Rigid cementitious partitions shall be detailed to accommodate a drift ratio of 0.02 in steel moment frame, concrete moment frame, and wood frame buildings. Rigid cementitious partitions shall be detailed to accommodate a drift ratio of 0.005 in other buildings. (Tier 2: Sec. 4.8.1.2)	NA
Lateral Bracing for Tops	The tops of framed or panelized partitions that only extend to the ceiling line shall have lateral bracing to the building structure at a spacing equal to or less than 6 feet. (Tier 2: Sec. 4.8.1.4)	NA
Seismic Control Joints	Partitions at structural separations shall have seismic or control joints. (Tier 2: Sec. 4.8.1.3)	NA

Piping		Compliance
C-Clamps	One-sided C-clamps that support piping greater than 2.5 inches in diameter shall be restrained. (Tier 2: Sec. 4.8.13.5)	NA
Fluid and Gas Piping Anchorage and Bracing	Fluid and gas piping shall be anchored and braced to the structure to prevent breakage in piping. (Tier 2: Sec 4.8.13.3)	NA
Shut-Off Valves	Shut-off devices shall be present at building utility interfaces to shut off the flow of gas and high-temperature energy in the event of earthquake-induced failure. (Tier 2: Sec. 4.8.13.4)	NA

3.9.2 Intermediate Nonstructural Component Checklist

		Compliance
Ceiling Systems		
Integrated Ceilings	Integrated suspended ceilings at exists and corridors or weighing more than 2 pounds per square foot shall be laterally restrained with a minimum of four diagonal wires or rigid members attached to the structure above at a spacing equal to or less than 12 feet. (Tier 2: Sec. 4.8.2.3)	NA
Lay-In Tiles	Lay-in tiles used in ceiling panels located at exits and corridors shall be secured with clips. (Tier 2: Sec. 4.8.2.2)	NA
Suspended Lath and Plaster	Ceilings consisting of suspended lath and plaster or gypsum board shall be attached to resist seismic forced for every 12 square feet of area. (Tier 2: Sec. 4.8.2.4)	NA
Cladding and Glazing		
Glazing	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall have safety glazing. Such glazing located over 10 feet above an exterior walking surface shall be laminated, annealed, or laminated heat strengthened safety glass that will remain in the frame when cracked (Tier 2: Sec. 4.8.4.8)	NA
Laminated Safety Glass	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall have safety glazing. Such glazing located over 10 feet above an exterior walking surface shall be laminated annealed or laminated heat-strengthened safety glass or other glazing system that will remain in the frame when glass is cracked. (Tier 2: Sec. 4.8.4.8)	NA
Ducts		
Stair and Smoke Duct Bracing	Stair pressurization and smoke control ducts shall be braced and shall have flexible connections at seismic joints. (Tier 2: Sec. 4.8.14.1)	NA
Light Fixtures		
Independent Support	Light fixtures in suspended grid ceilings shall be supported independently of the ceiling suspension system by a minimum of two wires at diagonally opposite. (Tier 2: Sec. 4.8.3.2)	NA

Compliance

Masonry Chimneys

Anchorage	Masonry chimneys shall be anchored at each floor level and the roof. (Tier 2: Sec. 4.8.9.2)This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. 4.8.8.4)	NA

Mechanical and Electrical Equipment

Vibration Isolators Restrained	Equipment mounted on vibration isolators shall be equipped with restraints or snubbers. (Tier 2: Sec. 4.8.12.4)	NA

Parapets, Cornices, Ornamentation, and Appendages

Appendages	Cornices, parapets, signs, and other appendages that extend above the highest point of anchorage to the structure or cantilever from exterior wall faces and other exterior wall ornamentation shall be reinforced and anchored to the structural system at a spacing equal to or less than 10 feet for Life Safety and 6 feet for Immediate Occupancy. This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. 4.8.8.4)	NA
Concrete Parapets	Concrete parapets with height-to-thickness ratios greater than 2.5 shall have vertical reinforcement. (Tier 2: Sec. 4.8.8.3)	NA

ASCE31 Tier 1 Seismic Screening
Structural and Non-Structural Findings

16 kW SWGR Building/Effluent PS VFD Building

3.7.13 Reinforced Masonry Bearing Walls with Flexible Diaphragms

Building System

		Compliance
ADJACENT BUILDINGS	The clear distance between the building being evaluated and any adjacent building shall be greater than 4 percent of the height of the shorter building for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.1.2)	C
DETERIORATION OF WOOD	There shall be no signs of decay, shrinkage, splitting, fire damage, or sagging in any of the wood members, and none of the metal connection hardware shall be deteriorated, broken, or loose. (Tier 2: Sec. 4.3.3.1)	C
GEOMETRY	There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30 percent in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines. (Tier 2: Sec. 4.3.2.3)	NA
LOAD PATH	The structure shall contain a minimum of one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)	C
MASONRY JOINTS	The mortar shall not be easily scraped away from the joints by hand with a metal tool, and there shall be no areas of eroded mortar. (Tier 2: Sec. 4.3.3.8)	C
MASONRY UNITS	There shall be no visible deterioration of masonry units. (Tier 2: Sec. 4.3.3.7)	C
MASS	There shall be no change in effective mass more than 50 percent from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses, and mezzanines need not be considered. (Tier 2: Sec. 4.3.2.5)	NA
MEZZANINES	Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.3)	NA

		Compliance
REINFORCED MASONRY WALL CRACKS	All existing diagonal cracks in wall elements shall be less than 1/8 inch for Life Safety and 1/16 inch for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern. (Tier 2: Sec. 4.3.3.10)	C
SOFT STORY	The stiffness of the lateral-force-resisting system in any story shall not be less than 70 percent of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80 percent of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2)	NA
VERTICAL DISCONTINUITIES	All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)	C
WEAK STORY	The strength of the lateral-force-resisting system in any story shall not be less than 80 percent of the strength in an adjacent story, above or below, for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)	NA
Connections		
FOUNDATION DOWELS	Wall reinforcement shall be doweled into the foundation for Life Safety, and the dowels shall be able to develop the lesser of the strength of the walls or the uplift capacity of the foundation for Immediate Occupancy. (Tier 2: Sec. 4.6.3.5)	C
GIRDER/COLUMN CONNECTION	There shall be a positive connection utilizing plates, connection hardware, or straps between the girder and the column support. (Tier 2: Sec. 4.6.4.1)	C
TRANSFER TO SHEAR WALLS	Diaphragms shall be connected for transfer of loads to the shear walls for Life Safety and the connections shall be able to develop the lesser of the shear strength of the walls or diaphragms for Immediate Occupancy. (Tier 2: Sec. 4.6.2.1)	C
WALL ANCHORAGE	Exterior concrete or masonry walls that are dependent on the diaphragm for lateral support shall be anchored for out-of-plane forces at each diaphragm level with steel anchors, reinforcing dowels, or straps that are developed into the diaphragm. Connections shall have adequate strength to resist the connection force calculated in the Quick Check procedure of Section 3.5.3.7. (Tier 2: Sec. 4.6.1.1)	C

		Compliance
WOOD LEDGERS	The connection between the wall panels and the diaphragm shall not induce cross-grain bending or tension in the wood ledgers. (Tier 2: Sec. 4.6.1.2)	C

Lateral Force Resisting System

REDUNDANCY	The number of lines of shear walls in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.1.1)	C
REINFORCING STEEL	The total vertical and horizontal reinforcing steel ratio in reinforced masonry walls shall be greater than 0.002 for Life Safety and Immediate Occupancy of the wall with the minimum of 0.0007 for Life Safety and Immediate Occupancy in either of the two directions; the spacing of reinforcing steel shall be less than 48 inches for Life Safety and Immediate Occupancy; and all vertical bars shall extend to the top of the walls. (Tier 2: Sec. 4.4.2.4.2)	NC
SHEAR STRESS CHECK	The shear stress in the reinforced masonry shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 70 psi for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.4.1)	NC

3.7.13S Reinforced Masonry Bearing Walls with Flexible Diaphragms

Connections

STIFFNESS OF WALL ANCHORS	Anchors of concrete or masonry walls to wood structural elements shall be installed taut and shall be stiff enough to limit the relative movement between the wall and the diaphragm to no greater than 1/8 inch prior to engagement of the anchors. (Tier 2: Sec. 4.6.1.4)	C

Diaphragms

CROSS TIES	There shall be continuous cross ties between diaphragm chords. (Tier 2: Sec. 4.5.1.2)	C
DIAPHRAGM REINFORCEMENT AT OPENINGS	There shall be reinforcing around all diaphragm openings larger than 50 percent of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)	C
NON-CONCRETE FILLED DIAPHRAGMS	Untopped metal deck diaphragms or metal deck diaphragms with fill other than concrete shall consist of horizontal spans of less than 40 feet and shall have span/depth ratios less than 4-to-l. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.3.1)	NA
OPENINGS AT EXTERIOR MASONRY SHEAR WALLS	Diaphragm openings immediately adjacent to exterior masonry shear walls shall not be greater than 8 feet long for Life Safety and 4 feet long for Immediate Occupancy. (Tier 2: Sec. 4.5.1.6)	NA
OPENINGS AT SHEAR WALLS	Diaphragm openings immediately adjacent to the shear walls shall be less than 25 percent of the wall length for Life Safety and 15 percent of the wall length for Immediate Occupancy. (Tier 2: Sec. 4.5.1.4)	C
OTHER DIAPHRAGMS	The diaphragm shall not consist of a system other than wood, metal deck, concrete, or horizontal bracing. (Tier 2: Sec. 4.5.7.1)	C
PLAN IRREGULARITIES	There shall be tensile capacity to develop the strength of the diaphragm at re-entrant comers or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)	NA
SPANS	All wood diaphragms with spans greater than 24 feet for Life Safety and 12 feet for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing. (Tier 2: Sec. 4.5.2.2)	C

16 kW SWGR Building/Effluent PS VFD Building

		Compliance
STRAIGHT SHEATHING	All straight sheathed diaphragms shall have aspect ratios less than 2- to-1 for Life Safety and 1-to-1 for Immediate Occupancy in the direction being considered. (Tier 2: Sec. 4.5.2.1)	C
UNBLOCKED DIAPHRAGMS	All diagonally sheathed or unblocked wood structural panel diaphragms shall have horizontal spans less than 40 feet for Life Safety and 30 feet for Immediate Occupancy and shall have aspect ratios less than or equal to 4-to-1 for Life Safety and 3-to-l for Immediate Occupancy. (Tier 2: Sec. 4.5.2.3)	NA

Lateral Force Resisting System

PROPORTIONS	The height-to-thickness ratio of the shear walls at each story shall be less than 30. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.4.4)	NC
REINFORCING AT OPENINGS	All wall openings that interrupt rebar shall have trim reinforcing on all sides. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.4.3)	C

16 kW SWGR Building/Effluent PS VFD Building

Compliance

3.9.1 Basic Nonstructural Component Checklist

Building Contents and Furnishing

Tall Narrow Contents	Contents over 4 feet in height with a height-to-depth or height-to-width ratio greater than 3-to-1 shall be anchored to the floor slab or adjacent structural walls. A height-to-depth or height-to-width ratio of up to 4-to-1 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.11.1)	C

Ceiling Systems

Integrated Ceilings	Integrated suspended ceilings at exits and corridors or weighing more than 2 lb/ft^2 shall be laterally restrained by a minimum of 4 diagonal wires or rigid members attached to the structure above at a spacing equal to or less than 12 ft (Tier 2: Sec. 4.8.2.1)	NA
Lay-In Tiles	Lay-in tiles used in ceiling panels located at exits and corridors shall be secured with clips. (Tier 2: Sec. 4.8.2.2)	NA
Supporting Partitions	The integrated suspended ceiling system shall not be used to laterally support the tops of gypsum board, masonry, or hollow clay tile partitions. Gypsum board partitions need not be evaluated where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.2.1)	NA
Suspended Lath and Plaster	Ceilings consisting of suspended lath and plaster or gypsum board shall be attached for each 10 square feet of area (Tier 2: Sec. 4.8.2.4)	NA

Cladding and Glazing

Bearing Connections	Where bearing connections are required, there shall be a minimum of two bearing connections for each wall panel. (Tier 2: Sec. 4.8.4.5)	NA
Cladding Anchorage	Cladding components weighing more than 10 psf shall be mechanically anchored to the exterior wall framing at a spacing equal to or less than 4 feet. A spacing of up to 6 feet is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2 (Tier 2: Sec. 4.8.4.1)	NA
Cladding Isolation	For moment frame buildings of steel or concrete, panel connections shall be detailed to accommodate a drift ratio of 0.02 for Life Safety and 0.01for Immediate Occupancy (Tier 2: Sec. 4.8.4.2)	NA

		Compliance
Connections Out of Plane	Exterior cladding panels shall be anchored out-of-plane with a minimum of 4 connections for each wall panel. Two connections per wall panel are permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.7)	NA
Damage	There shall be no damage to exterior wall cladding. (Tier 4.8.4.8)	NA
Deterioration in Connections	There shall be no evidence of deterioration, damage or corrosion in any of the connection elements. (Tier 2: Sec. 4.8.4.2)	NA
Drift Isolation	For moment frame buildings of steel or concrete, panel connections shall be detailed to accommodate a story drift ratio of 0.02. Panel connection detailing for a story drift ratio of 0.01 is permitted where only the Basic nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.3)	NA
Glazing	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall be laminated, annealed, or heat strengthened safety glass that will remain in the frame when cracked (Tier 2: Sec. 4.8.4.9)	NA
Inserts	Where inserts are used in concrete connections, the inserts shall be anchored to reinforcing steel or other positive anchorage. (Tier 2: Sec. 4.8.4.6)	NA
Multi-Story Panels Drift	For multi-story panels attached at each floor level, panel connections shall be detailed to accommodate a story drift ratio of 0.02 and 0.01 for immediate occupancy. Panel connection detailing for a story drift ratio (Tier 2: Sec. 4.8.4.4)	NA
Panel Connections	Exterior cladding panels shall be anchored with a minimum of 2 connections for each wall panel for Life Safety and 4 connections for Immediate Occupancy. (Tier 2: Sec. 4.8.4.6)	NA

Hazardous Materials Storage and Distribution

Toxic Substances Lateral Bracing and Anchorage	Toxic and hazardous substances stored in breakable containers shall be restrained from falling by latched doors, shelf lips, wires, or other methods. (Tier 2: Sec 4.8.15.1)	NS

		Compliance
Light Fixtures		
Emergency Lighting Anchorage	Emergency lighting shall be anchored or braced to prevent falling or swaying during an earthquake. (Tier 2: Sec. 4.8.3.2)	NC
Independent Support	Light fixtures in suspended grid ceilings shall be supported independently of the ceiling suspension system by a minimum of two wires at diagonally opposite corners of the fixtures (Tier 2: Sec. 4.8.3.1)	NA
Masonry Chimneys		
Urm Chimneys	No reinforced masonry chimney shall extend above the roof surface more than twice the least dimension of the chimney. A height above the roof surface of up to three times the least dimension of the chimney is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.9.1)	NA
Masonry Veneer		
Deterioration	There shall be no evidence of deterioration, damage or corrosion in any of the connection elements. (Tier 2: Sec. 4.8.5.4)	NA
Shelf Angles	Masonry veneer shall be supported by shelf angles or other elements at each floor 30 feet or more above ground for Life Safety and at each floor above the first floor for Immediate Occupancy. (Tier 2: Sec. 4.8.5.1)	NA
Ties	Masonry veneer shall be connected to the back-up with corrosion-resistant ties. The ties shall have a spacing equal to or less than 24 inches with a minimum of one tie for every 2-2/3 square feet. A spacing of up to 36 inches is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2. (Tier 2: Sec. 4.8.5.2)	NA
Weakened Planes	Masonry veneer shall be anchored to the back-up adjacent to weakened planes, such as at the locations of flashing. (Tier 2: Sec. 4.8.5.3)	NA
Mechanical and Electrical Equipment		
Attached Equipment	Equipment weighting over 20 lb that is attached to ceilings, walls, or other supports 4 feet above the floor level shall be mounted. (Tier 2: Sec 4.8.12.2)	C

		Compliance
Deterioration	There shall be no evidence of deterioration, damage, or corrosion in any of the anchorage or supports of mechanical or electrical equipment. (Tier 2: Sec. 4.8.12.3)	NC
Emergency Power Mounting	Equipment used as part of an emergency power system shall be mounted to maintain continued operation after an earthquake. (Tier 2: Sec. 4.8.12.1)	C
Hazardous Material Equipment	HVAC or other equipment containing hazardous material shall not have damaged supply lines or unbraced isolation supports. (Tier 2: Sec. 4.8.12.2)	C

Parapets, Cornices, Ornamentation, and Appendages

Canopies	Canopies located at building exits shall be anchored to the structural framing at a spacing of 6 feet or less. An anchorage spacing of up to 10 feet is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.8.2)	NA
Urm Parapets	There shall be no laterally unsupported unreinforced masonry parapets or cornices with height-to-thickness ratios greater than 1.5. A height-to-thickness ratio of up to 2.5 is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2. (Tier 2: Sec. 4.8.8.1)	NA

Partitions

Unreinforced Masonry Bracing	Unreinforced masonry or hollow clay tile partitions shall be braded at a spacing equal to or less than 10 feet in levels of low or moderate seismicity and 6 feet in levels of high seismicity. (Tier 2: Sec. 4.8.1.1)	NA

Piping

Fire Suppression Piping	Fire suppression piping shall be anchored and braced in accordance with NFPA-13 (NFPA, 1996). (Tier 2: Sec. 4.8.13.1)	NC
Flexible Couplings	Fluid, gas, and fire suppression piping shall have flexible couplings. (Tier 2: Sec. 4.8.13.2)	NC

		Compliance
Stairs		
Stair Details	In moment frame structures, the connection between the stairs and the structure shall not rely on shallow anchors in concrete. Alternatively, the stair details shall be capable of accommodating the drift calculated using the Quick Check procedure of Section 3.5.3.1 without including tension in the anchors. (Tier 2: Sec. 4.8.10.2)	NA
Urm Walls	Walls around stair enclosures shall not consist of unbraced hollow clay tile or unreinforced masonry with a height-to-thickness ratio greater than 12-to-1. A height-to-thickness ratio of up to 15-to-1 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.10.1)	NA

		Compliance

3.9.1S Supplemental Nonstructural Component Checklist

Building Contents and Furnishing

Access Floor Anchorage	Access floors over 9 inches in height shall be braced. (Tier 2: Sec. 4.8.11.4)	NA
Drawers	Cabinet drawers shall have latches to keep them closed during an earthquake (Tier 2: Sec 4.8.11.3)	NA
Equipment Bracing and Anchorage to Access Floors	Equipment and computers supported on access floor systems shall be either attached to the structure or fastened to a laterally braced floor system. (Tier 2: Sec. 4.8.11.5)	NA
File Cabinets	File cabinets arranged in groups shall be attached to one another. (Tier 2: Sec. 4.8.11.2)	NA
File Cabinets Attachments, Doors, and Drawer Locks	Cabinet doors and drawers shall have latches to keep them closed during an earthquake. (Tier 2: Sec. 4.8.11.3)	NA

Ceiling Systems

Edges Separation	The edges of integrated suspended ceilings shall be separated from enclosing walls by a minimum of 1/2 inch. (Tier 2: Sec. 4.8.2.5)	NA
Seismic Joint	The ceiling system shall not extend continuously across any seismic joint. (Tier 2: Sec. 4.8.2.6)	NA

Cladding and Glazing

Safety Glass	All exterior glazing shall be laminated, annealed or laminated heat-strengthened safety glass or other glazing system that will remain in the frame when glass is cracked. (Tier 2: Sec. 4.8.4.9)	NA

Concrete Block and Masonry Back-Up Systems

Anchorage	Back-up shall have a positive anchorage to the structural framing at a spacing equal to or less than 4 feet along the floors and roof. (Tier 2: Sec. 4.8.7.1)	NA
Concrete Block	Concrete block shall qualify as reinforced masonry (Tier 2: Sec. 4.8.7.1)	NA

		Compliance
Urm Back-Up	There shall be no unreinforced masonry back-up. (Tier 2: Sec. 4.8.7.2)	NA
Ducts		
Duct Bracing	Rectangular ductwork exceeding 6 square feet in cross-sectional area, and round ducts exceeding 28 inches in diameter, shall be braced. Maximum spacing of transverse bracing shall not exceed 30 feet. Maximum spacing of longitudinal bracing shall not exceed 60 feet. Intermediate supports shall not be considered part of the lateral-force resisting system. (Tier 2: Sec. 4.8.14.2)	NA
Duct Supports	Ducts shall not be supported by piping or electrical conduit. (Tier 2: Sec. 4.8.14.3)	NA
Stair and Smoke Duct Bracing	Stair pressurization and smoke flow of gas and high temperature energy in the event of an earthquake-induced failure. (Tier 2: Sec. 4.8.13.4)	NA
Elevators		
Brackets	The brackets that tie the car rails and the counterweight rail to the building structure shall be sized in accordance with ASME A17.1. (Tier 2: Sec. 4.8.16.7)	NA
Counterweight Rails	All counterweight rails and divider beams shall be sized in accordance with ASME A17.1. (Tier 2: Sec. 4.8.16.6)	NA
Go-Slow Elevators	The building shall have a go-slow elevator system. (Tier 2: Sec. 4.8.16.9)	NA
Retainer Guards	Cable retainer guards on sheaves and drums shall be present to inhibit the displacement of cables. (Tier 2: Sec. 4.8.16.4)	NA
Retainer Plate	A retainer plate shall be present at the top and bottom of both car and counterweight. (Tier 2: Sec. 4.8.16.5)	NA
Seismic Switch	All elevators shall be equipped with seismic switches that will terminate operations when the ground motion exceeds 0.10g. (Tier 2: Sec. 4.8.16.2)	NA
Shaft Walls	All elevator shaft walls shall be anchored and reinforced to prevent toppling into the shaft during strong shaking. (Tier 2: Sec. 4.8.16.3)	NA

		Compliance
Spreader Bracket	Spreader brackets shall not be used to resist seismic forces. (Tier 2: Sec. 4.8.16.8)	NA
Support System	All elements of the elevator system shall be anchored. (Tier 2: Sec. 4.8.16.1)	NA
Hazardous Materials Storage and Distribution		
Gas Cylinder Restraints	Compressed gas-cylinders shall be restrained. (Tier 2: Sec. 4.8.15.2)	NA
Hazardous Materials Shutoff Valves	Piping containing hazardous materials shall have shut-off valves or other devices to prevent major spills or leaks. (Tier 2: Sec. 4.8.16.4)	NA
Light Fixtures		
Lens Covers	Lens covers on light fixtures shall be attached or supplied with safety devices. (Tier 2: Sec. 4.8.3.4)	C
Pendant Supports	Light fixtures on pendant supports shall be attached at a spacing equal to or less than 6 feet and, if rigidly, supported, shall be free to move with the structure to which they are attached without damaging adjoining materials. (Tier 2: Sec. 4.8.3.3)	NC
Masonry Veneer		
Mortar	The mortar in masonry veneer shall not be easily scraped away from the joints by hand with a metal tool, and there shall not be significant areas of eroded mortar. (Tier 2: Sec. 4.8.5.5)	NA
Stone Cracks	There shall be no visible cracks or signs of visible distortion in the stone. (Tier 2: Sec. 4.8.5.7)	NA
Weep Holes	In veneer braced by stud walls, functioning weep holes and base flashing shall be present. (Tier 2: Sec. 4.8.5.6)	NA
Mechanical and Electrical Equipment		
Door Drift Allowance	Mechanically operated doors shall be detailed to operate at a story drift ratio of 0.01. (Tier 2: Sec. 4.8.12.8)	NA
Electrical Equipment Bracing	Electrical equipment and associated wiring shall be laterally braced to the structural system. (Tier 2: Sec. 4.8.12.7)	NC

		Compliance
Heavy Equipment Anchorage	Equipment weighing over 100 pounds shall be anchored to the structure or foundation. (Tier 2: Sec. 4.8.12.6)	C
Vibration Isolators Restrained	Equipment mounted on vibration isolators shall be equipped with restraints or snubbers. (Tier 2: Sec. 4.8.12.4)	NA

Metal Stud Back-Up Systems

Openings	Steel studs shall frame window and door openings. (Tier 2: Sec. 4.8.6.2)	C
Stud Tracks	Stud tracks shall be fastened to structural framing at a spacing equal to or less than 24 inches on center. (Tier 2: Sec. 4.8.6.1)	C

Parapets, Cornices, Ornamentation, and Appendages

Appendages	Cornices, parapets, signs, and other appendages that extend above the highest anchorage level or cantilever from exterior wall faces and other exterior wall ornamentation shall be reinforced and anchored to the structural system at a spacing equal to or less than 10 feet for Life Safety and 6 feet for Immediate Occupancy. This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. f4.8.8.4)	NA
Concrete Parapets	Concrete parapets with height-to-thickness ratios greater than 2.5 shall have vertical reinforcement. (Tier 2: Sec. 4.8.8.3)	NA

Partitions

Drift Allowance	Rigid cementitious partitions shall be detailed to accommodate a drift ratio of 0.02 in steel moment frame, concrete moment frame, and wood frame buildings. Rigid cementitious partitions shall be detailed to accommodate a drift ratio of 0.005 in other buildings. (Tier 2: Sec. 4.8.1.2)	NA
Lateral Bracing for Tops	The tops of framed or panelized partitions that only extend to the ceiling line shall have lateral bracing to the building structure at a spacing equal to or less than 6 feet. (Tier 2: Sec. 4.8.1.4)	NA
Seismic Control Joints	Partitions at structural separations shall have seismic or control joints. (Tier 2: Sec. 4.8.1.3)	NA

16 kW SWGR Building/Effluent PS VFD Building

		Compliance
Piping		
C-Clamps	One-sided C-clamps that support piping greater than 2.5 inches in diameter shall be restrained. (Tier 2: Sec. 4.8.13.5)	C
Fluid and Gas Piping Anchorage and Bracing	Fluid and gas piping shall be anchored and braced to the structure to prevent breakage in piping. (Tier 2: Sec 4.8.13.3)	C
Shut-Off Valves	Shut-off devices shall be present at building utility interfaces to shut off the flow of gas and high-temperature energy in the event of earthquake-induced failure. (Tier 2: Sec. 4.8.13.4)	C

Compliance

3.9.2 Intermediate Nonstructural Component Checklist

Ceiling Systems		
Integrated Ceilings	Integrated suspended ceilings at exists and corridors or weighing more than 2 pounds per square foot shall be laterally restrained with a minimum of four diagonal wires or rigid members attached to the structure above at a spacing equal to or less than 12 feet. (Tier 2: Sec. 4.8.2.3)	NA
Lay-In Tiles	Lay-in tiles used in ceiling panels located at exits and corridors shall be secured with clips. (Tier 2: Sec. 4.8.2.2)	NA
Suspended Lath and Plaster	Ceilings consisting of suspended lath and plaster or gypsum board shall be attached to resist seismic forced for every 12 square feet of area. (Tier 2: Sec. 4.8.2.4)	NA
Cladding and Glazing		
Glazing	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall have safety glazing. Such glazing located over 10 feet above an exterior walking surface shall be laminated, annealed, or laminated heat strengthened safety glass that will remain in the frame when cracked (Tier 2: Sec. 4.8.4.8)	NA
Laminated Safety Glass	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall have safety glazing. Such glazing located over 10 feet above an exterior walking surface shall be laminated annealed or laminated heat-strengthened safety glass or other glazing system that will remain in the frame when glass is cracked. (Tier 2: Sec. 4.8.4.8)	NA
Ducts		
Stair and Smoke Duct Bracing	Stair pressurization and smoke control ducts shall be braced and shall have flexible connections at seismic joints. (Tier 2: Sec. 4.8.14.1)	NA
Light Fixtures		
Independent Support	Light fixtures in suspended grid ceilings shall be supported independently of the ceiling suspension system by a minimum of two wires at diagonally opposite. (Tier 2: Sec. 4.8.3.2)	NA

		Compliance
Masonry Chimneys		
Anchorage	Masonry chimneys shall be anchored at each floor level and the roof. (Tier 2: Sec. 4.8.9.2)This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. 4.8.8.4)	NA
Mechanical and Electrical Equipment		
Vibration Isolators Restrained	Equipment mounted on vibration isolators shall be equipped with restraints or snubbers. (Tier 2: Sec. 4.8.12.4)	NA
Parapets, Cornices, Ornamentation, and Appendages		
Appendages	Cornices, parapets, signs, and other appendages that extend above the highest point of anchorage to the structure or cantilever from exterior wall faces and other exterior wall ornamentation shall be reinforced and anchored to the structural system at a spacing equal to or less than 10 feet for Life Safety and 6 feet for Immediate Occupancy. This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. 4.8.8.4)	NA
Concrete Parapets	Concrete parapets with height-to-thickness ratios greater than 2.5 shall have vertical reinforcement. (Tier 2: Sec. 4.8.8.3)	NA

ASCE31 Tier 1 Seismic Screening
Structural and Non-Structural Findings

Administration Building

3.7.2 Wood Frames, Commercial and Industrial

Building System

		Compliance
DETERIORATION OF WOOD	There shall be no signs of decay, shrinkage, splitting, fire damage, or sagging in any of the wood members, and none of the metal connection hardware shall be deteriorated, broken, or loose. (Tier 2: Sec. 4.3.3.1)	NC
GEOMETRY	There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30 percent in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines. (Tier 2: Sec. 4.3.2.3)	N
LOAD PATH	The structure shall contain a minimum of one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)	C
MASS	There shall be no change in effective mass more than 50 percent from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses, and mezzanines need not be considered. (Tier 2: Sec. 4.3.2.5)	NA
MEZZANINES	Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.3)	NA
SOFT STORY	The stiffness of the lateral-force-resisting system in any story shall not be less than 70 percent of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80 percent of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2)	NA
VERTICAL DISCONTINUITIES	All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)	C

		Compliance
WEAK STORY	The strength of the lateral-force-resisting system in any story shall not be less than 80 percent of the strength in an adjacent story, above or below, for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)	NA
WOOD STRUCTURAL PANEL SHEAR WALL FASTENERS	There shall be no more than 15 percent of inadequate fastening such as overdriven fasteners, omitted blocking, excessive fastening spacing, or inadequate edge distance. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.3.3.2)	C

Connections

GIRDER/COLUMN CONNECTION	There shall be a positive connection utilizing plates, connection hardware, or straps between the girder and the column support. (Tier 2: Sec. 4.6.4.1)	C
WOOD POSTS	There shall be a positive connection of wood posts to the foundation. (Tier 2: Sec. 4.6.3.3)	C
WOOD SILLS	All wood sills shall be bolted to the foundation. (Tier 2: Sec. 4.6.3.4)	C

Lateral Force Resisting System

SHEAR STRESS CHECK	The shear stress in the shear wall, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than the following values for Life Safety and Immediate Occupancy (Tier 2: Sec. 4.4.2.7.1): Structural panel sheathing 1,000 plf, Diagonal sheathing 700 plf, Straight shthing 100 plf. All other conditions 100 plf	NC

Lateral-Force-Resisting System

CRIPPLE WALLS	Cripple walls below first-floor-level shear walls shall be braced to the foundation with wood structural panels. (Tier 2: Sec. 4.4.2.7.7)	NA
GYPSUM WALLBOARD OR PLASTER SHEAR WALLS	Interior plaster or gypsum wallboard shall not be used as shear walls on buildings over one story in height with the exception of the uppermost level of a multi-story building. (Tier 2: Sec. 4.4.2.7.3)	C

		Compliance
HILLSIDE SITE	For structures that are taller on at least one side by more than one-half story due to a sloping site, all shear walls on the downhill slope shall have an aspect ratio less than 1-to-1 for Life Safety and 1-to-2 for Immediate Occupancy. (Tier 2: Sec. 4.4.2.7.6)	NA
NARROW WOOD SHEAR WALLS	Narrow wood shear walls with an aspect ratio greater than 2-to-1 for Life Safety and 1.5-to-1 for Immediate Occupancy shall not be used to resist lateral forces developed in the building in levels of moderate and high seismicity. Narrow wood shear walls with an aspect ratio greater than 2-to-1 for Immediate Occupancy shall not be used to resist lateral forces developed in the building in levels of low seismicity. (Tier 2: Sec. 4.4.2.7.4)	NA
OPENINGS	Walls with openings greater than 80 percent of the length shall be braced with wood structural panel shear walls with aspect ratios of not more than 1.5-to-1 or shall be supported by adjacent construction through positive ties capable of transferring the lateral forces. (Tier 2: Sec. 4.4.2.7.8)	NA
REDUNDANCY	The number of lines of shear walls in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.1.1)	C
STUCCO (EXTERIOR PLASTER) SHEAR WALLS	Multi-story buildings shall not rely on exterior stucco walls as the primary lateral-force-resisting system. (Tier 2: Sec. 4.4.2.7.2)	C
WALLS CONNECTED THROUGH FLOORS	Shear walls shall have interconnection between stories to transfer overturning and shear forces through the floor. (Tier 2: Sec. 4.4.2.7.5)	C

		Compliance

3.7.2S Wood Frames, Commercial and Industrial

Connections

WOOD SILL BOLTS	Sill bolts shall be spaced at 6 feet or less for Life Safety and 4 feet or less for Immediate Occupancy, with proper edge and end distance provided for wood and concrete. (Tier 2: Sec. 4.6.3.9)	C

Diaphragms

DIAPHRAGM CONTINUITY	The diaphragms shall not be composed of split-level floors and shall not have expansion joints. (Tier 2: Sec. 4.5.1.1)	C
DIAPHRAGM REINFORCEMENT AT OPENINGS	There shall be reinforcing around all diaphragm openings larger than 50 percent of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)	C
OTHER DIAPHRAGMS	The diaphragm shall not consist of a system other than wood, metal deck, concrete, or horizontal bracing. (Tier 2: Sec. 4.5.7.1)	C
PLAN IRREGULARITIES	There shall be tensile capacity to develop the strength of the diaphragm at re-entrant corners or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)	NA
ROOF CHORD CONTINUITY	All chord elements shall be continuous, regardless of changes in roof elevation. (Tier 2: Sec. 4.5.1.3)	NA
SPANS	All wood diaphragms with spans greater than 24 feet for Life Safety and 12 feet for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing. Wood commercial and industrial buildings may have rod-braced systems. (Tier 2: Sec. 4.5.2.2)	C
STRAIGHT SHEATHING	All straight sheathed diaphragms shall have aspect ratios less than 2-to-1 for Life Safety and 1-to-1 for Immediate Occupancy in the direction being considered. (Tier 2: Sec. 4.5.2.1)	C
UNBLOCKED DIAPHRAGMS	All diagonally sheathed or unblocked wood structural panel diaphragms shall have horizontal spans less than 40 feet for Life Safety and 30 feet for Immediate Occupancy and shall have aspect ratios less than or equal to 4-to-l for Life Safety and 3-to-1 for Immediate Occupancy. (Tier 2: Sec. 4.5.2.3)	NA

Compliance

Lateral-Force-Resisting System

HOLD-DOWN ANCHORS	All shear walls shall have hold-down anchors constructed per acceptable construction practices, attached to the end studs. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.7.9)	C

3.9.1 Basic Nonstructural Component Checklist

Building Contents and Furnishing

Tall Narrow Contents	Contents over 4 feet in height with a height-to-depth or height-to-width ratio greater than 3-to-1 shall be anchored to the floor slab or adjacent structural walls. A height-to-depth or height-to-width ratio of up to 4-to-1 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.11.1)	C

Ceiling Systems

Integrated Ceilings	Integrated suspended ceilings at exits and corridors or weighing more than 2 lb/ft^2 shall be laterally restrained by a minimum of 4 diagonal wires or rigid members attached to the structure above at a spacing equal to or less than 12 ft (Tier 2: Sec. 4.8.2.1)	C
Lay-In Tiles	Lay-in tiles used in ceiling panels located at exits and corridors shall be secured with clips. (Tier 2: Sec. 4.8.2.2)	C
Supporting Partitions	The integrated suspended ceiling system shall not be used to laterally support the tops of gypsum board, masonry, or hollow clay tile partitions. Gypsum board partitions need not be evaluated where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.2.1)	C
Suspended Lath and Plaster	Ceilings consisting of suspended lath and plaster or gypsum board shall be attached for each 10 square feet of area (Tier 2: Sec. 4.8.2.4)	NA

Cladding and Glazing

Bearing Connections	Where bearing connections are required, there shall be a minimum of two bearing connections for each wall panel. (Tier 2: Sec. 4.8.4.5)	NA
Cladding Anchorage	Cladding components weighing more than 10 psf shall be mechanically anchored to the exterior wall framing at a spacing equal to or less than 4 feet. A spacing of up to 6 feet is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2 (Tier 2: Sec. 4.8.4.1)	NA
Cladding Isolation	For moment frame buildings of steel or concrete, panel connections shall be detailed to accommodate a drift ratio of 0.02 for Life Safety and 0.01for Immediate Occupancy (Tier 2: Sec. 4.8.4.2)	NA

		Compliance
Connections Out of Plane	Exterior cladding panels shall be anchored out-of-plane with a minimum of 4 connections for each wall panel. Two connections per wall panel are permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.7)	NA
Damage	There shall be no damage to exterior wall cladding. (Tier 4.8.4.8)	NA
Deterioration in Connections	There shall be no evidence of deterioration, damage or corrosion in any of the connection elements. (Tier 2: Sec. 4.8.4.2)	NA
Drift Isolation	For moment frame buildings of steel or concrete, panel connections shall be detailed to accommodate a story drift ratio of 0.02. Panel connection detailing for a story drift ratio of 0.01 is permitted where only the Basic nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.3)	NA
Glazing	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall be laminated, annealed, or heat strengthened safety glass that will remain in the frame when cracked (Tier 2: Sec. 4.8.4.9)	NA
Inserts	Where inserts are used in concrete connections, the inserts shall be anchored to reinforcing steel or other positive anchorage. (Tier 2: Sec. 4.8.4.6)	NA
Multi-Story Panels Drift	For multi-story panels attached at each floor level, panel connections shall be detailed to accommodate a story drift ratio of 0.02 and 0.01 for immediate occupancy. Panel connection detailing for a story drift ratio (Tier 2: Sec. 4.8.4.4)	NA
Panel Connections	Exterior cladding panels shall be anchored with a minimum of 2 connections for each wall panel for Life Safety and 4 connections for Immediate Occupancy. (Tier 2: Sec. 4.8.4.6)	NA

Hazardous Materials Storage and Distribution

Toxic Substances Lateral Bracing and Anchorage	Toxic and hazardous substances stored in breakable containers shall be restrained from falling by latched doors, shelf lips, wires, or other methods. (Tier 2: Sec 4.8.15.1)	NC

		Compliance
Light Fixtures		
Emergency Lighting Anchorage	Emergency lighting shall be anchored or braced to prevent falling or swaying during an earthquake. (Tier 2: Sec. 4.8.3.2)	C
Independent Support	Light fixtures in suspended grid ceilings shall be supported independently of the ceiling suspension system by a minimum of two wires at diagonally opposite corners of the fixtures (Tier 2: Sec. 4.8.3.1)	NC
Masonry Chimneys		
Urm Chimneys	No reinforced masonry chimney shall extend above the roof surface more than twice the least dimension of the chimney. A height above the roof surface of up to three times the least dimension of the chimney is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.9.1)	NA
Masonry Veneer		
Deterioration	There shall be no evidence of deterioration, damage or corrosion in any of the connection elements. (Tier 2: Sec. 4.8.5.4)	NA
Shelf Angles	Masonry veneer shall be supported by shelf angles or other elements at each floor 30 feet or more above ground for Life Safety and at each floor above the first floor for Immediate Occupancy. (Tier 2: Sec. 4.8.5.1)	NA
Ties	Masonry veneer shall be connected to the back-up with corrosion-resistant ties. The ties shall have a spacing equal to or less than 24 inches with a minimum of one tie for every 2-2/3 square feet. A spacing of up to 36 inches is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2. (Tier 2: Sec. 4.8.5.2)	NA
Weakened Planes	Masonry veneer shall be anchored to the back-up adjacent to weakened planes, such as at the locations of flashing. (Tier 2: Sec. 4.8.5.3)	NA
Mechanical and Electrical Equipment		
Attached Equipment	Equipment weighting over 20 lb that is attached to ceilings, walls, or other supports 4 feet above the floor level shall be mounted. (Tier 2: Sec 4.8.12.2)	NC

		Compliance
Deterioration	There shall be no evidence of deterioration, damage, or corrosion in any of the anchorage or supports of mechanical or electrical equipment. (Tier 2: Sec. 4.8.12.3)	NC
Emergency Power Mounting	Equipment used as part of an emergency power system shall be mounted to maintain continued operation after an earthquake. (Tier 2: Sec. 4.8.12.1)	C
Hazardous Material Equipment	HVAC or other equipment containing hazardous material shall not have damaged supply lines or unbraced isolation supports. (Tier 2: Sec. 4.8.12.2)	C

Parapets, Cornices, Ornamentation, and Appendages

Canopies	Canopies located at building exits shall be anchored to the structural framing at a spacing of 6 feet or less. An anchorage spacing of up to 10 feet is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.8.2)	NA
Urm Parapets	There shall be no laterally unsupported unreinforced masonry parapets or cornices with height-to-thickness ratios greater than 1.5. A height-to-thickness ratio of up to 2.5 is permitted where only the Basic Nonstructural Component checklist is required by Table 3-2. (Tier 2: Sec. 4.8.8.1)	NA

Partitions

Unreinforced Masonry Bracing	Unreinforced masonry or hollow clay tile partitions shall be braded at a spacing equal to or less than 10 feet in levels of low or moderate seismicity and 6 feet in levels of high seismicity. (Tier 2: Sec. 4.8.1.1)	NA

Piping

Fire Suppression Piping	Fire suppression piping shall be anchored and braced in accordance with NFPA-13 (NFPA, 1996). (Tier 2: Sec. 4.8.13.1)	NC
Flexible Couplings	Fluid, gas, and fire suppression piping shall have flexible couplings. (Tier 2: Sec. 4.8.13.2)	NC

		Compliance
Stairs		
Stair Details	In moment frame structures, the connection between the stairs and the structure shall not rely on shallow anchors in concrete. Alternatively, the stair details shall be capable of accommodating the drift calculated using the Quick Check procedure of Section 3.5.3.1 without including tension in the anchors. (Tier 2: Sec. 4.8.10.2)	NA
Urm Walls	Walls around stair enclosures shall not consist of unbraced hollow clay tile or unreinforced masonry with a height-to-thickness ratio greater than 12-to-1. A height-to-thickness ratio of up to 15-to-1 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.10.1)	C

3.9.1S Supplemental Nonstructural Component Checklist

		Compliance
Building Contents and Furnishing		
Access Floor Anchorage	Access floors over 9 inches in height shall be braced. (Tier 2: Sec. 4.8.11.4)	C
Drawers	Cabinet drawers shall have latches to keep them closed during an earthquake (Tier 2: Sec 4.8.11.3)	NC
Equipment Bracing and Anchorage to Access Floors	Equipment and computers supported on access floor systems shall be either attached to the structure or fastened to a laterally braced floor system. (Tier 2: Sec. 4.8.11.5)	C
File Cabinets	File cabinets arranged in groups shall be attached to one another. (Tier 2: Sec. 4.8.11.2)	NC
File Cabinets Attachments, Doors, and Drawer Locks	Cabinet doors and drawers shall have latches to keep them closed during an earthquake. (Tier 2: Sec. 4.8.11.3)	NC
Ceiling Systems		
Edges Separation	The edges of integrated suspended ceilings shall be separated from enclosing walls by a minimum of 1/2 inch. (Tier 2: Sec. 4.8.2.5)	C
Seismic Joint	The ceiling system shall not extend continuously across any seismic joint. (Tier 2: Sec. 4.8.2.6)	C
Cladding and Glazing		
Safety Glass	All exterior glazing shall be laminated, annealed or laminated heat-strengthened safety glass or other glazing system that will remain in the frame when glass is cracked. (Tier 2: Sec. 4.8.4.9)	NA
Concrete Block and Masonry Back-Up Systems		
Anchorage	Back-up shall have a positive anchorage to the structural framing at a spacing equal to or less than 4 feet along the floors and roof. (Tier 2: Sec. 4.8.7.1)	NA
Concrete Block	Concrete block shall qualify as reinforced masonry (Tier 2: Sec. 4.8.7.1)	C

		Compliance
Urm Back-Up	There shall be no unreinforced masonry back-up. (Tier 2: Sec. 4.8.7.2)	NA
Ducts		
Duct Bracing	Rectangular ductwork exceeding 6 square feet in cross-sectional area, and round ducts exceeding 28 inches in diameter, shall be braced. Maximum spacing of transverse bracing shall not exceed 30 feet. Maximum spacing of longitudinal bracing shall not exceed 60 feet. Intermediate supports shall not be considered part of the lateral-force resisting system. (Tier 2: Sec. 4.8.14.2)	C
Duct Supports	Ducts shall not be supported by piping or electrical conduit. (Tier 2: Sec. 4.8.14.3)	C
Stair and Smoke Duct Bracing	Stair pressurization and smoke flow of gas and high temperature energy in the event of an earthquake-induced failure. (Tier 2: Sec. 4.8.13.4)	NA
Elevators		
Brackets	The brackets that tie the car rails and the counterweight rail to the building structure shall be sized in accordance with ASME A17.1. (Tier 2: Sec. 4.8.16.7)	NA
Counterweight Rails	All counterweight rails and divider beams shall be sized in accordance with ASME A17.1. (Tier 2: Sec. 4.8.16.6)	NA
Go-Slow Elevators	The building shall have a go-slow elevator system. (Tier 2: Sec. 4.8.16.9)	NA
Retainer Guards	Cable retainer guards on sheaves and drums shall be present to inhibit the displacement of cables. (Tier 2: Sec. 4.8.16.4)	NA
Retainer Plate	A retainer plate shall be present at the top and bottom of both car and counterweight. (Tier 2: Sec. 4.8.16.5)	NA
Seismic Switch	All elevators shall be equipped with seismic switches that will terminate operations when the ground motion exceeds 0.10g. (Tier 2: Sec. 4.8.16.2)	NA
Shaft Walls	All elevator shaft walls shall be anchored and reinforced to prevent toppling into the shaft during strong shaking. (Tier 2: Sec. 4.8.16.3)	NA

		Compliance
Spreader Bracket	Spreader brackets shall not be used to resist seismic forces. (Tier 2: Sec. 4.8.16.8)	NA
Support System	All elements of the elevator system shall be anchored. (Tier 2: Sec. 4.8.16.1)	NA

Hazardous Materials Storage and Distribution

Gas Cylinder Restraints	Compressed gas-cylinders shall be restrained. (Tier 2: Sec. 4.8.15.2)	NA
Hazardous Materials Shutoff Valves	Piping containing hazardous materials shall have shut-off valves or other devices to prevent major spills or leaks. (Tier 2: Sec. 4.8.16.4)	C

Light Fixtures

Lens Covers	Lens covers on light fixtures shall be attached or supplied with safety devices. (Tier 2: Sec. 4.8.3.4)	C
Pendant Supports	Light fixtures on pendant supports shall be attached at a spacing equal to or less than 6 feet and, if rigidly, supported, shall be free to move with the structure to which they are attached without damaging adjoining materials. (Tier 2: Sec. 4.8.3.3)	NA

Masonry Veneer

Mortar	The mortar in masonry veneer shall not be easily scraped away from the joints by hand with a metal tool, and there shall not be significant areas of eroded mortar. (Tier 2: Sec. 4.8.5.5)	NA
Stone Cracks	There shall be no visible cracks or signs of visible distortion in the stone. (Tier 2: Sec. 4.8.5.7)	NA
Weep Holes	In veneer braced by stud walls, functioning weep holes and base flashing shall be present. (Tier 2: Sec. 4.8.5.6)	NA

Mechanical and Electrical Equipment

Door Drift Allowance	Mechanically operated doors shall be detailed to operate at a story drift ratio of 0.01. (Tier 2: Sec. 4.8.12.8)	NA
Electrical Equipment Bracing	Electrical equipment and associated wiring shall be laterally braced to the structural system. (Tier 2: Sec. 4.8.12.7)	NC

		Compliance
Heavy Equipment Anchorage	Equipment weighing over 100 pounds shall be anchored to the structure or foundation. (Tier 2: Sec. 4.8.12.6)	C
Vibration Isolators Restrained	Equipment mounted on vibration isolators shall be equipped with restraints or snubbers. (Tier 2: Sec. 4.8.12.4)	NA

Metal Stud Back-Up Systems

Openings	Steel studs shall frame window and door openings. (Tier 2: Sec. 4.8.6.2)	C
Stud Tracks	Stud tracks shall be fastened to structural framing at a spacing equal to or less than 24 inches on center. (Tier 2: Sec. 4.8.6.1)	C

Parapets, Cornices, Ornamentation, and Appendages

Appendages	Cornices, parapets, signs, and other appendages that extend above the highest anchorage level or cantilever from exterior wall faces and other exterior wall ornamentation shall be reinforced and anchored to the structural system at a spacing equal to or less than 10 feet for Life Safety and 6 feet for Immediate Occupancy. This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. f4.8.8.4)	NA
Concrete Parapets	Concrete parapets with height-to-thickness ratios greater than 2.5 shall have vertical reinforcement. (Tier 2: Sec. 4.8.8.3)	NA

Partitions

Drift Allowance	Rigid cementitious partitions shall be detailed to accommodate a drift ratio of 0.02 in steel moment frame, concrete moment frame, and wood frame buildings. Rigid cementitious partitions shall be detailed to accommodate a drift ratio of 0.005 in other buildings. (Tier 2: Sec. 4.8.1.2)	NA
Lateral Bracing for Tops	The tops of framed or panelized partitions that only extend to the ceiling line shall have lateral bracing to the building structure at a spacing equal to or less than 6 feet. (Tier 2: Sec. 4.8.1.4)	NA
Seismic Control Joints	Partitions at structural separations shall have seismic or control joints. (Tier 2: Sec. 4.8.1.3)	NA

Administration Building

Piping		Compliance
C-Clamps	One-sided C-clamps that support piping greater than 2.5 inches in diameter shall be restrained. (Tier 2: Sec. 4.8.13.5)	C
Fluid and Gas Piping Anchorage and Bracing	Fluid and gas piping shall be anchored and braced to the structure to prevent breakage in piping. (Tier 2: Sec 4.8.13.3)	C
Shut-Off Valves	Shut-off devices shall be present at building utility interfaces to shut off the flow of gas and high-temperature energy in the event of earthquake-induced failure. (Tier 2: Sec. 4.8.13.4)	C

3.9.2 Intermediate Nonstructural Component Checklist

		Compliance
Ceiling Systems		
Integrated Ceilings	Integrated suspended ceilings at exists and corridors or weighing more than 2 pounds per square foot shall be laterally restrained with a minimum of four diagonal wires or rigid members attached to the structure above at a spacing equal to or less than 12 feet. (Tier 2: Sec. 4.8.2.3)	C
Lay-In Tiles	Lay-in tiles used in ceiling panels located at exits and corridors shall be secured with clips. (Tier 2: Sec. 4.8.2.2)	C
Suspended Lath and Plaster	Ceilings consisting of suspended lath and plaster or gypsum board shall be attached to resist seismic forced for every 12 square feet of area. (Tier 2: Sec. 4.8.2.4)	NA
Cladding and Glazing		
Glazing	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall have safety glazing. Such glazing located over 10 feet above an exterior walking surface shall be laminated, annealed, or laminated heat strengthened safety glass that will remain in the frame when cracked (Tier 2: Sec. 4.8.4.8)	NA
Laminated Safety Glass	Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall have safety glazing. Such glazing located over 10 feet above an exterior walking surface shall be laminated annealed or laminated heat-strengthened safety glass or other glazing system that will remain in the frame when glass is cracked. (Tier 2: Sec. 4.8.4.8)	NA
Ducts		
Stair and Smoke Duct Bracing	Stair pressurization and smoke control ducts shall be braced and shall have flexible connections at seismic joints. (Tier 2: Sec. 4.8.14.1)	NA
Light Fixtures		
Independent Support	Light fixtures in suspended grid ceilings shall be supported independently of the ceiling suspension system by a minimum of two wires at diagonally opposite. (Tier 2: Sec. 4.8.3.2)	NC

Masonry Chimneys		Compliance
Anchorage	Masonry chimneys shall be anchored at each floor level and the roof. (Tier 2: Sec. 4.8.9.2)This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. 4.8.8.4)	NA

Mechanical and Electrical Equipment

Vibration Isolators Restrained	Equipment mounted on vibration isolators shall be equipped with restraints or snubbers. (Tier 2: Sec. 4.8.12.4)	NA

Parapets, Cornices, Ornamentation, and Appendages

Appendages	Cornices, parapets, signs, and other appendages that extend above the highest point of anchorage to the structure or cantilever from exterior wall faces and other exterior wall ornamentation shall be reinforced and anchored to the structural system at a spacing equal to or less than 10 feet for Life Safety and 6 feet for Immediate Occupancy. This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. 4.8.8.4)	NA
Concrete Parapets	Concrete parapets with height-to-thickness ratios greater than 2.5 shall have vertical reinforcement. (Tier 2: Sec. 4.8.8.3)	NA

ASCE31 Tier 1 Seismic Screening
Structural and Non-Structural Findings

Oxnard WTP

3.8 Geologic Site Hazards and Foundations Checklist

Capacity of Foundations

		Compliance
DEEP FOUNDATIONS	Piles and piers shall be capable of transferring the lateral forces between the structure and the soil. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.7.3.4)	NA
OVERTURNING	The ratio of the horizontal dimension of the lateral-force-resisting system at the foundation level to the building height (base/height) shall be greater than 0.6Sa• (Tier 2: Sec. 4.7.3.2)	C
POLE FOUNDATIONS	Pole foundations shall have a minimum embedment depth of 4 feet for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.7.3.1)	NA
SLOPING SITES	The difference in foundation embedment depth from one side of the building to another shall not exceed one story in height. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.7.3.5)	C
TIES BETWEEN FOUNDATION ELEMENTS	The foundation shall have ties adequate to resist seismic forces where footings, piles, and piers are not restrained by beams, slabs, or .'soils classified as Class A, B, or C. (Section 3.5.2.3.1, Tier 2: Sec. 4.7.3.3)	C

Condition of Foundations

DETERIORATION	There shall not be evidence that foundation elements have deteriorated due to corrosion, sulfate attack, material breakdown, or other reasons ·in a manner that would affect the integrity or strength of the structure. (Tier 2: Sec. 4.7.2.2)	C
FOUNDATION PERFORMANCE	There shall be no evidence of excessive foundation movement such as settlement or heave that would affect the integrity or strength of the structure. (Tier 2: Sec. 4.7.2.1)	C

		Compliance
Geologic Site Hazards		
LIQUEFACTION	Liquefaction-susceptible, saturated, loose granular soils that could jeopardize the building's seismic performance shall not exist in the foundation soils at depths within 50 feet under the building for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.7.1.1)	NA
SLOPE FAILURE	The buildin£ site shall be sufficiently remote from potential earthquakeinduced slope failures or rockfalls to be unaffected by such failures or shall be capable of accommodating any predicted movements without failure. (Tier 2: Sec. 4.7.1.2)	NC
SURFACE FAULT RUPTURE	Surface fault rupture and surface displacement at the building site is not anticipated. (Tier 2: Sec. 4.7.1.3)	NC

APPENDIX D – OXNARD WASTEWATER TREATMENT PLANT CONCRETE BASINS-CONDITION ASSESSMENT

OXNARD WASTEWATER TREATMENT PLANT CONCRETE BASINS – CONDITION ASSESSMENT

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V&A Project No. 14-0195 T04

Table of Contents

TABLES

FIGURES

APPENDICES

ES EXECUTIVE SUMMARY

V&A Consulting Engineers, Inc. (V&A) was retained by Carollo Engineers to perform a condition assessment of five concrete basins at the Oxnard Wastewater Treatment Plant (OWTP) in Oxnard, California. The purpose of this project was to perform a condition assessment to aid Carollo and the City of Oxnard (City) in determining if the structures are adequate for another 30 years of service life. The focus of the assessment activities was to conduct confined-space-entry evaluations of the interior concrete surfaces of the selected basins.

Condition assessment methods included visual and qualitative evaluation and core sampling. Core samples were drilled and removed from each structure entered. Core samples were tested for compressive strength, carbonation depth, and chloride contamination depth, and used for petrographic analysis. Additional techniques included surface pH measurements, soundings, and scanning of the reinforcing steel depth and spacing using surface penetrating radar (SPR).

The structures selected for entry and evaluation were the following:

- Activated Sludge Tank (AST) 1B.
- Primary Clarifier (PC) 1.
- Secondary Sedimentation Tank (SST) 2.
- The South Chlorine Contact Chamber (CCC).
- The West Flow Equalization Basin (FEB).

Some of the other ASTs, SSTs, and PCs, as well as the East FEB, were also documented from topside. The majority of the evaluation was performed during the first site visit on January 13 and 14, 2015. During the first site visit, the South CCC was evaluated from topside. A second site visit was conducted on February 26, 2015, in order to conduct a confined space entry for further evaluation of the South CCC.

Conclusions

Based on the information gathered during the condition assessment, V&A presents the following conclusions.

West Flow Equalization Basin

- **Core samples** – Core samples were collected from the west wall and floor of the West FEB. Test results from the core samples are as follows:
    - Carbonation testing indicated that the reinforcing steel is embedded in an alkaline (protective) environment at the sample locations. The maximum carbonation depth was 0.45 inches at the sample locations. However, the minimum reinforcing steel depth was much less at the scan locations on the north and east walls, so the steel may be subject to corrosion there if the carbonation depth is similar.
    - Chloride testing indicated that the reinforcing steel may be subject to corrosion at the west wall sample location. Due to the lower reinforcing steel depth on the north and east walls, the steel may also be subject to corrosion there if the chloride contamination depth is similar.
    - Compressive strength of the west wall and floor core samples was 8,240 and 5,360 psi, respectively. These results exceed the current requirement of 4,000 psi in ACI 350 for water-retaining structures.
    - Petrographic analysis was conducted on a core sample from the West FEB floor. The water-cement ratio of the sample was estimated at 0.45, which is equal to the maximum water-cement ratio of 0.45 given in ACI 350 for water-retaining structures. A minor degree of alkali-silica reaction (ASR) was noted, but it was not observed to be causing deleterious expansion.
- **Surface penetrating radar** – Scans were conducted on the west, north, and east walls as well as the floor. The depth of concrete cover over the reinforcing steel in many locations was significantly less than the 2 inches recommended as a guideline for this type of structure. The minimum measured depth of cover was 0.4 inches, on the east wall near an area of visible spalling.
- **Concrete surfaces** – In general, the concrete interior surfaces of the West FEB were in good condition. The concrete surfaces, particularly the floor, showed generalized shrinkage cracking. Soundings in the West FEB generally indicated sound, hard concrete. There were several areas where minor or moderate defects or evidence of deterioration was observed. As a result of the number and frequency of these observations, the West FEB is rated VANDA Level 2 for concrete condition. Specific observations include the following:
    - Construction joints on the west wall typically had a concrete mortar overlay that was spalling or loose in many places. Over a length of approximately 50 feet near the midpoint of the wall, there was a horizontal reinforcing bar running along the joint with very little concrete cover, and it was exposed in some locations.
    - The sealant at the expansion joints is generally cracked and split, although it is still somewhat pliable. In some places, sections of the sealant are missing or there are weeds growing out of the gaps. A few locations exhibited minor spalling of the concrete adjacent to the expansion joints.

- The east and west walls exhibited minor exposed aggregate in some locations. Surface defects such as bug holes and apparent rock pockets were also observed.
- There was minor vertical cracking in the south wall. The wall along the ramp was cracked in a few locations, possibly through its entire thickness.
- The walls of the West FEB exhibited spalling in isolated locations. Most of these were small, individual spalls. There was a pattern of spalling over the vertical bars in the east wall. There was also one diagonal bar visible through a spalled area a few feet in length near the top of the west wall.
- The columns holding up the ramp and platform at the north end of the basin exhibited minor areas of exposed aggregate. One of the columns had a small gouge on one of the corners. The tapered concrete collar at the base of some columns was broken and hollow-sounding.

- **Additional observations** – A few additional observations were noted in the West FEB:
  - There is a ductile iron pipe near the south wall that exhibits signs of coating failure and corrosion, particularly on the coupling hardware and supports.
  - The wall along the ramp leading into the FEB is only about 18 inches high, which poses a fall hazard for personnel walking near the edge.

Secondary Sedimentation Tank 2

- **Core samples** – Core samples were collected from the north wall and floor of SST 2. Test results from the core samples are as follows:
  - Carbonation testing indicated that the reinforcing steel is embedded in an alkaline (protective) environment at the sample locations. The maximum carbonation depth was 0.40 inches at the sample locations. The reinforcement depth was similar or greater at the scan locations on the east and south walls, so the reinforcing steel would also be within an alkaline environment there if the carbonation depth is similar.
  - Based on the chloride testing results, there is chloride contamination at the surface and decreasing with depth into the concrete. The chloride contamination is not above the given threshold of 0.025% at the reinforcing steel depth, but this threshold may vary based on other factors. Corrosion of the reinforcing steel may be a future concern if this contamination continues. There may also be locations within the structure where the reinforcing steel cover depth is less or the chloride contamination depth is greater.
  - Compressive strength of the north wall and floor core samples was 6,940 and 4,270 psi, respectively. These results exceed the current requirement of 4,000 psi in ACI 350 for water-retaining structures.
  - Petrographic analysis was conducted on a core sample from the north wall of SST 2. The water-cement ratio of the sample was estimated at 0.43, which is below the maximum

water-cement ratio of 0.45 given in ACI 350 for water-retaining structures. A minor degree of alkali-silica reaction (ASR) was noted, but it was not observed to be causing deleterious expansion.

- **Surface penetrating radar** – Scans were conducted on the north, east, and south walls as well as the floor. The depth of concrete cover over the reinforcing steel in some locations was somewhat less than the 2 inches recommended as a guideline for this type of structure. The minimum measured depth of cover was 1.7 inches.
- **Concrete surfaces** – In general, the concrete interior surfaces of SST 2 were in good condition and are rated VANDA Level 1 for concrete condition. There were several areas where minor defects or evidence of deterioration was observed. These are presently minor issues, but they may accelerate future deterioration of the structure. Specific observations include the following:
  - Cracking was observed in many locations within SST 2, including cracks in the slab overhanging the west end of the basin, vertical cracks along the length of the north wall, hairline cracks in some other locations, and general cracking in some areas of the floor. The cracks in the slab at the west end had begun to separate slightly. There was possible groundwater infiltration from the floor cracking in one location.
  - The sealant at the expansion joints is in fair condition, with some signs of brittleness and shrinkage. The expansion joint near the west end of the basin exhibited gaps and possible groundwater infiltration.
  - There is a gap between the east wall and the fill concrete at the bottom of the wall. The fill concrete becomes thin near the toe, due to its circular concave surface, and it is irregular and possibly broken in this area.
- **Additional observations** – There was evidence of coating failure and minor surface corrosion on the metallic appurtenances within SST 2.

Activated Sludge Tank 1B

- **Core samples** – Core samples were collected from the west wall and floor of AST 1B. Test results from the core samples are as follows:
  - Carbonation testing indicated that the reinforcing steel is embedded in an alkaline (protective) environment at the sample locations. The maximum carbonation depth was 0.50 inches at the sample locations. The reinforcement depth was similar or greater at the scan locations on the north and east walls, so the reinforcing steel would also be within an alkaline environment there if the carbonation depth is similar.
  - Based on the chloride testing results, there is chloride contamination at the surface and decreasing with depth into the concrete. The chloride contamination is not above the given threshold of 0.025% at the reinforcing steel depth, but this threshold may vary based on other factors. Corrosion of the reinforcing steel may be a future concern if this

contamination continues. There may also be locations within the structure where the reinforcing steel cover depth is less or the chloride contamination depth is greater.

- Compressive strength of the west wall and floor core samples was 6,920 and 6,270 psi, respectively. These results exceed the current requirement of 4,000 psi in ACI 350 for water-retaining structures.
- Petrographic analysis was conducted on a core sample from the AST 1B floor. The water-cement ratio of the sample was estimated at 0.45, which is equal to the maximum water-cement ratio of 0.45 given in ACI 350 for water-retaining structures. A minor degree of alkali-silica reaction (ASR) was noted, but it was not observed to be causing deleterious expansion.

- **Surface penetrating radar** – Scans were conducted on the west, north, and east walls as well as the floor. The minimum depth of cover at the floor scan location was slightly less than the 2 inches recommended as a guideline for this type of structure. The minimum measured depth of cover was 1.8 inches.
- **Concrete surfaces** – In general, the concrete interior surfaces of AST 1B were in good condition and are rated VANDA Level 1 for concrete condition. There were several areas where minor defects or evidence of deterioration was observed. These are presently minor issues, but they may accelerate future deterioration of the structure. Some of these locations were rated VANDA Level 2. Specific observations include the following:
  - Cracking was observed in many locations within AST 1B, including minor cracks in the floor, west wall, and walkways. There was also cracking in the top of the east wall. The concrete appeared to be loose in some of these areas, and one location may have been repaired previously. The ends of the reinforcing bars were also visible at the top of the east wall. The top of the east wall is rated VANDA Level 2 for concrete condition.
  - There were several locations where there was corrosion staining evident at the interior surface of the concrete walls. Most of these appeared to be due to wires or other metal objects embedded in the concrete. One location appeared to have an exposed reinforcing bar.
  - The sealant at the expansion joints is generally cracked and split, although it is still somewhat pliable. In some places, there are gaps between the sealant and the concrete. One location exhibited active groundwater infiltration during the evaluation. Spalling of the concrete was noted adjacent to the expansion joints in one location, which was rated VANDA Level 2 for concrete condition as a result.
- **Additional observations** – There were several steel manifold pipes crossing AST 1B. These exhibited minor coating failure and surface corrosion. There was also minor coating failure and surface corrosion on the sluice gates and their frames.

Primary Clarifier 1

- **Core samples** – Core samples were collected from the wall and floor of PC 1 near the catwalk. Test results from the core samples are as follows:
  - Carbonation testing indicated that the reinforcing steel is embedded in an alkaline (protective) environment at the sample locations. The maximum carbonation depth was 0.15 inches at the sample locations. The reinforcement depth was similar or greater at the other two scan locations on the wall, so the reinforcing steel would also be within an alkaline environment there if the carbonation depth is similar.
  - Based on the chloride testing results, the reinforcing steel is not expected to be subject to corrosion due to chloride at the wall sampling location. The results are unclear for the floor sample location.
  - Compressive strength of the wall and floor core samples was 4,910 and 5,760 psi, respectively. These results exceed the current requirement of 4,000 psi in ACI 350 for water-retaining structures.
  - Petrographic analysis was conducted on a core sample from the PC 1 floor. This sample included approximately 3 inches of mortar topping over the concrete. The water-cement ratio of the concrete (lower) layer was estimated at 0.48, which is above the maximum water-cement ratio of 0.45 given in ACI 350 for water-retaining structures. A minor degree of alkali-silica reaction (ASR) was noted, but it was not observed to be causing deleterious expansion.
- **Surface penetrating radar** – Scans were conducted at three locations on the wall and one location on the floor. The minimum depth of cover over the vertical bars at one wall scanning location was somewhat less than the 2 inches recommended as a guideline for this type of structure. The minimum measured depth of cover was 1.5 inches.
- **Concrete surfaces** – The interior concrete surfaces of PC 1 were in fair condition, showing some evidence of deterioration, and were rated VANDA Level 2 for concrete condition. The condition of the PC 1 concrete was very uniform around the circumference of the clarifier. In general, the wall exhibited exposed medium-diameter aggregate up to about 4 feet above the floor. The wall also exhibited a pattern of fine vertical cracks spaced approximately every 1 to 2 feet. The floor showed a pattern of general fine cracks across most of its surface. In one location, there was minor apparent groundwater infiltration from the floor cracks. Except near the center column, the cracks in the floor and wall exhibited minimal separation. A few other notable observations from PC 1 are as follows:
  - Near the stairway, there was a section of broken concrete at the top of the clarifier wall.
  - The effluent towers also exhibited varying degrees of cracking within the top few inches of the concrete wall. The effluent towers are covered by a grating. On some of the other primary clarifiers, the gratings are visibly displaced because of corrosion around the seating surface. According to operations staff, the gratings have fallen through on at

least one prior occasion, and staff is restricted from climbing on top of the effluent towers.
   - The wall is coated on its outer surfaces and the upper part of the interior surface. The coating on the interior surface is deteriorated near the apparent normal water line.

- **Additional observations** – Most of the steel components within PC 1 showed some degree of corrosion and were rated VANDA Level 3 or 4 for metal condition. The launders, their support brackets, the rake arms, and the center support structure exhibited coating failure and corrosion, primarily at edges. Some of the smaller members, such as the cross-braces across the top of the launders, showed severe section loss (more than 50% in some cases). The catwalk frame exhibited perforations and broken welds. Due to the visible corrosion damage on the catwalk, plant operations staff has restricted access to the catwalks and normally keeps them cordoned off.

South Chlorine Contact Chamber

- **General** – A confined space entry was conducted to assess the condition of the existing coating, conduct coating adhesion tests, and obtain concrete samples for testing. The coated concrete surfaces of the South CCC were evaluated and documented from within the channels. There is cracking and spalling at the top of the east and west walls.

- **Coating condition** – The coating is in poor condition, as it exhibits blistering and delaminations on approximately 40% of the immersed surfaces. Per OWTP maintenance staff, the large blisters have been evident for several years and have not increased in size. Approximately 22 large blisters and several areas of small blisters were visible. The coating does not appear to have punctured at the blister locations. A few edge delaminations, which were due to overspray, were visible on the lower surfaces of the walls.

- **Concrete degradation** – At the northeast corner of the South CCC, there was a crack extending through the top of the concrete wall. The crack has separated slightly. The top of the west wall was spalling around the railing bases. Otherwise, concrete degradation was not observed in the South CCC during the evaluation.

- **Additional observations** – The support brackets and bolts of the baffles were in good condition. The metal surfaces of the sluice gates were in good condition, but there was water leaking in through the gates.

Other Structures

Photographic documentation from topside was also collected for some of the other structures at the OWTP. These consisted of the ASTs, SSTs, and FEB that were out of service at the time, as well as the other three PCs.

Recommendations

Based on the conclusions of the field assessment, V&A presents the following recommendations for consideration.

West Flow Equalization Basin

- Apply an organosilane corrosion inhibitor to the concrete to reduce the migration of chlorides into the concrete. Products similar to BASF MasterProtect 8000 CI are recommended.
- Remove and replace the cracked overlay on the construction joints. This can be done by chipping out the concrete to a depth of 1 inch and applying a repair mortar such as Sika Sikatop 123.
- Replace the sealant in the expansion joints. Consider repairing the adjacent areas of spalled concrete on the floor. Also, replace the sealant in the joints surrounding the sprinklers at the north and south ends of the basin. The joints may be sealed with products such as Sikaflex 2C SL on horizontal surfaces and Sikaflex 2C NS on vertical walls.
- Monitor the construction joints and areas of spalling for evidence of further degradation and corrosion of the exposed reinforcing steel.
- Seal the cracks in the wall running along the edge of the ramp. Repair the spalled concrete on the wall adjacent to the expansion joint.
- Monitor the cracks in other locations for widening or corrosion staining.
- Consider adding a railing to the top of the wall along the ramp to mitigate the fall hazard.
- Repair the areas of damaged concrete on the columns at the north end of the basin. The surfaces should be abrasive-blasted to meet an ICRI 310.2 Concrete Surface Profile 3 to 4. Products such as Sika Sikatop 123 or BASF MasterEmaco S488 CI are recommended.
- Consider evaluating the piping, sprinklers, etc., for condition. If it is not significantly corroded upon further investigation, recoat the ductile iron pipe near the south wall.
- Reassess the concrete interior surfaces of the West FEB in approximately 10 years.

Secondary Sedimentation Tank 2

- Seal the cracks in the slab over the west end of the basin. Monitor these cracks for further widening or corrosion staining.
- Monitor the cracks in other locations for separation and additional groundwater infiltration.
- Replace the sealant in the expansion joints with a product such as Sikaflex 2C SL.

- Consider recoating the metallic appurtenances within SST 2. Products such as two coats of Carboline Carboguard 890, PPG Amerlock 2, or International Paint Bar-Rust 233, at 4 to 6 mils per coat, should be applied on steel that has been abrasive-blasted per SSPC SP10 with a 2 to 3 mil surface profile.

Activated Sludge Tank 1B

- Repair the cracking and exposed ends of the reinforcing bars at the top of the east wall.
- Monitor the cracks in other locations for further widening or corrosion staining.
- Monitor the areas of corrosion staining for evidence of further degradation and corrosion of exposed reinforcing steel.
- Replace the sealant in the expansion joints. Repair the spalled concrete adjacent to one of the expansion joints. The spalled surfaces should be abrasive-blasted to meet an ICRI 310.2 Concrete Surface Profile 3 to 4. Products such as Sika Sikatop 123 or BASF MasterEmaco S488 CI are recommended. The joints may be sealed with products such as Sikaflex 2C SL on horizontal surfaces and Sikaflex 2C NS on vertical walls.
- Consider recoating the metallic appurtenances within AST 1B. Products such as two coats of Carboline Carboguard 890, PPG Amerlock 2, or International Paint Bar-Rust 233, at 4 to 6 mils per coat, should be applied on steel that has been abrasive-blasted per SSPC SP10 with a 2 to 3 mil surface profile.

Primary Clarifier 1

- Coat the interior surfaces of the clarifier as follows. Surfaces above the elevation of the trough weir, and 1 foot below, should be abrasive-blasted to meet an ICRI 310.2 Concrete Surface Profile 4 to 5. A 100% epoxy or polyurethane coating with a dry film thickness of 125 mils is recommended to be applied on the concrete.

  Extending the coating down the wall to the floor is optional, but not required, as the surfaces will always be immersed and the surfaces were in VANDA Level 2 condition. If the concrete will be continuously submerged, it is anticipated that this will be acceptable since there will be limited oxygen available to facilitate corrosion. If the clarifier will be left out of service for long periods of time and subject to possible wind-borne chloride contamination, coating the lower wall surfaces may be justified.
- Seal the cracks and delaminations in the floor near the center column. Coat the small segment of exposed reinforcing steel in the center well, ensuring that the coating terminates adequately on the surrounding concrete.
- Repair the broken concrete at the top of the wall and effluent towers. In planning the repairs, consider whether the repairs conducted previously on the other clarifiers have provided

adequate long-term performance. Also consider whether there are ways to make the grating support less likely to fail in the event that future deterioration does occur.

- Replace the launders with fiberglass launders and replace the bridge support structural members. Replace the bridge support with coated steel. Products such as two coats of Carboline Carboguard 890, PPG Amerlock 2, or International Paint Bar-Rust 233, at 4 to 6 mils, per coat should be applied on steel that has been abrasive-blasted per SSPC SP10 with a 2 to 3 mil surface profile. A finish coat of Carboline Carbothane 133VOC, PPG Amerlock 2, or International Paint Devthane 379H at 2 to 3 mils dry film thickness is recommended on non-immersed steel exposed to ultraviolet light.
- Reassess the concrete interior surfaces of PC 1 in approximately 10 years.

South Chlorine Contact Chamber

- Plan for the removal and replacement of the existing lining in the South CCC in the next 10 years. The lining is still protecting the concrete, but it may begin to peel off the walls in the future. The concrete should be abrasive-blasted to meet an ICRI 310.2 Concrete Surface Profile 4 to 5. A 100% polyurethane coating with a dry film thickness of 125 mils is recommended to be applied on the concrete. Products such as International Paint Polibrid 705 or Global EcoTech Enduraflex EF1988 are compatible products with the existing system.
- Seal the crack at the northeast corner and monitor it for further widening.
- Repair the spalling damage around the railing bases at the west wall.

1.0 INTRODUCTION

V&A Consulting Engineers, Inc. (V&A) was retained by Carollo Engineers to perform a condition assessment of five concrete basins at the Oxnard Wastewater Treatment Plant (OWTP) in Oxnard, California. The purpose of this project was to perform a condition assessment to aid Carollo and the City of Oxnard (City) in determining if the structures are adequate for another 30 years of service life. The focus of the assessment activities was to conduct confined-space-entry evaluations of the interior concrete surfaces of the selected basins.

Condition assessment methods included visual and qualitative evaluation and core sampling. Core samples were drilled and removed from each structure entered. Core samples were tested for compressive strength, carbonation depth, and chloride contamination depth, and used for petrographic analysis. Additional techniques included surface pH measurements, soundings, and scanning of the reinforcing steel depth and spacing using surface penetrating radar (SPR).

Figure 1-1 shows the location of the structures within the OWTP. The structures selected for entry and evaluation were the following:

- Activated Sludge Tank (AST) 1B.
- Primary Clarifier (PC) 1.
- Secondary Sedimentation Tank (SST) 2.
- The South Chlorine Contact Chamber (CCC).
- The West Flow Equalization Basin (FEB).

Some of the other ASTs, SSTs, and PCs, as well as the East FEB, were also documented from topside, as shown in Appendix C. The majority of the evaluation was performed during the first site visit on January 13 and 14, 2015. During the first site visit, the South CCC was evaluated from topside. A second site visit was conducted on February 26, 2015, in order to conduct a confined space entry for further evaluation of the South CCC.

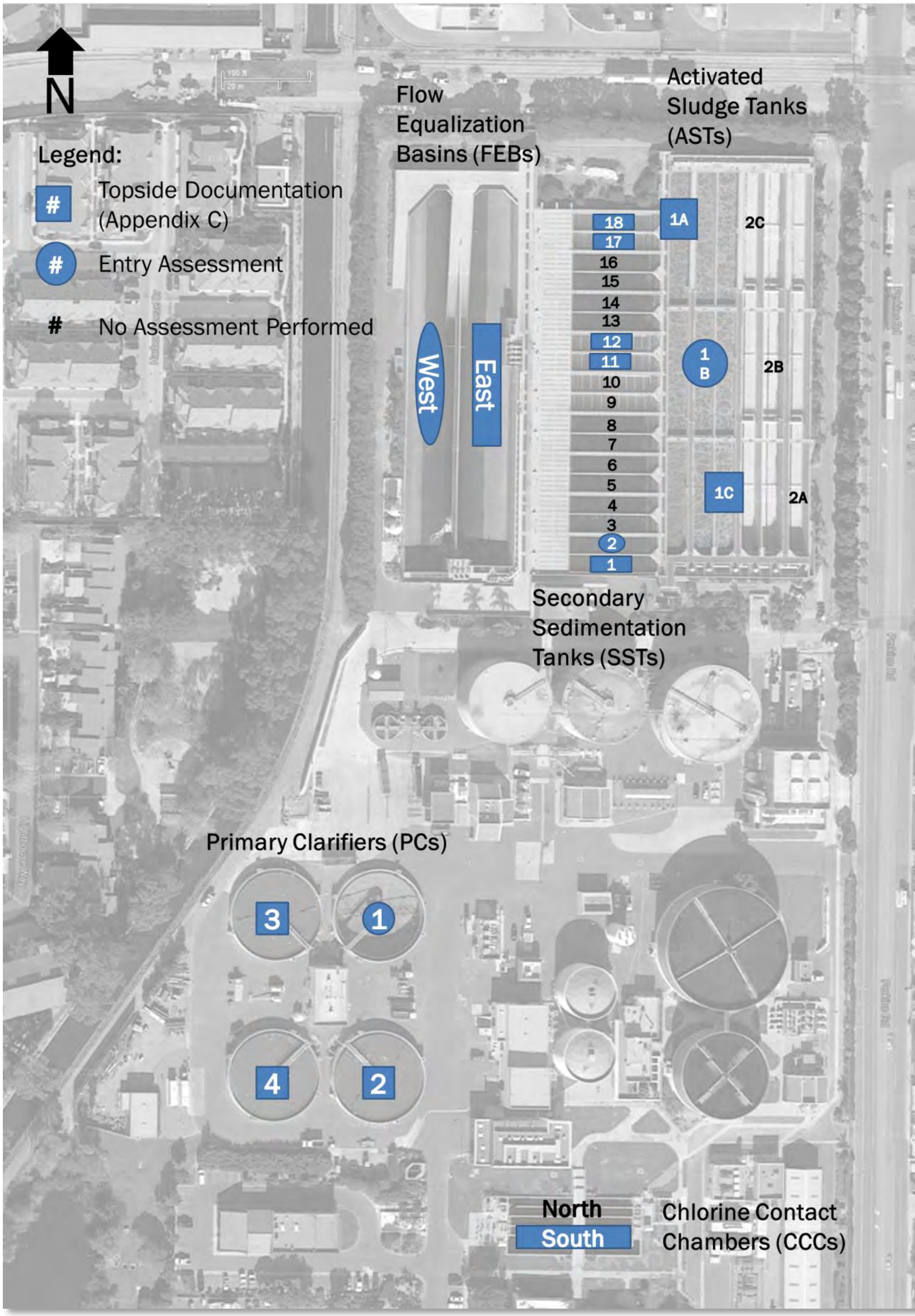


Figure 1-1. Aerial View of the City of Oxnard Wastewater Treatment Plant

2.0 METHODS AND PROCEDURES

2.1 Access and Confined Space Entry

The interior of the structures that were entered are considered non-permit confined spaces. The confined space entries were made using precautions including non-permit space certification procedures, atmospheric monitoring equipment, and appropriate personal protective equipment. Access into SST 2, AST 1B, PC 1, and the South CCC was by an extension ladder that was placed on the platform above and secured. A self-retracting lifeline (SRL) was used to provide fall protection and emergency retrieval capabilities. The West FEB did not require ladders or fall protection, as access was by a ramp from the north end of the basin.

OWTP staff ensured that the basins were drained and cleaned prior to entry. V&A and OWTP staff also conducted lockout/tagout (LOTO) procedures prior to entry to ensure that hazardous sources of energy, such as influent flows or chemical feeds, were deactivated.

2.2 Visual/Qualitative

Visual and qualitative evaluations were conducted from within each structure that was entered for condition assessment. The primary investigative method was to conduct visual examinations supplemented with digital photographs. The visual assessment focused on the condition of reinforced concrete surfaces and coatings. Defects such as cracks, spalls, exposed aggregate, reinforcing steel staining and other concrete defects were documented with digital photographs. The assessments are subjective in nature and are based on V&A's extensive experience evaluating concrete and steel structures in the water and wastewater industry.

2.3 Concrete pH Measurement

Within the West FEB, SST 2, AST 1B, and PC 1, V&A conducted two in-situ pH measurements within each basin to determine the pH of the concrete exposed to the wastewater environment. These in-situ pH measurements were made with a pH-indicating pencil manufactured by Micro Essential Laboratory. The pH of the South CCC concrete was measured from the concrete powder samples submitted to Scientific Construction Laboratories, Inc. (SCL). SCL used an electronic pH probe manufactured by Hanna Instruments.

Cementitious mortars are generally made from a combination of aggregate, sand and Portland cement. The Portland cement in mortar has a pH of approximately 13.5 after curing. This elevated pH level provides corrosion control for the steel. Steel will transform from a state of active corrosion to a state of passivity, which is characterized by a thin layer of iron oxide that protects the steel from corrosion when the steel surface is exposed to a pH greater than 10. At a pH of less than 10, corrosion is possible. V&A has developed a table correlating the effect of the pH of the environment on the rate of corrosion of concrete. The data in Table 2-1 is derived from past experience and review of literature, such as American Concrete Institute (ACI) 201.2R-92, "Guide to Durable Concrete."

Table 2-1. pH and Corrosivity Correlation for Reinforced Concrete

pH	Degree of Corrosivity
< 7	Severe
7 to 9	Moderate
9 to 11	Mild
>11	Negligible

2.4 Soundings

Soundings are performed using a chipping hammer to tap the concrete structure surfaces. The sound from the tap can indicate discontinuities within the surface. The sound returned from sound concrete without subsurface voids is a solid "ping" noise. A "hollow" sound generally means that a void or discontinuity exists beneath the sounding location. A soft "thud" typically results from deteriorated concrete and soft cement paste. V&A conducted soundings at 20 or more equally distributed locations on the walls of the structures to listen for concrete surface delaminations. Soundings were also performed in areas of concern such as visible cracks and spalls.

2.5 Penetration Measurements

Penetration measurements involve applying a constant force from a chipping hammer to the concrete surface, until sound, hard material is reached, and then measuring the depth of the resulting cavity. The cavity depth provides quantitative data on the integrity and condition of the concrete surfaces. Typically, as concrete deteriorates, the cement paste begins to lose integrity and becomes soft. The penetration measurement sites were not repaired, as the penetration depths from this evaluation measured 1/8 of an inch or less.

2.6 Surface Penetrating Radar (SPR)

A Geophysical Survey Systems, Inc., StructureScan Mini High Resolution (HR) surface penetrating radar (SPR) unit was used to measure the depth and spacing of reinforcing steel and detect coarse voids and defects within the concrete walls and floor slabs at four 3-foot by 3-foot areas within each structure. The portable wheel-mounted unit is rolled across the surface to be investigated. A radar beam scans up to 16 inches into the concrete and generates a 2-dimensional image of the underlying concrete member. The distance scanned is plotted on the x-axis and the depth scanned on the y-axis. Figure 2-1 shows a sample graphical image of the SPR scan. Automatic and manual procedures were used to locate the depth of the reinforcing steel on the resulting plots. The SPR unit is also equipped with laser markers on the sides, which facilitated marking the reinforcing steel bar locations on the concrete surfaces for positioning of the core drill.

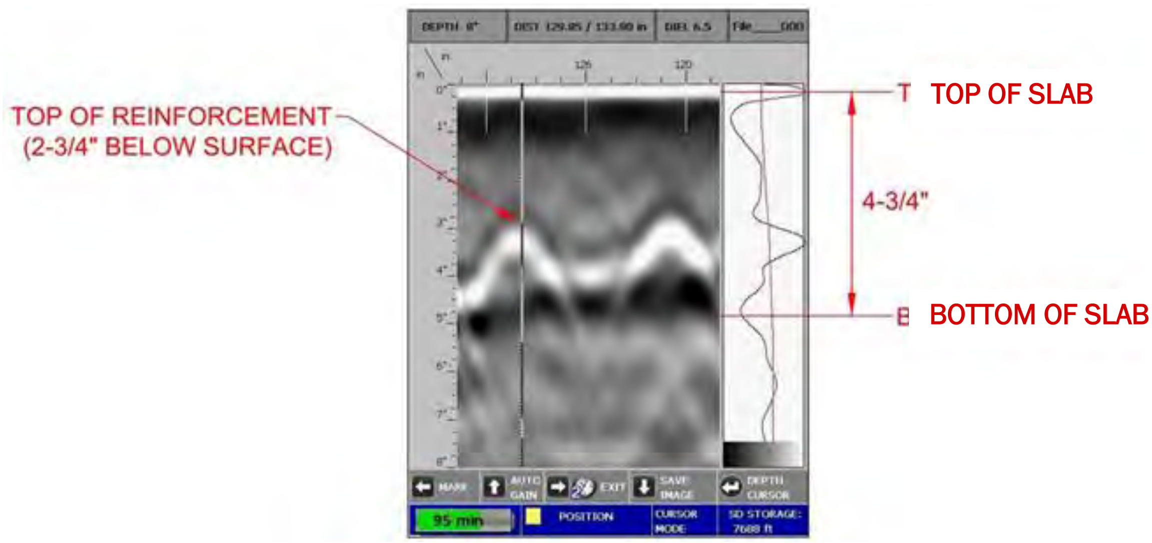


Figure 2-1. Sample SPR Scan

Concrete cover depth is an important element in corrosion protection of reinforced concrete structures. The greater the thickness of concrete cover, the less likely that corrosive constituents have reached the embedded reinforcing steel.

According to ACI 350-06, "Code Requirements for Environmental Engineering Concrete Structures," the minimum depth of concrete cover for corrosion protection of reinforcing steel in water-retaining structures should be 2 inches. In formed concrete surfaces exposed to earth, water, sewage, weather, or in contact with the ground, the minimum depth to reinforcing steel should also be 2 inches. Thus for the structures that were evaluated, the minimum depth of concrete cover over reinforcing steel should be 2 inches.

2.7 Concrete Core Sampling and Testing

V&A subcontracted with Penhall Co. of Los Angeles to perform concrete core drilling and repairs. Cylindrical core samples of concrete were taken from the walls and floors of the structures using a core drill anchored with concrete bolts to the surface being drilled. Water is injected into the hollow rotating core to cool the diamond cutting ring at the end of the core shaft and to remove the concrete particles so the core does not bind. Cores were taken to determine depth of carbonation, concrete compressive strength, and chloride concentration, and to perform petrographic analysis of the concrete samples. Coring was also used to verify the reinforcing steel bar diameter. V&A used SPR to verify the location of the reinforcing steel prior to the core drilling. Penhall patched the core holes with Sikatop 123+ polymer-modified repair mortar with FerroGard 901 corrosion inhibitor.

2.7.1 Depth of Carbonation Test

Two core samples from each structure were used to test the depth of concrete carbonation. The carbonation of concrete refers to the reaction of atmospheric carbon dioxide (CO_2) with cement hydrates in concrete. Atmospheric CO_2 penetrates into the surface of the concrete and reacts with cement hydrates such as calcium hydroxide ($Ca(OH)_2$) to form $CaCO_3$. Other reactions with cement hydrates may produce silica, alumina, and ferric oxide. The carbonation of concrete reduces the pH of the pore water in the hydrated cement from approximately 13 to 9. This reaction causes a loss of hardness and durability of the concrete and inhibits passivation of the reinforcing steel if it is already exposed to air or water.

SCL measured the depth of carbonation on the core samples by applying “Deep Purple” solution (Germann Instruments), which becomes a lavender color above a pH between 8.5 to 9.5. This visually distinct color can be used to distinguish between carbonated cement paste (uncolored) and unaltered cement paste (lavender color). The core samples were cut into flat slices in the laboratory, and the freshly cut surfaces were sprayed with the indicator solution within an hour.

2.7.2 Chloride Content Test

Two core samples from each structure were used to test the depth of chloride contamination. SCL performed chloride content tests in accordance with ASTM C1218, “Standard Test Method for Water-Soluble Chloride in Mortar and Concrete,” using a silver nitrate solution. The chloride content tests were performed on pulverized samples of the concrete in 1/2-inch depth increments to a maximum depth of 2 inches.

The chloride concentration in concrete can vary depending on the type of aggregate used, water-to-cement ratio, and other mix ingredients. Corrosion can occur in concrete with a high water-to-cement ratio, surfaces with concrete cover less than 1 inch over reinforcing steel, or concrete with cracks or spalls. The chlorides tend to break down otherwise protective surface deposits and can result in corrosion of reinforcing steel in concrete structures. Table 2-2 lists the maximum allowable chloride concentration in concrete for new construction from various sources. The threshold values for chloride as a percent by weight of concrete were converted from the standard values by dividing by a factor of 6 for a 7-sack concrete mix (as reported from the petrographic testing results for several of the samples).

Table 2-2. Maximum Allowable Chloride Concentration for New Reinforced Concrete

Source	Water-soluble Chloride Concentration (Percent by Weight of Cement Mortar)	Water-soluble Chloride Concentration (Percent by Weight of Concrete)
ACI 318-11 (C2 exposure)	0.15%	0.025%
FHWA-RD-76-70	0.16%	0.027%
ACI 222R-01 (dry conditions)	0.15%	0.025%
ACI 222R-01 (wet conditions)	0.08%	0.013%

SCL reported chloride content by weight of concrete, rather than by weight of cement mortar as shown in the table. SCL recommends use of a chloride threshold of 0.025% to 0.030% by weight of concrete. To be conservative and to match the most recent ACI literature (ACI 318-11), the lower limit of 0.025% was used as the threshold in this report. It should be noted that the exact threshold for the initiation of corrosion in a given structure may vary due to other factors as discussed above. Also, the test locations represent only a small portion of the structure surfaces; the chloride contamination and reinforcing steel cover depths will vary in other parts of the structures.

2.7.3 Compressive Strength Test

Two core samples from each structure were tested for compressive strength per ASTM C42. Cores for compressive strength testing were approximately 3 inches in diameter by 6 inches long. Compressive strength testing was performed by SCL.

2.7.4 Petrographic Analysis

Applied Materials & Engineering, Inc. (AME), performed the petrographic analysis per ASTM C856 *Standard Practice for Petrographic Examination of Hardened Concrete*. This method utilizes light microscopy to examine lapped saw-cut mortar surfaces and thin sections prepared from the core sample to characterize its microstructure and alteration. Wet chemical techniques described in ASTM C856 are used to determine the type of mortar based on its Portland cement, hydrated lime or dolomitic lime, and aggregate contents.

Concrete can degrade through a number of processes including acid attack, leaching and carbonation of the cement (paste). Generally, cement is a porous material, but it is largely dependent on water-to-cement ratio, admixtures, coarse aggregates, fine aggregates, embedded items, hardened paste, and air void structure. These pores form during the hydration process where water that is not used during hydration is left behind, forming pores. The more water that is used in the concrete mix (i.e., higher water-to-cement ratio), the more porous the concrete matrix will become.

2.7.5 Reinforcing Bar Size Verification

Reinforcing steel size was verified at core locations by coring directly over the top of the reinforcing steel and chipping out the concrete cover. Care was taken not to damage the reinforcing steel. The core holes that were drilled for verification of the reinforcing bar sizes were repaired using the same methods that were used for repairing the core sample holes.

2.8 VANDA™ Concrete Condition Rating System

The VANDA™ Concrete Condition Index (Table 2-3) was created by V&A to provide consistent reporting of corrosion damage based on qualitative, objective criteria. Condition of concrete can vary from Level 1 to Level 4 based upon visual observations and field measurements, with Level 1 indicating the best case and Level 4 indicating severe damage.

Table 2-3. VANDA™ Concrete Condition Index Rating System

Condition Rating	Description	Representative Photograph
Level 1	**None/Minimal Damage to Concrete** Hardness: No Loss Surface Profile: No Loss Cracking: Shrinkage Cracks Spalling: None Reinforcing Steel (Rebar): Not Exposed or Damaged	
Level 2	**Damage to Concrete Mortar** Hardness: Damage to Concrete Mortar Surface Profile: Some Loss Cracking: Thumbnail Sized Cracks of Minimal Frequency Spalling: Shallow Spalling of Minimal Frequency, Related Rebar Damage Reinforcing Steel (Rebar): May Be Exposed but Not Damaged	
Level 3	**Loss of Concrete Mortar/Damage to Rebar** Hardness: Complete Loss Surface Profile: Large Diameter Exposed Aggregate Cracking: ¼-inch to ½-inch Cracks, Moderate Frequency Spalling: Deep Spalling of Moderate Frequency, Related Rebar Damage Reinforcing Steel (Rebar): Exposed and Damaged, Can Be Rehabilitated	
Level 4	**Rebar Severely Corroded/Significant Damage to Structure** Hardness: Complete Loss Surface Profile: Large Diameter Exposed Aggregate Cracking: ½-inch Cracks or Greater, High Frequency Spalling: Deep Spalling at High Frequency, Related Rebar Damage Reinforcing Steel (Rebar): Damaged or Consumed, Loss of Structural Integrity	

2.9 VANDA™ Metal Condition Rating System

The VANDA™ Metal Condition Index (Table 2-4) was created by V&A to provide consistent reporting of corrosion damage based on qualitative, objective criteria. Condition of ferrous metal can vary from Level 1 to Level 4 based upon visual observations and field measurements, with Level 1 indicating the best case and Level 4 indicating severe damage.

Table 2-4. VANDA™ Metal Condition Index Rating System

Condition Rating	Description	Representative Photograph
Level 1	**Little or No Corrosion** Loss of Wall Thickness %: None Pitting Depth (as % of Wall Thickness): None to Minimal Extent (Area) of Corrosion: None	
Level 2	**Minor Surface Corrosion** Loss of Wall Thickness %: < 25% Pitting Depth (as % of Wall Thickness): < 25% Extent (Area) of Corrosion: Localized	
Level 3	**Moderate to Significant Corrosion** Loss of Wall Thickness %: 25%-75% Pitting Depth (as % of Wall Thickness): 25%-75% Extent (Area) of Corrosion: 25%-75%	
Level 4	**Severe Corrosion; Immediate Repair/Replacement Needed** Loss of Wall Thickness %: > 75% Pitting Depth (as % of Wall Thickness): 75% or More Extent (Area) of Corrosion: Affects Most or All of Surface	

3.0 RESULTS

3.1 West Flow Equalization Basin

3.1.1 Core Sampling Results

Core samples in the West FEB were taken from two locations, one near the midpoint of the west wall and one near the midpoint of the floor. The west wall core samples were taken at a height of approximately 6 feet above the floor, about 52 feet south of the expansion joint that crosses the FEB near the bottom of the ramp. The floor core samples were taken from a location approximately 10 feet east of the west wall, about 5 feet south of the expansion joint that crosses the FEB near the bottom of the ramp. The expansion joint used for reference for the coring locations is shown on Drawing S-2802 at a northing of 594.57 feet.

One of the vertical reinforcing bars was exposed at the coring location on the west wall. It appeared to be a No. 8 bar. One of the reinforcing bars running east-west was exposed at the coring location on the floor. It appeared to be a No. 7 bar.

The core samples were sent to SCL for testing of compressive strength, carbonation depth, and chloride contamination depth. SCL sent some of the core samples to AME for petrographic analysis. A summary of the laboratory analysis findings is provided in this section. The laboratory reports are provided in Appendix B.

Table 3-1 shows the carbonation depth, surface pH, and penetration depth measurements from the four core sampling and SPR scanning locations (see Section 3.1.2) within the West FEB. Based on the carbonation testing results from the core samples, the concrete has lost alkalinity to a maximum depth of 0.45 inches at the sampling locations. SPR scans at these locations indicated a minimum concrete cover of 1.3 inches, so the reinforcing steel is still embedded in an alkaline (protective) environment. However, the minimum reinforcing steel depth was 0.4 to 0.7 inches at the scan locations on the north and east walls, so the steel may be subject to corrosion there if the carbonation depth is similar.

The surface pH was measured at the SPR scanning locations and indicates a surface loss of alkalinity. Penetration depth measurements at these locations indicate that the lowered surface pH has not been associated with a significant loss of concrete hardness.

Table 3-1. Carbonation, pH, and Penetration Measurements – West FEB

Core/SPR Loc.	Max. Depth of Carbonation (in.)	Surface pH	Penetration Depth (in.)
West Wall	0.45	–	–
Floor	0.40	–	–
East Wall	No core sample	8	1/16
North Wall	No core sample	8	1/16

Table 3-2 summarizes the chloride testing results from the core sampling locations within the West FEB. The table also includes the minimum reinforcing steel depth as measured by SPR scanning. At the west wall sample location, there is more than 0.025% chloride content at the depth of the reinforcing steel, so it may be subject to corrosion there. The minimum reinforcing steel depth measured 0.4 to 0.7 inches at the scan locations on the north and east walls, so the steel may also be subject to corrosion there if the chloride contamination depth is similar. Spalling over the vertical bars was noted near the east wall scanning location.

Table 3-2. Chloride Content Test Results for West FEB

Core Location	Chloride Percentage by Weight of Concrete			Min. Depth to Reinforcing Steel (in.)	Chlorides above 0.025% at Reinforcement Depth?
	Depth 0.5 in. to 1.0 in.	Depth 1.0 in. to 1.5 in.	Depth 1.5 in. to 2.0 in.		
West Wall	**0.0657%**	**0.0253%**	0.0053%	1.3	Yes
Floor	**0.0284%**	0.0109%	0.0031%	2.2	No

Table 3-3 summarizes the compressive strength test results for the core samples from the West FEB. The results exceed the current requirement of 4,000 psi in ACI 350 for water-retaining structures.

Table 3-3. Compressive Strength Test Results for West FEB

Core Loc.	Capped Ht. (in.)	Dia. (in.)	Max. Load (lbf)	Compressive Strength (psi)
West Wall	5.6	2.74	48,600	8,240
Floor	5.4	2.74	31,600	5,360

AME performed petrographic analysis on a core sample from the West FEB floor. The water-cement ratio of the sample was estimated at 0.45. This is equal to the maximum water-cement ratio of 0.45 given in ACI 350 for water-retaining structures. The sample consisted of 31.4% cement paste, 67.8% aggregate, and 0.8% air (not air-entrained). The cementitious materials content was calculated to be 6.9 sacks per cubic yard. The petrographic analysis indicated that the core samples from the West

FEB (floor), SST 2 (north wall), and AST 1B (floor) were the same concrete mixture, aggregate, and composition. A minor degree of alkali-silica reaction (ASR) was noted, but it was not observed to be causing deleterious expansion.

3.1.2 Surface Penetrating Radar Scans

SPR scanning in the West FEB was conducted at four locations. Two of the locations were the same as the west wall and floor core sampling locations, as described above. Scans were also conducted on the east wall and the north wall. The east wall scanning location was approximately 3 feet above the ramp and 10 feet north of the bottom of the ramp. The north wall scanning location was within the bottom 3 feet of the wall, approximately 5 feet west of the second column from the east supporting the platform at the north end of the FEB.

Table 3-4 summarizes the depth and spacing of reinforcing steel as measured at the SPR scanning locations. The depth of cover in many locations was significantly less than the 2 inches recommended as a guideline for this type of structure (see Section 2.6).

Table 3-4. SPR Scan Results for West FEB

Loc.	Bar Dir.	Reinforcing Bar Depth (in.)			Reinforcing Bar Spacing (in.)		
		Min.	Avg.	Max.	Min.	Avg.	Max.
West Wall	V	1.3	1.7	2.0	4.9	5.8	6.5
West Wall	H	1.5	2.9	4.7	7.7	10.6	11.9
Floor	E-W	2.2	2.6	3.0	3.9	5.8	7.3
Floor	N-S	3.6	4.0	4.3	6.4	11.1	12.7
East Wall*	V	0.4	0.7	1.3	5.0	7.8	9.6
East Wall	H	1.8	2.2	2.7	10.3	11.7	13.1
North Wall	V	0.7	1.4	2.7	4.9	5.9	6.9
North Wall	H	2.1	2.6	3.2	9.8	11.5	12.7

* At this location there appeared to be two sets of vertical bars over part of the scan area. Depth and spacing is reported for the shallowest set of bars only.

3.1.3 Visual and Qualitative Evaluation

In general, the concrete interior surfaces of the West FEB were in good condition. Photo 3-1 through Photo 3-3 show the general appearance of the West FEB interior. The concrete surfaces, particularly the floor, showed generalized shrinkage cracking (Photo 3-4). Soundings in the West FEB generally indicated sound, hard concrete. Details of the soundings performed in the West FEB are shown in Table 3-5.

Table 3-5. Soundings in West FEB

Location	Number of Soundings	Results
South wall, west wall near corner, and nearby floor	5+	• Sound, hard concrete; no voids noted • Includes areas with exposed aggregate
West wall, sloped wall "toe," and floor near expansion joint approx. 80 feet north of south wall	3	• Sound, hard concrete; no voids noted
West wall, sloped wall "toe," and floor near west wall coring location	3	• Sound, hard concrete; no voids noted
North wall, west wall near corner, and nearby floor	9	• Sound, hard concrete; no voids noted
Six northernmost columns supporting ramps and platform over north end of FEB	Multiple each	• Sound, hard concrete except in areas with exposed aggregate • Tapered concrete fill at bases sounds hollow where cracks are visible • Tapered concrete fill at bases sounds solid where cracks are not visible

Photo 3-1. West FEB as viewed from platform at north end.

Photo 3-2. West wall near midpoint of West FEB.

Photo 3-3. East wall of West FEB below ramp.

Photo 3-4. Typical cracking on West FEB floor.

There were several areas where minor or moderate defects or evidence of deterioration was observed, as described below. As a result of the number and frequency of these observations, the West FEB is rated VANDA Level 2 for concrete condition. Key observations are illustrated in this section; additional photos are provided in Appendix A.

- **Construction joints:** Along the length of the west wall, there is a horizontal construction joint with a mortar overlay approximately 5.5 feet above the floor. In many locations, the mortar overlay was found to be spalling off of the surface or cracked and loose. Over the distance between the wall coring location and the expansion joint crossing the FEB near the bottom of the ramp (approximately 50 feet), there was a horizontal reinforcing bar running along the joint with very little concrete cover, and it was exposed in some locations (Photo 3-5 and Photo 3-6). Similar mortar overlays, with evidence of deterioration, were found on some of the vertical construction joints along the west wall as well.

Photo 3-5. Broken mortar and exposed reinforcing bar at some locations along construction joint in west wall.

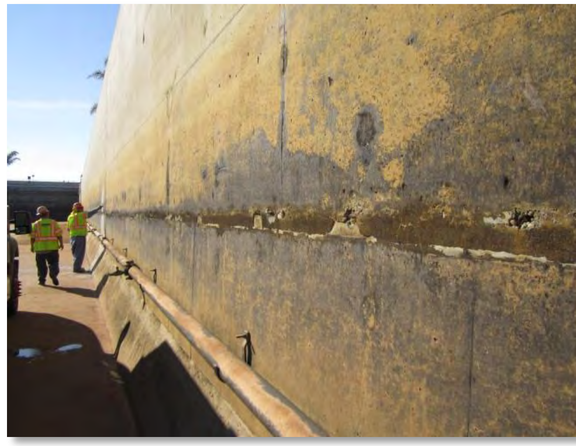


Photo 3-6. Reinforcing bar exposed at construction joint intermittently over approximate 50-foot length.

- **Expansion joints:** There were several expansion joints running east-west across the FEB. The sealant at the expansion joints is generally cracked and split, although it is still somewhat pliable. In some places, sections of the sealant are missing or there are weeds growing out of the gaps. A few locations exhibited minor spalling of the concrete adjacent to the expansion joints. Conversely, the control joints cast into the floor slab typically were in good condition. Photo 3-7 through Photo 3-10 illustrate these observations.

Photo 3-7. Weeds growing from expansion joint in floor.

Photo 3-8. Spalled concrete adjacent to expansion joint in floor.

Photo 3-9. Spalled concrete adjacent to expansion joint in wall at bottom of ramp.

Photo 3-10. Typical control joints in floor.

- **Surface defects:** The east wall of the West FEB (dividing wall between the two FEBs) exhibited minor exposed aggregate in some locations near the apparent high water line. There were also some locations along the lower part of the east wall that exhibited bug holes or rock pockets (Photo 3-11). On the west wall of the West FEB, there were some rock pockets and areas of exposed aggregate in isolated locations (Photo 3-12 and Photo 3-13).

  On the exterior of the wall along the edge of the ramp, as well as the outside edge of the ramp itself, there was an apparent overlay coating of mortar in some locations. This was cracked and delaminating from the concrete substrate in some locations. Photo 3-14 and Photo 3-15 illustrate these observations.

Photo 3-11. Bug holes and exposed aggregate along lower east wall.

Photo 3-12. Typical concrete surfaces along toe of west wall with intermittent areas of exposed aggregate.

Photo 3-13. Typical isolated rock pocket in west wall near southwest corner.

Photo 3-14. Overlay layer spalling off of edge of wall and ramp.

Photo 3-15. Cracked surface layer near bottom of ramp.

- Cracking: The south wall of the West FEB exhibited a few near-vertical cracks (Photo 3-16). The cracks exhibit minimal separation. The platform at the north end of the FEB exhibited minor cracking on the underside. In this area, there was efflorescence from the cracks as well as the construction joints. In a few locations, the wall along the edge of the ramp exhibited cracking that probably extended through the wall (Photo 3-17).

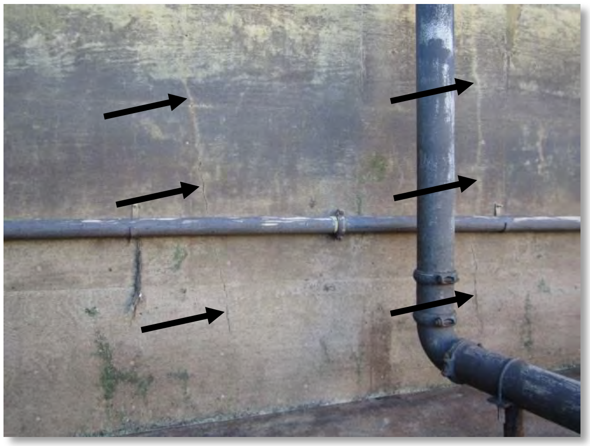


Photo 3-16. Cracks in south wall.

Photo 3-17. Cracks in a few locations are visible on both sides of the wall and appear to extend through it.

- **Spalling:** The walls of the West FEB exhibited spalling in isolated locations. Most of these were small, individual spalls up to a few inches in length (Photo 3-18). There was a pattern of spalling over the vertical bars in the east wall, which forms the dividing wall between the two FEBs (Photo 3-19). There was also one diagonal bar visible through a spalled area a few feet in length near the top of the west wall (Photo 3-20 and Photo 3-21). There was also spalling near some of the expansion joints (see above).

Photo 3-18. Typical minor spalling on outside of ramp.

Photo 3-19. Spalling on east wall near bottom of ramp.

Photo 3-20. Location of spall near top of midpoint of west wall.

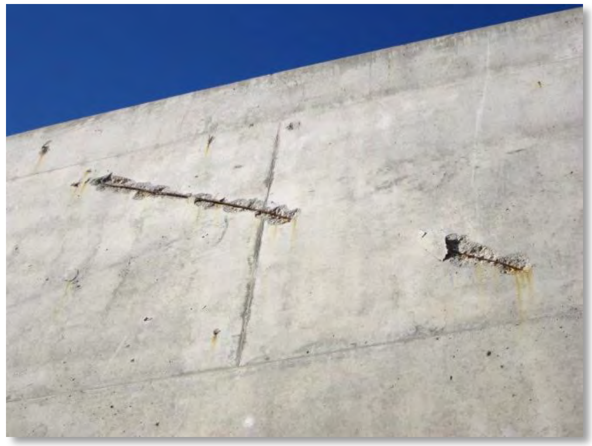


Photo 3-21. Detail view of spall near top of midpoint of west wall.

- **Joints surrounding sprinklers:** The FEB is equipped with a row of sprinklers running along the middle of the floor. The northernmost and southernmost sprinklers had separate concrete joints in the concrete floor around them (Photo 3-22 and Photo 3-23). At the south end of the FEB, the joints had been filled with sealant, which was coming loose. The joints at the north end exhibited minor chipping of the adjacent concrete edges. A few of the sprinkler heads within the FEB were missing and apparently capped off.

Photo 3-22. Joints surrounding sprinkler near north end of FEB.

Photo 3-23. Joints around sprinkler near south end of FEB, with sealant coming loose.

- **Columns:** At the north end of the FEB, there are columns holding up the ramp as well as a platform that overhangs the north end of the basin. Some of the columns exhibited minor areas of exposed aggregate. One of the columns had a small gouge on one of the corners. Some of the columns had a tapered concrete collar at the base, and in some cases this concrete was broken and hollow-sounding. Photo 3-24 through Photo 3-27 illustrate these observations.

Photo 3-24. Columns at north end of West FEB.

Photo 3-25. Typical exposed aggregate on column.

Photo 3-26. Damaged corner on column.

Photo 3-27. Cracked concrete at base of column with apparent repair at right.

3.1.4 Additional Observations

There was a ductile iron pipe descending into the FEB near the south wall that exhibited corrosion on its supports as well as on the hardware for the Victaulic couplings. The coating on the underside of the horizontal pipe has failed and there may be corrosion occurring there as well. The coating and corrosion products were not disturbed, so the extent of metal loss is unknown. Appendix A provides more information on these observations.

The wall along the ramp leading into the FEB is only about 18 inches high, which poses a fall hazard for personnel walking near the edge.

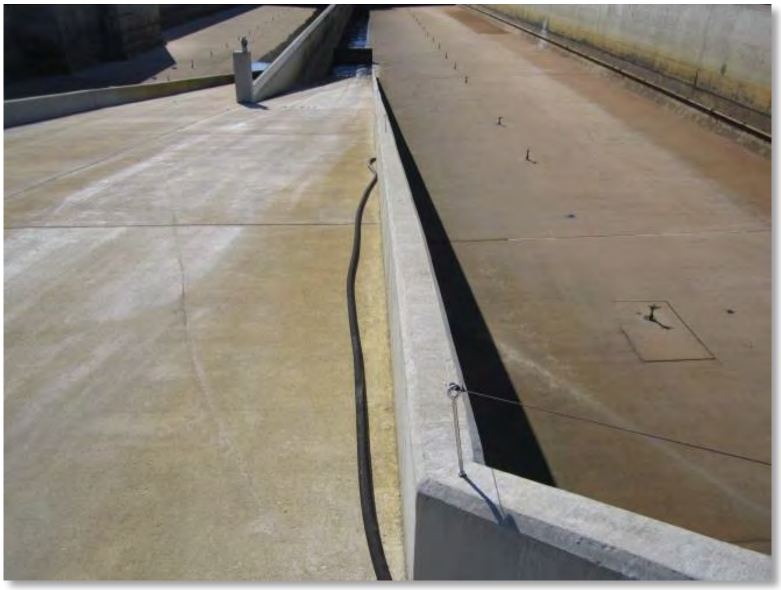


Photo 3-28. North end of wall along ramp. Low height of wall presents a fall hazard.

3.2 Secondary Sedimentation Tank 2

3.2.1 Core Sampling

Core samples in SST 2 were taken from two locations near the west end of the basin, one on the north wall and one on the floor. The north wall core samples were taken at a height of approximately 4 feet above the floor, about 16 feet east of the end of the overhanging platform above the west end of the basin. The floor core sampling location was approximately 7 feet south of the north wall, in line with the north wall sampling location. Some of the core samples at this location broke off at approximately the 3-inch depth. The core drilling personnel suspected that this was due to a rock pocket within the concrete. In order to retrieve cores that were long enough for testing, additional cores were taken within this vicinity but closer to the south wall.

One of the vertical reinforcing bars was exposed at the coring location on the north wall. It appeared to be a No. 7 bar. One of the reinforcing bars running north-south was exposed at the coring location on the floor. It appeared to be a No. 7 bar.

The core samples were sent to SCL for testing of compressive strength, carbonation depth, and chloride contamination depth. SCL sent some of the core samples to AME for petrographic analysis. A summary of the laboratory analysis findings is provided in this section. The laboratory reports are provided in Appendix B.

Table 3-6 shows the carbonation depth, surface pH, and penetration depth measurements from the four core sampling and SPR scanning locations (see Section 3.2.2) within SST 2. Based on the carbonation testing results from the core samples, the concrete has lost alkalinity to a maximum depth of 0.40 inches at the north wall sampling location and to a negligible depth at the floor sampling location. SPR scans at these locations indicated a minimum concrete cover of 1.7 inches, so the reinforcing steel is still embedded in an alkaline (protective) environment. The reinforcement depth was similar or greater at the scan locations on the east and south walls, so the reinforcing steel would also be within an alkaline environment there if the carbonation depth is similar.

The surface pH was measured at the SPR scanning locations and indicates a surface loss of alkalinity. Penetration depth measurements at these locations indicate that the lowered surface pH has not been associated with a significant loss of concrete hardness.

Table 3-6. Carbonation, pH, and Penetration Measurements – SST 2

Core/SPR Loc.	Max. Depth of Carbonation (in.)	Surface pH	Penetration Depth (in.)
North Wall	0.40	–	–
Floor	<0.05	–	–
East Wall	No core sample	7	1/8
South Wall	No core sample	6	1/16

Table 3-7 summarizes the chloride testing results from the core sampling locations within SST 2. The table also includes the minimum reinforcing steel depth as measured by SPR scanning. Although the chloride content is below 0.025% at the reinforcing steel depth, it is approaching this threshold at the floor sampling location. Corrosion of the reinforcing steel may be a future concern if this contamination continues. There may also be locations within the structure where the reinforcing steel cover depth is less or the chloride contamination depth is greater. The 0.025% threshold may also vary due to other factors, as discussed in Section 2.7.2.

Table 3-7. Chloride Content Test Results for SST 2

Core Location	Chloride Percentage by Weight of Concrete			Min. Depth to Reinforcing Steel (in.)	Chlorides above 0.025% at Reinforcement Depth?
	Depth 0.5 in. to 1.0 in.	**Depth 1.0 in. to 1.5 in.**	**Depth 1.5 in. to 2.0 in.**		
North Wall	**0.0350%**	0.0069%	0.0001%	1.7	No
Floor	**0.0312%**	0.0217%	0.0141%	2.1	No

Table 3-8 summarizes the compressive strength test results for the core samples from SST 2. The results exceed the current requirement of 4,000 psi in ACI 350 for water-retaining structures.

Table 3-8. Compressive Strength Test Results for SST 2

Core Loc.	Capped Ht. (in.)	Dia. (in.)	Max. Load (lbf)	Compressive Strength (psi)
North Wall	5.4	2.74	40,900	6,940
Floor	5.5	2.74	25,200	4,270

AME performed petrographic analysis on a core sample from the north wall of SST 2. The water-cement ratio of the sample was estimated at 0.43. This is below the maximum water-cement ratio of 0.45 given in ACI 350 for water-retaining structures. The sample consisted of 31.5% cement paste, 67.9% aggregate, and 0.6% air (not air-entrained). The cementitious materials content was calculated to be 6.9 sacks per cubic yard. The petrographic analysis indicated that the core samples from the West FEB (floor), SST 2 (north wall), and AST 1B (floor) were the same concrete mixture, aggregate, and composition. A minor degree of alkali-silica reaction (ASR) was noted, but it was not observed to be causing deleterious expansion.

3.2.2 Surface Penetrating Radar Scans

SPR scanning in SST 2 was conducted at four locations. Two of the locations were the same as the north wall and floor core sampling locations, as described above. Scans were also conducted on the east wall and the south wall. The east wall scanning location was centered between the tee fittings projecting from the wall. The south wall scanning location was approximately 3 feet above the floor, about 55 feet east of the end of the overhanging platform above the west end of the basin.

Table 3-9 summarizes the depth and spacing of reinforcing steel as measured at the SPR scanning locations. The minimum depth of cover in some locations on the north and east walls was somewhat less than the 2 inches recommended as a guideline for this type of structure (see Section 2.6).

Table 3-9. SPR Scan Results for SST 2

Loc.	Bar Dir.	Reinforcing Bar Depth (in.)			Reinforcing Bar Spacing (in.)		
		Min.	Avg.	Max.	Min.	Avg.	Max.
North Wall	V	1.7	1.8	2.1	4.5	6.1	7.6
North Wall	H	2.8	3.0	3.2	11.5	12.4	13.7
Floor	N-S	2.1	2.3	2.9	11.6	11.9	12.7
Floor	E-W	3.4	3.6	4.0	10.6	12.0	13.4
East Wall*	V	1.8	2.3	2.8	9.3	10.6	12.2
East Wall	H	2.7	3.1	3.9	11.6	12.3	13.0
South Wall	V	2.3	2.5	2.8	4.3	6.0	8.2
South Wall	H	3.8	3.9	4.2	9.6	11.7	13.4

* At this location there appeared to be overlapping vertical bars over part of the scan area. Depth and spacing is reported for the shallowest set of bars only.

3.2.3 Visual and Qualitative Evaluation

In general, the concrete interior surfaces of SST 2 were in good condition and were rated VANDA Level 1 for concrete condition. Photo 3-29 through Photo 3-32 show the general appearance of the SST 2 interior. Additional photos are provided in Appendix A. Soundings were performed at over 20 locations on the north, east, and south walls of SST 2, as well as the adjacent floor areas. The soundings generally indicated sound, hard concrete, except at the toe of the curved fill mortar near the east wall, which sounded hollow or loose (see details below). There were also a few soft spots, evidenced by a more muffled sound, intermittently along the south wall from 3 to 6 feet above the floor, and on the mortar overlays on the construction joints at the 3-foot height on both the north and south walls.

Photo 3-29. SST 2, looking west.

Photo 3-30. Inside SST 2, looking east.

Photo 3-31. Looking west inside SST 2.

Photo 3-32. Platform and launders over west end of SST 2.

There were several areas where minor defects or evidence of deterioration was observed, as described below. These are presently minor issues, but they may accelerate future deterioration of the structure. Key observations are illustrated in this section; additional photos are provided in Appendix A.

- **Cracking:** There were several locations throughout SST 2 that exhibited minor cracking. Except as noted, the cracks had not begun to separate. Cracks were noted as follows:
    - In the slab overhanging the west end of the basin. Near the corners of the covers over the launders, slight separation was observed (Photo 3-33).
    - Vertical cracks every few feet along the north wall of the basin (Photo 3-34). Most of these cracks extended most of the height of the wall.

- The construction joints at the midpoints of the north and south walls exhibited evidence of seepage.
- Hairline cracks on the underside of the triangular platform at the southeast corner.
- Hairline cracks in the walkway slab above the north wall.
- General cracking in some areas on the floor (Photo 3-35). Near the east end of the basin, there was one location that exhibited possible groundwater infiltration.

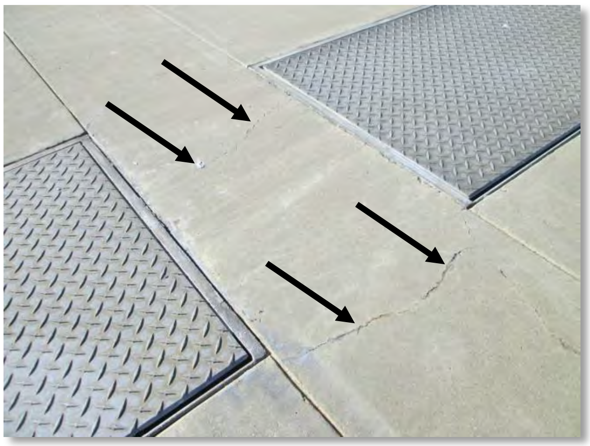


Photo 3-33. Cracking of platform above west end of SST 2 (typical).

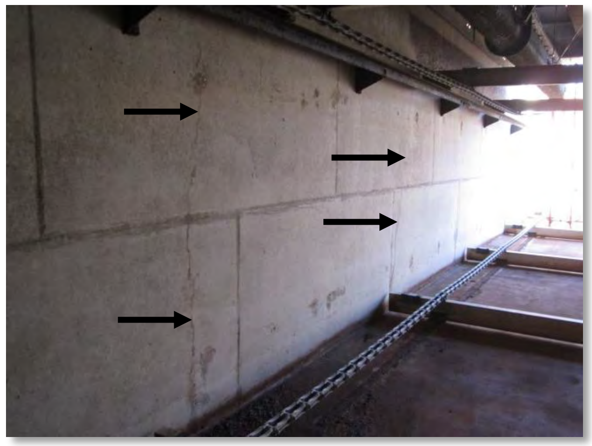


Photo 3-34. Typical vertical cracks spaced every few feet along length of north wall.

Photo 3-35. Typical minor cracking on floor of SST 2. Possible infiltration visible at bottom of image.

- **Expansion joints:** SST 2 has expansion joints running north-south across the basin. In general, the sealant was in fair condition, with some signs of brittleness and shrinkage. The expansion joint near the west end of the basin exhibited gaps and possible groundwater infiltration, as shown in Photo 3-36 and Photo 3-37.

Photo 3-36. Deteriorated sealant at expansion joint near west end of SST 2 with evidence of possible infiltration.

Photo 3-37. Deteriorated sealant at expansion joint near west end of SST 2 with evidence of possible infiltration.

- **Fill concrete at east wall:** At the bottom of the east wall, there is a tapered and concave section of concrete fill that appears to be contoured to the path of the skimmer arms. At the top edge, there is a gap between the east wall and the fill concrete (Photo 3-38). The fill concrete becomes thin near the toe, due to the circular concave surface, and it is irregular and possibly broken in this area (Photo 3-39). The fill concrete also exhibits a few vertical cracks.

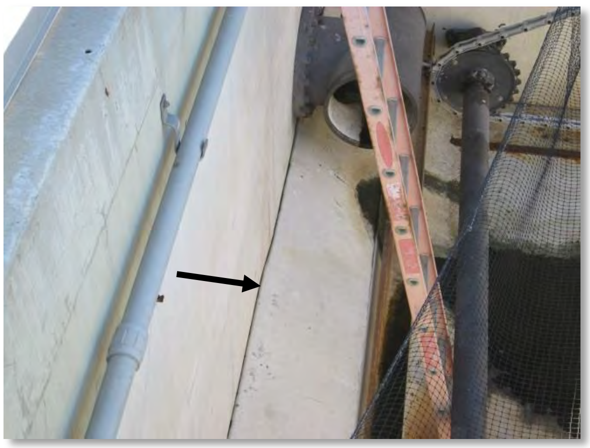


Photo 3-38. Gap between east wall and fill concrete.

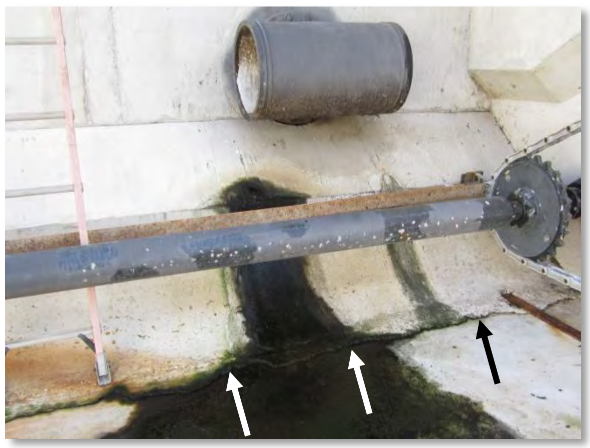


Photo 3-39. Broken or irregular concrete at toe of fill at east wall.

3.2.4 Additional Observations

Metallic appurtenances within SST consisted of the steel brackets, hardware, etc., for the skimmer mechanism, as well as the two tee fittings protruding through the east wall. The tees appear to serve as inlets to the basin. There was evidence of exterior coating failure, primarily along edges, and minor corrosion on these metallic objects. The mortar lining inside the tees was also deteriorated, with surface corrosion occurring. Appendix A provides more information on these observations.

3.3 Activated Sludge Tank 1B

3.3.1 Core Sampling

Core samples in the AST 1B were taken from two locations, one on the west wall and one on the floor. The west wall core samples were taken at a height of approximately 4 feet above the floor, about 22 feet south of the north wall of the basin. The floor core sampling location was adjacent to the west wall sampling location, near the center trough.

One of the vertical reinforcing bars was exposed at the coring location on the north wall. It appeared to be a No. 7 bar. One of the reinforcing bars running north-south was exposed at the coring location on the floor. It appeared to be a No. 7 bar.

The core samples were sent to SCL for testing of compressive strength, carbonation depth, and chloride contamination depth. SCL sent some of the core samples to AME for petrographic analysis. A summary of the laboratory analysis findings is provided in this section. The laboratory reports are provided in Appendix B.

Table 3-10 shows the carbonation depth, surface pH, and penetration depth measurements from the four core sampling and SPR scanning locations (see Section 3.3.2) within AST 1B. Based on the carbonation testing results from the core samples, the concrete has lost alkalinity to a maximum depth of 0.3 inches at the west wall sampling location and to depth of 0.5 inches at the floor sampling location. SPR scans at these locations indicated a minimum concrete cover of 1.8 inches, so the reinforcing steel is still embedded in an alkaline (protective) environment. The reinforcement depth was similar or greater at the scan locations on the east and north walls, so the reinforcing steel would also be within an alkaline environment there if the carbonation depth is similar.

The surface pH was measured at the SPR scanning locations and indicates a surface loss of alkalinity.

Table 3-10. Carbonation, pH, and Penetration Measurements – AST 1B

Core/SPR Loc.	Max. Depth of Carbonation (in.)	Surface pH	Penetration Depth (in.)
West Wall	0.30	–	–
Floor	0.50	–	–
North Wall	No core sample	7	–
East Wall	No core sample	7	–

Table 3-11 summarizes the chloride testing results from the core sampling locations within AST 1B. The table also includes the minimum reinforcing steel depth as measured by SPR scanning. Although the chloride content is below 0.025% at the reinforcing steel depth, it is approaching this threshold at the sampling locations. Corrosion of the reinforcing steel may be a future concern if this contamination continues. There may also be locations within the structure where the reinforcing steel cover depth is less or the chloride contamination depth is greater. The 0.025% threshold may also vary due to other factors, as discussed in Section 2.7.2.

Table 3-11. Chloride Content Test Results for AST 1B

Core Location	Chloride Percentage by Weight of Concrete			Min. Depth to Reinforcing Steel (in.)	Chlorides above 0.025% at Reinforcement Depth?
	Depth 0.5 in. to 1.0 in.	**Depth 1.0 in. to 1.5 in.**	**Depth 1.5 in. to 2.0 in.**		
West Wall	**0.0355%**	0.0228%	0.0135%	3.0	No
Floor	**0.0306%**	0.0214%	0.0064%	1.8	No

Table 3-12 summarizes the compressive strength test results for the core samples from AST 1B. The results exceed the current requirement of 4,000 psi in ACI 350 for water-retaining structures.

Table 3-12. Compressive Strength Test Results for AST 1B

Core Loc.	Capped Ht. (in.)	Dia. (in.)	Max. Load (lbf)	Compressive Strength (psi)
West Wall	5.0	2.74	40,800	6,920
Floor	5.6	2.74	37,000	6,270

AME performed petrographic analysis on a core sample from the AST 1B floor. The water-cement ratio of the sample was estimated at 0.45. This is equal to the maximum water-cement ratio of 0.45 given in ACI 350 for water-retaining structures. The sample consisted of 34.9% cement paste, 63.8% aggregate, and 1.3% air (not air-entrained). The cementitious materials content was calculated to be

7.5 sacks per cubic yard. The petrographic analysis indicated that the core samples from the West FEB (floor), SST 2 (north wall), and AST 1B (floor) were the same concrete mixture, aggregate, and composition. A minor degree of alkali-silica reaction (ASR) was noted, but it was not observed to be causing deleterious expansion.

3.3.2 Surface Penetrating Radar Scans

SPR scanning in AST 1B was conducted at four locations. Two of the locations were the same as the west wall and floor core sampling locations, as described above. Scans were also conducted on the north wall and the east wall. The north wall scanning location was approximately 3 feet above the floor and 4 feet west of the east wall. The east wall scanning location was approximately 3 feet above the floor, approximately 210 feet south of the north wall. The scan location was on the north side of the expansion joint at that location.

Table 3-13 summarizes the depth and spacing of reinforcing steel as measured at the SPR scanning locations. The minimum depth of cover at the floor scan location was slightly less than the 2 inches recommended as a guideline for this type of structure (see Section 2.6).

Table 3-13. SPR Scan Results for AST 1B

Loc.	Bar Dir.	Reinforcing Bar Depth (in.)			Reinforcing Bar Spacing (in.)		
		Min.	Avg.	Max.	Min.	Avg.	Max.
West Wall	V	3.0	3.4	4.1	5.0	5.9	6.9
West Wall	H	4.6	5.0	5.6	9.2	10.2	11.4
Floor	E-W	1.8	2.1	2.3	10.5	11.8	13.0
Floor	N-S	3.5	3.7	4.0	11.5	11.8	12.1
North Wall	V	2.5	2.8	3.3	10.7	11.9	14.0
North Wall	H	3.3	3.8	4.1	11.0	12.2	13.4
East Wall	V	2.0	2.2	2.5	4.2	6.0	6.9
East Wall	H	3.2	3.7	4.3	11.1	12.2	13.8

3.3.3 Visual and Qualitative Evaluation

In general, the concrete interior surfaces of AST 1B were in good condition and were rated VANDA Level 1 for concrete condition. Photo 3-40 through Photo 3-43 show the general appearance of the AST 1B interior. Additional photos are provided in Appendix A. Soundings were performed at over 20 locations on the west, north, and east walls of AST 1B, as well as the adjacent floor areas. The soundings generally indicated sound, hard concrete, except on the mortar overlays on some of the construction joints, which sounded hollow or loose. There were also a few soft spots, evidenced by a more muffled sound, intermittently along the sloped "toe" of the east wall.

Photo 3-40. Looking south from north end of AST 1B.

Photo 3-41. Looking south from north end of AST 1B.

Photo 3-42. East wall of AST 1B (typical).

Photo 3-43. West wall of AST 1B (typical).

There were several areas where minor defects or evidence of deterioration was observed, as described below. These are presently minor issues, but they may accelerate future deterioration of the structure. Key observations are illustrated in this section; additional photos are provided in Appendix A.

- **Cracking:** There were several locations throughout AST 1B that exhibited minor cracking. Except as noted, the cracks had not begun to separate. Cracks were noted as follows:
  - Small cracks in the floor, west wall, and walkways over the basin (Photo 3-44).
  - Many of the construction joints had a mortar overlay, which was missing or spalling in some locations. In one location, the spalling exposed reinforcing steel (Photo 3-45).
  - The top of the east wall exhibited cracking near the walkways crossing over the basin. The concrete appeared to be loose in some of these areas, and one location may have been repaired previously. The ends of the reinforcing bars were also visible at the top of the east wall in these locations (Photo 3-46 and Photo 3-47). The top of the east wall is rated VANDA Level 2 for concrete condition.

Photo 3-44. Typical cracking on floor and walls of center trough.

Photo 3-45. Spalling mortar with moderate corrosion of reinforcing steel near expansion joint 396 feet south of north wall.

Photo 3-46. Exposed ends of reinforcing bars at top of wall between ASTs 1B and 1C.

Photo 3-47. Cracking on top surface of wall between ASTs 1B and 1C (typical).

- **Corrosion staining:** There were several locations where there was corrosion staining evident at the interior surface of the concrete walls. Most of these appeared to be due to wires or other metal objects embedded in the concrete (Photo 3-48). One location appeared to have an exposed reinforcing bar (Photo 3-49).

Photo 3-48. Corrosion staining at construction joint on east wall. There may have been a metal strip embedded in the surface of the concrete.

Photo 3-49. Exposed steel (possible vertical reinforcing bar) about 4 feet above floor on west wall and about 95 feet south of north wall.

- **Expansion joints:** There were several expansion joints running east-west across the AST. The sealant at the expansion joints is generally cracked and split, although it is still somewhat pliable. In some places, there are gaps between the sealant and the concrete. Some of the joints appear to have been repaired with an overlay sealant, but there were typically gaps beneath these. One location exhibited active groundwater infiltration during the evaluation. Spalling of the concrete was noted adjacent to the expansion joints in one location, which was rated VANDA Level 2 for concrete condition as a result. Photo 3-50 through Photo 3-52 illustrate these observations.

Photo 3-50. Typical sealant in expansion joint with shrinkage and gaps.

Photo 3-51. Overlay sealant on expansion joint with gaps at ends (typical).

Photo 3-52. Spalling concrete adjacent to expansion joint on west wall about 303 feet south of north wall.

Photo 3-53. Puddle of water caused by groundwater infiltration at expansion joint 210 feet south of north wall.

- **Construction defects:** One of the construction joints along the east wall, about 150 feet south of the north wall, showed a considerable (approx. 1 inch) offset between the concrete surfaces on either side of the joint. There was an apparent rock pocket above the manifold pipe about 305 feet south of the north wall.

3.3.4 Additional Observations

There were several steel manifold pipes crossing AST 1B. These exhibited minor coating failure and surface corrosion. There was also minor coating failure and surface corrosion on the sluice gates and their frames. These observations are illustrated in Photo 3-54 and Photo 3-55 and in Appendix A.

Photo 3-54. Steel manifold pipe with minor coating failure and corrosion.

Photo 3-55. Minor coating failure and corrosion on sluice gates and frames.

3.4 Primary Clarifier 1

Locations within Primary Clarifier 1 were referenced to clock positions around the circumference of the clarifier, as shown in Figure 3-1. The 6:00 position was aligned with the catwalk to the center column.

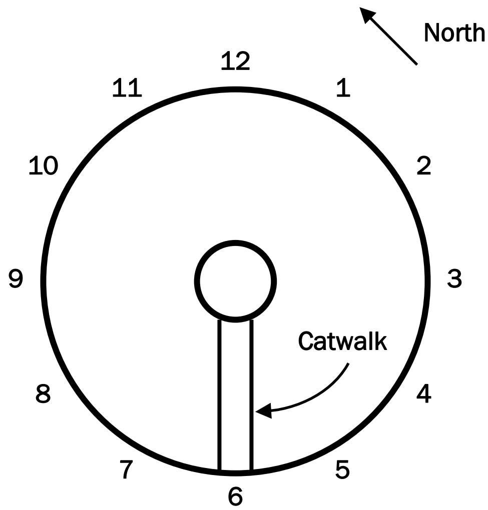


Figure 3-1. Clock Position References – PC 1

3.4.1 Core Sampling

Core samples in PC 1 were taken from two locations, one on the wall at the 5:30 position and one on the floor at the 5:00 position. The wall samples were taken at a height of approximately 4 feet above the floor. The floor samples were taken about 6 feet from the wall.

One of the vertical reinforcing bars was exposed at the coring location on the wall at the 5:30 position. It appeared to be a No. 5 bar. One of the radial reinforcing bars was exposed at the coring location on the floor at the 5:00 position. It appeared to be a No. 4 bar.

The core samples were sent to SCL for testing of compressive strength, carbonation depth, and chloride contamination depth. SCL sent some of the core samples to AME for petrographic analysis. A summary of the laboratory analysis findings is provided in this section. The laboratory reports are provided in Appendix B.

Table 3-14 shows the carbonation depth, surface pH, and penetration depth measurements from the four core sampling and SPR scanning locations (see Section 3.4.2) within PC 1. Based on the carbonation testing results from the core samples, the concrete has lost alkalinity to a maximum depth of 0.15 inches at the sampling locations. SPR scans at these locations indicated a minimum concrete cover of 1.5 inches, so the reinforcing steel is still embedded in an alkaline (protective) environment. The reinforcement depth was similar or greater at the other two scan locations on the wall, so the reinforcing steel would also be within an alkaline environment there if the carbonation depth is similar.

The surface pH was measured at the SPR scanning locations and indicates a surface loss of alkalinity. Penetration depth measurements at these locations indicate that the lowered surface pH has not been associated with a significant loss of concrete hardness.

Table 3-14. Carbonation, pH, and Penetration Measurements – PC 1

Core/SPR Loc.	Max. Depth of Carbonation (in.)	Surface pH	Penetration Depth (in.)
Wall at 5:30	0.15	–	–
Floor at 5:00	<0.05	–	–
Wall at 12:00	No core sample	7	1/16
Wall at 9:00	No core sample	7	1/16

Table 3-15 summarizes the chloride testing results from the core sampling locations within PC 1. The table also includes the minimum reinforcing steel depth as measured by SPR scanning. At the wall sampling location, the chloride content is well below 0.025% throughout the sample, so the steel is not expected to be subject to corrosion due to chloride. At the floor sampling location, the results are unclear, as the chloride sampling was only conducted to a depth of 2 inches, while the minimum cover over the reinforcing steel was 5.2 inches.

Table 3-15. Chloride Content Test Results for PC 1

Core Location	Chloride Percentage by Weight of Concrete			Min. Depth to Reinforcing Steel (in.)	Chlorides above 0.025% at Reinforcement Depth?
	Depth 0.5 in. to 1.0 in.	**Depth 1.0 in. to 1.5 in.**	**Depth 1.5 in. to 2.0 in.**		
Wall at 5:30	0.0068%	0.0067%	0.0058%	1.5	No
Floor at 5:00	**0.0280%**	**0.0266%**	**0.0263%**	5.2	Unknown

Table 3-16 summarizes the compressive strength test results for the core samples from PC 1. The results exceed the current requirement of 4,000 psi in ACI 350 for water-retaining structures.

Table 3-16. Compressive Strength Test Results for PC 1

Core Loc.	Capped Ht. (in.)	Dia. (in.)	Max. Load (lbf)	Compressive Strength (psi)
Wall	3.7	2.74	30,500	4,910
Floor	3.4	2.74	36,500	5,760

AME performed petrographic analysis on a core sample from the PC 1 floor. This sample included approximately 3 inches of mortar topping over the concrete. The water-cement ratio was estimated at 0.48 for the concrete, which is below the maximum water-cement ratio of 0.45 given in ACI 350 for water-retaining structures, and 0.55 for the mortar. The concrete consisted of 34.3% cement paste, 64.6% aggregate, and 1.1% air (not air-entrained). The mortar consisted of 40.4% cement paste, 57.4% aggregate, and 2.2% air (not air-entrained). The cementitious materials content was calculated to be 7.3 sacks per cubic yard for the concrete and 8.0 for the mortar. The petrographic analysis indicated that the concrete was similar to the core samples from the West FEB (floor), SST 2 (north wall), and AST 1B (floor) in terms of concrete mixture, aggregate, and composition. A minor degree of alkali-silica reaction (ASR) was noted, but it was not observed to be causing deleterious expansion. Also, carbonation to a depth of 0.25 inches was noted within the top of the concrete layer below the mortar.

3.4.2 Surface Penetrating Radar Scans

SPR scanning in SST 2 was conducted at four locations. Two of the locations were the same as the 5:30 wall and 5:00 floor core sampling locations, as described above. Scans were also conducted on the wall at the 12:00 and 9:00 positions approximately 3 feet above the floor.

Table 3-17 summarizes the depth and spacing of reinforcing steel as measured at the SPR scanning locations. The minimum depth of cover over the vertical bars in the wall at 5:30 was somewhat less than the 2 inches recommended as a guideline for this type of structure (see Section 2.6).

Table 3-17. SPR Scan Results for PC 1

Loc.	Bar Dir.	Reinforcing Bar Depth (in.)			Reinforcing Bar Spacing (in.)		
		Min.	Avg.	Max.	Min.	Avg.	Max.
Wall at 5:30	V	1.5	2.0	2.5	12.4	14.0	16.3
Wall at 5:30	H	2.3	2.8	3.2	6.8	9.5	12.6
Floor at 5:00	Radial	5.2	6.1	7.5	14.2	17.3	19.4
Floor at 5:00	Circumf.	5.5	6.9	7.4	13.4	15.4	17.3
Wall at 12:00	V	2.1	2.4	2.8	7.3	10.8	13.2
Wall at 12:00	H	3.0	3.4	3.9	6.9	10.1	13.7
Wall at 9:00	V	2.5	2.8	3.2	13.7	14.0	14.3
Wall at 9:00	H	2.8	3.3	4.2	8.6	9.7	11.5

3.4.3 Visual and Qualitative Evaluation

Photo 3-56 and Photo 3-57 show general views of Primary Clarifier 1.

Photo 3-56. General view inside PC 1.

Photo 3-57. General view of launders and wall inside PC 1.

The interior concrete surfaces of PC 1 were in fair condition, showing some evidence of deterioration, and were rated VANDA Level 2 for concrete condition. The condition of the PC 1 concrete was very uniform around the circumference of the clarifier. In general, the wall exhibited exposed medium-diameter aggregate up to about 4 feet above the floor. The wall also exhibited a pattern of fine vertical cracks spaced approximately every 1 to 2 feet. The floor showed a pattern of general fine cracks across most of its surface. In one location, there was minor apparent groundwater infiltration from the floor cracks. Except near the center column, the cracks in the floor and wall exhibited minimal separation. Along the edges of the center well, there was apparent delamination below the upper grout or mortar floor layer and a short segment of apparent exposed reinforcing steel. The lower wall also exhibited some rock pockets, primarily near the 10:30 clock position. Photo 3-58 through Photo 3-63 illustrate typical deterioration observed on the concrete interior surfaces of PC 1.

Photo 3-58. Typical exposed aggregate and cracking on lower wall.

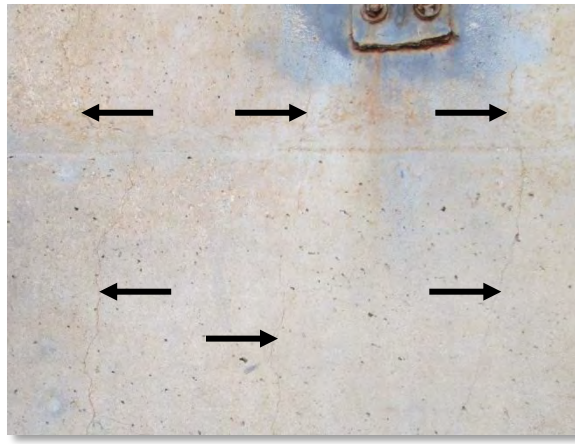


Photo 3-59. Typical vertical cracks in wall.

Photo 3-60. Typical cracks in PC 1 floor.

Photo 3-61. Minor apparent groundwater infiltration from cracks in floor.

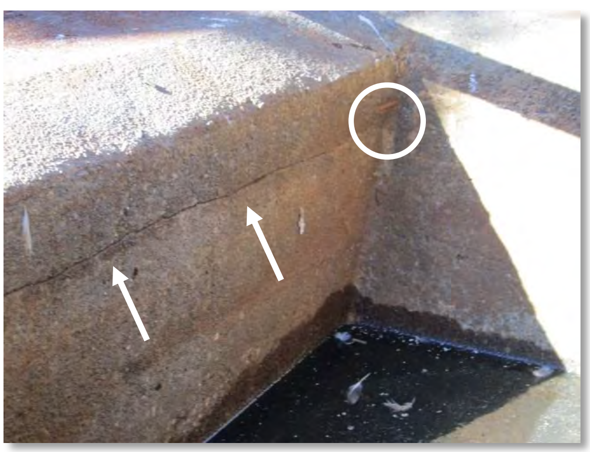


Photo 3-62. Grout or mortar joint at the center sludge pit. A short section of apparently exposed reinforcing steel was also visible (circle).

Photo 3-63. Rock pockets in PC 1 wall at approximate 10:30 position.

A few other notable observations from PC 1 are as follows:

- Near the stairway, there was a section of broken concrete at the top of the clarifier wall (Photo 3-64).
- The effluent towers also exhibited varying degrees of cracking within the top few inches of the concrete wall (Photo 3-65). The effluent towers are covered by a grating. On some of the other primary clarifiers (see Appendix C), the gratings are visibly displaced because of corrosion around the seating surface. According to operations staff, the gratings have fallen through on at least one prior occasion, and staff is restricted from climbing on top of the effluent towers.
- The wall is coated on its outer surfaces and the upper part of the interior surface. The coating on the interior surface is deteriorated near the apparent normal water line.
- Near the 7:00 position, there is a concrete pedestal for a pump located up against the exterior surface of the clarifier. The pedestal has shifted, leaving a gap between it and the clarifier wall.

Additional photos of these observations are provided in Appendix A.

Photo 3-64. Broken concrete at top of PC 1 wall near stairway.

Photo 3-65. Broken concrete at top of effluent tower (typical).

3.4.4 Additional Observations

Most of the steel components within PC 1 showed some degree of corrosion and were rated VANDA Level 3 or 4 for metal condition. The launders and their support brackets exhibited coating failure and corrosion, primarily at edges. The rake arms and center support structure were in similar condition. Some of the smaller members, such as the cross-braces across the top of the launders, showed severe section loss (more than 50% in some cases). The lower main members of the catwalk frame, which were constructed of angle sections, were perforated in several locations.

A weld within the upper horizontal railing at the end of the catwalk had apparently corroded through, leaving the railing in two pieces. Some of the diagonal braces on the catwalk frame were no longer attached at one end due to broken or corroded welds. The corrosion damage on the catwalk frame has been painted over, and its full extent was not visible. These observations are illustrated in Photo 3-66 through Photo 3-69 and in Appendix A.

Plant operations staff has restricted access to the catwalks and normally keeps them cordoned off due to the visible corrosion damage on the catwalk. Plant staff allowed limited access to the catwalks for the condition assessment activities.

Photo 3-66. Severe corrosion of cross-braces across top of PC 1 launders.

Photo 3-67. Typical coating failure and corrosion at edges on PC 1 launders.

Photo 3-68. Holes through lower members of catwalk truss. Corrosion damage has been painted over.

Photo 3-69. Corroded (separated) railing at end of PC 1 catwalk.

3.5 South Chlorine Contact Chamber

The South CCC was evaluated from topside during the first site visit in January 2015 and via confined space entry during the second site visit on February 26, 2015.

The South CCC consists of three parallel “passes” running east-west, divided by walls. The south pass is adjacent to the OWTP administration building. The north pass is adjacent to the North CCC, which itself consists of three passes. There is also a dividing wall (inner east wall) at the east end of the north and center passes that divides them from a north-south-oriented channel at the east end of the CCC. Per OWTP maintenance staff, the CCCs were constructed in 1975 and coated circa 2000. The coating was reportedly applied as an experiment in order to prolong the life of the structures; there was no significant concrete degradation that could be recalled to have occurred up to that time. No concrete repairs were reportedly done in conjunction with the coating application.

3.5.1 Concrete Sample Testing

Concrete samples in the South CCC were taken from three locations, one on the outer east wall, one on the north wall of the north pass, and one on the west wall of the center pass. The outer east wall samples were taken at a height of approximately 4 feet above the floor approximately 12 feet north of the south wall. The north pass samples were taken at a height of approximately 5 feet above the floor approximately 16 feet west of the inner east wall. The center pass samples were taken at a height of approximately 4 feet, approximately 4 feet south of the wall dividing the center and north passes.

Concrete samples were taken by drilling with a 5/8-inch-diameter bit to incremental depths and collecting the powder from within the hole. Coring was not conducted in the South CCC. The reinforcing bar size was not verified. Penetration depth measurements were not taken within the South CCC because the surfaces were coated.

The concrete samples were sent to SCL for testing of pH (carbonation depth) and chloride contamination depth. A summary of the laboratory analysis findings is provided in this section. The laboratory reports are provided in Appendix B.

Table 3-18 shows the sample pH measurements from the three concrete sampling locations (see Section 3.1.2) within the South CCC.

The pH of the concrete samples at three different locations was 11.0 or greater. Based on the pH testing results from the concrete samples, the concrete has lost a minor amount of alkalinity at the depths evaluated.

Table 3-18. Concrete pH Test Results for South CCC

Sample Location	Concrete Sample pH		
	Depth 0.0 in. to 0.5 in.	Depth 0.5 in. to 1.0 in.	Depth 1.0 in. to 1.5 in.
East wall	11.0	11.3	11.4
North wall of north pass	11.1	11.5	11.6
West wall of center pass	11.2	11.3	11.3

Table 3-19 summarizes the chloride testing results from the sampling locations within the South CCC. The table also includes the minimum reinforcing steel depth as measured by SPR scanning. The chloride content of the samples is well below 0.025%, so the steel is not expected to be subject to corrosion due to chloride at the sampling locations.

Table 3-19. Chloride Content Test Results for South CCC

Sample Location	Chloride Percentage by Weight of Concrete			Min. Depth to Reinforcing Steel (in.)	Chlorides above 0.025% at Reinforcement Depth?
	Depth 0.0 in. to 0.5 in.	Depth 0.5 in. to 1.0 in.	Depth 1.0 in. to 1.5 in.		
East wall	0.0052%	0.0033%	0.0028%	3.2	No
North wall of north pass	0.0025%	0.0065%	0.0015%	1.9	No
West wall of center pass	0.0032%	0.0051%	0.0032%	–	No

3.5.2 Surface Penetrating Radar Scans

SPR scanning was conducted at nine locations, in three groups of three scan areas, within the South CCC. The first group was in the short north-south-oriented channel at the east end of the CCC; this group included scans in the center of the inner and outer east walls and on the floor between these locations within a few feet of a joint. The wall scans were conducted approximately 12 feet north of the south wall at a height of approximately 4 feet. The second group was near the west end of the center pass; this group included three scan areas adjacent to one another on the north wall, south wall, and floor. The wall scans were taken at a height of approximately 4 feet, about 4 feet east of the end of the wall dividing the center and south passes. The third group was taken in the north pass approximately 16 feet west of the inner east wall; this group included three scan areas adjacent to one another on the north wall, south wall, and floor. The wall scans were taken at a height of approximately 5 feet.

Table 3-20 summarizes the depth and spacing of reinforcing steel as measured at the SPR scanning locations. There were two locations within the north pass, on the floor and the south wall, where the minimum depth of cover was 1.9 inches, slightly less than the 2 inches recommended as a guideline for this type of structure (see Section 2.6). The other locations scanned exhibited concrete cover depths greater than 2 inches.

Table 3-20. SPR Scan Results for South CCC

Location	Bar Dir.	Reinforcing Bar Depth (in.)			Reinforcing Bar Spacing (in.)		
		Min.	Avg.	Max.	Min.	Avg.	Max.
Outer east wall	V	3.6	4.3	4.8	11.2	12.5	13.7
Outer east wall	H	3.2	3.5	4.0	9.2	10.9	12.6
Inner east wall	V	2.1	2.9	3.6	10.2	12.2	15.6
Inner east wall	H	2.8	3.4	3.9	11.2	11.9	12.8
Floor between inner and outer east walls	N-S	4.9	6.8	7.5	10.4	11.8	13.1
Floor between inner and outer east walls*	E-W	6.9	8.7	10.7	7.2	11.7	18.2
North wall of center pass	V	2.7	3.1	3.4	11.1	12.1	13.0
North wall of center pass	H	3.6	3.9	4.2	10.7	12.2	13.4
South wall of center pass	V	2.8	3.0	3.2	10.4	12.2	13.8
South wall of center pass	H	3.5	3.8	4.1	11.9	12.7	13.9
Floor of center pass	N-S	4.2	4.7	5.6	9.0	11.7	13.4
Floor of center pass	E-W	4.7	5.7	6.5	16.1	18.4	21.0
North wall of north pass	V	2.7	3.1	3.6	11.3	12.1	13.7
North wall of north pass	H	3.3	4.0	4.6	11.0	11.8	12.7
South wall of north pass*	V	1.9	2.8	3.6	4.2	10.1	13.4
South wall of north pass	H	3.2	3.6	4.3	10.7	11.8	13.7
Floor of north pass	N-S	1.9	2.4	2.8	11.0	12.0	13.1
Floor of north pass	E-W	2.7	3.2	3.5	17.1	18.3	20.0

* At this location there appeared to be two different bar spacings within the scan area.

3.5.3 Coating Adhesion Tests

Given that the CCC was built in 1975 and coated circa 2000 and the geotextile that is visible, the coating may be Polibrid 705. It is a 100% solids polyurethane that was applied in three layers in the following steps: 1) 20 to 30 mils of the polyurethane, 2) polypropylene geotextile fabric to provide flexibility over cracks or blisters, 3) 60 to 80 mils of the polyurethane.

The adhesion strength of the existing lining at the three separate locations was determined using the DeFelsko Positest AT-M gage per ASTM D7234 guidelines. A 1-inch-diameter drill bit was used to pre-drill the lining before the dolly was glued to the coated wall. A fast-set Gorilla Super Glue was used to affix the dollies to the existing lining and allowed to cure for 1 to 2 hours. Two dollies were glued to each location; one as the primary test and one as a backup. The dollies were glued to surfaces that were not covered with algae in order to ensure that the dolly adhered properly. Table 3-21 summarizes the results of the tests.

Typical industry-accepted coating adhesion values for concrete are between 150 psi and 250 psi. Only one measurement was acceptable and the remaining measurements indicated poor adhesion between the lining and the concrete. It is possible that the existing coating system was applied over concrete that was not abrasive-blasted but rather cleaned with high-pressure water. The high-pressure water removes the surface contaminants, but it does not remove carbonated concrete nor does it create an adequate surface profile for the coating to adhere properly.

Table 3-21. Coating Adhesion Results for South CCC

Location	Elevation	Adhesion Results (psi)	Type of Failure
Outer East Wall	3 feet above floor	98	Concrete 100%
Outer East Wall	3 feet above floor	250	Glue failure
West Wall of Center Pass	8 feet above floor	141	Concrete 100%
West Wall of Center Pass	8 feet above floor	91	Concrete 100%
North Wall of North Pass	8 feet above floor	236	Concrete 100%
North Wall of North Pass	8 feet above floor	139	Concrete 100%

3.5.4 Visual and Qualitative Evaluation – North Pass

Photo 3-70 shows an overall view of the inlet sluice gate and wooden baffle in the north pass. A small amount of water was leaking into the CCC from the bottom of the gate. Photo 3-71 and Photo 3-72 show two large blisters along the lower walls of the north pass. The blisters may be a result of not installing a saw cut into the concrete and properly terminating the coating. Per OWTP maintenance staff, the large blisters have been evident for several years and have not increased in size. Photo 3-73 shows a surface that appeared normal but was found to be hollow during sounding of the surface. Photo 3-74 shows the underside of the pedestrian bridge that spans across the CCC. The coated concrete surfaces are in VANDA Level 1 condition.

Photo 3-70. The bolts and supports of the baffles were in VANDA Level 1 condition.

Photo 3-71. Approx. 24-inch-long by 12-inch-wide blister on north wall of north pass.

Photo 3-72. Approx. 48-inch-long by 12-inch-wide blister on south wall of north pass.

Photo 3-73. Area of hollow coating on south wall of north pass suggests the coating is not properly adhered.

Photo 3-74. No cracks or spalls were observed on the underside of the pedestrian bridge.

Photo 3-75. Crack observed on the deck level at the northeast corner of the north pass.

3.5.5 Visual and Qualitative Evaluation – Center Pass

Photo 3-76 shows the pedestrian bridge that spans across the CCC. The coated concrete surfaces are in VANDA Level 1 condition. Photo 3-77 shows minor coating delamination on the lower walls of the center pass. The delamination is likely due to overspray during the lining application on the floor. The vertical walls were likely coated and cured at the time, and the overspray was applied onto those surfaces. Photo 3-78 shows blisters on the floor that were observed throughout the center pass. Photo 3-79 shows the coated bolts and support brackets for the baffles that were in good condition.

Photo 3-76. No cracks or spalls were observed on the underside of the pedestrian bridge.

Photo 3-77. Detail of coating overspray on the floor and coating delamination.

Photo 3-78. Blisters on floor were observed along a 40-foot-long section of the floor.

Photo 3-79. The coating on the brackets for the wooden baffles is in good condition.

3.5.6 Visual and Qualitative Evaluation – South Pass

Photo 3-80 shows the coated support brackets for the baffle within the south pass. Photo 3-81 shows the coated concrete surfaces on the underside of the pedestrian bridge. The coated concrete surfaces are in VANDA Level 1 condition. Photo 3-82 shows a typical coating repair observed along the lower walls of the south pass. Photo 3-83 shows a large blister observed along the lower walls of the south pass.

Photo 3-80. The coating on the brackets for the wooden baffles is in good condition.

Photo 3-81. No cracks or spalls were observed on the underside of the pedestrian bridge.

Photo 3-82. Approx. 24-inch-long by 24-inch-wide coating repair section. This section is hollow, which suggests the coating is not properly adhered.

Photo 3-83. Approx. 54-inch-long by 12-inch-wide coating blister on north wall of south pass.

3.5.7 Visual and Qualitative Evaluation – East End Channel

Photo 3-84 shows a large blister at the southeast corner of the CCC. Coating adhesion tests and concrete samples were obtained above this blister. The blisters may be a result of not installing a saw cut into the concrete and properly terminating the coating. Photo 3-85 shows the concrete surfaces above the outlet sluice gate. The surfaces were covered in sediment and cobwebs, but there were no visible defects observed.

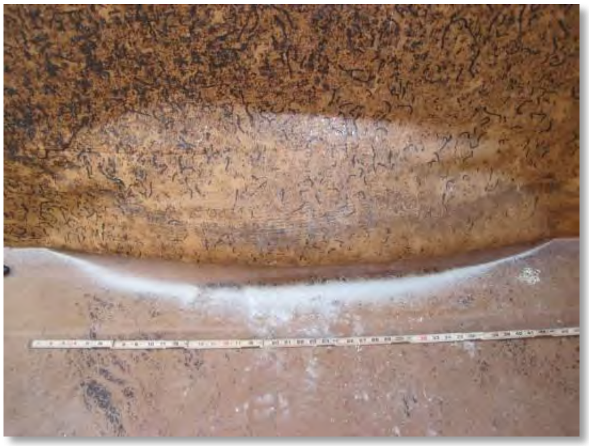


Photo 3-84. Approx. 48-inch-long by 18-inch-wide blister at east end of south pass on outside east wall of CCC.

Photo 3-85. Coated surfaces above the outlet sluice gate were in good condition.

3.5.8 Other Observations

Photo 3-86 and Photo 3-87 show the outlet sluice gate surfaces and water that was leaking in from the top of the gate. Photo 3-88 shows minor coating delamination on the top of the gate guide of the inlet sluice gate. Photo 3-89 shows water leaking into the CCC from the bottom of the gate.

Photo 3-86. Outlet sluice gate at northeast corner of CCC was leaking.

Photo 3-87. Close-up of leak on sluice gate at northeast corner of CCC.

Photo 3-88. Minor damage to the coating on the gate guide.

Photo 3-89. Minor leaking of the inlet sluice gate.

4.0 Conclusions

Based on the information gathered during the condition assessment, V&A presents the following conclusions.

4.1 West Flow Equalization Basin

- **Core samples** – Core samples were collected from the west wall and floor of the West FEB. Test results from the core samples are as follows:
  - Carbonation testing indicated that the reinforcing steel is embedded in an alkaline (protective) environment at the sample locations. The maximum carbonation depth was 0.45 inches at the sample locations. However, the minimum reinforcing steel depth was much less at the scan locations on the north and east walls, so the steel may be subject to corrosion there if the carbonation depth is similar.
  - Chloride testing indicated that the reinforcing steel may be subject to corrosion at the west wall sample location. Due to the lower reinforcing steel depth on the north and east walls, the steel may also be subject to corrosion there if the chloride contamination depth is similar.
  - Compressive strength of the west wall and floor core samples was 8,240 and 5,360 psi, respectively. These results exceed the current requirement of 4,000 psi in ACI 350 for water-retaining structures.
  - Petrographic analysis was conducted on a core sample from the West FEB floor. The water-cement ratio of the sample was estimated at 0.45, which is equal to the maximum water-cement ratio of 0.45 given in ACI 350 for water-retaining structures. A minor degree of alkali-silica reaction (ASR) was noted, but it was not observed to be causing deleterious expansion.
- **Surface penetrating radar** – Scans were conducted on the west, north, and east walls as well as the floor. The depth of concrete cover over the reinforcing steel in many locations was significantly less than the 2 inches recommended as a guideline for this type of structure. The minimum measured depth of cover was 0.4 inches, on the east wall near an area of visible spalling.
- **Concrete surfaces** – In general, the concrete interior surfaces of the West FEB were in good condition. The concrete surfaces, particularly the floor, showed generalized shrinkage cracking. Soundings in the West FEB generally indicated sound, hard concrete. There were several areas where minor or moderate defects or evidence of deterioration was observed.

As a result of the number and frequency of these observations, the West FEB is rated VANDA Level 2 for concrete condition. Specific observations include the following:

  - Construction joints on the west wall typically had a concrete mortar overlay that was spalling or loose in many places. Over a length of approximately 50 feet near the midpoint of the wall, there was a horizontal reinforcing bar running along the joint with very little concrete cover, and it was exposed in some locations.
  - The sealant at the expansion joints is generally cracked and split, although it is still somewhat pliable. In some places, sections of the sealant are missing or there are weeds growing out of the gaps. A few locations exhibited minor spalling of the concrete adjacent to the expansion joints.
  - The east and west walls exhibited minor exposed aggregate in some locations. Surface defects such as bug holes and apparent rock pockets were also observed.
  - There was minor vertical cracking in the south wall. The wall along the ramp was cracked in a few locations, possibly through its entire thickness.
  - The walls of the West FEB exhibited spalling in isolated locations. Most of these were small, individual spalls. There was a pattern of spalling over the vertical bars in the east wall. There was also one diagonal bar visible through a spalled area a few feet in length near the top of the west wall.
  - The columns holding up the ramp and platform at the north end of the basin exhibited minor areas of exposed aggregate. One of the columns had a small gouge on one of the corners. The tapered concrete collar at the base of some columns was broken and hollow-sounding.

- **Additional observations** – A few additional observations were noted in the West FEB:
  - There is a ductile iron pipe near the south wall that exhibits signs of coating failure and corrosion, particularly on the coupling hardware and supports.
  - The wall along the ramp leading into the FEB is only about 18 inches high, which poses a fall hazard for personnel walking near the edge.

4.2 Secondary Sedimentation Tank 2

- **Core samples** – Core samples were collected from the north wall and floor of SST 2. Test results from the core samples are as follows:
  - Carbonation testing indicated that the reinforcing steel is embedded in an alkaline (protective) environment at the sample locations. The maximum carbonation depth was 0.40 inches at the sample locations. The reinforcement depth was similar or greater at the scan locations on the east and south walls, so the reinforcing steel would also be within an alkaline environment there if the carbonation depth is similar.

  - Based on the chloride testing results, there is chloride contamination at the surface and decreasing with depth into the concrete. The chloride contamination is not above the given threshold of 0.025% at the reinforcing steel depth, but this threshold may vary based on other factors. Corrosion of the reinforcing steel may be a future concern if this contamination continues. There may also be locations within the structure where the reinforcing steel cover depth is less or the chloride contamination depth is greater.
  - Compressive strength of the north wall and floor core samples was 6,940 and 4,270 psi, respectively. These results exceed the current requirement of 4,000 psi in ACI 350 for water-retaining structures.
  - Petrographic analysis was conducted on a core sample from the north wall of SST 2. The water-cement ratio of the sample was estimated at 0.43, which is below the maximum water-cement ratio of 0.45 given in ACI 350 for water-retaining structures. A minor degree of alkali-silica reaction (ASR) was noted, but it was not observed to be causing deleterious expansion.

- **Surface penetrating radar** – Scans were conducted on the north, east, and south walls as well as the floor. The depth of concrete cover over the reinforcing steel in some locations was somewhat less than the 2 inches recommended as a guideline for this type of structure. The minimum measured depth of cover was 1.7 inches.
- **Concrete surfaces** – In general, the concrete interior surfaces of SST 2 were in good condition and are rated VANDA Level 1 for concrete condition. There were several areas where minor defects or evidence of deterioration was observed. These are presently minor issues, but they may accelerate future deterioration of the structure. Specific observations include the following:
  - Cracking was observed in many locations within SST 2, including cracks in the slab overhanging the west end of the basin, vertical cracks along the length of the north wall, hairline cracks in some other locations, and general cracking in some areas of the floor. The cracks in the slab at the west end had begun to separate slightly. There was possible groundwater infiltration from the floor cracking in one location.
  - The sealant at the expansion joints is in fair condition, with some signs of brittleness and shrinkage. The expansion joint near the west end of the basin exhibited gaps and possible groundwater infiltration.
  - There is a gap between the east wall and the fill concrete at the bottom of the wall. The fill concrete becomes thin near the toe, due to its circular concave surface, and it is irregular and possibly broken in this area.
- **Additional observations** – There was evidence of coating failure and minor surface corrosion on the metallic appurtenances within SST 2.

4.3 Activated Sludge Tank 1B

- **Core samples** – Core samples were collected from the west wall and floor of AST 1B. Test results from the core samples are as follows:
    - Carbonation testing indicated that the reinforcing steel is embedded in an alkaline (protective) environment at the sample locations. The maximum carbonation depth was 0.50 inches at the sample locations. The reinforcement depth was similar or greater at the scan locations on the north and east walls, so the reinforcing steel would also be within an alkaline environment there if the carbonation depth is similar.
    - Based on the chloride testing results, there is chloride contamination at the surface and decreasing with depth into the concrete. The chloride contamination is not above the given threshold of 0.025% at the reinforcing steel depth, but this threshold may vary based on other factors. Corrosion of the reinforcing steel may be a future concern if this contamination continues. There may also be locations within the structure where the reinforcing steel cover depth is less or the chloride contamination depth is greater.
    - Compressive strength of the west wall and floor core samples was 6,920 and 6,270 psi, respectively. These results exceed the current requirement of 4,000 psi in ACI 350 for water-retaining structures.
    - Petrographic analysis was conducted on a core sample from the AST 1B floor. The water-cement ratio of the sample was estimated at 0.45, which is equal to the maximum water-cement ratio of 0.45 given in ACI 350 for water-retaining structures. A minor degree of alkali-silica reaction (ASR) was noted, but it was not observed to be causing deleterious expansion.
- **Surface penetrating radar** – Scans were conducted on the west, north, and east walls as well as the floor. The minimum depth of cover at the floor scan location was slightly less than the 2 inches recommended as a guideline for this type of structure. The minimum measured depth of cover was 1.8 inches.
- **Concrete surfaces** – In general, the concrete interior surfaces of AST 1B were in good condition and are rated VANDA Level 1 for concrete condition. There were several areas where minor defects or evidence of deterioration was observed. These are presently minor issues, but they may accelerate future deterioration of the structure. Some of these locations were rated VANDA Level 2. Specific observations include the following:
    - Cracking was observed in many locations within AST 1B, including minor cracks in the floor, west wall, and walkways. There was also cracking in the top of the east wall. The concrete appeared to be loose in some of these areas, and one location may have been repaired previously. The ends of the reinforcing bars were also visible at the top of the east wall. The top of the east wall is rated VANDA Level 2 for concrete condition.
    - There were several locations where there was corrosion staining evident at the interior surface of the concrete walls. Most of these appeared to be due to wires or other metal

objects embedded in the concrete. One location appeared to have an exposed reinforcing bar.

- The sealant at the expansion joints is generally cracked and split, although it is still somewhat pliable. In some places, there are gaps between the sealant and the concrete. One location exhibited active groundwater infiltration during the evaluation. Spalling of the concrete was noted adjacent to the expansion joints in one location, which was rated VANDA Level 2 for concrete condition as a result.

- **Additional observations** – There were several steel manifold pipes crossing AST 1B. These exhibited minor coating failure and surface corrosion. There was also minor coating failure and surface corrosion on the sluice gates and their frames.

4.4 Primary Clarifier 1

- **Core samples** – Core samples were collected from the wall and floor of PC 1 near the catwalk. Test results from the core samples are as follows:
    - Carbonation testing indicated that the reinforcing steel is embedded in an alkaline (protective) environment at the sample locations. The maximum carbonation depth was 0.15 inches at the sample locations. The reinforcement depth was similar or greater at the other two scan locations on the wall, so the reinforcing steel would also be within an alkaline environment there if the carbonation depth is similar.
    - Based on the chloride testing results, the reinforcing steel is not expected to be subject to corrosion due to chloride at the wall sampling location. The results are unclear for the floor sample location.
    - Compressive strength of the wall and floor core samples was 4,910 and 5,760 psi, respectively. These results exceed the current requirement of 4,000 psi in ACI 350 for water-retaining structures.
    - Petrographic analysis was conducted on a core sample from the PC 1 floor. This sample included approximately 3 inches of mortar topping over the concrete. The water-cement ratio of the concrete (lower) layer was estimated at 0.48, which is above the maximum water-cement ratio of 0.45 given in ACI 350 for water-retaining structures. A minor degree of alkali-silica reaction (ASR) was noted, but it was not observed to be causing deleterious expansion.
- **Surface penetrating radar** – Scans were conducted at three locations on the wall and one location on the floor. The minimum depth of cover over the vertical bars at one wall scanning location was somewhat less than the 2 inches recommended as a guideline for this type of structure. The minimum measured depth of cover was 1.5 inches.
- **Concrete surfaces** – The interior concrete surfaces of PC 1 were in fair condition, showing some evidence of deterioration, and were rated VANDA Level 2 for concrete condition. The condition of the PC 1 concrete was very uniform around the circumference of the clarifier. In

general, the wall exhibited exposed medium-diameter aggregate up to about 4 feet above the floor. The wall also exhibited a pattern of fine vertical cracks spaced approximately every 1 to 2 feet. The floor showed a pattern of general fine cracks across most of its surface. In one location, there was minor apparent groundwater infiltration from the floor cracks. Except near the center column, the cracks in the floor and wall exhibited minimal separation. A few other notable observations from PC 1 are as follows:

- Near the stairway, there was a section of broken concrete at the top of the clarifier wall.
- The effluent towers also exhibited varying degrees of cracking within the top few inches of the concrete wall. The effluent towers are covered by a grating. On some of the other primary clarifiers, the gratings are visibly displaced because of corrosion around the seating surface. According to operations staff, the gratings have fallen through on at least one prior occasion, and staff is restricted from climbing on top of the effluent towers.
- The wall is coated on its outer surfaces and the upper part of the interior surface. The coating on the interior surface is deteriorated near the apparent normal water line.

- **Additional observations** – Most of the steel components within PC 1 showed some degree of corrosion and were rated VANDA Level 3 or 4 for metal condition. The launders, their support brackets, the rake arms, and the center support structure exhibited coating failure and corrosion, primarily at edges. Some of the smaller members, such as the cross-braces across the top of the launders, showed severe section loss (more than 50% in some cases). The catwalk frame exhibited perforations and broken welds. Due to the visible corrosion damage on the catwalk, plant operations staff has restricted access to the catwalks and normally keeps them cordoned off.

4.5 South Chlorine Contact Chamber

- **General** – A confined space entry was conducted to assess the condition of the existing coating, conduct coating adhesion tests, and obtain concrete samples for testing. The coated concrete surfaces of the South CCC were evaluated and documented from within the channels. There is cracking and spalling at the top of the east and west walls.
- **Coating condition** – The coating is in poor condition, as it exhibits blistering and delaminations on approximately 40% of the immersed surfaces. Per OWTP maintenance staff, the large blisters have been evident for several years and have not increased in size. Approximately 22 large blisters and several areas of small blisters were visible. The coating does not appear to have punctured at the blister locations. A few edge delaminations, which were due to overspray, were visible on the lower surfaces of the walls.
- **Concrete degradation** – At the northeast corner of the South CCC, there was a crack extending through the top of the concrete wall. The crack has separated slightly. The top of the west wall was spalling around the railing bases. Otherwise, concrete degradation was not observed in the South CCC during the evaluation.

- **Additional observations** – The support brackets and bolts of the baffles were in good condition. The metal surfaces of the sluice gates were in good condition, but there was water leaking in through the gates.

4.6 Other Structures

Photographic documentation from topside was also collected for some of the other structures at the OWTP. These consisted of the ASTs, SSTs, and FEB that were out of service at the time, as well as the other three PCs. Appendix C documents these structures in terms of notable observations and significant differences with respect to the structures evaluated via entry.

5.0 RECOMMENDATIONS

Based on the conclusions of the field assessment, V&A presents the following recommendations for consideration.

5.1 West Flow Equalization Basin

- Apply an organosilane corrosion inhibitor to the concrete to reduce the migration of chlorides into the concrete. Products similar to BASF MasterProtect 8000 CI are recommended.
- Remove and replace the cracked overlay on the construction joints. This can be done by chipping out the concrete to a depth of 1 inch and applying a repair mortar such as Sika Sikatop 123.
- Replace the sealant in the expansion joints. Consider repairing the adjacent areas of spalled concrete on the floor. Also, replace the sealant in the joints surrounding the sprinklers at the north and south ends of the basin. The joints may be sealed with products such as Sikaflex 2C SL on horizontal surfaces and Sikaflex 2C NS on vertical walls.
- Monitor the construction joints and areas of spalling for evidence of further degradation and corrosion of the exposed reinforcing steel.
- Seal the cracks in the wall running along the edge of the ramp. Repair the spalled concrete on the wall adjacent to the expansion joint.
- Monitor the cracks in other locations for widening or corrosion staining.
- Consider adding a railing to the top of the wall along the ramp to mitigate the fall hazard.
- Repair the areas of damaged concrete on the columns at the north end of the basin. The surfaces should be abrasive-blasted to meet an ICRI 310.2 Concrete Surface Profile 3 to 4. Products such as Sika Sikatop 123 or BASF MasterEmaco S488 CI are recommended.
- Consider evaluating the piping, sprinklers, etc., for condition. If it is not significantly corroded upon further investigation, recoat the ductile iron pipe near the south wall.
- Reassess the concrete interior surfaces of the West FEB in approximately 10 years.

5.2 Secondary Sedimentation Tank 2

- Seal the cracks in the slab over the west end of the basin. Monitor these cracks for further widening or corrosion staining.
- Monitor the cracks in other locations for separation and additional groundwater infiltration.
- Replace the sealant in the expansion joints with a product such as Sikaflex 2C SL.
- Consider recoating the metallic appurtenances within SST 2. Products such as two coats of Carboline Carboguard 890, PPG Amerlock 2, or International Paint Bar-Rust 233, at 4 to 6 mils per coat, should be applied on steel that has been abrasive-blasted per SSPC SP10 with a 2 to 3 mil surface profile.

5.3 Activated Sludge Tank 1B

- Repair the cracking and exposed ends of the reinforcing bars at the top of the east wall.
- Monitor the cracks in other locations for further widening or corrosion staining.
- Monitor the areas of corrosion staining for evidence of further degradation and corrosion of exposed reinforcing steel.
- Replace the sealant in the expansion joints. Repair the spalled concrete adjacent to one of the expansion joints. The spalled surfaces should be abrasive-blasted to meet an ICRI 310.2 Concrete Surface Profile 3 to 4. Products such as Sika Sikatop 123 or BASF MasterEmaco S488 CI are recommended. The joints may be sealed with products such as Sikaflex 2C SL on horizontal surfaces and Sikaflex 2C NS on vertical walls.
- Consider recoating the metallic appurtenances within AST 1B. Products such as two coats of Carboline Carboguard 890, PPG Amerlock 2, or International Paint Bar-Rust 233, at 4 to 6 mils per coat, should be applied on steel that has been abrasive-blasted per SSPC SP10 with a 2 to 3 mil surface profile.

5.4 Primary Clarifier 1

- Coat the interior surfaces of the clarifier as follows. Surfaces above the elevation of the trough weir, and 1 foot below, should be abrasive-blasted to meet an ICRI 310.2 Concrete Surface Profile 4 to 5. A 100% epoxy or polyurethane coating with a dry film thickness of 125 mils is recommended to be applied on the concrete.

  Extending the coating down the wall to the floor is optional, but not required, as the surfaces will always be immersed and the surfaces were in VANDA Level 2 condition. If the concrete will be continuously submerged, it is anticipated that this will be acceptable since there will be limited oxygen available to facilitate corrosion. If the clarifier will be left out of service for long periods of time and subject to possible wind-borne chloride contamination, coating the lower wall surfaces may be justified.

- Seal the cracks and delaminations in the floor near the center column. Coat the small segment of exposed reinforcing steel in the center well, ensuring that the coating terminates adequately on the surrounding concrete.
- Repair the broken concrete at the top of the wall and effluent towers. In planning the repairs, consider whether the repairs conducted previously on the other clarifiers have provided adequate long-term performance. Also consider whether there are ways to make the grating support less likely to fail in the event that future deterioration does occur.
- Replace the launders with fiberglass launders and replace the bridge support structural members. Replace the bridge support with coated steel. Products such as two coats of Carboline Carboguard 890, PPG Amerlock 2, or International Paint Bar-Rust 233, at 4 to 6 mils, per coat should be applied on steel that has been abrasive-blasted per SSPC SP10 with a 2 to 3 mil surface profile. A finish coat of Carboline Carbothane 133VOC, PPG Amerlock 2, or International Paint Devthane 379H at 2 to 3 mils dry film thickness is recommended on non-immersed steel exposed to ultraviolet light.
- Reassess the concrete interior surfaces of PC 1 in approximately 10 years.

5.5 South Chlorine Contact Chamber

- Plan for the removal and replacement of the existing lining in the South CCC in the next 10 years. The lining is still protecting the concrete, but it may begin to peel off the walls in the future. The concrete should be abrasive-blasted to meet an ICRI 310.2 Concrete Surface Profile 4 to 5. A 100% polyurethane coating with a dry film thickness of 125 mils is recommended to be applied on the concrete. Products such as International Paint Polibrid 705 or Global EcoTech Enduraflex EF1988 are compatible products with the existing system.
- Seal the crack at the northeast corner and monitor it for further widening.
- Repair the spalling damage around the railing bases at the west wall.

Appendix A. Additional Photographic Documentation

AST 1B

General

Photo A-1. Looking south from midpoint of AST 1B.

Photo A-2. Looking north from midpoint of AST 1B.

Photo A-3. North wall of AST 1B.

Photo A-4. South wall of AST 1B.

Photo A-5. Underside of platform at north end of AST 1B.

Photo A-6. Center trough at south end of AST 1B (typical).

Condition Assessment

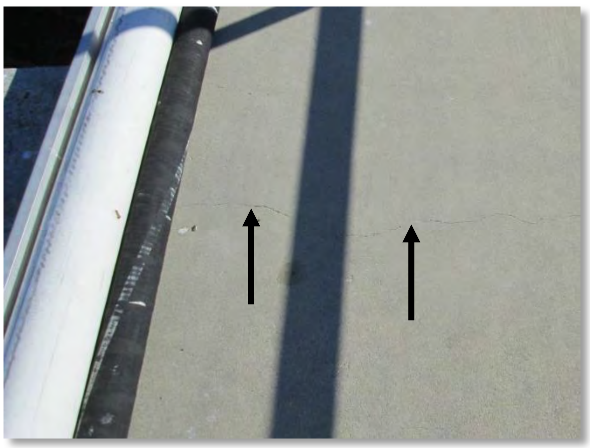


Photo A-7. Crack across walkway over AST 1B.

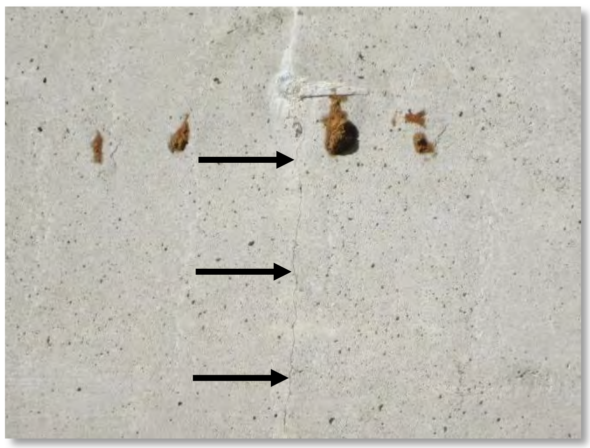


Photo A-8. Hairline cracking on west wall.

Photo A-9. Loss of mortar over construction joint on east wall about 350 feet south of north wall.

Photo A-10. Multiple small sources of corrosion staining on west wall.

Photo A-11. Multiple small sources of corrosion staining on north wall.

Photo A-12. Typical sealant in expansion joint with shrinkage and gaps.

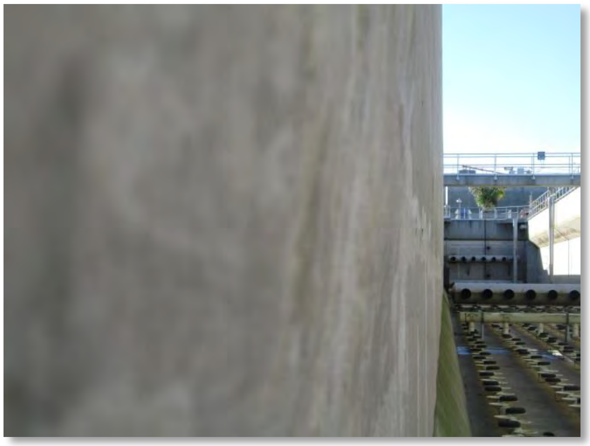


Photo A-13. Uneven construction joint (approx. 1-inch offset) on east wall about 150 feet south of north wall.

Photo A-14. Rock pocket above manifold pipe penetration about 305 feet south of north wall.

Additional Observations

Photo A-15. Minor coating failure and corrosion on sluice gates and frames.

Photo A-16. Steel manifold pipe with minor coating failure and corrosion.

Photo A-17. Steel manifold pipe with minor coating failure and corrosion.

Photo A-18. Steel manifold pipe with minor coating failure and corrosion.

PC 1

General

Photo A-19. General view of PC 1.

Photo A-20. General view of launders and wall inside PC 1.

Photo A-21. PC 1 rake arms.

Photo A-22. PC 1 center column.

Condition Assessment

Photo A-23. Typical exposed aggregate on lower wall.

Photo A-24. Typical cracks in PC 1 floor.

Photo A-25. Cracks near center column have separated about 1/8 of an inch.

Photo A-26. Rock pockets in PC 1 wall at approximate 10:30 position.

Photo A-27. Deteriorated coating on upper interior surfaces of wall.

Photo A-28. Gap between pump base and clarifier wall.

Additional Observations

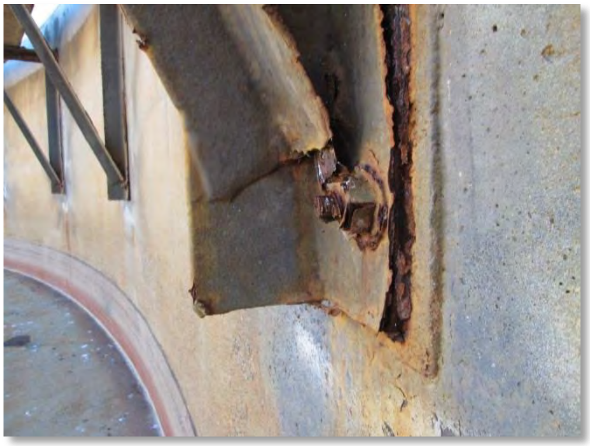


Photo A-29. Typical coating failure and corrosion on PC 1 launder brackets.

Photo A-30. End of rake arm within PC 1.

Photo A-31. Typical coating failure and exfoliating corrosion products on PC 1 rake arms.

Photo A-32. Loose bracing on PC 1 catwalk truss due to broken or corroded welds.

SST 2

General

Photo A-33. Interior of east end of SST 2.

Photo A-34. Underside of platform at west end of SST 2.

Photo A-35. Southwest corner of SST 2, above sump.

Photo A-36. Sump at southwest corner of SST 2.

Condition Assessment

Photo A-37. Cracking of platform above west end of SST 2.

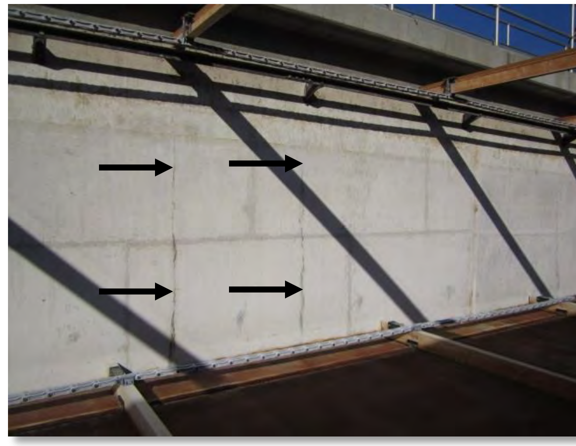


Photo A-38. Typical vertical cracks spaced every few feet along length of north wall.

Photo A-39. Evidence of possible seepage through construction joint near midpoint of north wall (south wall similar).

Photo A-40. Detail of possible seepage through construction joint near midpoint of north wall.

Photo A-41. Minor cracking on underside of diagonal platform over southeast corner of SST 2.

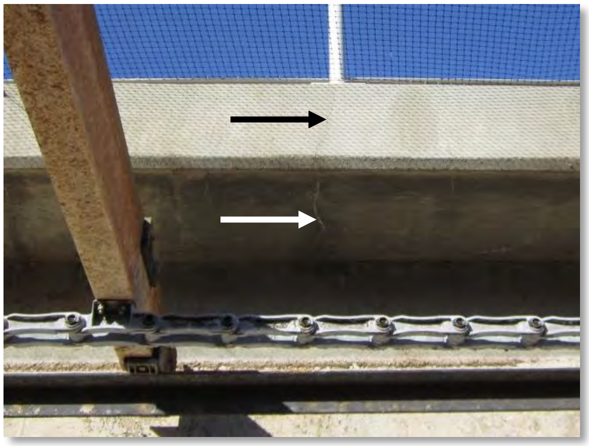


Photo A-42. Minor cracking of walkway above north wall of SST 2.

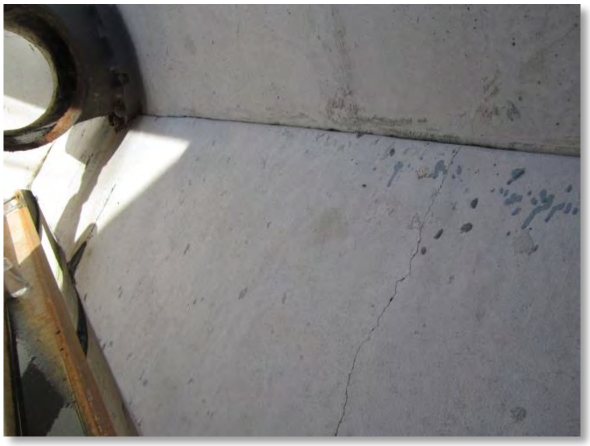


Photo A-43. Minor cracking in tapered fill concrete at east wall of SST 2.

Additional Observations

Photo A-44. Coating failure and minor corrosion on brackets for skimmer system.

Photo A-45. Apparent corrosion of floor tracks for skimmer system.

Photo A-46. Inlet tee at east wall. Arrow denotes minor coating failure and surface corrosion.

Photo A-47. Damage to cement mortar lining inside inlet tee at east wall.

West FEB

General

Photo A-48. South wall of West FEB.

Photo A-49. Southeast corner of West FEB.

Photo A-50. Northwest corner of West FEB.

Photo A-51. Northwest corner of West FEB.

Condition Assessment

Photo A-52. Construction joints on west wall with deteriorating mortar overlay (typical).

Photo A-53. Construction joints on west wall with deteriorating mortar overlay (typical).

Photo A-54. Typical condition of expansion joint sealant on walls.

Photo A-55. Typical condition of expansion joint sealant on floor.

Photo A-56. Typical view of lower east wall.

Photo A-57. Typical view of lower east wall.

Photo A-58. Southwest corner of West FEB with isolated rock pockets.

Photo A-59. Detail of southwest corner of West FEB.

Photo A-60. Typical minor spalling on west wall.

Photo A-61. Typical minor corrosion staining on west wall.

Photo A-62. Minor cracking and efflorescence on bottom of platform at northwest corner of West FEB.

Photo A-63. Wood embedded in wall at northeast corner.

Additional Observations

Photo A-64. Corroding pipe support near south wall.

Photo A-65. Corroded hardware on Victaulic couplings for pipe at south wall.

Photo A-66. Underside of horizontal pipe near south wall.

Photo A-67. Missing sprinkler head in West FEB.

South CCC

General

Photo A-68. General coating condition in south pass.

Photo A-69. General view of west wall from center pass.

Photo A-70. West end of north pass.

Photo A-71. General coating condition on upper walls.

Photo A-72. Northeast corner and sluice gate.

Photo A-73. Coating condition at east end of CCC.

Photo A-74. Coating condition at top of north wall of north pass (North CCC at left).

Condition Assessment

Photo A-75. Typical coating patch.

Photo A-76. Typical coating patch.

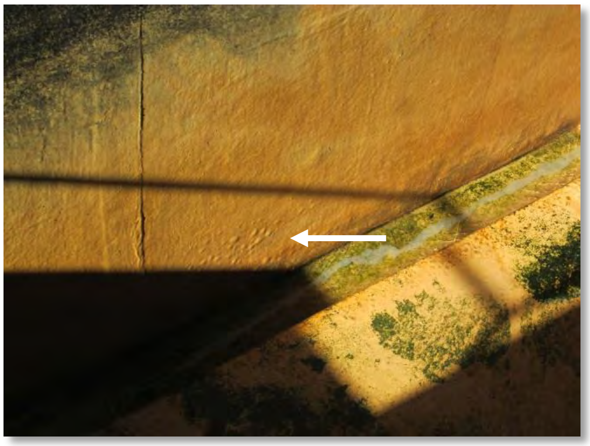


Photo A-77. Typical blisters on lower wall.

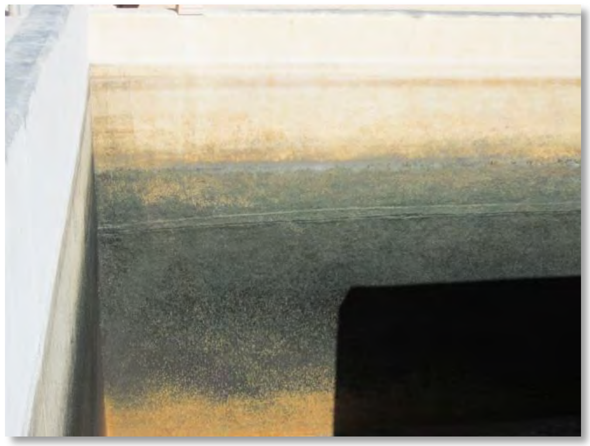


Photo A-78. Typical coating texture.

Photo A-79. Coating termination at top of south wall near walkway.

Photo A-80. Coating delamination at northeast corner.

Appendix B. Concrete Sample Testing Reports

February 6, 2015 SCL Project No. 15006

Mr. Michael Johannessen
Villalobos and Associates
155 Grand Ave, Suite 700
Oakland, CA 94612

Email: mjohannessen@vaengineering.com

RE: V&A Job #14-0195 - Oxnard WWTP
Concrete Evaluation
Oxnard, California

Dear Mr. Johannessen:

Scientific Construction Laboratories, Inc. (SCL) has completed materials testing of the cores from the above referenced project. The purpose of the testing was to determine material properties and to use this information to assist future remedial work, etc. This report includes test results, and a brief summary of results.

LABORATORY TESTING

VISUAL EXAMINATION OF CONCRETE CORES

Each of the cores were visually inspected and photographed. Photos of cores in the as-received condition are shown in the attached visual inspection data sheets. The maximum size aggregate was found to be approximately three quarters of an inch. The paste was found to be hard and intact.

CARBONATION DEPTH MEASUREMENTS

Depth of carbonation was determined on each core sample by an application of *Deep Purple* (manufactured by Germann Instruments) on freshly-cut cross sections of concrete core samples. These results indicate that the depth of carbonation on the concrete cores to range from less than 0.05 inches to 0.5 inches. Results are shown in table #1 and photo #1.

CHLORIDE CONTENT TESTING

Chloride content tests were performed on concrete powder samples in accordance ASTM C1218 –*Standard Test Method for Water-Soluble Chloride in Mortar and Concrete*. Sections of each sample were pulverized to pass a #20 sieve. This method involves digesting a small amount of the sample followed by titrating the resulting sample with a silver nitrate solution. Three samples were tested from each of the eight cores for a total of twenty-four tests. The depths on each core that were tested were from 0.5" to 1.0", 1.0" to 1.5", and 1.5" to 2.0". Test results are reported in Table 2. The average chloride content of the eight samples tested at the depth of 0.5" to 1.0" was found to be 0.0327% by weight of concrete which exceeds the threshold to initiate corrosion. The chloride content at which corrosion may occur (~0.025 - 0.030% by weight of concrete) is commonly referred to as the chloride threshold. This is the point at which a protective passive oxidation layer around the reinforcing steel is broken down allowing corrosion to occur. The average chloride content dropped on the eight samples tested from 1.5" to 2.0" to 0.0094% by weight of concrete.

CONCRETE COMPRESSIVE STRENGTH TESTING

Eight concrete cores were tested for compressive strength. The average compressive strength was 6,080 psi. Compressive strength results are shown in Table 3.

PETROGRAPHIC EXAMINATION

Examinations were performed on four concrete samples submitted to Applied Materials and Engineering (AME). The full report is attached in the appendices. A summary of the report is as follows:

1. The concrete was not air entrained.
2. Trace amounts of reactive aggregate particles were found in some of the concretes, but no deleterious cracking or alkali-silica gel formation was observed.
3. The estimated water to cement ratio is 0.44.
4. Cement content is estimated to be 7.2 sacks/yd.
5. Core P from the primary clarifier floor had a mortar topping from the surface to a depth of approximately 3.0 inches.

SUMMARY

A brief summary of the laboratory testing is as follows:

1. The chloride content testing showed that each of the cores demonstrated exposure to either saltwater or brackish waters during the lifetime of the structure. Chloride content profiling demonstrated contamination was typically to a depth of one inch and in some cases (Primary Clarifier Floor) up to two inches.
2. The depth of carbonation was measured at a maximum of 0.50 inches.
3. No information has been provided regarding design compressive strengths but the average strength exceeded 6000 psi.

4. Petrographic examination showed that the concrete was a seven sack mix with an estimated water to cementitious ratio of 0.44. Alkali-Silica reactivity was minor.

If you have any questions, please call.

Very truly yours,

SCIENTIFIC CONSTRUCTION LABORATORIES, INC.

Thomas A. Voss
Civil Engineer

TABLE 1. CONCRETE DEPTH OF CARBONATION TEST RESULTS

Core No.	Location	Maximum Depth of Carbonation (inches)
A	Activated Sludge Basin 1B (Aeration Basin/AST) – West Wall	0.30
D	Activated Sludge Basin 1B (Aeration Basin/AST) – Floor	0.50
F	Secondary Sedimentation Basin 2 (SST) – North Wall	0.40
G	Secondary Sedimentation Basin 2 (SST) – Floor	<0.05
J	West Flow Equalization Basin (FEB) – West Wall	0.45
L	West Flow Equalization Basin (FEB) - Floor	0.40
N	Primary Clarifier 1 - Wall	0.15
P	Primary Clarifier 1 - Floor	<0.05

TABLE 2. CHLORIDE TESTING

Core No.	Location	% Chloride by Weight of Concrete (at three depths)		
		0.5″ to 1.0″	1.0″ to 1.5″	1.5″ to 2.0″
A	Activated Sludge Basin 1B (Aeration Basin/AST) – West Wall	0.0355	0.0228	0.0135
D	Activated Sludge Basin 1B (Aeration Basin/AST) – Floor	0.0306	0.0214	0.0064
F	Secondary Sedimentation Basin 2 (SST) – North Wall	0.0350	0.0069	0.00009
G	Secondary Sedimentation Basin 2 (SST) – Floor	0.0312	0.0217	0.0141
J	West Flow Equalization Basin (FEB) – West Wall	0.0657	0.0253	0.0053
L	West Flow Equalization Basin (FEB) - Floor	0.0284	0.0109	0.0031
N	Primary Clarifier 1 - Wall	0.0068	0.0067	0.0058
P	Primary Clarifier 1 - Floor	0.0280	0.0266	0.0263

TABLE 3. CONCRETE COMPRESSIVE STRENGTH TEST RESULTS

Core No.	Location	Capped Height (in.)	Diameter (in.)	Maximum Load (lbf)	Compressive Strength* (psi)
B	Activated Sludge Basin 1B (Aeration Basin/AST) – West Wall	5.0	2.74	40,800	6,920
C	Activated Sludge Basin 1B (Aeration Basin/AST) – Floor	5.6	2.74	37,000	6,270
E	Secondary Sedimentation Basin 2 (SST) – North Wall	5.4	2.74	40,900	6,940
H	Secondary Sedimentation Basin 2 (SST) – Floor	5.5	2.74	25,200	4,270
I	West Flow Equalization Basin (FEB) – West Wall	5.6	2.74	48,600	8,240
K	West Flow Equalization Basin (FEB) - Floor	5.4	2.74	31,600	5,360
M	Primary Clarifier 1 - Wall	3.7	2.74	30,500	4,910
O	Primary Clarifier 1 - Floor	3.4	2.74	36,500	5,760

*Compressive strengths corrected for L/D ratios of less than 1.75 as per ASTM C42

Photo #1 –Depth of carbonation testing on each of the eight cores.

Appendix

Visual Inspection of Concrete Cores

AME Petrographic Report

Scientific Construction Laboratories, Inc.

Visual Examination of Cores

Core ID: **Core A -Activated Sludge Basin 1B (Aeration Basin/AST) – West Wall**

General Properties

Length of Core, inches: 5.3 inches

Diameter, inches: 2.74 inches

Reinforcing Steel: None found

Observations and Comments

No scaling on the exterior surface of the core was observed. The paste was hard and intact throughout the core section. There was a slight discoloration (tannish) of the paste from the surface to a depth of 1/8 inch. The maximum size aggregate is approximately 0.75 inches. The aggregate was well graded.

Scientific Construction Laboratories, Inc.

Visual Examination of Cores

Core ID: **Core D - Activated Sludge Basin 1B (Aeration Basin/AST) – Floor**

General Properties

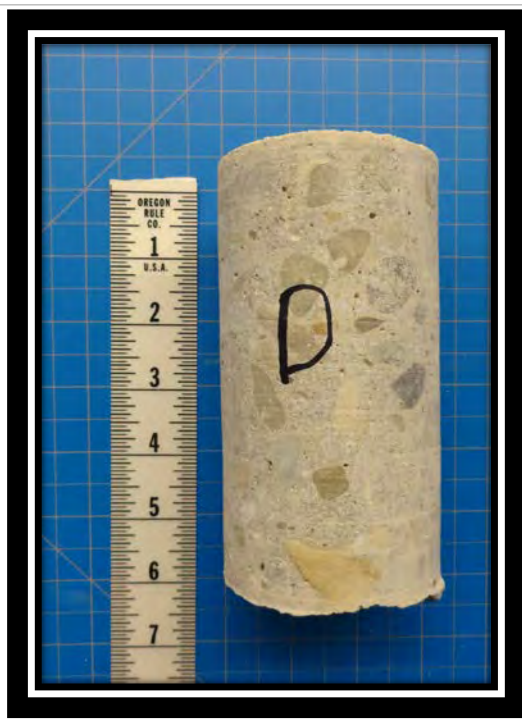
Length of Core, inches: 5.5 inches

Diameter, inches: 2.74 inches

Reinforcing Steel: None found

Observations and Comments

No scaling on the exterior surface of the core was observed. The paste was hard and intact throughout the core section. There was a slight discoloration (tannish) of the paste from the surface to a depth of 1/8 inch. The maximum size aggregate is approximately 0.75 inches. The aggregate was well graded.



Visual Examination of Cores

Core ID: **Core F - Secondary Sedimentation Basin 2 (SST) – North Wall**

General Properties

Length of Core, inches: 4.3 inches

Diameter, inches: 2.74 inches

Reinforcing Steel: None found

Observations and Comments

No scaling on the exterior surface of the core was observed. The paste was hard and intact throughout the core section. There was a slight discoloration (tannish) of the paste from the surface to a depth of 1/8 inch. The maximum size aggregate is approximately 0.75 inches. The aggregate was well graded.

Visual Examination of Cores

Core ID: **Core G -Secondary Sedimentation Basin 2 (SST) – Floor**

General Properties

Length of Core, inches:	3.6 inches
Diameter, inches:	2.74 inches
Reinforcing Steel:	None found

Observations and Comments

No scaling on the exterior surface of the core was observed. The paste was hard and intact throughout the core section. The maximum size aggregate is approximately 0.75 inches. The aggregate was well graded.

Scientific Construction Laboratories, Inc.

Visual Examination of Cores

Core ID: **Core J -West Flow Equalization Basin (FEB) – West Wall**

General Properties

Length of Core, inches: 2.1 inches

Diameter, inches: 2.74 inches

Reinforcing Steel: None found

Observations and Comments

No scaling on the exterior surface of the core was observed. The paste was hard and intact throughout the core section. The maximum size aggregate is approximately 0.75 inches. The aggregate was well graded.

Visual Examination of Cores

Core ID: **Core L -West Flow Equalization Basin (FEB) - Floor**

General Properties

Length of Core, inches: 2.9 inches

Diameter, inches: 2.74 inches

Reinforcing Steel: None found

Observations and Comments

No scaling on the exterior surface of the core was observed. The paste was hard and intact throughout the core section. The maximum size aggregate is approximately 0.75 inches. The aggregate was well graded.

Scientific Construction Laboratories, Inc.

Visual Examination of Cores

Core ID: **Core N -Primary Clarifier 1 - Wall**

General Properties

Length of Core, inches: 4.6 inches

Diameter, inches: 2.74 inches

Reinforcing Steel: None found

Observations and Comments

No scaling on the exterior surface of the core was observed. The paste was hard and intact throughout the core section. The maximum size aggregate is approximately 0.75 inches. The aggregate was well graded.

Visual Examination of Cores

Core ID: **Core P -Primary Clarifier 1 - Floor**

General Properties

Length of Core, inches: 5.0 inches

Diameter, inches: 2.74 inches

Reinforcing Steel: None found

Observations and Comments

No scaling on the exterior surface of the core was observed. The paste was hard and intact throughout the core section. The top three inches of the core did not contain coarse aggregate. This section appears to be either a topping material or a partial depth repair. The maximum size aggregate in the rest of the core is approximately 0.75 inches. The aggregate was well graded.

APPLIED MATERIALS & ENGINEERING, INC.
980 41st Street
Oakland, CA 94608
Tel: (510) 420-8190
FAX: (510) 420-8186
e-mail: info@appmateng.com

February 6, 2015

Project Number: 115054C

Mr. Tom Voss
SCIENTIFIC CONSTRUCTION LABORATORIES, INC.
3397 Mt. Diablo Blvd., Suite E
Lafayette, CA 94549

Fax Transmittal: (925) 284-3360

Subject: Petrographic Examinations of Concrete Samples
Oxnard WWTP

Dear Mr. Voss:

As requested, Applied Materials & Engineering, Inc. (AME) has examined four (4) concrete core samples reportedly removed from the above-captioned project. The objectives of the examinations were to determine the physical and mineralogical properties of the concrete, and if any deleterious reactions were present.

SAMPLE IDENTIFICATION

Four (4) longitudinally sliced half-core samples were received in good condition on January 20, 2015. The core sample descriptions are given in Table I and shown, as received, in Photo 1.

TEST METHOD & RESULTS

The concrete was examined following procedures described in ASTM C 856, "*Standard Practice for Petrographic Examination of Hardened Concrete*."

The following information was obtained:

Cores D, F and L

a) Cores D, F and L represented the same concrete mixture, contained the same aggregates, and had nearly identical compositions. The concrete was composed of portland cement/fly ash paste and normal-weight siliceous aggregate. The concrete was well proportioned and properly consolidated.

b) The aggregate consisted of ¾" maximum size subround to subangular coarse aggregate with a lithology dominated by granitic rock types (granite, granodiorite, diorite and some gabbro), arkosic to arenitic sandstone, mafic volcanic rocks, vein quartz and lesser amounts of limestone and opaline shale. The opaline shale was reactive. The fine aggregate was composed of rock fragments and minerals typical of the coarse aggregate, including reactive opal and opaline shale.

c) On average, the concrete was composed of approximately 33% cement paste and 67% aggregate, by volume. The cementitious paste contained approximately 15% residual fly ash particles, by volume of paste. The air content was less than 1%. The concrete was not air-entrained.

d) The average volumetric coarse-to-fine aggregate ratio (CA/FA) was approximately 1.4:1. The volumetric proportions are given in Table II. The aggregate was generally well graded and well distributed.

e) The bulk cementitious paste was medium gray and hard (difficult to scratch with steel probe), with a Mohs Hardness of 4 to 4½. The aggregate-to-paste bond was good.

f) The amount of unhydrated portland cement (UPC) clinker in the cementitious paste was approximately 6% to 8%. The paste was well hydrated and had very low to low capillary void porosity (dense paste).

g) The maximum carbonation depth, measured from the exterior surfaces, was 0.29" (Core F). Photo 2 shows the paste carbonation on longitudinally sawn-cut sections of the cores. On all cores a thin band of brownish-gray discoloration occurred directly beneath the carbonated layers. The band appeared to be due to slight alteration of the paste due to aggressive water.

h) The average water-cementitious materials ratio (w/cm), estimated from the optical examination, was approximately 0.44 ± 0.05. Based on the estimated w/cm (0.44) and the average volumetric proportion of paste (33%), the calculated cementitious materials content was approximately 7.2 sacks/yd^3. Core L had a higher paste content compared to Cores D and F, which increased the average cementitious materials content.

i) There was minor alkali-silica reactivity (ASR) involving some volcanic rock types, sandstone and some opal/opaline shale. The ASR was observed primarily as loss of calcium hydroxide around the reactive particles (calcium hydroxide depletion) and minor radial microcracking in the surrounding cement paste. Some internal aggregate cracking was observed in the sandstones, but was common in the opal/opaline shale particles. Overall, ASR gel was generally absent, although trace amounts ASR gel was observed in one crack and a small void in Core F. Overall microcracking was low and the ASR is considered to be minor.

<u>Core P</u>

a) Core P consisted of a portland cement paste and normal-weight siliceous aggregate concrete (base), overlaid with a mortar (topping). The lower half the core was concrete and the upper half was mortar. Both the concrete and the topping mortar were well proportioned and properly consolidated. Neither the concrete nor the mortar pastes contained fly ash.

b) The base concrete aggregate consisted of ¾" maximum size subround to subangular coarse aggregate and siliceous fine aggregate with lithologies identical to Cores D, F and L. The topping mortar also had the same aggregate rock and mineral types, except very few particles larger than ⅛" were present. As with Cores D, F and L, the aggregates contained reactive opal and opaline shale.

c) The concrete was composed of approximately 34% cement paste and 65% aggregate, by volume. The concrete was not air-entrained. The air content was approximately 1%. The volumetric coarse-to-fine aggregate ratio (CA/FA) was approximately 1.2:1. The aggregate was generally well graded and well distributed.

d) The concrete bulk cement paste was medium light gray and hard (difficult to scratch with steel probe), with a Mohs Hardness of 4 to 4½. The aggregate-to-paste bond was good.

e) The amount of unhydrated portland cement (UPC) clinker in the cement paste was approximately 6%. The cement paste was well hydrated and had moderate capillary void porosity (fairly dense paste).

f) The maximum carbonation depth, measured from the surface beneath the mortar topping, was nominally 0.16", but reached to 0.25" along bleed channels next to some coarse aggregate particles. A thin band of brownish-gray discoloration occurred directly beneath mortar topping within the carbonated layer of the concrete. The band appeared to be due to slight alteration of the paste due to aggressive water. Photo 2 shows the paste carbonation on longitudinally sawn-cut sections of the cores.

g) The water-cement ratio (w/c) of the concrete, estimated from the optical examination, was approximately 0.48 ± 0.05. Based on the estimated w/cm (0.48) and the volumetric proportion of paste (34%), the calculated cement content was approximately 7.3 sacks/yd^3.

h) The mortar was composed of approximately 40% cement paste and 57% aggregate, by volume. The mortar was not air-entrained. The air content was approximately 2%. The aggregate was generally well graded and well distributed.

i) The mortar bulk cement paste was medium light gray and hard (difficult to scratch with steel probe), with a Mohs Hardness of 4. The aggregate-to-paste bond was good.

j) The amount of unhydrated portland cement (UPC) clinker in the cement paste of the mortar was approximately 5% to 7%. The cement paste was well hydrated and had moderate capillary void porosity (fairly dense paste).

k) The maximum carbonation depth of the mortar, measured from the exterior surface less than 0.04". The paste carbonation on longitudinally sawn-cut section of Core P is shown in Photo 2.

l) The water-cement ratio (w/c) of the mortar, estimated from the optical examination, was approximately 0.48 ± 0.05. Based on the estimated w/cm (0.48) and the volumetric proportion of paste (34%), the calculated cement content was approximately 7.3 sacks/yd^3. The volumetric proportions for Core P are given in Table II.

m) As with Cores D, F and L, both the concrete and topping mortar had minor ASR.

Details of the petrographic examinations are given in Appendix A.

CONCLUSIONS

1) The concrete represented by Cores D. F and L was composed of portland cement/fly ash paste and subround to subangular siliceous coarse aggregate.

2) The concrete represented by Core P was composed of portland cement and subround to subangular siliceous coarse aggregate. The concrete in Core P was overlaid with a topping mortar of similar composition but without coarse aggregate.

3) There was minor alkali-silica reactivity (ASR) between the cementitious pastes and some volcanic, sandstone and opal/opal-bearing rocks. At this time, microcracking due to ASR is minor (low). Only trace amounts of ASR gel were detected (only observed in Core F) and deleterious expansion due to ASR was not observed. There was a minor amount of paste alteration at the surfaces of the concretes, which was most likely due to alteration by aggressive water.

4) The opal and opal-bearing rock are considered highly reactive aggregate which can potentially cause deleterious expansion due to ASR.

Please call if any questions arise.

Sincerely,

APPLIED MATERIALS & ENGINEERING, INC.

Jon Asselanis
Materials Scientist/Petrographer

Reviewed by:

Armen Tajirian, Ph.D., P.E.
Principal

Samples will be held for 30 days after submittal of final report and then discarded unless notified in writing. Storage of held samples will be billed monthly. There is a $100 per month storage fee. Return shipment charges are the responsibility of the client

TABLE I

SAMPLE IDENTIFICATIONS

Oxnard WWTP

AME Project No. 115054C

Core ID	Diameter (in.)*	Nominal Length (in.)	Description
D	2.66	5.65	Activated Sludge Basin 1B – Floor
F	2.70	4.24	Secondary Sedimentation Basin 2 – North Wall
L	2.66	2.91	West Flow Equalization Basin – Floor
P	2.71	5.15	Primary Clarifier – Floor

*widest dimension of longitudinal saw-cut

TABLE II

VOLUMETRIC PROPORTIONS OF CONCRETE CORE SAMPLES

Oxnard WWTP

AME Project No. 115054C

Component	D	F	L	Average D, F, L	P (Base)	P (Topping)
Paste, %	31.4	31.5	34.9	32.6	34.3	40.4
Coarse Aggregate, %	40.2	40.8	36.0	39.0	35.2	0.0
Fine Aggregate, %	27.6	27.0	27.8	27.5	29.4	57.4
Entrained Air*, %	0.5	0.2	0.3	0.3	0.5	1.9
Entrapped Air, %	0.3	0.5	0.9	0.6	0.6	0.3
Total, %	100.0	100.0	100.0	100.0	100.0	100.0
Coarse to Fine Aggregate Ratio	1.46:1	1.51:1	1.3:1	1.4:1	1.2:1	----
Total Air Content, %	0.8	0.6	1.3	0.9	1.1	2.2
Total Aggregate Content, %	67.8	67.9	63.8	66.5	64.6	57.4
Estimated water-cementitious materials ratio	0.45	0.43	0.45	0.44	0.48	0.55
Estimated cementitious materials content (lb/yd^3)	6.9	6.9	7.5	7.2	7.3	8.0

*spherical air voids smaller than 1 mm (0.039″) in diameter

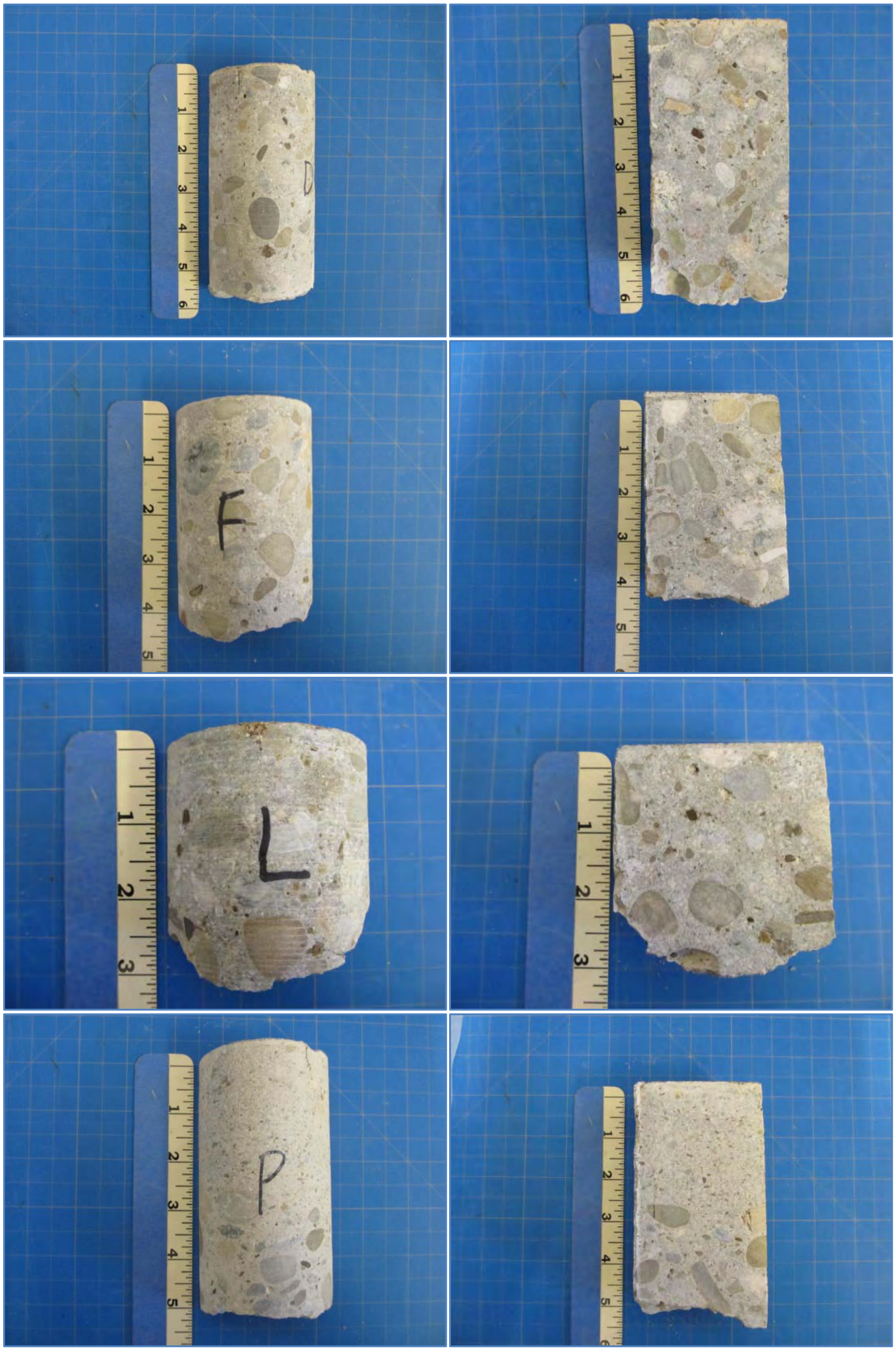


Photo 1. Core samples as received. The photo on the right is the sawn-cut face of the core sample shown to the left.

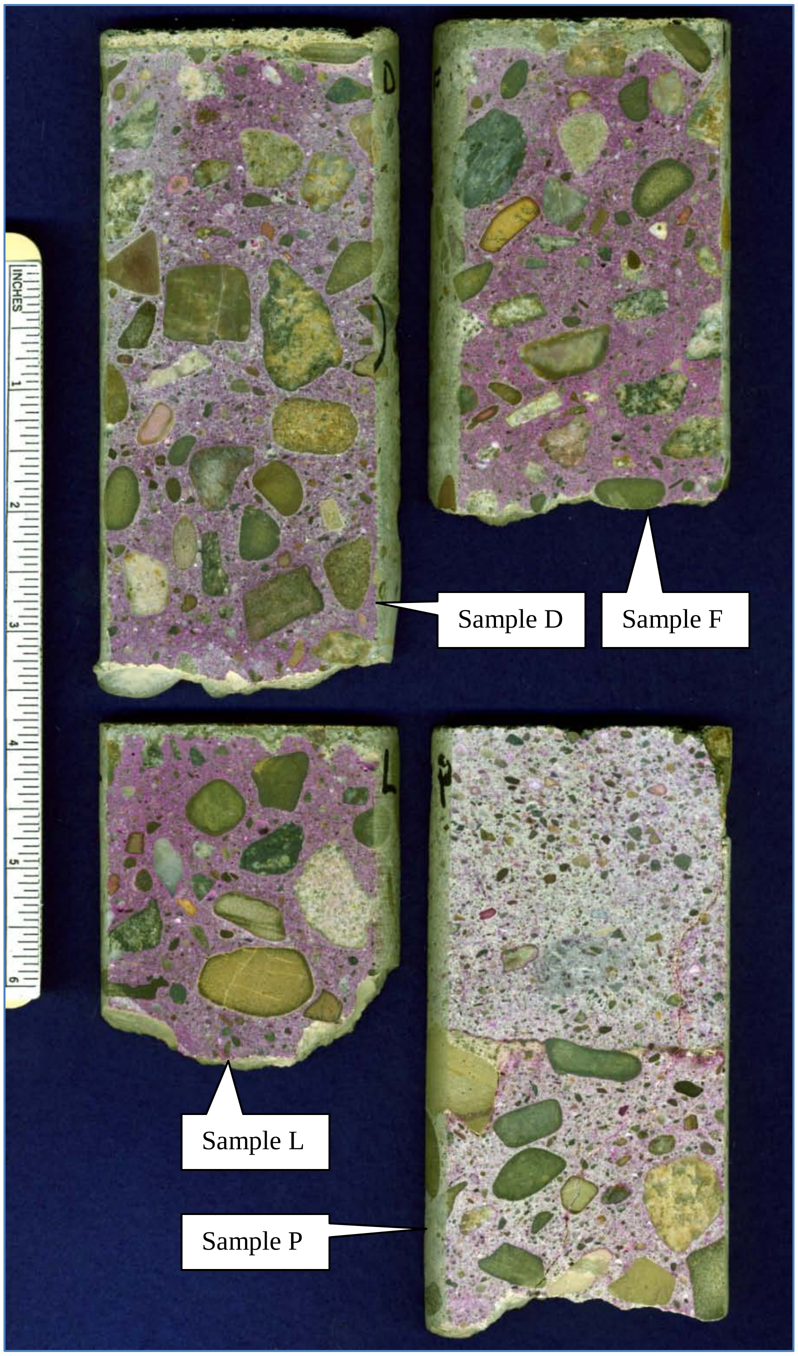


Photo 2. Carbonation across the length of the core samples. Non-carbonation paste has been stained purple by phenolphthalein pH indicator solution.

APPENDIX A

PETROGRAPHIC EXAMINATION DATA SHEETS

Petrographic Examination
Macroscopic Analysis

Client: SCL
Project: Oxnard WWTP
AME Project Number: 115054C
1/29/2015

Sample ID: D

GENERAL AGGREGATE PROPERTIES:

Point Count	Core D	
	Count	%
Paste	647	31.4
CA	828	40.2
FA	569	27.6
Entrained Air*	10	0.5
Entrapped Air	7	0.3
Total	2061	100.0
CA/FA		1.46
Total % Air		0.8
Total % Agg		67.8

* voids with diameters < 1 mm

Maximum Size Aggregate (MSA), in.: ¾"
Volumetric Proportions (% Aggregate): 68
Distribution: Good
Segregation: None
Flat & Elongated Particles: Nil
CA/FA: 1.46:1
Gap Graded: Slightly gapped at #4
One Size: No

Coarse Aggregate Rock Types: Normal Weight
Major: Granitic rock types, quartzite
Minor: Vein quartz, arkosic sandstone
Trace: Scoria, opal/opaline shale, limestone
Shape and Texture: Subround to subangular

Calculated cement (cementitious materials) content (sacks/yd³): 6.9

Fine Aggregate Mineral Species and Rock Types:
Major: Feldspar, quartz, granitic rock fragments
Minor: Volcanic rock fragments, arkosic sandstone rock fragments, opal
Trace: Opaques, biotite mica, pyroxene, calcite, scoria
Shape and Texture: Angular

Reinforcement: None

Air Content:
Entrained: 0.5%
Entrapped: 0.3%
Total: 0.8%

Cement Paste:
Color: Medium gray
Scratch Hardness (Mohs Hardness): 4 to 4½

Surface Carbonation Depth, in. (Determined by pH):
Up to 0.24" depth from exterior surface

Cracking and Other Features: Grayish brown band (0.04" thick) directly beneath carbonated paste layer, passes through sandstone CA particle. Apparent broom finish.

MISCELLANEOUS SAMPLE INFORMATION:	Diameter (in.)	Length, nominal (in.)
Half core sample sliced longitudinally	2.66	5.65

Petrographic Examination
Microscopic Analysis

Client: SCL
Project: Oxnard WWTP
AME Project Number: 115054C
1/29/2015

Sample ID: D

Thin-section (TS) Number(s): 3207, 3208

CEMENT PASTE PROPERTIES:

Carbonation: Determined by thin-section:
Carbonation Intensity: Medium

Calcium Hydroxide Content (CH)*: 15%
Size: Small
Distribution: Even

Transition Zone (TZ) Development: Very thin to thin

Capillary Void Porosity (CVP): Very low, some mottling, particularly beneath carbonated layer

Unhydrated Portland Cement Particles (UPC's), %*: 6% to 7%
Shape: Subangular to subround
Type: Belite clusters, belite
Size: Clusters up to 0.210 mm, but typically < 0.080 mm across
Grain Relief: Very low (well hydrated)

Pozzolans*, Additives and Pigments: 15% Fly ash
*percent of cement paste volume

Estimated water-binder ratio (w/b): 0.45 ± 0.05
(Binder = cement + pozzolan)

Secondary Deposits: Brown discoloration (cloudiness) of paste directly beneath carbonated paste layer. Possible aggressive water alteration. Minor CH depletion around some aggregate particles, ettringite filling and partially lining some voids

Deleterious Reactions: Very minor ASR (internal cracking of opal particles, CH depletion and reaction rims around some CA and FA particles, but no ASR gel observed)

Fiber Reinforcement (type and amount**): None
**percent of sample volume

Microcracking:
Radial: Low
Transverse: Low

MISCELLANEOUS CEMENT PASTE INFORMATION: ----

Petrographic Examination
Macroscopic Analysis

Client: SCL
Project: Oxnard WWTP
AME Project Number: 115054C
1/29/2015

Sample ID: F

GENERAL AGGREGATE PROPERTIES:

Point Count	Core F	
	Count	%
Paste	536	31.5
CA	695	40.8
FA	460	27.0
Entrained Air*	3	0.2
Entrapped Air	8	0.5
Total	1702	100.0
CA/FA		1.51
Total % Air		0.6
Total % Agg		67.9

* voids with diameters < 1 mm

Maximum Size Aggregate (MSA), in.: ¾"
Volumetric Proportions (% Aggregate): 68
Distribution: Good
Segregation: No
Flat & Elongated Particles: Nil
CA/FA: 1.51:1
Gap Graded: Gapped @ #4
One Size: No

Coarse Aggregate Rock Types: Normal Weight
Major: Granitic rock types, quartzite
Minor: Vein quartz, arkosic sandstone
Trace: Limestone
Shape and Texture: Subround to subangular

Calculated cement (cementitious materials) content (sacks/yd³): 6.9

Fine Aggregate Mineral Species and Rock Types:
Major: Feldspar, quartz, granitic rock fragments
Minor: Volcanic rock fragments, arkosic sandstone rock fragments, opal
Trace: Opaques, biotite mica, pyroxene, calcite, scoria
Shape and Texture: Angular

Reinforcement: None

Air Content:
Entrained: 0.2%
Entrapped: 0.5%
Total: 0.6%

Cement Paste:
Color: Medium gray
Scratch Hardness (Mohs Hardness): 4

Surface Carbonation Depth, in. (Determined by pH):
Up to 0.29" depth from exterior surface

Cracking and Other Features: Grayish brown band (0.03" thick) directly beneath carbonated paste layer, passes through sandstone CA particle and gradually decreases in color to approximately 0.30" depth. Smooth form finish.

MISCELLANEOUS SAMPLE INFORMATION:	Diameter (in.)	Length, nominal (in.)
Half core sample sliced longitudinally	2.70	4.24

Petrographic Examination
Microscopic Analysis

Client: SCL
Project: Oxnard WWTP
AME Project Number: 115054C
1/29/2015

Sample ID: F

Thin-section (TS) Number(s): 3209, 3210

CEMENT PASTE PROPERTIES:

Carbonation: Determined by thin-section:
Carbonation Intensity: Medium typically

Calcium Hydroxide Content (CH)*: 15%
Size: Small
Distribution: Even

Transition Zone (TZ) Development: Very thin to nil

Capillary Void Porosity (CVP): Very low, with some mottling

Unhydrated Portland Cement Particles (UPC's), %*: 6% to 8%
Shape: Subangular to subround
Type: Belite clusters
Size: Clusters up to 0.100 mm, typically < 0.085 mm across
Grain Relief: Very low (well hydrated)

Pozzolans*, Additives and Pigments: 15% to 20% Fly ash
*percent of cement paste volume

Estimated water-binder ratio (w/b): 0.43 ± 0.05
(Binder = cement + pozzolan)

Secondary Deposits: Ettringite lining a few voids, Trace amounts of ASR gel in small voids and cracks

Deleterious Reactions: Minor ASR

Fiber Reinforcement (type and amount**): None
**percent of sample volume

Microcracking:
Radial: Low
Transverse: Low (more prominent near surface)

MISCELLANEOUS CEMENT PASTE INFORMATION: ----

Petrographic Examination
Macroscopic Analysis

Client: SCL
Project: Oxnard WWTP
AME Project Number: 115054C
1/30/2015

Sample ID: L

GENERAL AGGREGATE PROPERTIES:

Point Count	Core L	
	Count	%
Paste	442	34.9
CA	456	36.0
FA	352	27.8
Entrained Air*	4	0.3
Entrapped Air	12	0.9
Total	1266	100.0
CA/FA		1.30
Total % Air		1.3
Total % Agg		63.8

* voids with diameters < 1 mm

Maximum Size Aggregate (MSA), in.: ¾"
Volumetric Proportions (% Aggregate): 64
Distribution: Good
Segregation: No
Flat & Elongated Particles: Nil
CA/FA: 1.3:1
Gap Graded: Gapped @ #4
One Size: No

Coarse Aggregate Rock Types: Normal Weight
Major: Granitic rock types, quartzite
Minor: Vein quartz, arkosic/arenite sandstone
Trace: Limestone
Shape and Texture: Subround to subangular

Calculated cement (cementitious materials) content (sacks/yd³): 7.5

Fine Aggregate Mineral Species and Rock Types:
Major: Feldspar, quartz, granitic rock fragments
Minor: Volcanic rock fragments, arkosic sandstone rock fragments, opal
Trace: Opaques, biotite mica, pyroxene, calcite, scoria
Shape and Texture: Angular

Reinforcement: None

Air Content:
Entrained: 0.3%
Entrapped: 0.9%
Total: 1.3%

Cement Paste:
Color: Medium gray
Scratch Hardness (Mohs Hardness): 4½

Surface Carbonation Depth, in. (Determined by pH):
Up to 0.25" depth from surface, nominally 0.10"

Cracking and Other Features: Grayish brown band (0.03" thick) directly beneath carbonated paste layer. Smooth surface, slightly eroded with brown discoloration.

MISCELLANEOUS SAMPLE INFORMATION:	Diameter (in.)	Length, nominal (in.)
Half core sample sliced longitudinally	2.66	2.91

Petrographic Examination
Microscopic Analysis

Client: SCL
Project: Oxnard WWTP
AME Project Number: 115054C
1/30/2015

Sample ID: L

Thin-section (TS) Number(s): 3211

CEMENT PASTE PROPERTIES:

Carbonation: Determined by thin-section:
Carbonation Intensity: Medium

Calcium Hydroxide Content (CH)*: 15% to 18%
Size: Small
Distribution: Even

Transition Zone (TZ) Development: Thin to nil

Capillary Void Porosity (CVP): Low, slightly mottled

Unhydrated Portland Cement Particles (UPC's), %*: 6% to 8%
Shape: Subangular to subround
Type: Belite clusters, som ebelite
Size: Clusters typically < 0.100 mm across
Grain Relief: Low

Pozzolans*, Additives and Pigments: 13% to 15% Fly ash
*percent of cement paste volume

Estimated water-binder ratio (w/b): 0.45 ± 0.05
(Binder = cement + pozzolan)

Secondary Deposits: Some secondary CH in small voids, traces of ettringite

Deleterious Reactions: Minor CH depletion around some particles

Fiber Reinforcement (type and amount**): None
**percent of sample volume

Microcracking:
Radial: Low
Transverse: Low

MISCELLANEOUS CEMENT PASTE INFORMATION: ----

Petrographic Examination
Macroscopic Analysis

Client: SCL
Project: Oxnard WWTP
AME Project Number: 115054C
1/30/2015

Sample ID: P (Base)

GENERAL AGGREGATE PROPERTIES:

Maximum Size Aggregate (MSA), in.: ¾"
Volumetric Proportions (% Aggregate): 65
Distribution: Moderately good
Segregation: No
Flat & Elongated Particles: Appears low
CA/FA: 1.2:1
Gap Graded: Gapped at #4
One Size: No

Point Count	Core P (Base)	
	Count	%
Paste	401	34.3
CA	412	35.2
FA	344	29.4
Entrained Air*	6	0.5
Entrapped Air	7	0.6
Total	1170	100.0
CA/FA		1.20
Total % Air		1.1
Total % Agg		64.6

* voids with diameters < 1 mm

Calculated cement (cementitious materials) content (sacks/yd³): 7.3

Coarse Aggregate Rock Types: Normal Weight
Major: Granitic rock types, quartzite
Minor: Vein quartz, arkosic to arenite sandstone, limestone
Trace: ----
Shape and Texture: Subround to subangular

Fine Aggregate Mineral Species and Rock Types:
Major: Feldspar, quartz, granitic rock fragments
Minor: Volcanic rock fragments, arkosic sandstone rock fragments, opal
Trace: Opaques, biotite mica, pyroxene, calcite, scoria
Shape and Texture: Angular

Reinforcement: None

Air Content:
Entrained: 0.5%
Entrapped: 0.6%
Total: 1.1%

Cement Paste:
Color: Medium light gray
Scratch Hardness (Mohs Hardness): 4 to 4½

Surface Carbonation Depth, in. (Determined by pH):
Negligible up to 0.05" depth on topping surface, from 0.07" to 0.25" on surface of base

Cracking and Other Features: Cracks extending from base to surface of topping.Core consists of nearly equal halves of base concrete and topping or overlay. Gray discoloration band at surface of base concrete. Bleed channels observed (carbonated)

MISCELLANEOUS SAMPLE INFORMATION:	Diameter (in.)	Length, nominal (in.)
Half core sample sliced longitudinally	2.71	5.15

Petrographic Examination
Microscopic Analysis

Client: SCL
Project: Oxnard WWTP
AME Project Number: 115054C
1/30/2015

Sample ID: P (Base)

Thin-section (TS) Number(s):	3213
CEMENT PASTE PROPERTIES:	
Carbonation: Determined by thin-section:	
Carbonation Intensity	Medium
Calcium Hydroxide Content (CH)*:	20% to 22%
Size:	Small
Distribution:	Even
Transition Zone (TZ) Development:	Moderately thin
Capillary Void Porosity (CVP):	Moderate
Unhydrated Portland Cement Particles (UPC's), %*:	6%
Shape:	Subangular to subround
Type:	Belite clusters, belite
Size:	Clusters up to 0.170 mm across, typically < 0.100 mm
Grain Relief:	Low
Pozzolans*, Additives and Pigments: *percent of cement paste volume	None
Estimated water-binder ratio (w/b): (Binder = cement + pozzolan)	0.48 ± 0.05
Secondary Deposits:	Ettringite particle lining some voids
Deleterious Reactions:	Minor CH depletion, some paste discoloration, traces of ASR around some FA particles
Fiber Reinforcement (type and amount**): **percent of sample volume	None
Microcracking:	
Radial:	Moderately low
Transverse:	Low
MISCELLANEOUS CEMENT PASTE INFORMATION:	----

Petrographic Examination
Macroscopic Analysis

Client: SCL
Project: Monterey Outfall
AME Project Number: 114551C
9/15/2014

Sample ID: P (Topping)

Point Count	Core P (Topping)	
	Count	%
Paste	689	40.4
CA	0	0.0
FA	978	57.4
Entrained Air*	32	1.9
Entrapped Air	5	0.3
Total	1704	100.0
CA/FA		0.00
Total % Air		2.2
Total % Agg		57.4

* voids with diameters < 1 mm

Calculated cement (cementitious materials) content (sacks/yd³): 8.0

GENERAL AGGREGATE PROPERTIES:

Maximum Size Aggregate (MSA), in.: ⅛" (occasional particles up to ⅜")
Volumetric Proportions (% Aggregate): 57
Distribution: Good
Segregation: No
Flat & Elongated Particles: Nil
CA/FA: 0:1
Gap Graded: No
One Size: No

Coarse Aggregate Rock Types: (No CA)
Major: ----
Minor: ----
Trace: ----
Shape and Texture: ----

Fine Aggregate Mineral Species and Rock Types:
Major: Feldspar, quartz, granitic rock fragments
Minor: Volcanic rock fragments, arkosic sandstone rock fragments, opal
Trace: Opaques, biotite mica, pyroxene, calcite, scoria
Shape and Texture: Angular

Reinforcement: None

Air Content:
Entrained: 1.9%
Entrapped: 0.3%
Total: 2.2%

Cement Paste:
Color: Medium light gray
Scratch Hardness (Mohs Hardness): 4

Surface Carbonation Depth, in. (Determined by pH): < 0.04"

Cracking and Other Features: Cracks extending from base to surface of topping.Core consists of nearly equal halves of base concrete and topping or overlay.

MISCELLANEOUS SAMPLE INFORMATION:	Diameter (in.)	Length, nominal (in.)
Half core sample sliced longitudinally	2.71	5.15

Petrographic Examination
Microscopic Analysis

Client: SCL
Project: Monterey Outfall
AME Project Number: 114551C
9/15/2014

Sample ID: P (Topping)

Thin-section (TS) Number(s): 3212

CEMENT PASTE PROPERTIES:

Carbonation: Determined by thin-section:
Carbonation Intensity — Generally Medium. Some large crystals in TZ

Calcium Hydroxide Content (CH)*: 20% to 25% (some secondary CH)
Size: Small
Distribution: Even

Transition Zone (TZ) Development: Thin to occasionally moderately thick

Capillary Void Porosity (CVP): Moderate

Unhydrated Portland Cement Particles (UPC's), %*: 5% to 7%
Shape: Subangular to subround
Type: Belite clusters, belite, some alite
Size: Clusters up to 0.090 mm across
Grain Relief: Low to moderately low (well to moderately well hydrated)

Pozzolans*, Additives and Pigments: None
*percent of cement paste volume

Estimated water-binder ratio (w/b): 0.55 ± 0.05
(Binder = cement + pozzolan)

Secondary Deposits: Ettringite filling or partially filling most voids

Deleterious Reactions: CH depletion around some aggregate particles (particularly volcanics)

Fiber Reinforcement (type and amount**): None
**percent of sample volume

Microcracking:
Radial: Moderate
Transverse: Low

MISCELLANEOUS CEMENT PASTE INFORMATION: ----

March 12, 2015 SCL Project No. 15006

Mr. Michael Johannessen
Villalobos and Associates
155 Grand Ave, Suite 700
Oakland, CA 94612

Email: mjohannessen@vaengineering.com

RE: V&A Job #14-0195 T04- Oxnard WWTP
Concrete Evaluation
Oxnard, California

Dear Mr. Johannessen:

Scientific Construction Laboratories, Inc. (SCL) has completed materials testing of the submitted powdered samples from the above referenced project. The purpose of the testing was to determine material properties and to use this information to assist future remedial work, etc. This report includes test results, and a brief summary of results.

LABORATORY TESTING

CHLORIDE CONTENT TESTING

Chloride content tests were performed on concrete powder samples in accordance ASTM C1218 –*Standard Test Method for Water-Soluble Chloride in Mortar and Concrete*. Powdered samples were sieved with a #20 sieve and the retained sample was then pulverized to pass a #20 sieve. This test method involves digesting a small amount of the sample followed by titrating the resulting sample with a silver nitrate solution. Nine submitted samples were tested. Test results are reported in Table 1.

pH TESTING ON POWDER SAMPLES

pH tests were performed on the nine submitted samples. Powdered samples were sieved with a #20 sieve and the retained sample was then pulverized to pass a #20 sieve. Testing was performed by wetting the test samples to create a slurry and tested with a spot probe manufactured by Hanna instruments. Results are shown in Table 2.

SUMMARY

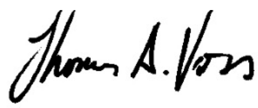
A brief summary of the laboratory testing is as follows:

1. All of the chloride content tests were below the threshold to initiate corrosion.

If you have any questions, please call.

Very truly yours,

SCIENTIFIC CONSTRUCTION LABORATORIES, INC.



Thomas A. Voss
Civil Engineer

TABLE 1. CHLORIDE TESTING				
Sample No.	Location	% Chloride by Weight of Concrete (at three depths)		
		0.0″ to 0.5″	0.5″ to 1.0″	1.0″ to 1.5″
1	North Wall Pass 1	0.0025	0.0065	0.0015
2	Oxnard CCC East Wall	0.0052	0.0033	0.0028
3	West Wall Pass 2	0.0032	0.0051	0.0032

TABLE 2. pH TESTING				
Sample No.	Location	pH (at three depths)		
		0.0″ to 0.5″	0.5″ to 1.0″	1.0″ to 1.5″
1	North Wall Pass 1	11.1	11.5	11.6
2	Oxnard CCC East Wall	11.0	11.3	11.4
3	West Wall Pass 2	11.2	11.3	11.3

APPENDIX C. OTHER STRUCTURES

The structures described above in Sections 3.1 through 3.5 were selected for condition assessment via confined space entry. Photographic documentation from topside was also collected for some of the other structures at the OWTP. These consisted of the ASTs, SSTs, and FEB that were out of service at the time, as well as the other three PCs. This section presents highlights of those observations relative to the detailed findings presented in Sections 3.1 through 3.5.

Activated Sludge Tank 1A

The condition of AST 1A was generally similar to that of AST 1B (Section 3.3). Significant differences and notable observations are as shown in Photo C-1 through Photo C-4.

Photo C-1. Cracking on edge of walkway.

Photo C-2. Cracking on edge of walkway.

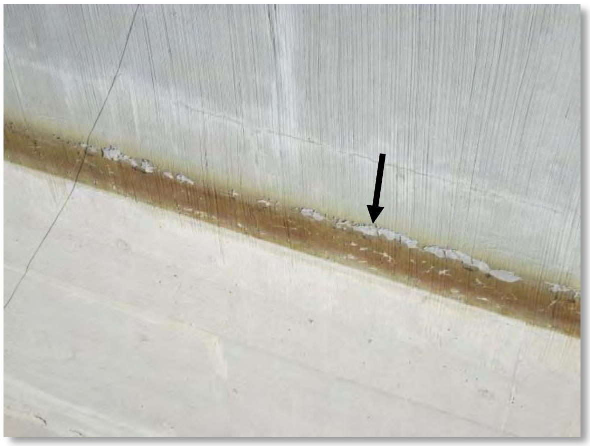


Photo C-3. Deteriorating mortar overlay at top of west wall.

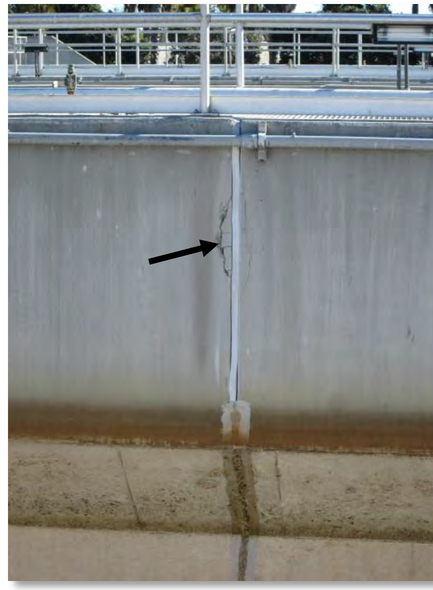


Photo C-4. Spalling concrete adjacent to expansion joint.

Activated Sludge Tank 1C

The condition of AST 1C was generally similar to that of AST 1B (Section 3.3). Significant differences and notable observations are as shown in Photo C-5 through Photo C-8.

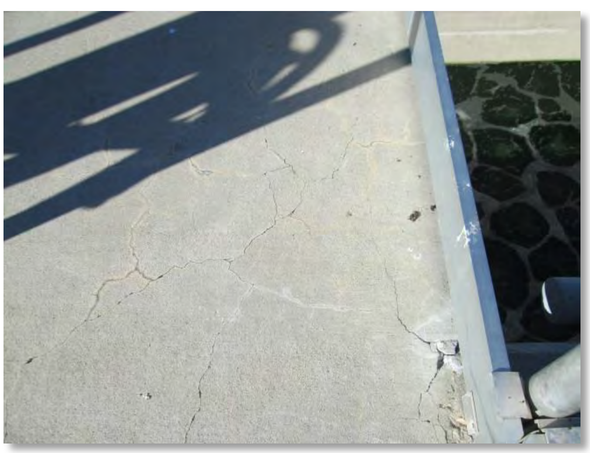


Photo C-5. Cracking on top surface of walkway.

Photo C-6. Gaps in sealant in expansion joint in walkway.

Photo C-7. Cracking at southeast corner of basin.

Photo C-8. Spalling concrete adjacent to expansion joint.

Primary Clarifier 2

The condition of PC 2 was generally similar to that of PC 1 (Section 3.4). PC 2 was in service, so most of the interior was not visible. The concrete damage at the top of the effluent towers was more severe, as shown in Photo C-9 and Photo C-10.

Photo C-9. Broken concrete at top of effluent tower (repaired).

Photo C-10. Broken concrete at top of effluent tower.

Primary Clarifier 3

The condition of PC 3 was generally similar to that of PC 1 (Section 3.4). PC 3 was in service, so most of the interior was not visible. Significant differences and notable observations are as shown in Photo C-11 and Photo C-12.

Photo C-11. Grating on top of effluent tower not seated properly, reportedly due to corrosion products.

Photo C-12. Effluent tower separating from clarifier wall.

Primary Clarifier 4

The condition of PC 4 was generally similar to that of PC 1 (Section 3.4). PC 4 was in service, so most of the interior was not visible. Significant differences and notable observations are as shown in Photo C-13 through Photo C-18.

Photo C-13. Spalling on edge of landing at top of stairs.

Photo C-14. Spalling on edge of landing at top of stairs.

Photo C-15. Broken and missing concrete at top of effluent tower.

Photo C-16. Broken concrete at top of effluent tower.

Photo C-17. Apparent broken welds on catwalk.

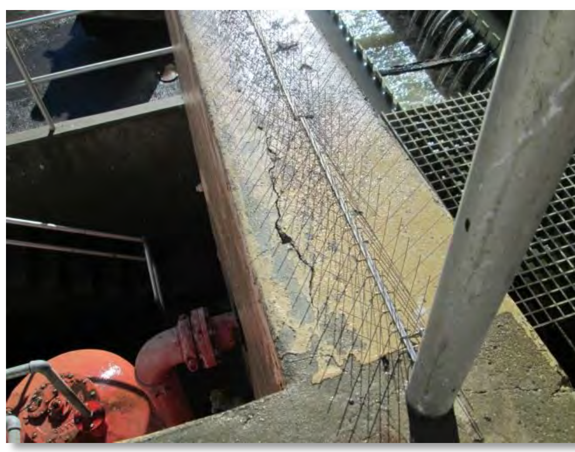


Photo C-18. Crack in top of wall.

East Flow Equalization Basin

The condition of the East FEB was generally similar to that of the West FEB (Section 3.1). Significant differences and notable observations are as shown in Photo C-19 through Photo C-24.

Photo C-19. Spalling on column.

Photo C-20. Typical crack in east wall (appears to pass through wall).

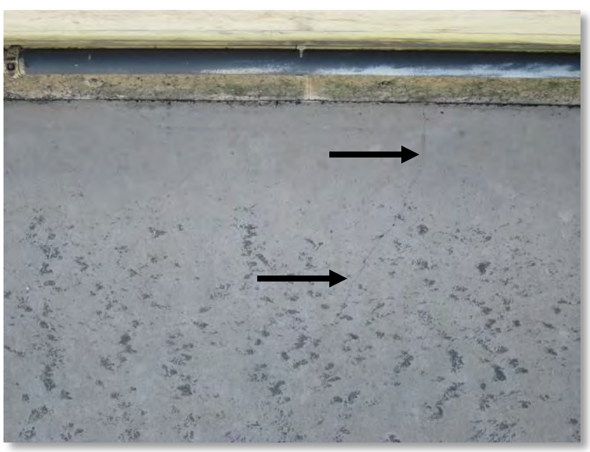


Photo C-21. Crack in floor near east wall (north is to left in photo).

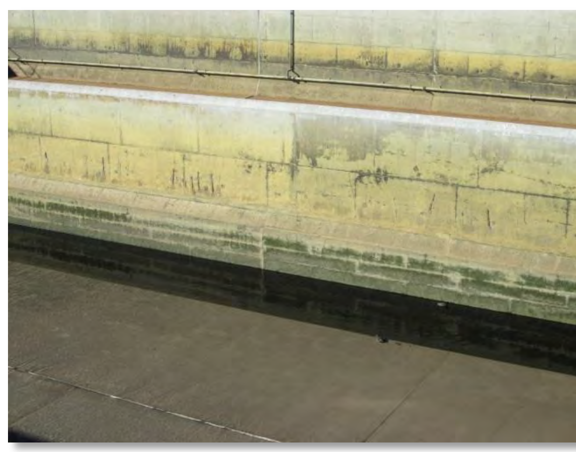


Photo C-22. Spalling over vertical bars in west (dividing) wall.

Photo C-23. Spalling over vertical bars in west (dividing) wall.

Photo C-24. Weeds growing from sealant in east wall.

Secondary Sedimentation Tank 1

The condition of SST 1 was generally similar to that of SST 2 (Section 3.2). Significant differences and notable observations are as shown in Photo C-25 and Photo C-26.

Photo C-25. Cracking in slab over west end of basin.

Photo C-26. Cracking in slab over west end of basin (more extensive than SST 2).

Secondary Sedimentation Tank 11

The condition of SST 11 was generally similar to that of SST 2 (Section 3.2). Significant differences and notable observations are as shown in Photo C-27.

Photo C-27. Cracking in east wall above inlet tee.

Secondary Sedimentation Tank 12

The condition of SST 12 was generally similar to that of SST 2 (Section 3.2). Significant differences and notable observations are as shown in Photo C-28 through Photo C-31.

Photo C-28. Vertical cracks every few feet along length of north wall (similar to SST 2).

Photo C-29. Gaps in expansion joint sealant with possible seepage.

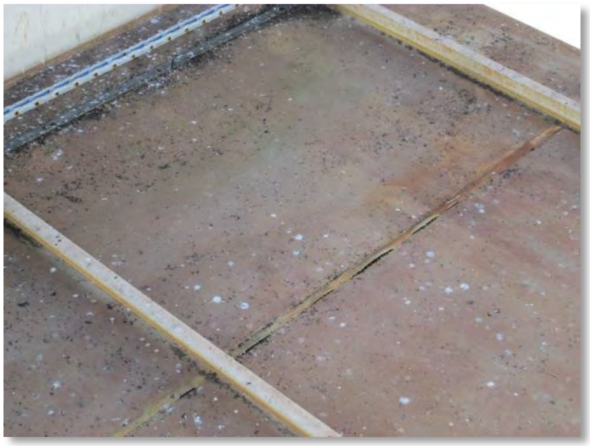


Photo C-30. Gaps in expansion joint sealant.

Photo C-31. Plants growing from gap behind fill concrete at east wall.

Secondary Sedimentation Tank 17

The condition of SST 17 was generally similar to that of SST 2 (Section 3.2). Significant differences and notable observations are as shown in Photo C-32 and Photo C-33.

Photo C-32. Weeds growing from expansion joints.

Photo C-33. Weeds growing from expansion joints.

Secondary Sedimentation Tank 18

The condition of SST 18 was generally similar to that of SST 2 (Section 3.2). Significant differences and notable observations are as shown in Photo C-34 through Photo C-36.

Photo C-34. Weeds growing from expansion joints.

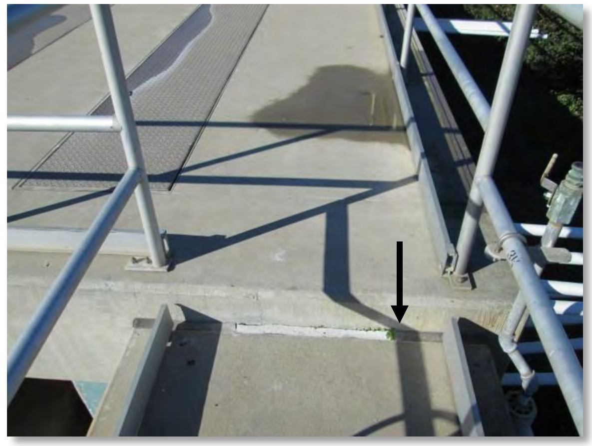


Photo C-35. Weeds growing from expansion joints.

Photo C-36. Spalling on underside of platform at southeast corner.

This document is released for the purpose of information exchange review and planning only under the authority of Tracy Anne Clinton, September 2017, State of California, PE No. 48199 and Elizabeth Abigail Charbonnet, September 2017, State of California, PE No. 84612

City of Oxnard

Public Works Integrated Master Plan

WASTEWATER

PROJECT MEMORANDUM 3.7.1
TRADITIONAL OXNARD WASTEWATER TREATMENT PLANT ALTERNATIVES - UPGRADE IN PLACE

REVISED FINAL DRAFT
September 2017

Engineers...Working Wonders With Water™

2700 YGNACIO VALLEY ROAD • SUITE 300 • WALNUT CREEK, CALIFORNIA 94598 • (925) 932-1710 • FAX (925) 930-0208

PREFACE

The analysis and evaluations contained in these Project Memorandum (PM) are based on data and information available at the time of the original date of publication, December 2015. After development of the December 2015 Final Draft PMs, the City continued to move forward on two concurrent aspects: 1) advancing the facilities planning for the water, wastewater, recycled water, and stormwater facilities; and 2) developing Updated Cost of Service (COS) Studies (Carollo, 2017) for the wastewater/collection system and the water/distribution system. The updated 2017 COS studies contain the most recent near-term Capital Improvement Projects (CIP). **The complete updated CIP based on the near-term and long-term projects is contained in the Brief History and Overview of the City of Oxnard Public Works Department's Integrated Planning Efforts: May 2014 – August 2017 section.**

At the time of this Revised PWIMP, minor edits were also incorporated into the PMs. Minor edits included items such as table title changes and updating reports that were completed after the December 2015 original publication date.

City of Oxnard

Public Works Integrated Master Plan

WASTEWATER

PROJECT MEMORANDUM 3.7.1
TRADITIONAL OXNARD WASTEWATER TREATMENT PLANT ALTERNATIVES - UPGRADE IN PLACE

TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

TRADITIONAL OXNARD WASTEWATER TREATMENT PLANT ALTERNATIVES - UPGRADE IN PLACE

1.0 INTRODUCTION

The purpose of this Project Memorandum (PM) is to develop the list of projects to be included in the wastewater Capital Improvement Program (CIP) of the Public Works Integrated Master Plan (PWIMP) with associated project cost, timing, and drivers. The CIP is an estimate of the City of Oxnard’s (City's) capital expenses over the next 25 years to address limitations, rehabilitation needs, and recommended improvements to the wastewater treatment plant. The CIP is intended to assist the City in planning future budgets and making financial decisions.

1.1 PMs Used for Reference

The recommendations outlined in this PM include recommendations from the following other PMs:

- PM 1.1 – Overall – Master Planning Process Overview.
- PM 1.4 – Overall – Basis of Costs.
- PM 3.2 – Wastewater System – Flow and Load Projections.
- PM 3.4 – Wastewater System – Treatment Plant Performance and Capacity.
- PM 3.5 – Wastewater System – Condition Assessment.
- PM 3.6 – Wastewater System – Seismic Assessment.
- PM 3.8 – Wastewater System – Arc Flash Assessment.
- PM 3.9 – Wastewater System – Cathodic Protection Assessment.
- PM 3.10 – Wastewater System – SCADA Assessment.
- PM 3.11 – Wastewater System – Flow Monitoring.
- PM 4.3 – Recycled Water System – AWPF/OWTP Outfall Regulatory Considerations.

1.2 Other Reports Used for Reference

In developing the wastewater Scenarios, recommendations from other reports were incorporated to ensure a well-rounded and holistic look at the wastewater treatment plant system. The following reports are used in this PWIMP analysis:

- “Water and Wastewater Process Optimization and Mechanical Audit Report DRAFT” (The Energy Network - Process Optimization, 2014). - Appendix A.

- "Mechanical Audit Report" (The Energy Network - Mechanical Audit, 2014). - Appendix B.
- "Oxnard Wastewater Treatment Plant Energy Evaluation Report" (Carollo, 2013). - Appendix C.
- "Preliminary Identification of Immediate Needs for the Oxnard Wastewater Treatment Plant and Collection System Sewers and Lift Stations" (KEH, 2014). - Appendix D.
- "Energy Action Plan: A component of the Oxnard Climate Action and Adaptation Plan" (Oxnard Planning Division, 2013).

2.0 WASTEWATER TREATMENT GOALS

In considering improvements to the Oxnard Wastewater Treatment Plant (OWTP), a number of goals were established to aid in scenario development. The five main goals are as follows:

- Goal 1: Provide a compliant, reliable, resilient, and flexible system.
- Goal 2: Manage assets effectively (economic sustainability).
- Goal 3: Mitigate and adapt to potential impacts of climate change.
- Goal 4: Protect and enhance environmental and resource sustainability.
- Goal 5: Investigate green and grey infrastructure with an emphasis on energy efficiency.

3.0 DEVELOPMENT OF WASTEWATER TREATMENT PLANT SCENARIOS

Three scenarios were developed for consideration by the City of Oxnard (City). These three scenarios all address plant reliability concerns and future capacity needs. The scenarios differ in their area of focus. Scenario 1 focuses simply on plant reliability, Scenario 2 focuses on energy efficiency, and Scenario 3 focuses on resource recovery. It is important to recognize that these scenarios are not mutually exclusive. Instead, these scenarios are compatible with one another and additive to provide for increasing levels of treatment. A detailed discussion of these three scenarios and their associated projects can be found in the sections below.

3.1 Scenario 1: Baseline

Scenario 1 includes all projects needed to meet existing and anticipated future level of treatment requirements. Projects to optimize operations and maintenance are included in this scenario as are projects that adopt newer technologies in place of aging equipment. Because of the OWTP's age and state of repair, the majority of OWTP projects recommended in this master plan are related to repair and replacement required for continued plant operation. Because of this, this baseline scenario includes a majority of the proposed projects. All of these rehabilitation and replacement driven projects are required to achieve wastewater treatment goal number one and will require a substantial near-term investment. All proposed improvements to the OWTP under Scenario 1 are discussed below by process area.

3.1.1 Headworks

The proposed headworks improvement projects include improvements to odor containment and ventilation facilities, below cover coating repairs of influent structures, a new seal water system for the influent pumps, fiberglass covers for the headworks structures, minor modifications for seismic reliability at the grit screenings building, concrete repairs, and small equipment replacement. In addition, a new non-hazardous liquid (septage) receiving station and screen wall are also recommended. All of these projects provide greater reliability to help maintain a fully NPDES permit compliant plant, and do not increase plant capacity.

The odor control project will enclose the influent screens and horizontal screenings conveyors with RFP or aluminum covers and provide ventilation. These improvements produce an air quality benefit. Coating repair should include coating the influent sewer vortex structure, influent junction structure, influent screen channels, grit chamber bypass channels, and influent pump station wet well.

Small equipment at the headworks will be replaced as each item reaches the end of its remaining useful life. Equipment will be replaced with more energy efficient models, thus decreasing power usage, an environmental benefit. A list of small equipment in need of replacement and their economic remaining useful life (EcRUL) can be found in Table 1.

3.1.2 Primary Treatment

Based on the condition assessment and seismic evaluation done at the OWTP, it has been determined that the primary clarifiers are in poor condition and in some cases past their EcRUL. Due to this assessment, as a conservative approach in this PWIMP, it was assumed that all four clarifiers are in need of replacement.

In addition to rebuilding both the primary clarifiers and the associated primary clarifier building, it is recommended that an influent splitter box be added for better flow control. Also, with the construction of new primary clarifiers the City should continue to incorporate Chemically Enhanced Primary Treatment (CEPT) for better nutrient removal and allowance for cathodic protection. While it is assumed that the primary clarifiers will be replaced in full, budget was allocated to replace the existing primary clarifier equipment to maintain reliable service during the construction of new primary clarifiers. The recommendation to replace the primary clarifiers will increase the reliability of the OWTP and the safety of plant operators.

Table 1 Small Equipment at the Headworks Public Works Integrated Master Plan City of Oxnard	
Item	**EcRUL (years)**
Bar Screens	6 to 8
Flowmeter	4
Grit Blowers	8
Grit Pumps	8
Grit Separator/Classifiers	8
Hypo Chemical Feed Pump (Sodium Hypo Pump 2)	4
Influent Check Valves	14
Influent Pumps	8
Odor Control Ductworks & Vessels	8
Screening Compactors	6
Sodium Hydroxide Pumps	3
Sodium Hydroxide Storage Tank	9
Sodium Hypochlorite Pump	3
Sodium Hypochlorite Storage Tank	9
Standby Generator	8
VFDs	6

3.1.3 Secondary Treatment

This section outlines the recommendations of this PWIMP for OWTP's secondary treatment processes.

3.1.4 Biotowers and Interstage Pumping

Based on the condition assessment and seismic evaluation done at the OWTP, it has been determined that the biotowers are in poor condition and past their EcRUL. Due to this assessment, this PWIMP recommends that the biotowers be demolished. Since it is recommended that the biotowers be removed from the process stream, no associated equipment has been budgeted for replacement in this PWIMP.

While it is recommended that the biotowers be removed, the interstage pump station is still necessary. This PWIMP recommends that the interstage pump station be re-configured when the biotowers are demolished. The existing pumps are nearing the end of their EcRUL and the current pump station location is not optimal for future plant operation. When the pump station is replaced, the pumps should be replaced with more energy efficient models and a location should be determined to minimize pumping head from primary to secondary treatment. This reconfiguration will potentially decrease power usage, an environmental benefit. When the facility is reconfigured, it is also recommended that a water quality early warning system be constructed. This facility would alert downstream recycled water users to any changes in water quality leaving the OWTP. None of the recommended changes to the biotowers or interstage pumping will increase the capacity of the plant. The proposed modifications will only increase operator safety and plant reliability.

3.1.5 Activated Sludge Tanks

The activated sludge tanks (ASTs) were constructed during the 1988 improvement project, and as of 2015, they are 27 years old. Based on their condition, this PWIMP recommends that the City invest in concrete repair of these structures. Additionally, based on the age of their construction and their existing condition they are in need of a seismic retrofit. A seismic assessment was performed on these structures and it was found that the AST walls are under reinforced and present shear failure. Concrete testing determined that shotcrete reinforcing is needed for seismic safety.

In addition to structural repairs, equipment associated with the ASTs are also in need of replacement. It is recommended that the diffusers and blowers be replaced, as they are nearing the end of their EcRUL. Additionally, as is recommended in the “Water and Wastewater Process Optimization and Mechanical Audit Report DRAFT” (Appendix A) at least three (3) of the six (6) blowers should be replaced with high efficiency turbo blowers to reduce energy usage (The Energy Network - Process Optimization, 2014). With this blower change, an upgrade to the supervisory control and data acquisition (SCADA) system to accommodate better control of the new aeration blowers and the aeration process is also recommended.

When the biotowers are removed, the ASTs will see an increase in loading. Because of this, it is recommended that baffle walls be added to facilitate better BOD removal in the ASTs. Additionally, it is recommended that the ASTs be run in a step-feed configuration, something these facilities are already set up to do. These minor alterations will allow the ASTs to treat higher loadings without expanding their footprint.

3.1.6 Secondary Sedimentation Tanks

The Secondary Sedimentation Tanks (SSTs) were also constructed in 1988. Like the ASTs, the SSTs are also in need of concrete repair. However, based on concrete testing, these structures are in fair condition seismically and are not in need of a retrofit. It is recommended that instead, the SSTs be re-painted.

Much of the SST equipment is nearing the end of its EcRUL. Table 2 lists the small equipment items associated with the SSTs as well as their EcRUL. In addition to this small equipment, the RAS pumps and collectors, skimmers, and drives also need to be replaced. This equipment has nearly reached or passed its EcRUL.

Table 2	Small Equipment at the SSTs Public Works Integrated Master Plan City of Oxnard
Item	**EcRUL (years)**
RAS Pump Galley Ventilation Fans	6
Secondary Sed. Sludge Magnetic Flow Meters	3
VFDs	4
WAS Pumps	2

In order to optimize the secondary treatment process, the following process changes are recommended. These changes do not alter the plant's capacity, but instead improve performance. The first improvement is a modification to the SST inlet to more equally partition flow between each SST. The second improvement is the addition of a mixed liquor (ML) wasting station to automatically control the solids residence time (SRT) in the secondary system.

3.1.7 Membrane Bioreactor

As the Advanced Water Purification Facility (AWPF) is expanded, it will draw a larger percentage of OWTP effluent from the outfall and replace this flow with reverse osmosis (RO) concentrate. As discussed in PM 4.3, this will cause a concentration effect in the outfall and prevent the OWTP from complying with the technical-based effluent limits of its National Pollutant Discharge Elimination System (NPDES) permit. To address this, this PWIMP recommends the City take a three-pronged approach. It is recommended that the City:

- Pursue a change in the point of compliance for secondary treatment with the regulatory board (LARWQCB).
- Pursue a mass loading effluent limit with the regulatory board (LARWQCB).
- Add membrane bioreactors (MBRs) when the AWPF is expanded in Phase 2.

Recommendations 1 and 2 are both regulatory policy approaches and should be pursued first. However, in the event the policy changes are unachievable, then the engineering solution will require MBR due to the footprint constraints at the OWTP. The addition of MBRs is recommended as a "placeholder" technology to replace the SSTs and would treat all OWTP flow. Details of this recommendation can be found in PM 4.3. In addition to MBRs, a Ultraviolet/Advanced Oxidation Process (UV/AOP) is recommended as an additional step for flows sent to the AWPF. Details on this recommendation can be found in Section 3.1.9.1.

3.1.8 Flow Equalization

Like the ASTs and the SSTs, the flow equalization basins were constructed in 1988 and have similar condition and seismic concerns as the ASTs. Based on their condition, this

PWIMP recommends that the City invest in concrete repair of these structures. Additionally, based on concrete testing, shotcrete reinforcing is needed for seismic safety.

The EcRULs of small equipment at the equalization basins are shown in Table 3. The replacement of this equipment is included in Scenario 1.

Table 3 Small Equipment at the Equalization Basins
Public Works Integrated Master Plan
City of Oxnard

Item	EcRUL (years)
3WHP Facilities Pumps	2
Flow Equalization Gates & Drives	6
Flow Equalization Pumps	6

Additionally, in the "Water and Wastewater Process Optimization and Mechanical Audit Report DRAFT" The Energy Network recommends modifying the SCADA system control of the utility water system, which draws water from secondary effluent. It is recommended that the system pressure be reduced from 90 PSI to 60 PSI during the night when high-pressure water is not necessary. The cost of this modification is included in the CIP and it is expected that this cost will ultimately be offset by resulting energy savings.

3.1.9 Disinfection

To keep the tanks functional and safe, this PWIMP recommends that the City invest in concrete repairs and a new interior coating. Additionally, a small equipment replacement cost has been incorporated to keep the facilities operational. The small equipment included is listed in Table 4.

Table 4 Small Equipment at the Chlorine Contact Tank
Public Works Integrated Master Plan
City of Oxnard

Item	EcRUL (years)
Hypo Pumps	3
Hypo Tanks	9
Chlorine Contact Gates, Supports & Operators	2

3.1.9.1 UV/AOP (Future)

As discussed in Section 3.1.7, the expansion of the AWPF will cause concentration effects in the OWTP outfall that need to be addressed. One recommendation to address this is the addition of MBR in place of the existing SSTs when the AWPF is expanded. Oxnard will be one of the first facilities to reuse a significant percentage of their wastewater flow in their AWPF. One concern with this high reuse percentage is that the concentrate will raise disinfection issues. Thus as a placeholder technology in this PWIMP, UV/AOP treatment is recommended to address the potential pathogen and toxics concern. UV/AOP treatment would be needed for all OWTP effluent sent to the AWPF. A detailed discussion of this recommendation can be found in PM 4.3.

3.1.10 Effluent Pumping

The effluent pump station was installed prior to 1975 and the structure was evaluated for Immediate Occupancy during the seismic analysis. Based on this assessment, the effluent pump station building was found to be in need of replacement. Furthermore, the associated effluent pump station equipment is nearing the end of its EcRUL. In light of this, it is recommended that the entire effluent pumping station facility be replaced. These effluent pump station changes do not alter plant capacity; instead, they provide reliability for downstream users and safety for plant operators.

3.1.11 Ocean Outfall

The existing outfall was constructed around 1963, and as of 2015, the outfall is 52 years old. A pipe dive inspection was conducted in 2013 and found that the outfall was in good condition. They did not find any leaks, erosion, holes, or cracks in the line, nor did they find any port obstructions. Because of the outfall's good condition, it is recommended that the City conduct an inspection every five years and allocate funds for minor repairs after each such inspection.

3.1.12 Sludge Thickening

This section outlines the major recommendations for baseline improvements to the sludge thickening operations at the OWTP.

3.1.12.1 Gravity Thickeners

The gravity thickeners were built prior to 1964 and are in poor condition. While record drawings were not available to seismically evaluate the structures, it was assumed that because the gravity thickeners are over 50 years old, they are not seismically sound. Due to their age and poor condition, and because the majority of the equipment associated with the gravity thickeners are reaching the end of their EcRUL, it is recommended that this facility be abandoned and that the City switch to co-thickening in the Dissolved Air Flotation Thickeners (DAFTs) or thickening in the new primary clarifiers. The gravity thickeners should not only be abandoned, they should be demolished because they are taking up valuable space in the center of the treatment plant. In addition, the associated blower building and odor reduction tower, which are nearing or have passed their EcRUL, should also be demolished.

3.1.12.2 Dissolved Air Flotation Thickeners

The DAFTs are currently located to the west of the existing digesters. DAFT No. 1 has an EcRUL of only 5 years while DAFT No. 2 has a EcRUL of 15 years. If the OWTP were to switch to co-thickening in the DAFTs, additional DAFT units would be required. At their existing location, there is not space for these additional DAFT units. Additionally, the location of the existing DAFTs is the logical location for additional digesters. Because of the lack of space for additional units at their current location, their obstruction of new digester facilities, and because DAFT No. 1 is reaching the end of its EcRUL this PWIMP recommends relocating all DAFT units in the near future. Because it is recommended that the DAFTs be relocated, the replacement of existing equipment is not recommended in this master plan. Since additional DAFT units are required for co-thickening and for handling the additional solids produced with the removal of the biotower and not for additional plant capacity needs, the proposed modifications do not increase the capacity of the OWTP.

When the DAFTs are relocated, larger thickened waste activated sludge (TWAS) pumps should be added to accommodate the additional co-thickened primary sludge.

3.1.13 Digestion

It is recommended that all digesters be replaced with larger equal-sized digesters within the planning period. Digester Nos. 1 and 2 were constructed in 1975 and are thus 40 years old. Digester No. 3 was constructed in 1988 and is thus 27 years old. Digester No. 2 is currently not in service because its cover is in need of replacement. Additionally, the majority of equipment associated with the digesters is nearing the end of their EcRUL. Equipment and structures associated with digestion have EcRULs ranging from -20 years to 9 years. The condition assessment done as part of this PWIMP determined that Digester No. 2 is past its EcRUL and Digester Nos. 1 and 3 have EcRULs of only 5 years. This PWIMP recommends that before the digesters are replaced, concrete testing be performed to better assess their seismic reliability. While initial assessment indicated no seismic deficiencies, the condition of the pre-stressing bars is unknown and there may be other defects that are hard to quantify without concrete testing. Concrete testing was not done as part of this PWIMP because currently a digester cannot be taken off-line. The digester control building was assessed and it does not meet seismic code. The replacement of this building is recommended.

Replacement is also recommended for all three digesters instead of rehabilitation in part because, with the current digester configuration, there is no room for digester expansion in the future. Additionally, all three digesters are nearing the end of their EcRUL so replacement in the near future makes sense. For these reasons, this PWIMP recommends replacing the digesters with slightly larger digesters and locating them further west, starting where the DAFTs are currently located. This allows space for a future Digester No. 4 if needed beyond the planning horizon of this master plan. In order to stage this digester transition, the cover on Digester No. 2 should be replaced so it can be put back in service temporarily while concrete testing is conducted and while Digester No. 1 is moved. No other equipment replacement is included in this master plan since the digesters will be replaced in full.

3.1.14 Sludge Dewatering

It is recommended that the Solids Processing Building be relocated to the central portion of the plant in order to concentrate unsightly and odorous operations away from property boundaries. This move also allows the OWTP the option of adding a Fats, Oil, and Grease (FOG) receiving station near the digester campus of the plant. When the Solids Processing Building is moved, it is recommended that the existing belt filter presses (BFPs) be replaced as they are past their EcRUL. For the purposes of this PWIMP it was assumed that the BFPs would be replaced with centrifuges or screw presses to allow for a conservative cost estimation. Also, as solids loads increase, an additional dewatering unit would allow more operator flexibility so that the dewatering units will not need to run continuously. While it is recommended that the dewatering facilities be replaced, funds for equipment replacement have been reserved to ensure reliability during transition to a new facility.

Additionally, to decouple dewatered sludge hauling from sludge dewatering, it is recommended that digested sludge silos be added. This addition will allow operators to run the dewatering units without having to haul the sludge at the same time.

3.1.15 Cogeneration

This PWIMP recommends that the existing cogeneration building be rebuilt because it was found to be nonconforming for the Immediate Occupancy performance level during a seismic review. When this building is rebuilt, it is recommended that the associated cogeneration equipment be replaced. Following the recommendations of the "Oxnard Wastewater Treatment Plant Energy Evaluation Report," it is recommended that the existing cogeneration units be replaced with two 850-kW generators (Carollo, 2013).

It is recommended that a complete overhaul of the existing facilities wait until after projects that are more critical have been completed. As an interim solution, this PWIMP recommends that the cogeneration building roof be rehabilitated in the near future. This recommendation is consistent with the "Preliminary Identification of Immediate Needs for the Oxnard Wastewater Treatment Plant and Collection System Sewers and Lift Stations" report (KEH, 2014) (Appendix D). A complete facility rebuild would then occur once other more critical projects, such as primary clarifier replacement, have been completed.

3.1.16 Electrical Equipment

It is recommended that the City implement a major re-electrification project at the OWTP. The majority of the existing electrical equipment was found to be in poor condition and in need of replacement. All of the motor control centers (MCCs) throughout the plant are within minus eight (-8) to eight (8) years of their EcRUL. Table 5 lists all the plant MCCs and their EcRUL. Furthermore, many of the programmable logic controllers (PLCs) and local control panels (LCPs) need to be replaced as well. A list of all electrical equipment and their EcRUL is shown in Table 6.

Table 5 Plant-Wide MCCs
Public Works Integrated Master Plan
City of Oxnard

Item	EcRUL (year)
MCC-DP4A, MCC-EDPID, MCC- DP2A, MCC- EBPIB, MCC - DP3C, MCC -DP3D, MCC-DP2B, MCC-DPIA, MCC-DPIB, MCC-EDPIA	-8
MCC-DP2C, MCC-EDPIC, MCC-GF, MCC-DP4, MCC-DP4B, MCC-GB, MCC-GC, MCC-GD, MCC- DP2D, MCC-DP3A, MCC-EDPIE, MCC-HG, MCC-DP3B	2
MCC-SH, MCC-NA, MCC-NC, MCC-ND, MCC-NE, MCC-NF, MCC-HC, MCC-NG, MCC-GA	6
MCC- HW	8

Table 6 Small Electrical Equipment
Public Works Integrated Master Plan
City of Oxnard

Item	EcRUL (year)
Electrical - Main Electrical Building	
Older Transformers	2
Older Transformer 2	2
Switchboard MA-MB	6
Switchgear 1	6
Switchgear 2	2
Switchgear HW	6
Transformer A	10
Transformer B	10
Electrical - North Area Electrical Building	
Switchboard-NB	8
Switchgear	6
Switchboards Large	12
Transformer TC	6
Transformer TD	8
VFDs (13)	6
General - Effluent Electrical Building	
Gym Switchgear	-8

Another major electrical concern at the OWTP is the lack of emergency power. There is only one power feed to the plant. While the generators have adequate capacity, these cannot be brought on line quickly enough to serve as emergency power. In the event of power loss, influent is directed to a primary clarifier. This allows for a half hour detention time until power can be brought online. Reserving clarifier capacity for emergency use, however, means that many maintenance and rehabilitation activities cannot be conducted routinely. This PWIMP recommends replacing the generators.

This PWIMP also recommends conducting an electrical vault repair predesign study, which is consistent with KEH's findings (KEH, 2014). This study would look at the need to repair corroded concrete surfaces and replace corroded conduits, wires, and junction boxes. SCADA improvements are also recommended. A detailed discussion of these recommendations can be found in PM 3.10, *Wastewater - SCADA Assessment.*

3.1.17 Non Process Buildings

The non-process buildings were assessed during both the condition and the seismic analysis. The results of these two assessments are summarized in Table 7.

Table 7 Non Process Building Recommendations Public Works Integrated Master Plan City of Oxnard

Building	Seismic Deficiency	Condition Assessment EcRUL (year)
Replacement Recommended		
Main Switchgear Building	Replace	-20
Butler Storage Building - West	Replace	5
Operations Center Building	Replace	-20
Administration Building(1)	Structure is Adequate, Retrofit Non Structural Components(2)	15
Vacuum Filter Building	Replace	-20
Eastern Trunk Pump Station	Not Evaluated	5
Butler Storage Buildings - East	Replace	5
Effluent Electrical Building(3)	Replace	5
Rehabilitation Recommended		
Collection System Maintenance Building	Retrofit Structural and Non Structural Components(2)	5
Chemical Handling Facilities Building	Retrofit Structural and Non Structural Components(2)	5
Maintenance Building	Retrofit Structural and Non Structural Components(2)	15
North Area Electrical Building	Retrofit Non Structural Components(2)	20

Table 7	Non Process Building Recommendations Public Works Integrated Master Plan City of Oxnard

Notes:
(1) It is recommended that the Operations Center be replaced and co-located with the existing Administration Building, either as an addition or as a new combined structure. This frees space in the central corridor of the OWTP and concentrates non-process facilities at the perimeter.
(2) Details of the recommended retrofits can be found in the Seismic Assessment of OWTP Structures – Tier 2 Evaluation.
(3) It is recommended that the Effluent Electrical Building be replaced as part of the major electrical upgrade recommended. Additionally, this building is currently located at one of the lowest elevations at the plant most at risk for sea level rise.

3.1.18 Other Facility Recommendations

This section tabulates all the miscellaneous plant improvement recommendations of this PWIMP. On a plant-wide basis, it is recommended that budget be allocated for a plant re-paving project once the initial set of construction projects is complete. Additionally, this PWIMP recommends that budget be allocated for a plant-wide cathodic protection project and yearly cathodic protection maintenance. This recommendation is consistent with the "Asset Corrosion Assessment and CP Evaluation Survey" done by JDH Corrosion Consultants (PM 3.9) as part of this PWIMP. It is also recommended that the City invest in a new Computerized Maintenance Management System (CMMS). The existing system is old and outdated and does not communicate with all of the different departments. An upgrade will allow for more uniformity and the ability to share data between departments. Finally, as recommended in the "Mechanical Audit Report," various heat pumps and AC condensing units should be replaced with more efficient models (The Energy Network - Mechanical Audit, 2014).

In addition to these plant-wide improvements, it is recommended that the City allocate funds for the potential future need for a seawall. As shown in Figure 1, it is anticipated that the 100-year storm sea level could rise as much as seven (7) feet by 2040. Based on these high end projections, Table 8 shows the year when each major unit process could be flooded. This PWIMP recommends that the need for a sea wall be re-evaluated and potentially implemented as soon as 2034.

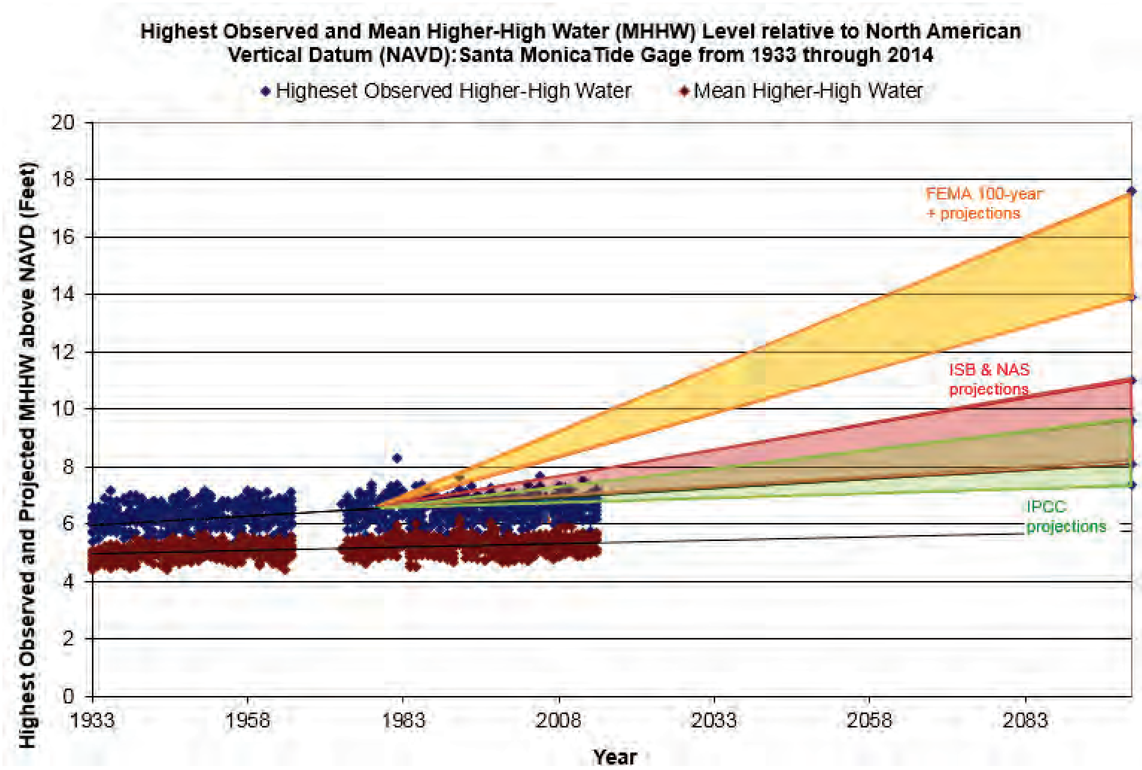


Figure 1 Projected Sea Level Rise

Table 8 Flood Level Projections for Major Unit Processes
Public Works Integrated Master Plan
City of Oxnard

Unit Process	Lowest Flood Elevation (ft)	Year of Flooding[1,2]	Notes
WAS Pumps	4.8	1958	Replacing Facility
Main Electrical Building	9.8	2014	Replacing and Moving Facility
Plant Control Center	10.3	2020	Replacing and Moving Facility
Gravity Thickeners	10.4	2021	Abandoning Facility
Interstage Pump Station	10.5	2021	Replacing and Moving Facility
Flow Equalization Basins	10.7	2023	
Primary Treatment Pumps	10.8	2025	Replacing Facility
Solids Processing/Dewatering	11.3	2030	Replacing and Moving Facility
Aerated Activated Sludge	12.0	2038	
North Area Electrical Building	12.2	2041	
Collection System Maintenance	12.3	2041	
Administration Building	12.6	2044	Replacing Facility
DAF Tanks	12.6	2045	Replacing and Moving Facility
Digesters	12.9	2048	Replacing and Moving Facility
Effluent Pump Station	12.9	2048	Replacing and Moving Facility
Sedimentation Basins	13.7	2057	

Table 8 Flood Level Projections for Major Unit Processes Public Works Integrated Master Plan City of Oxnard			
Unit Process	**Lowest Flood Elevation (ft)**	**Year of Flooding(1,2)**	**Notes**
Headworks	15.3	2075	
Disinfection Facilities	17.5	2099	
Primary Tanks	19.5	2121	Replacing Facility
RAS Pumps	27.1	2205	Replacing Facility

Note:
(1) Year of flooding based off of FEMA 100 Year+ Projections (Santa Monica Tide Levels 1933 to 2014).
(2) See Figure 7 in PM 3.1 for a graphical interpretation of this data.

3.2 Scenario 2: Energy Efficiency

While the baseline scenario, Scenario 1, focuses on repairs and additions necessary to keep the plant operational and in compliance with their existing NPDES permit, Scenario 2 focuses on projects that promote energy efficiency at the OWTP. This scenario includes all projects discussed under Scenario 1. However, Scenario 2 also includes projects to reduce energy use at the OWTP. These additional projects are discussed in the sections below.

3.2.1 FOG Receiving Station

The first project recommended as part of Scenario 2 is a Fats, Oil, and Grease (FOG) receiving station. This receiving station would allow for flexibility in FOG addition timing thus preventing slug loading which can cause digester upsets. This also allows for the addition of FOG when energy costs are high. Two alternatives for a FOG receiving station were recommended in the “Oxnard Wastewater Treatment Plant Energy Evaluation Report” (Carollo, 2013). The first alternative would double the current FOG addition. The second alternative would increase FOG addition to the digester capacity limit. For the purpose of this PWIMP, alternative two was chosen because it had the larger potential for energy savings. Adding a FOG receiving station by 2020 is also recommended as part of Oxnard’s Energy Action Plan (Oxnard Planning Division, 2013).

3.2.2 Solar or Alternative Energy Facility

The second project recommended as part of Scenario 2 is the addition of solar cells as recommended in the “Oxnard Wastewater Treatment Plant Energy Evaluation Report” (Carollo, 2013) (Appendix C). For this PWIMP, it was assumed that solar photovoltaic cells would be added to the rooftops and carports recommended in the Energy Evaluation Report (Carollo, 2013). This addition would increase the amount of energy produced onsite and thus help the OWTP achieve energy self-sufficiency.

3.3 Scenario 3: Resource Recovery

Scenario 3 focuses on projects that maximize water reuse and nutrient mining. This scenario includes all projects discussed under Scenario 1 and Scenario 2. However, Scenario 3's focus is to protect and enhance resource sustainability. The additional projects included in Scenario 3 are discussed in the sections that follow.

3.3.1 Phosphorous Recovery

The first project recommended as part of Scenario 3 in this PWIMP is the addition of a phosphorous recovery facility. This facility would harvest phosphorous from the dewatering centrate and create marketable fertilizer pellets. An example of such a process is shown in Figure 2.

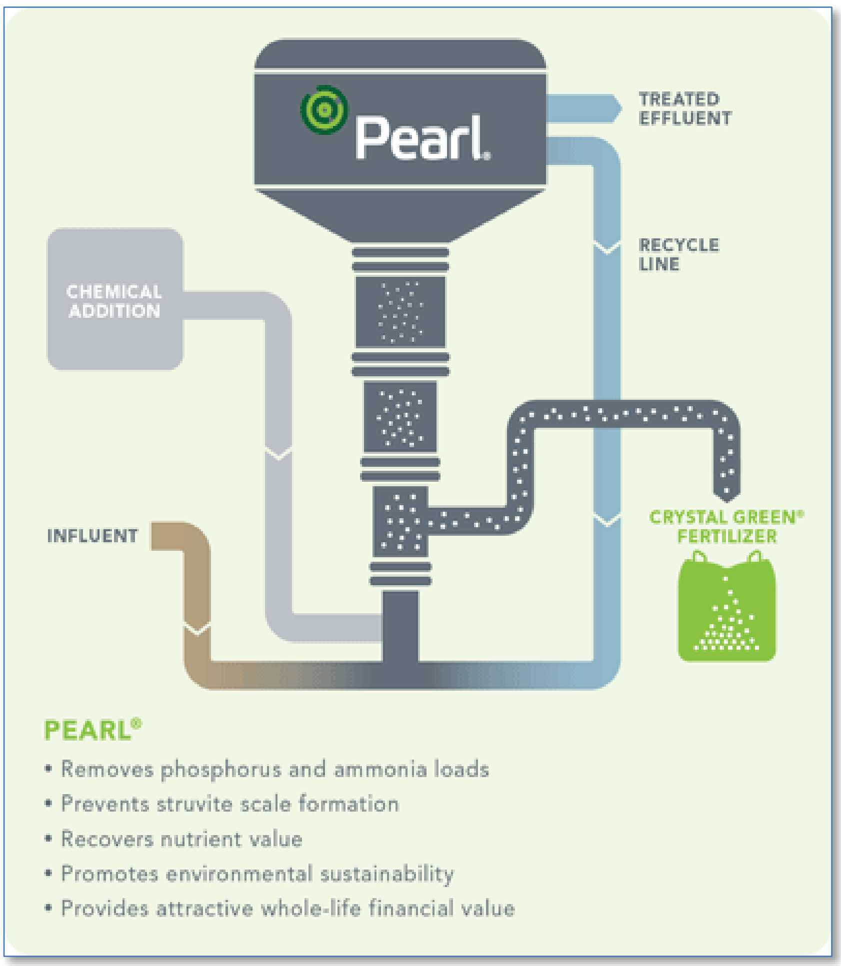


Figure 2 Phosphorous Recovery Schematic *Source: Ostara Nutrient Recovery Technologies*

3.3.2 Sludge Post Processing

The second project recommended as part of Scenario 3 is the addition of a sludge post processing facility. The purpose of this facility would be to decrease the amount of sludge hauled to a landfill. This reduction not only enhances onsite reuse of waste materials, but it is also more favorable from a regulatory standpoint. As discussed in PM 3.1 Section 2, sending sludge to a landfill facility will likely become increasingly difficult throughout California. It is thus prudent to plan for alternative sludge disposal methods.

4.0 SCENARIO EVALUATION

4.1 Economic Analysis

A cost estimate of the three main scenarios was developed for facilities needed through the planning period (2040). The costs were developed using factors outlined in PM 1.4, Basis of Cost as well as cost information from past projects and estimates. The economic comparison of the three scenarios considered is shown in Table 9.

Table 9 Comparison of Scenario Costs(1)
Public Works Integrated Master Plan
City of Oxnard

Cost ($ M)	Scenario 1	Scenario 2	Scenario 3
Headworks	$14.9	$14.9	$14.9
Primary Treatment	$20.9	$20.9	$20.9
Secondary Treatment	$100.3	$100.3	$100.3
Disinfection/Effluent Pumping/Outfall	$24.5	$24.5	$24.5
Sludge Thickening	$13.4	$13.4	$13.4
Digestion	$34.4	$34.4	$34.4
Dewatering and Sludge Post Processing	$27.6	$27.6	$88.1
Cogeneration/FOG	$13.8	$16.5	$16.5
Electrical	$18.3	$18.3	$18.3
Non-Process Buildings	$25.1	$25.1	$25.1
Other	$33.6	$34.8	$38.3
Total Construction Cost	**$327**	**$331**	**$395**
Total Project Cost(2)	**$405**	**$410**	**$489**
Annual Costs ($ M / yr)	$20.3	$20.5	$24.5
Annualized Project Cost(3)	$33	$33	$39
Total O&M(4)	$5.0	$5.4	$6.5
Total Annual Cost	$37.5	$38.3	$45.8

Table 9	Comparison of Scenario Costs[1] Public Works Integrated Master Plan City of Oxnard
Notes: (1) Costs derived using the methodology outlined in PM 1.4, Basis of Cost. (2) Project costs include project cost factor (as outlined in PM 1.4, Basis of Cost). (3) Annualized at 5% over 20 years. (4) O&M costs include only additional O&M costs from new capital improvement projects.	

4.2 Non-Economic Considerations

In addition to the economic analysis, non-economic considerations were summarized that relate to the goals and objectives for the PWIMP, as noted in Section 2.0. That summary is included in Table 10. Using those considerations, a combined comparison was done to determine if there was dramatic difference in the scenarios. The comparison, highlighted in Table 10, showed a slight advantage to Scenario 2 and 3 due to moderate to high goal achievement. Based upon this assessment and the lower cost of Scenario 2 compared to Scenario 3, the City agreed to move forward with Scenario 2: Energy Efficiency.

4.2.1 Energy Analysis

In addition to the overall comparison shown in Table 10, a specific energy comparison was developed to further assess the three scenarios. This comparison draws in large part from the following documents:

- "Energy Action Plan: A component of the Oxnard Climate Action and Adaptation Plan" (Oxnard Planning Division, 2013).
- "Oxnard Wastewater Treatment Plant Energy Evaluation Report" (Carollo, 2013).
- "Water and Wastewater Process Optimization and Mechanical Audit Report DRAFT" (The Energy Network, 2014).
- "Mechanical Audit Report" (The Energy Network, 2014).

This section summarizes the findings of the documents listed above and explains how they are applicable to the OWTP scenario evaluation. In general, there is the potential for energy savings from both large recommended capital improvement projects, and smaller equipment replacement projects. All of the smaller equipment replacement projects are recommended for all three scenarios, and thus while important, do not differentiate one scenario from another. The recommended small equipment projects are as follows:

- Replace the Admin Building 10-ton rooftop split system outdoor heat pump unit.
- Replace the Maintenance Building 4-ton rooftop single package heat pump unit.

Table 10 Non-Economic Consideration of Water Supply Alternatives
Public Works Integrated Master Plan
City of Oxnard

	Scenario 1 - Baseline	**Scenario 2 - Energy Efficiency**	**Scenario 3 - Resource Recovery**
Goal 1: Compliant, reliable, flexible system	Moderate	High	High
Goal 2: Economic sustainability	Moderate	High	Moderate
Goal 3: Mitigate/adapt to climate change	Moderate	Moderate	Moderate
Goal 4: Resource sustainability	Low	Moderate	High
Goal 5: Energy efficiency	Low	High	High
Benefits	• Lower overall cost • Focuses on rehabilitating the existing plant as the highest priority • Provides a seawall to protect against potential sea level rise from climate change	• Moderate cost • More flexible system to address potential future changes in the cost of energy • Provides a seawall to protect against potential sea level rise from climate change	• More flexible in sludge handling and resource recovery • More flexible system to address potential future changes in the cost of energy • Provides a seawall to protect against potential sea level rise from climate change
Drawbacks	• Does not directly address goal 4 or goal 5 • Less able to adapt to potential future increases in the cost of energy • Does little to take advantage of resources produced onsite	• Does not focus on recovering nutrients and sludge onsite	• High Cost

- Replace the Maintenance Building 5-ton rooftop single package gas/electric unit.
- Replace the Operations Center 4-ton and two 3-ton rooftop single package heat pumps.
- Replace the Effluent Electrical Room 3-ton rooftop split system outdoor heat pump unit.
- Replace the North Area Electrical Building 7.5-ton rooftop single package heat pump unit.
- Replace the storage building server room 5-ton split system AC condensing unit.
- Replace the new headworks 3-ton rooftop single package AC.

See The Energy Network's "Mechanical Audit Report" for more information on these recommendations. Combined, these changes could decrease energy use at the plant by 27,075 kWhs.

There is also the potential for some of the recommended larger capital improvement projects to produce energy savings. These projects and their potential energy savings are shown in Table 11.

Table 11 Potential Energy Savings
Public Works Integrated Master Plan
City of Oxnard

Recommendation	Potential Relative Energy Savings		
	Scenario 1	Scenario 2	Scenario 3
Biotower Removal and Interstage Pump Reconfiguration	Included in All Scenarios	Included in All Scenarios	Included in All Scenarios
AST Blower Replacement	Included in All Scenarios	Included in All Scenarios	Included in All Scenarios
Cogen Replacement	Included in All Scenarios	Included in All Scenarios	Included in All Scenarios
FOG Receiving Station	NA	+	+
Solar or Alternative Energy Facility	NA	+	+
Incineration	NA	NA	+
Total Potential Energy Savings:	+	++	+++

Note:
(1) Only projects that could produce energy savings are included in this analysis.

As shown in this table, both Scenario 2 and 3 achieve greater potential energy savings than Scenario 1. Furthermore, both Scenario 2 and 3 are consistent with Oxnard's Energy Action Plan.

As discussed in PM 1.1, one of Oxnard's goals, as stated in the Energy Action Plan, is to reduce City-wide energy usage by 10 percent. The Energy Action Plan outlines specific ways to help achieve this goal, and one of these recommendations is directly applicable to the OWTP. Goal G-14: Increase on-site electricity generation at City wastewater treatment and materials recovery facility is directly addressed in Scenario 2 and 3 with the addition of a FOG receiving station to increase FOG sent to the digesters. This project will subsequently increase the amount of energy the cogeneration facilities can recover. Given the greater potential for energy savings and the alignment with Oxnard's Energy Action Plan goals, Scenario 2 is recommended.

5.0 RECOMMENDED PROJECTS

After discussion with the City, the team recommends proceeding with Scenario 2. This section summarizes the estimated funding requirements for all within the fence-line OWTP projects in Scenario 2 through the year 2040. This information is used as the basis for the financial analysis portion of the PWIMP to determine the financial impact of the project to the City and its rate payers.

There are four main drivers for the projects included within the CIP: 1) Rehabilitation and Replacement (R&R), 2) Small Equipment Replacement, 3) Performance, and 3) Resource Sustainability. These drivers are noted next to each project along with their anticipated start year and length of project completion. The projects are categorized in phases which loosely also follows timing of the projects: 1) Phase 1A and B – Immediate needs; 2) Phase 2 – Near-Term Needs; and 3) Phase 3 – Long-Term Needs.

Each of the drivers is described in more detail below.

5.1 Rehabilitation and Replacement (R&R)

Several analysis conducted as part of the PWIMP have assessed the condition of the City's existing wastewater system assets. In general, R&R is the main driver for the majority of the recommended projects at the OWTP. The following PMs address the existing OWTP asset assessments that were made:

- PM 3.5 - Wastewater Condition Assessment - Assessed the R&R needs of and developed priorities for the wastewater lift stations and all mechanical and electrical equipment as well as all structures at the OWTP.

- PM 3.6 - Seismic Assessment - Assessed the seismic safety hazard of all buildings and all water retaining structures at the OWTP.

- PM 3.8 - Arc Flash Assessment - Included a Short Circuit Study, Protective Device Coordination Study and an Arc Flash Study of the OWTP facilities.
- PM 3.9 - Cathodic Protection - Assessed the cathodic protection needs of the wastewater system and developed a list of recommended projects to address deficiencies.

5.2 Small Equipment Replacement

Small equipment replacement budgets have been included for all unit processes. These budgets were developed as part of the condition assessment analysis conducted in PM 3.5, Wastewater Condition Assessment. All existing small equipment at the OWTP was assigned a remaining useful life as well as a replacement cost. Small equipment for each unit process was then grouped by expected replacement year into five year increments and their expected replacement costs were summed. The allocated costs in Table 10 reflect this analysis.

5.3 Performance

Performance projects include projects that will help optimize current OWTP plant operations. These projects with either make the plant easier to run for plant operators or they will help optimize the treatment ability of the plant.

5.4 Resource Sustainability

Resource sustainability is the main driver for the projects that aim to recover resources on site and decrease waste sent offsite. Such projects include onsite energy generation, onsite nutrient recovery, and onsite sludge reduction.

5.5 Cost, Phase and Schedule Summary

The Recommended Wastewater project costs presented in Table 12 are based on the preliminary layouts, sizing and configuration. Project costs are estimated based on unit costs developed from estimating guides, equipment manufacturer's information, unit prices, and construction costs of similar facilities and other locations. A more detailed discussion of the basis of costs is included in PM 1.4, Basis of Cost.

The costs and timing presented in this PM represent Carollo's best professional judgment of the capital expenditure needs of the City and of the timing needed to maintain a reliable and compliant system that can meet current and future wastewater generation needs. Timing was set to align with the seven master plan drivers, namely: R&R, regulatory requirements, economic benefit, performance benefit, growth, resource sustainability, and policy decisions. Timing is also based on input from City staff and the condition assessments performed.

Table 12 Recommended Projects, Cost Estimates, and Phasing for Within Fence-Line Wastewater System – Upgrade in Place(7)
Public Works Integrated Master Plan
City of Oxnard

Project Name	Driver	Start Year	Years to Implement	Un-escalated Project Cost ($)
Phase 1A Projects:				
Biotower Removal				
Demolish Biotowers	R&R	2016	1	$770,000(1)
Add Baffle Walls in ASTs	R&R	2016	1	$380,000
Reconfigure Interstage Pumping (and replace pumps)	R&R	2016	2	$15,020,000
Primary Clarifier Replacement				
Demolish and Rebuild Primary Clarifiers	R&R	2016	6	$18,600,000
Rebuild Primary Clarifier Building/ Pump Sludge Pump Station	R&R	2016	6	$2,893,000
Add CEPT including Mixing Facilities	Performance	2016	2	$1,470,000(2)
Add Influent Splitter Box	Performance	2016	2	$1,450,000
Demolish Butler Storage Building - West	R&R	2016	1	$49,000
New Butler Storage Building - West	R&R	2021	1	$954,000
Small Equipment Replacement - Primary Clarifier	R&R	2016	1	$469,000
Electrical Upgrade: MCC, Electrical Buildings, CMMS, and Emergency Generator Replacement				
New Main Switchgear Building	R&R	2017	3	$926,000
New Effluent Electrical Building	R&R	2017	3	$1,158,000
Electrical Vault Repair Pre-Design Study	R&R	2016	2	$27,000(3)
Replace Standby Generators	R&R	2016	3	$2,543,000
Replace Plant MCCs	R&R	2016	5	$5,430,000

Table 12 Recommended Projects, Cost Estimates, and Phasing for Within Fence-Line Wastewater System – Upgrade in Place(7)
Public Works Integrated Master Plan
City of Oxnard

Project Name	Driver	Start Year	Years to Implement	Un-escalated Project Cost ($)
Plant-wide SCADA System Upgrade	R&R	2016	5	$10,816,000
Small Equipment Replacement - Electrical 1	Small Equipment Replacement	2016	2	$275,000
Small Equipment Replacement - Electrical 2	Small Equipment Replacement	2020	2	$626,000
Small Equipment Replacement - Electrical 3	Small Equipment Replacement	2023	2	$653,000
CMMS	R&R	2016	3	$250,000
BFP Rehab and Non Hazardous Liquid Receiving Station				
BFP Rehab	R&R	2016	1	$2,280,000(2)
Construct a Non Hazardous Liquid Receiving Station(8)	Performance	2016	2	$2,564,000
Phase 1B Projects:				
Plant-wide Cathodic Protection	R&R	2016	2	$1,430,000(4)
Solids Campus Upgrade: Gravity Thickener Demo, Dewatering Move and Upgrade, and DAFT Move and Expansion				
Install Cover on Digester 2	R&R	2016	1	$2,260,000(3)
Demolish Gravity Thickeners and Blower Building	R&R	2017	1	$583,000
Demolish Odor Reduction Tower	R&R	2017	1	$100,000
Demolish Operations Center and Vac Filter Bld	R&R	2017	1	$448,000
Move Dewatering Facility and add New Centrifuges	Performance	2016	3	$23,370,000
Add Dewatering Capacity	Performance	2016	3	$2,160,000
New Operations Center Building co-located with new Administration Building	R&R	2016	4	$20,940,000
Add Sludge Silos	Performance	2018	3	$6,370,000

Table 12 Recommended Projects, Cost Estimates, and Phasing for Within Fence-Line Wastewater System – Upgrade in Place[7]
Public Works Integrated Master Plan
City of Oxnard

Project Name	Driver	Start Year	Years to Implement	Un-escalated Project Cost ($)
Demolish DAFTs and Rebuild (2) at New Solids Campus	Performance	2018	3	$8,590,000
Build additional 2 DAFTs at New Solids Campus	Performance	2018	3	$7,350,000
Add TWAS Sludge Pumping Capacity	Performance	2018	3	$40,000
Building Upgrades for Seismic Safety and Plant Paving Resurfacing				
Rehab Cogen Building Roof	R&R	2017	2	$120,000[3]
New Storage Building ("Vacuum Filter Building")	R&R	2017	3	$4,406,000
Rehab Collection System Maintenance Building	R&R	2019	2	$1,399,000
Rehab Chemical Handling Facilities Building	R&R	2019	2	$746,000
Rehab Maintenance Building	R&R	2019	2	$279,000
Rehab North Area Electrical Building	R&R	2019	2	$448,000
Rehab Grit Screening Building - Seismic Retrofit	R&R	2019	2	$1,866,000
New Eastern Trunk Pump Station	R&R	2019	2	$1,003,000
New Butler Storage Buildings - east	R&R	2022	2	$1,158,000
Small Equipment Replacement - General Building 1	Small Equipment Replacement	2016	2	$190,000
Small Equipment Replacement - General Building 2	Small Equipment Replacement	2023	2	$89,000
Plant Paving Resurfacing	Small Equipment Replacement	2022	3	$410,000[5]
Headworks Odor Control, Concrete and Coating Repair, and RPF Cover Replacement				
Headworks Odor Control with Screen Walls, Concrete Repair, and RPF Cover Replacement	R&R	2016	3	$4,640,000[2,3]
Below Cover Coating Repairs	R&R	2016	4	$1,310,000[3]

Table 12 Recommended Projects, Cost Estimates, and Phasing for Within Fence-Line Wastewater System – Upgrade in Place[7]
Public Works Integrated Master Plan
City of Oxnard

Project Name	Driver	Start Year	Years to Implement	Un-escalated Project Cost ($)
Secondary Treatment Concrete Rehab, Equipment Replacement, and Process Optimization				
Concrete Repair and Seismic Retrofit - EQ Basin	R&R	2016	3	$2,596,000
Concrete Repair and Seismic Retrofit - ASTs	R&R	2016	11	$8,121,000
Concrete Repair and Re-painting - SSTs	R&R	2016	11	$5,719,000
Modify SST Inlet	Performance	2016	3	$160,000
New ML Wasting Station	Performance	2016	3	$2,640,000
Replace Collectors, Skimmers, and Drives (Secondary Sedimentation Tanks)	R&R	2016	3	$9,925,000
RAS Pump Modifications	Performance	2016	3	$1,120,000
Replace Blowers	R&R	2016	3	$2,585,000
Diffuser Replacement	R&R	2016	3	$3,120,000[1]
Small Equipment Replacement - secondary 1	Small Equipment Replacement	2016	3	$610,000
Small Equipment Replacement - secondary 2	Small Equipment Replacement	2020	3	$62,000
Small Equipment Replacement - wet weather storage 2	Small Equipment Replacement	2020	3	$527,000
Disinfection and Effluent Pumping Equipment Replacement				
New Effluent Pumping Station Building	R&R	2017	4	$1,234,000
New Effluent Pump Station	R&R	2017	4	$13,838,000[2]
Water Quality Early Warning System	Performance	2017	4	$330,000[2]
		PHASE 1 TOTAL:		**$213,895,000**

Table 12 Recommended Projects, Cost Estimates, and Phasing for Within Fence-Line Wastewater System – Upgrade in Place(7)
Public Works Integrated Master Plan
City of Oxnard

Project Name	Driver	Start Year	Years to Implement	Un-escalated Project Cost ($)
Phase 2 Projects:				
Headworks Equipment Replacement and Building Rehab				
Small Equipment Replacement - Headworks 1	Small Equipment Replacement	2019	2	$383,000
Small Equipment Replacement - Headworks 2	Small Equipment Replacement	2023	3	$6,306,000
Small Equipment Replacement - Headworks 3	Small Equipment Replacement	2028	2	$149,000
Rehab Headworks Building	R&R	2032	3	$ 3,858,000
Digester Campus Rebuild of Digesters and Digester Control Building				
New Digester 1	R&R	2019	3	$12,950,000
New Digester 2	R&R	2020	3	$12,950,000
New Digester 3	R&R	2021	3	$12,950,000
New Digester Control Building	R&R	2019	5	$1,543,000
Cogen Building and Equipment Replacement, New FOG Receiving Station				
New Cogen Building	R&R	2022	3	$4,630,000
Small Equipment Replacement - Cogen	Small Equipment Replacement	2022	3	$2,233,000
Replace Cogen Engines	R&R	2022	3	$10,140,000(6)
Add a FOG Receiving Station	Resource Sustainability	2019	2	$3,390,000(6)
Disinfection Equipment Replacement				
Coating Replacement on Chlorine Contact Tanks	R&R	2026	2	$1,359,000
Small Equipment Replacement 1	Small Equipment Replacement	2024	3	$403,000
		PHASE 2 TOTAL:		**$73,244,000**

Table 12 Recommended Projects, Cost Estimates, and Phasing for Within Fence-Line Wastewater System – Upgrade in Place[7]
Public Works Integrated Master Plan
City of Oxnard

Project Name	Driver	Start Year	Years to Implement	Un-escalated Project Cost ($)
Phase 3 Projects:				
MBR	Resource Sustainability	2019	2	$71,000,000
Add UV/AOP after MBR	Resource Sustainability	2019	2	$13,200,000
Solar or Alternative Energy Facility	Resource Sustainability	2021	10	$1,540,000[6]
Seawall	Resource Sustainability	2033	5	$37,260,000
	PHASE 3 TOTAL:			**$123,000,000**

Notes:

(1) From 2014 report by MKN Associates.
(2) From AECOM's estimates.
(3) From KEH's 2014 Immediate Needs Report.
(4) From PM 3.8 Cathodic Protection Assessment.
(5) From City's 2013 CIP.
(6) From the 2013 Energy Evaluation Report by Carollo.
(7) Project costs, schedules, and phasing are based on data and information available at the time of the original date of preparation – December 2015. The updated CIP is contained in the Brief History section of the PMs, the Summary Report, and the Executive Summary.
(8) The Waste Receiving Station should be located near the OWTP Headworks (i.e., the head of the plant). Based on this, the City may need to use the land currently leased to the Port Hueneme Water Agency.

While the costs developed in this PM match the costs analyzed as part of the Cost of Service Study, the timing presented may differ. The Cost of Service Study will balance not only the CIP projects identified but also the rates and rate payer affordability based on a yearly balance and also the integrated costs for the different City funds and enterprises.

The Overall Project Costs for the Recommended Wastewater Projects are summarized in Table 13.

Based on capacity and reliability needs, a preferred project schedule for Scenario 2 was developed to phase the recommended project components over a 25-year period. The schedule presented in this section was developed based on the technical aspects of the projects to minimize risk and allow for future flexibility. Both design and construction durations are shown. Because the majority of the projects are R&R and many of them could ideally start now, consideration was given to constructability at the space-limited plant and precedence was shown for critical projects. It is possible that the actual timing of these projects will change when looking at all of the City's facilities holistically instead of just focusing on the within-fence line OWTP projects.

Table 13 Overall Project Costs by Phase for within Fence-Line Wastewater System – Upgrade in Place[(1)]
Public Works Integrated Master Plan
City of Oxnard

Phase	Un-escalated Project Cost
1A	$70,000,000
1B	$144,300,000
2	$73,200,000
3	$123,000,000
Total	**$410,500,000**

Notes:
(1) Project costs, schedules, and phasing are based on data and information available at the time of the original date of preparation – December 2015. The updated CIP is contained in the Brief History section of the PMs, the Summary Report, and the Executive Summary.

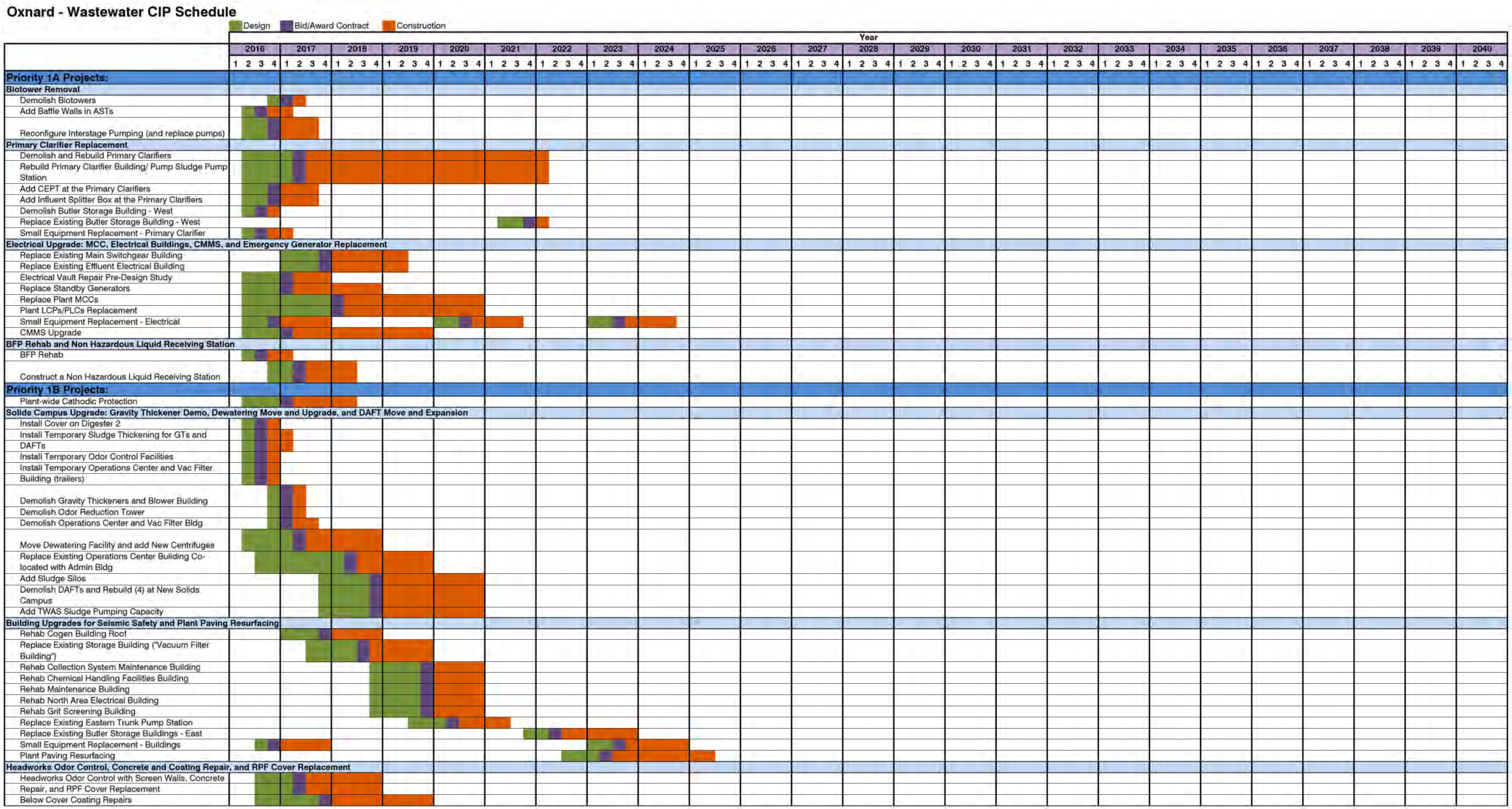
The 25-year CIP runs through FY 2039/40. During this period, the majority of the CIP is focused on rehabilitation and replacement of the existing system. Over the next 25 years, the City's CIP will accomplish:

- Removal of the Biotowers.
- Replacement of the Primary Clarifiers.
- A major re-electrification of the plant to increase reliability.

- A solids campus upgrade to increase the reliability of sludge thickening, digestion, and dewatering.
- Building upgrades to meet current seismic code.
- Headworks upgrades to control odors.
- Secondary treatment rehab to address seismic and aging equipment concerns.
- A replacement of the effluent pumping equipment.
- A replacement of the cogeneration facilities.
- Potential process changes to promote resource recovery and energy self-sufficiency.

Figures 3A and 3B show the Recommended Wastewater Project schedule for Scenario 2. Scenario 2 totals approximately $416 million in 2014 dollars. Recommended expenditures are heavily weighted towards the first 10 years of the program, totaling $373 million. Due to the front-loaded nature of the Recommended Projects, implementation of these projects will be the most significant driver of the City's financial plan.

Figures 3C through 3H show the 2015 – 2020 year-by-year implementation projects, respectively. Figures 3I through 3K show the 2025, 2030, and 2035 implementation projects, respectively.

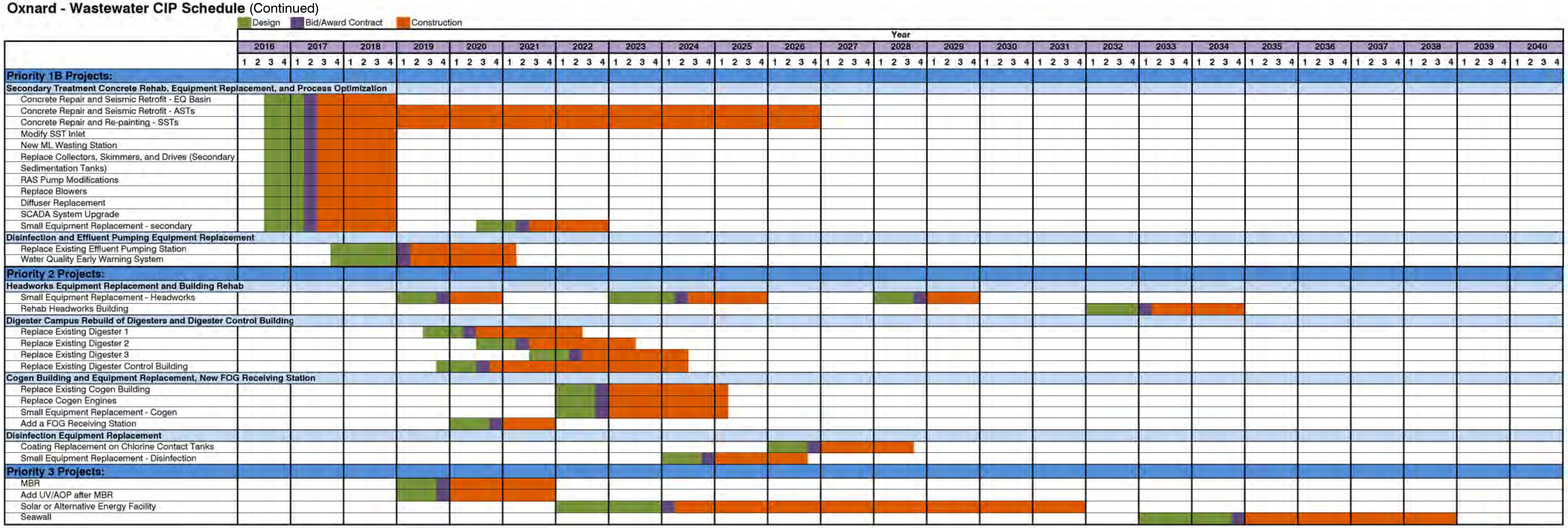


RECOMMENDED WASTEWATER CIP SCHEDULE (Part 1)

FIGURE 3A

CITY OF OXNARD
PM NO. 3.7.1 WASTEWATER
PUBLIC WORKS INTEGRATED MASTER PLAN

Oxnard - Wastewater CIP Schedule (Continued)

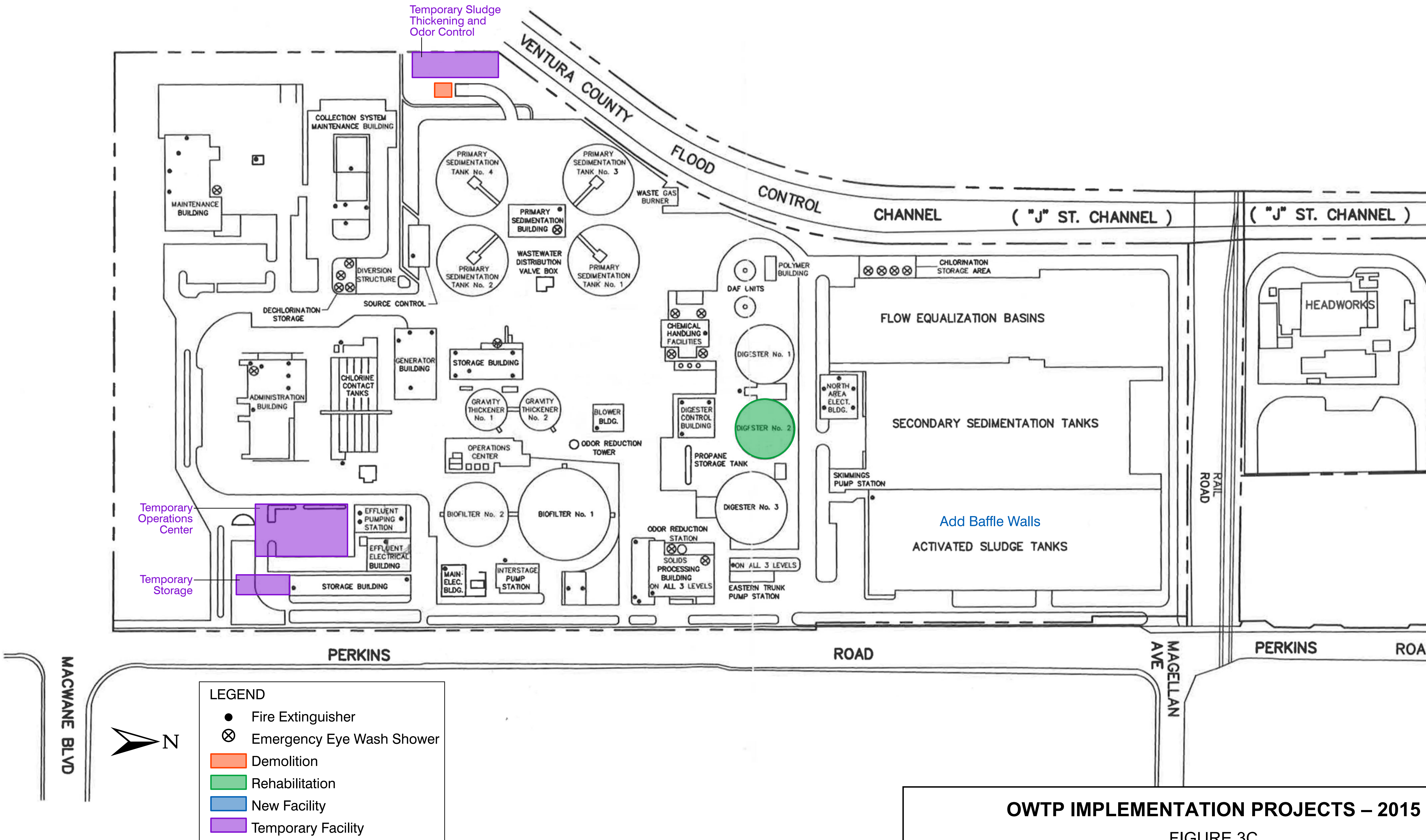


RECOMMENDED WASTEWATER CIP SCHEDULE (Part 2)

FIGURE 3B

CITY OF OXNARD
PM NO. 3.7.1 WASTEWATER
PUBLIC WORKS INTEGRATED MASTER PLAN

ox1015f2-9587(PM3-7-1FIG3B).ai

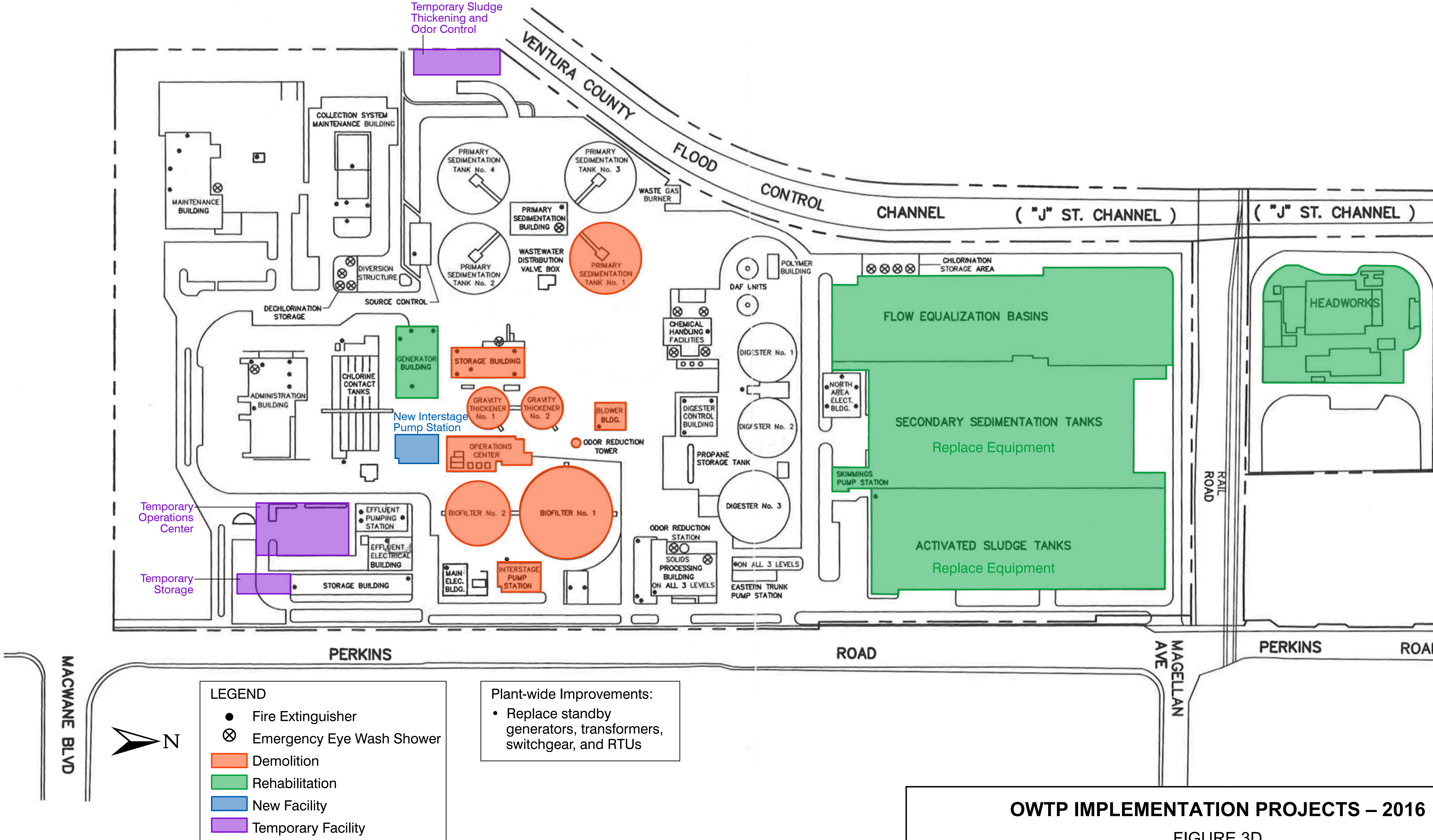


OWTP IMPLEMENTATION PROJECTS – 2015

FIGURE 3C

CITY OF OXNARD
PM NO. 3.7.1 WASTEWATER
PUBLIC WORKS INTEGRATED MASTER PLAN

ox0115f10-9587(PM3-7-1FIG3C).ai



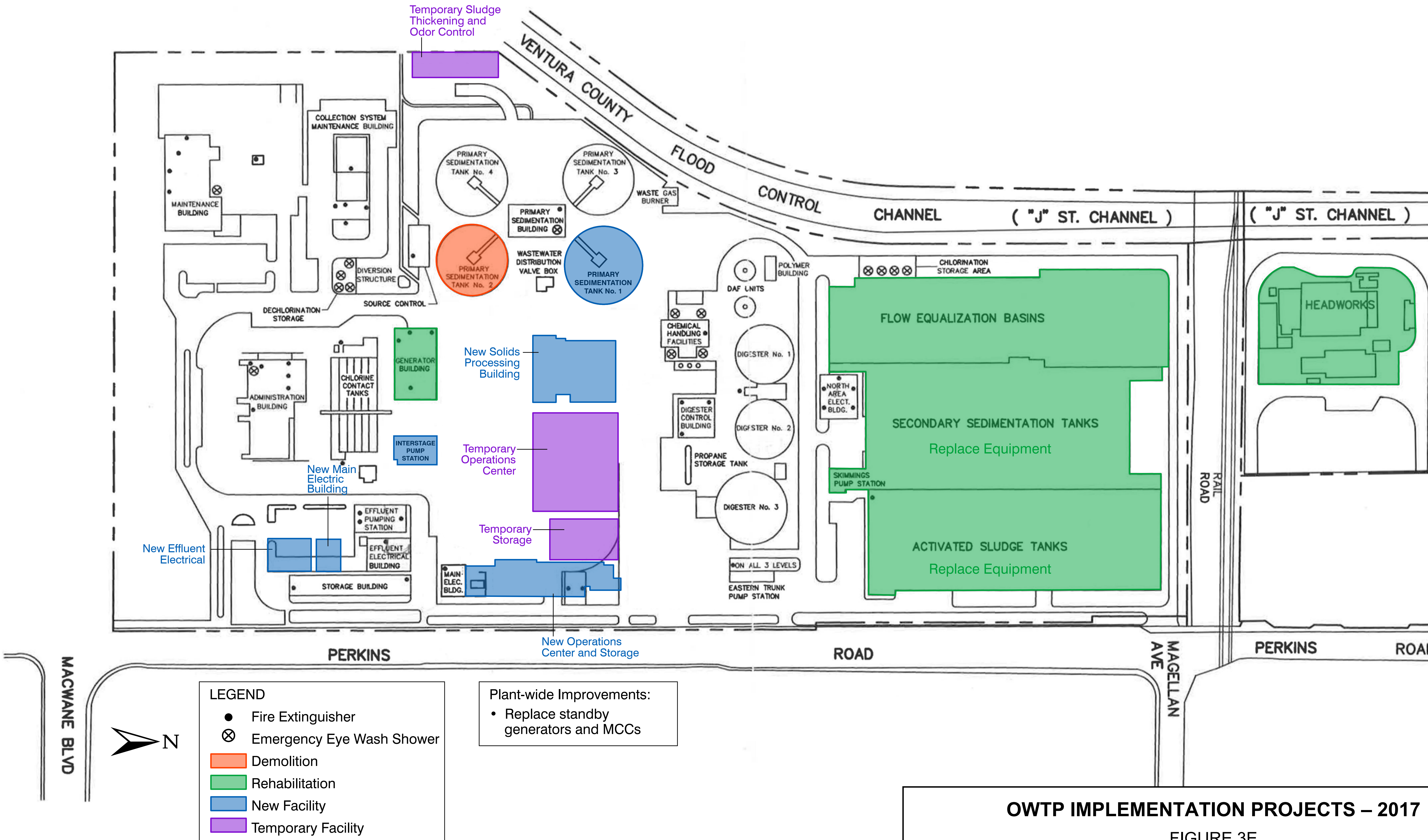
OWTP IMPLEMENTATION PROJECTS – 2016

FIGURE 3D

CITY OF OXNARD
PM NO. 3.7.1 WASTEWATER
PUBLIC WORKS INTEGRATED MASTER PLAN

carollo

ox0115f11-9587(PM3-7-1FIG3D).ai

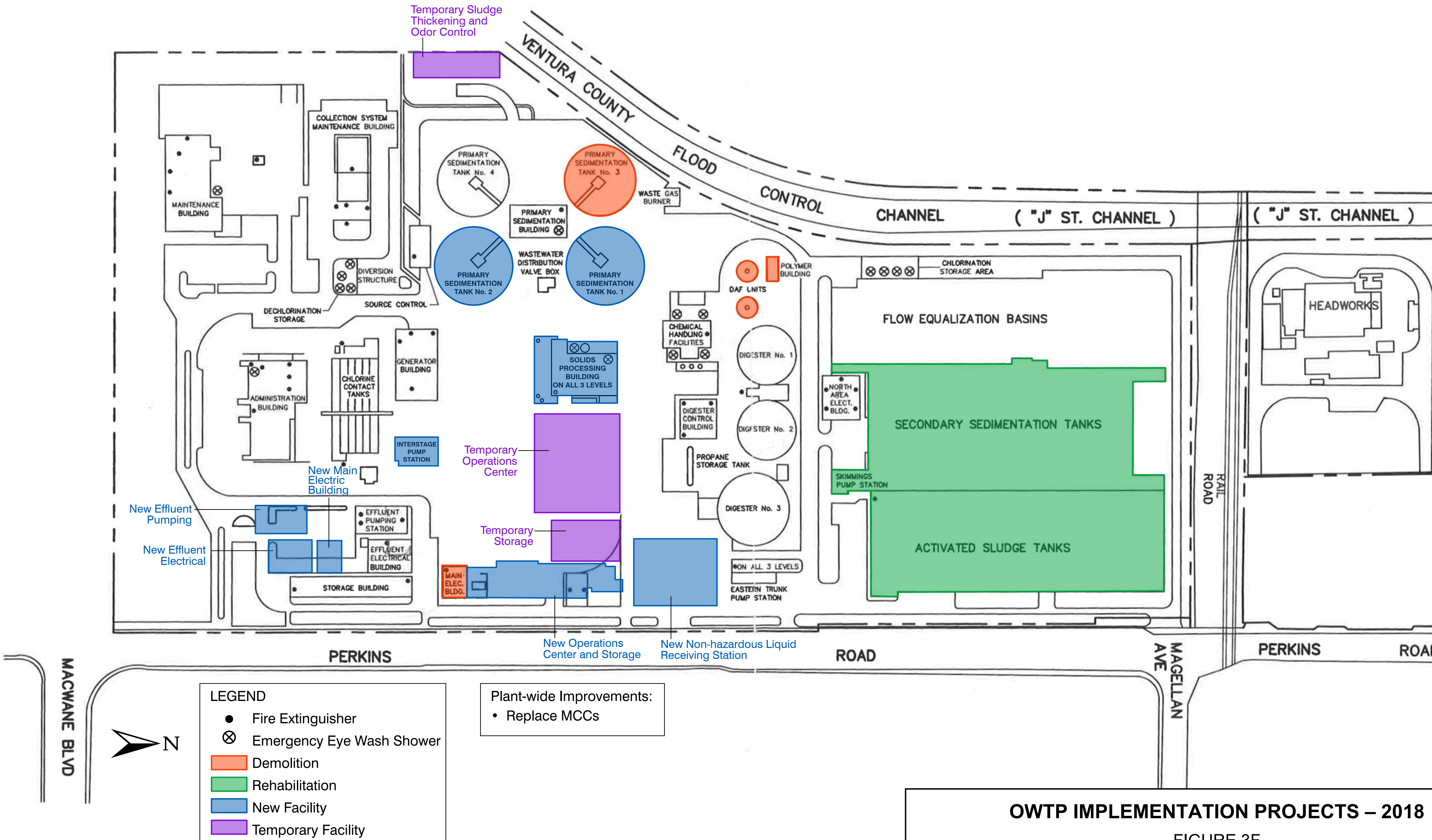


OWTP IMPLEMENTATION PROJECTS – 2017

FIGURE 3E

CITY OF OXNARD
PM NO. 3.7.1 WASTEWATER
PUBLIC WORKS INTEGRATED MASTER PLAN

ox0115f12-9587(PM3-7-1FIG3E).ai



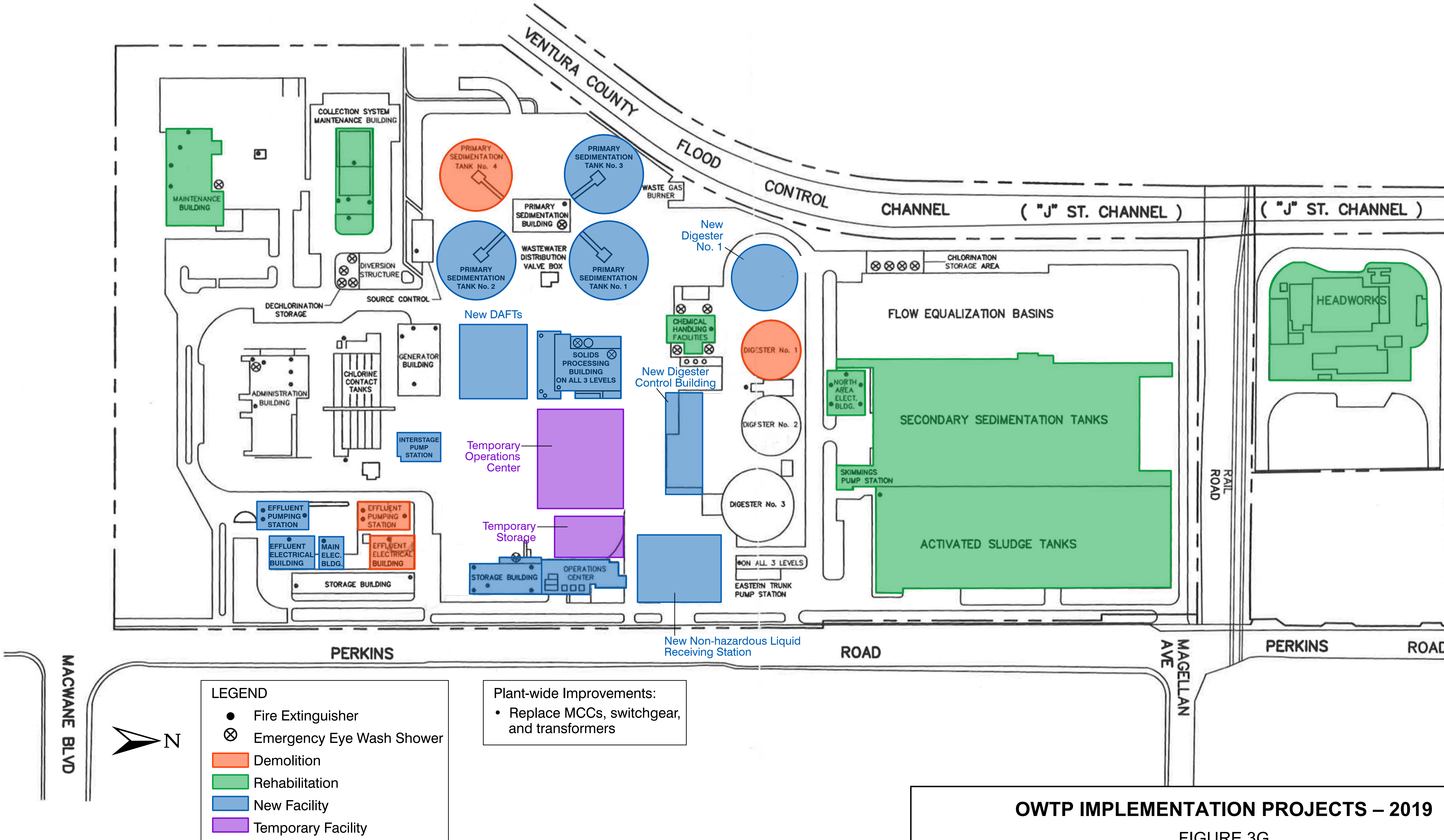
OWTP IMPLEMENTATION PROJECTS – 2018

FIGURE 3F

CITY OF OXNARD

PM NO. 3.7.1 WASTEWATER

PUBLIC WORKS INTEGRATED MASTER PLAN



OWTP IMPLEMENTATION PROJECTS – 2019

FIGURE 3G

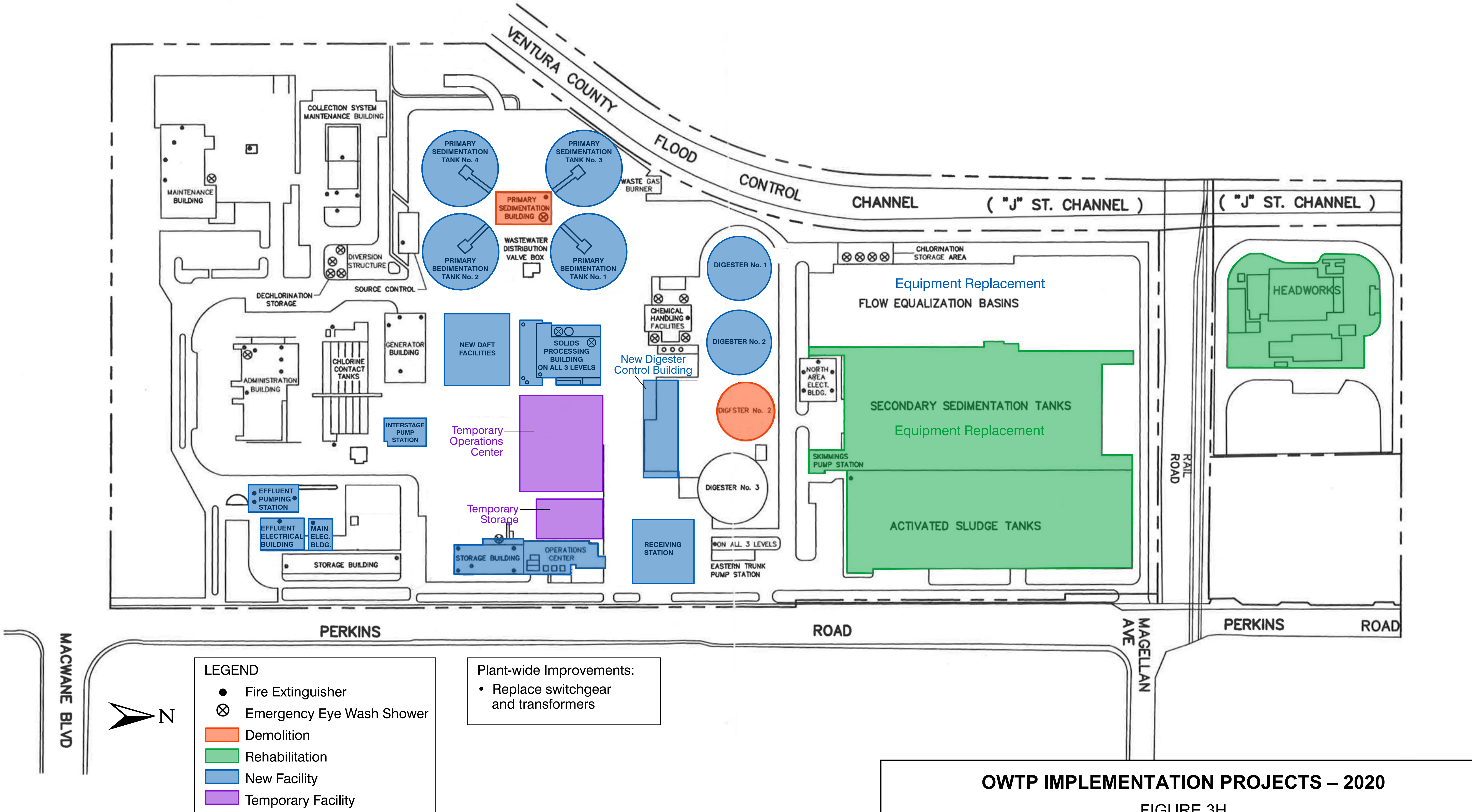
CITY OF OXNARD

PM NO. 3.7.1 WASTEWATER

PUBLIC WORKS INTEGRATED MASTER PLAN

CITY OF OXNARD CALIFORNIA

carollo Engineers...Working Wonders With Water®



OWTP IMPLEMENTATION PROJECTS – 2020

FIGURE 3H

CITY OF OXNARD

PM NO. 3.7.1 WASTEWATER

PUBLIC WORKS INTEGRATED MASTER PLAN

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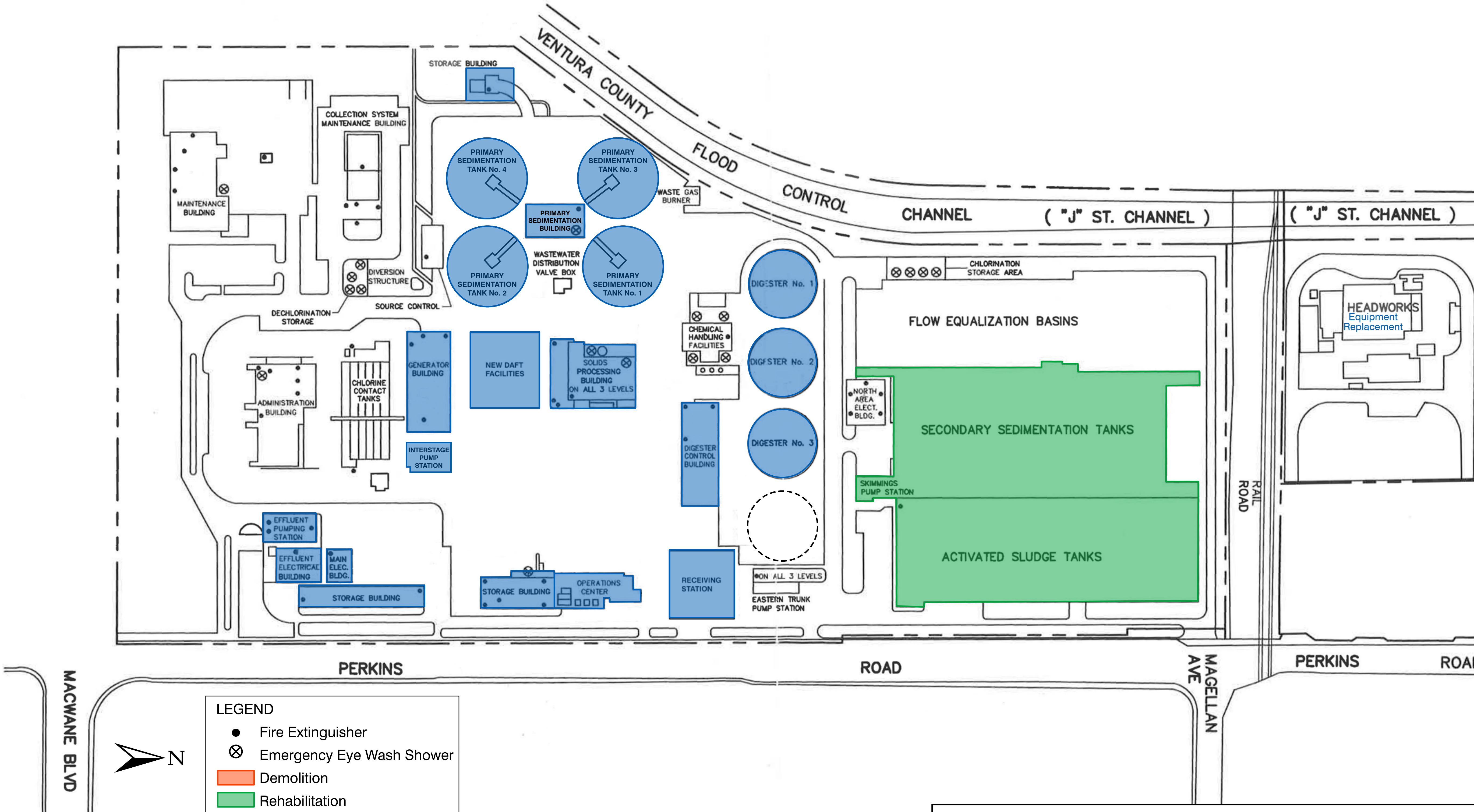

LEGEND

- ● Fire Extinguisher
- ⊗ Emergency Eye Wash Shower
- Demolition
- Rehabilitation
- New Facility
- Temporary Facility

OWTP IMPLEMENTATION PROJECTS – 2025

FIGURE 3I

CITY OF OXNARD
PM NO. 3.7.1 WASTEWATER
PUBLIC WORKS INTEGRATED MASTER PLAN

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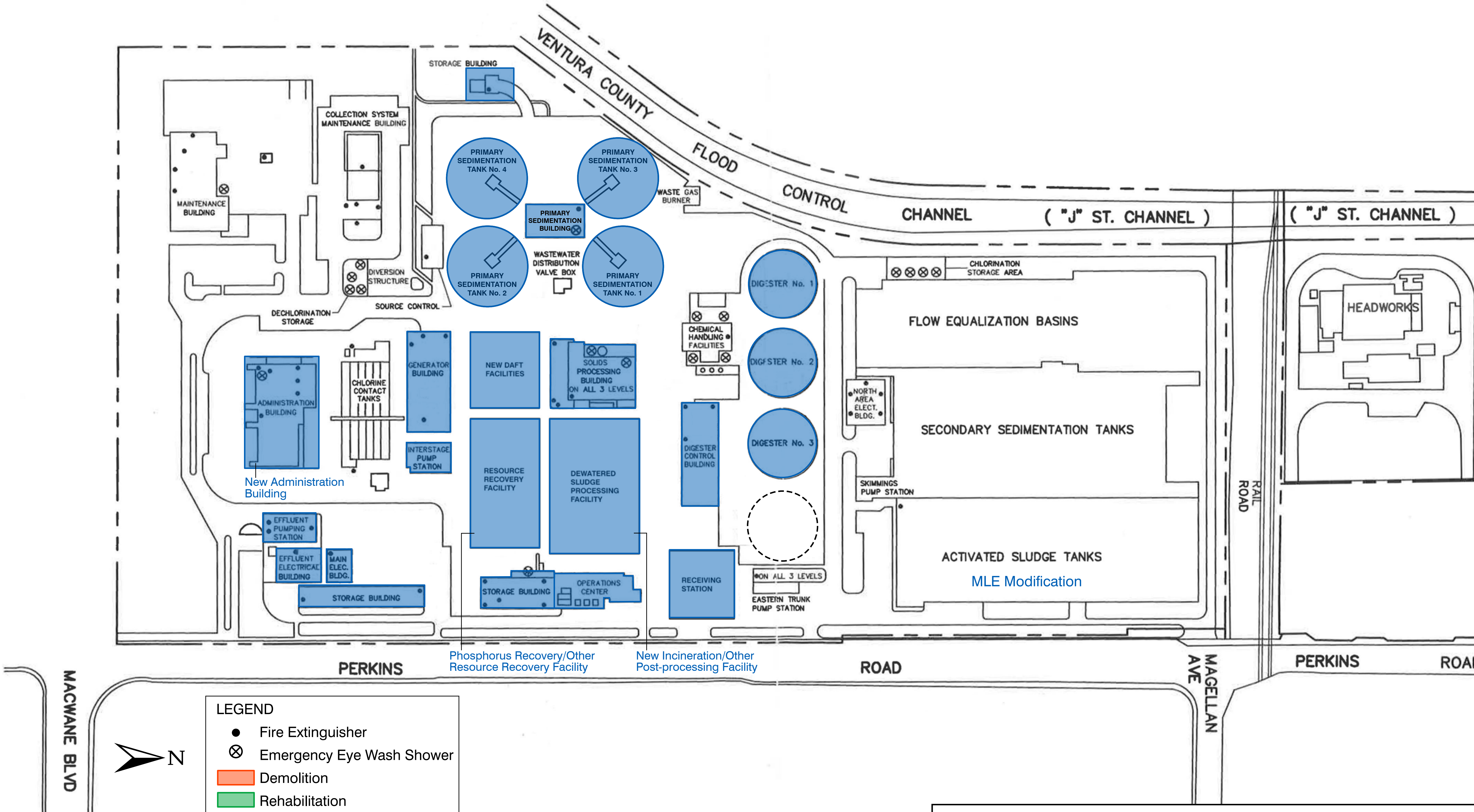

OWTP IMPLEMENTATION PROJECTS – 2030

FIGURE 3J

CITY OF OXNARD

PM NO. 3.7.1 WASTEWATER

PUBLIC WORKS INTEGRATED MASTER PLAN

CITY OF OXNARD CALIFORNIA

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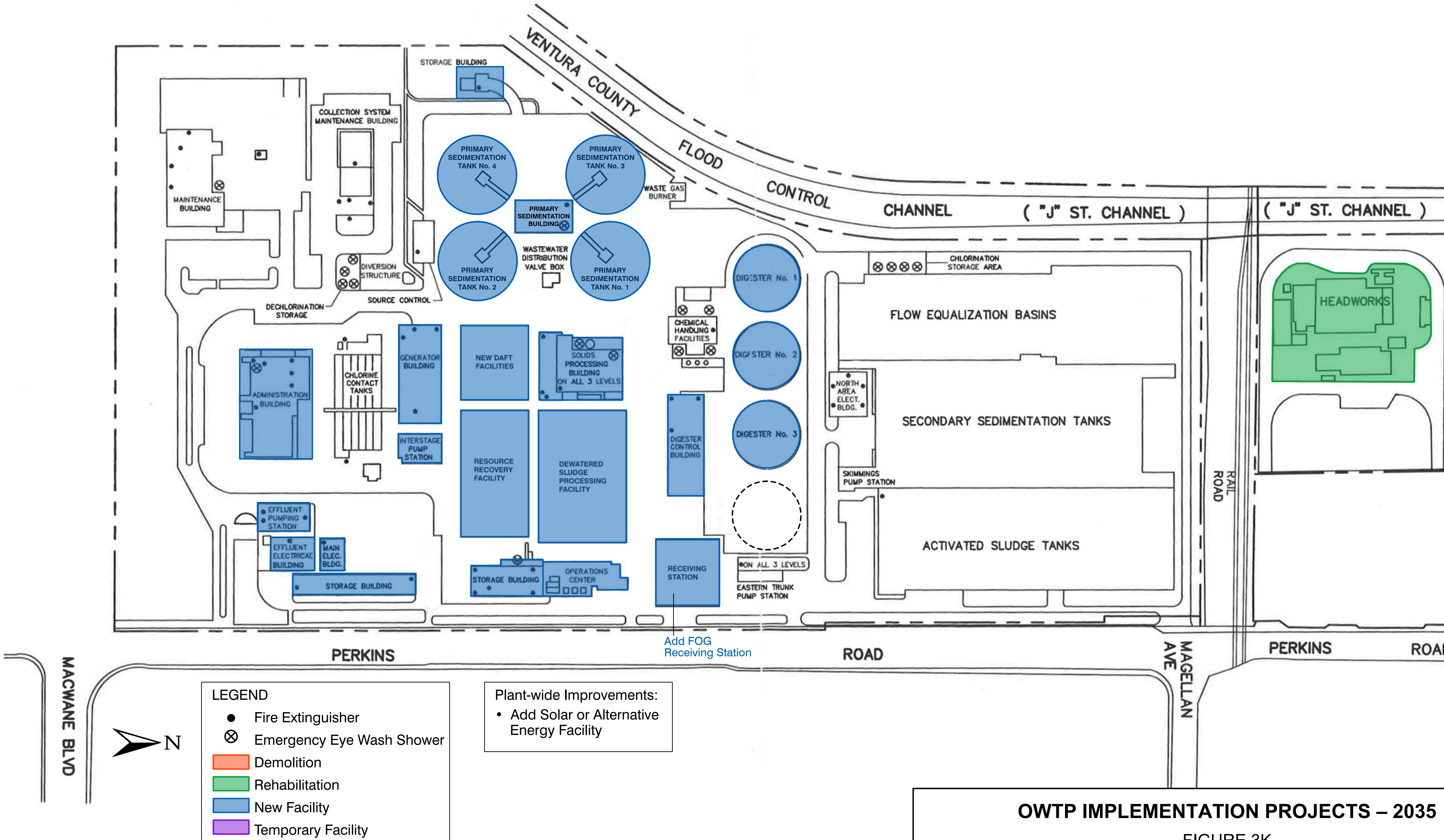

OWTP IMPLEMENTATION PROJECTS – 2035

FIGURE 3K

CITY OF OXNARD
PM NO. 3.7.1 WASTEWATER
PUBLIC WORKS INTEGRATED MASTER PLAN

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APPENDIX A - WATER AND WASTEWATER PROCESS OPTIMIZATION AND MECHANICAL AUDIT REPORT DRAFT

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Water and Wastewater Process Optimization and Mechanical Audit Report
DRAFT

Prepared for

City of Oxnard
City of Oxnard Wastewater Treatment Plant
A24CPO1

Prepared by

The Energy Network

Audit Performed by

QuEST, Inc.

November 11, 2014

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Table of Contents

1. Executive Summary

The Energy Network is pleased with the opportunity to provide this Engineering Audit Report to the City of Oxnard (City) that presents energy efficiency opportunities at the City of Oxnard Wastewater Treatment Plant (OWTP). The Energy Network, administered by Los Angeles County, was created by the California Public Utilities Commission to help eligible public agencies in Southern California harness their collective action, save energy, reduce operating costs and protect precious resources. To expand public agency participation in utility energy efficiency programs, The Energy Network is offering a range of energy efficiency services to assist public agencies with accelerating energy retrofits.

This report describes a package of recommended energy efficiency measures for the operational processes, electrical, and mechanical equipment at OTWP estimated to reduce total annual energy usage by 3,659,807 kWh 36% reduction of total energy provided by SCE, yielding estimated cost reduction of $361,461[1].

The Energy Network's engineering consultant, QuEST has performed a process and mechanical energy audit of OWTP. The facility has capacity to treat up to 31.7 million gallons per day (MGD) of wastewater at a secondary level, although the facility is currently operating at about 20 MGD.

Plant Overview

The City of Oxnard (City) Wastewater Treatment Plant (OWTP) is located at 6001 South Perkins Road. The OWTP provides secondary wastewater treatment. It has a nominal average day dry weather flow (ADWF) of 20 million gallons per day (mgd) with a design capacity of 31.7 (mgd). The OWTP includes the following major treatment facilities:

- Preliminary treatment (Headworks) including mechanically cleaned bar screens, aerated grit removal, and influent pumping.
- Primary sedimentation
- Biofilters (shown as Fixed Film Reactor in Figure No. 1)
- Inter-process pumping
- Fine-bubble activated sludge
- Secondary sedimentation
- Secondary effluent equalization
- Chlorination and dechlorination
- Effluent pumping and ocean outfall
- Emergency standby power generators
- Anaerobic digestion
- Solids processing facilities
- Onsite cogeneration facilities

[1]

The Public Works Department (Public Works) staff continually manages the treatment facilities assets to assure that they meet required performance standards, are cost-effective, and maximize water reuse and other benefits to the community.

1.1. Energy Efficiency Measures

The following energy efficiency measures (EEMs) were developed in consultation with site staff and the TEN consulting team. A total of six measures were developed with two measures being a variation of the bio-filter removal. The recommended measures are as follows:

- EEM # 1 Replace 2 Grit Pumps
- EEM # 2 Replace Primary Sludge Pumps
- *EEM #3 - Remove Bio-filters and Replace 3 Aeration Blowers (EEM #3A includes the addition of Chemically Enhanced Primary Sedimentation)*
- *EEM #4 - Turn off Bio-filters and Add Additional SCADA Control to Aeration System (EEM #4A includes the addition of Chemically Enhanced Primary Sedimentation)*
- EEM # 5 Modify Reclaimed Water System
- EEM # 6 Modify Digester Mixing and Heating
- EEM # 7 Replace Biofilter Interstage Pumps

A major issue exists in relationship to the disposition of the existing Bio-Filters. The structural integrity and seismic safety require a capital project. In both cases they require demolition. Reconstruction/rehabilitation will be a major added capital construction item in the long-term Master Plan. In either case, a factor outside of the energy audit is the potential for avoided cost of reconstruction/rehabilitation. The analysis performed within the energy audit indicates that there is low value in reconstructing the bio-filters and therefore serious consideration should be given to not reconstructing them. Then the question is how and when to integrate the cost of demolition.

Until that issue is addressed, the audit provides two options : 1) the bio-filters are removed now, as a discrete project, and the aeration system upgraded (EEM3), or 2) the bio-filters turned off (EEM4) and demolition and the aeration upgrades are delayed until the future as part of the long-term Master Plan, with cost integrated within the overall Master Plan schedule and financial plan. For each of these options there is the opportunity to add Chemically Enhanced Primary Sedimentation (CEPS) as a means of reducing aeration needs.

For each of the options above the most cost-effective option was assessed along with the other non-bio-filter measures to create a package of wastewater measures.

- **Option A** - defined as removal of the bio-filters and upgrading the aeration system (EEM#3) and installation of the remaining measures (EEMs #1, #2, #5, #6),
- **Option B** - defined as turning off and isolating the bio-filters with delayed demolition, and adding CEPS (EEM#4A) and installation of the remaining measures (EEMs #1, #2, #5, #6),

If Option A is implemented the total annual electricity savings is estimated at 3,659,807 kWh – approximately 36% of total electricity provided by SCE. If Option B is implemented annual electricity savings is estimated at 3,166,029 kWh – approximately 31 % of total electricity provided by SCE. The associated cost savings are estimated to be $361,461 for Option A and $294,259 for Option B.

The project savings, costs and financial analyses are summarized in Tables 1.1 through 1.6.

The Gross Project Cost, estimated at $4,274,000 and $2,777,000, for Option's A and B respectively. These costs include those borne by the agency and those covered through The Energy Network services. The projected incentives are contingent on a number of factors. The potential incentives for these projects if fully realized are estimated at $703,844 and $611,442 for Option's A and B respectively.

Total Rebate/Incentives are based on the utility incentive rates. When subtracting incentives from the Gross Project Cost, the Net Project Cost to your agency is estimated at $3,570,156 and $2,165,558 for Option's A and B respectively.

See Table 1.2 for a breakdown of the various project cost components.

Table 1.1: Recommended Mechanical Measures - Option A

			Annual Savings[1]			Cost Savings, Project Costs, and Utility			
EEM #	Facility	Energy Efficiency Measure Description	Electric Savings (kWh/yr)	Peak Savings (kW)	Gas Savings (therms/yr)	Total Annual Cost Savings[2] ($/yr)	Gross Project Costs[3] ($)	Total Incentives[4] ($)	Net Project Costs ($)
EEM-1	OWTP - Oxnard Wastewater	Replace 2 grit pumps	36,858	4.2	-	$4,479	$85,000	$23,851	$61,149
EEM-2	OWTP - Oxnard Wastewater Treatment Facility	Replace sludge pumps	65,788	7.5	-	$9,001	$202,000	$13,235	$188,765
EEM-3	OWTP - Oxnard Wastewater Treatment Facility	Remove Bio-Filter and replace blowers system	2,175,332	248.3	-	$218,579	$2,727,000	$407,051	$2,319,949
EEM-5	OWTP - Oxnard Wastewater Treatment Facility	Modify reclaimed water system	66,571	15.2	-	$5,540	$26,000	$13,597	$12,403
EEM-6	OWTP - Oxnard	Modify digestor heating and	1,315,258	150.1	-	$123,862	$1,234,000	$246,109	$987,891
		Total	**3,659,807**	**425.3**	**-**	**$361,461**	**$4,274,000**	**$703,844**	**$3,570,156**

Table 1.2: Financial Benefits - Option A

	Gross Project Costs ($)	Total Incentives ($)	Net Project Costs ($)	Net Present Value[5,6] (NPV)	Internal Rate of Return (IRR)	Savings-to-Investment Ratio[7] (SIR)	Return on Investment[8] (ROI)	Simple Payback[9] (years)
Project Summary	**$4,274,000**	**$703,844**	**$3,570,156**	**$1,092,203**	**8.9%**	**1.31**	**9%**	**9.9**

Table 1.3: Recommended Mechanical Measures - Option B

			Annual Savings[1]			Cost Savings, Project Costs, and Utility			
EEM #	Facility	Energy Efficiency Measure Description	Electric Savings (kWh/yr)	Peak Savings (kW)	Gas Savings (therms/yr)	Total Annual Cost Savings[2] ($/yr)	Gross Project Costs[3] ($)	Total Incentives[4] ($)	Net Project Costs ($)
EEM-1	OWTP - Oxnard Wastewater	Replace 2 grit pumps	36,858	4.2	-	$4,479	$85,000	$23,851	$61,149
EEM-2	OWTP - Oxnard Wastewater Treatment Facility	Replace sludge pumps	65,788	7.5	-	$9,000	$202,000	$13,235	$188,765
EEM-3	OWTP - Oxnard Wastewater Treatment Facility	Turn off Bio-Filter and Implement CEPS	1,681,554	191.9	-	$151,389	$1,230,000	$314,649	$915,351
EEM-5	OWTP - Oxnard Wastewater Treatment Facility	Modify reclaimed water system	66,571	15.2	-	$5,539	$26,000	$13,597	$12,403
EEM-6	OWTP - Oxnard	Modify digestor heating and	1,315,258	150.1	-	$123,850	$1,234,000	$246,109	$987,891
		Total	**3,166,029**	**368.9**	**-**	**$294,259**	**$2,777,000**	**$611,442**	**$2,165,558**

Table 1.4: Financial Benefits - Option B

	Gross Project Costs ($)	Total Incentives ($)	Net Project Costs ($)	Net Present Value[5,6] (NPV)	Internal Rate of Return (IRR)	Savings-to-Investment Ratio[7] (SIR)	Return on Investment[8] (ROI)	Simple Payback[9] (years)
Project Summary	**$2,777,000**	**$611,442**	**$2,165,558**	**$766,261**	**10.4%**	**1.35**	**6%**	**7.4**

1.2. Project Cost Breakdown

Table 1.5 Project Cost Breakdown Option A

Budget Component	Estimated Cost
Construction (JOC)	$3,631,000
Contingency	$643,000
Subtotal: Agency Gross Construction Costs	**$4,274,000**
SCE/SCG Incentives	$703,844
Subtotal: Agency Net Construction Costs	**$3,570,156**
Project Management	$6,740
Audit	$48,555
Design	$3,680
Construction Management Support	$5,630
M&V	$5,970
Subtotal: The Energy Network Costs	**$70,575**
TOTAL PROJECT COST	**$3,640,731**

Contingency at 17.7%

Table 1.6 Project Cost Breakdown Option B

Budget Component	Estimated Cost
Construction (JOC)	$2,455,000
Contingency	$322,000
Subtotal: Agency Gross Construction Costs	**$2,777,000**
SCE/SCG Incentives	$611,442
Subtotal: Agency Net Construction Costs	**$2,165,558**
Project Management	$6,740
Audit	$48,555
Design	$3,680
Construction Management Support	$5,630
M&V	$5,970
Subtotal: The Energy Network Costs	**$70,575**
TOTAL PROJECT COST	**$2,236,133**

2. Introduction

This section provides an overview of The Energy Network, the energy efficiency services available to participating agencies, and the Project Team that contributed to completing this report.

2.1. Program Overview

The Energy Network, administered by Los Angeles County, was created by the California Public Utilities Commission to help eligible public agencies in Southern California harness their collective action, save energy, reduce operating costs and protect precious resources.

To expand public agency participation in utility energy efficiency programs, The Energy Network is offering an unprecedented level of services. Our Turnkey Project Delivery method is aimed at minimizing strain on your agency's resources. The Network provides all of the services you need to carry out successful energy retrofit projects including project management, energy audits, retrofit design, construction management support, and expedited construction services.

Turnkey Project Delivery Services provided at no cost to your Agency include:

- Project Management
- Energy Audits
- Project Design
- Evaluating and Arranging Construction Financing
- Rebate and Incentive Process Handling
- Retrofit Construction Management Support

Construction costs net of any applicable incentives would be covered by your agency, but The Energy Network offers expedited construction procurement services specifically designed to fast track energy efficiency retrofits and reduce your costs. Pools of pre-qualified mechanical and electrical contractors in your region have already been selected and awarded indefinite quantity construction contracts by the National Joint Powers Alliance® (NJPA) through a public competitively bid process.

By becoming a member of the NJPA, participating agencies can receive on call, energy retrofit construction services and be assured they are getting high quality firms that will perform work at guaranteed prices. Becoming a member of the NJPA can be done on-line at no-cost, no obligation and no liability.

The City of Oxnard can save time and money by not going through a lengthy qualification and bidding process, and the pricing for any work is transparent, detailed and guaranteed up front. And because the construction prices are set by the unit pricing in the catalog, the risk of inflated costs for change orders is greatly reduced. The Energy Network can help arrange financing for your energy efficiency projects, including utilizing our Energy Project Master Lease Program financing designed specifically for public agency energy projects; and we can handle the entire utility rebate and incentive process on your behalf

After construction, The Energy Network can assist the City of Oxnard to realize the full energy savings potential of recommended EEMs by training your staff on the effective operation of the installed measures.

By providing unbiased expertise, project management, financing, and premium engineering services, The Energy Network addresses the common barriers that prevent many local governments and public agencies with limited resources from adopting energy saving measures. The Energy Network's services will complement and support services provided by other existing programs.

2.2. Project Team

Commissioned by Thien Ng through The Energy Network, QuEST, Inc. performed a process and mechanical energy audit of the OWTP operated by the City.

The project team consisted of:

- City of Oxnard : John Jardin, Chief Plant Operator, OWTP
- Wyatt Troxel (Consultant to TEN) who provided invaluable assistance and access to the facility areas.
- The Energy Network's Project Manager was Douglas O'Brien.
- The personnel performing this audit were Derrick Rebello, QuEST, Inc. and Gregory Harris, Herwit Engineering.

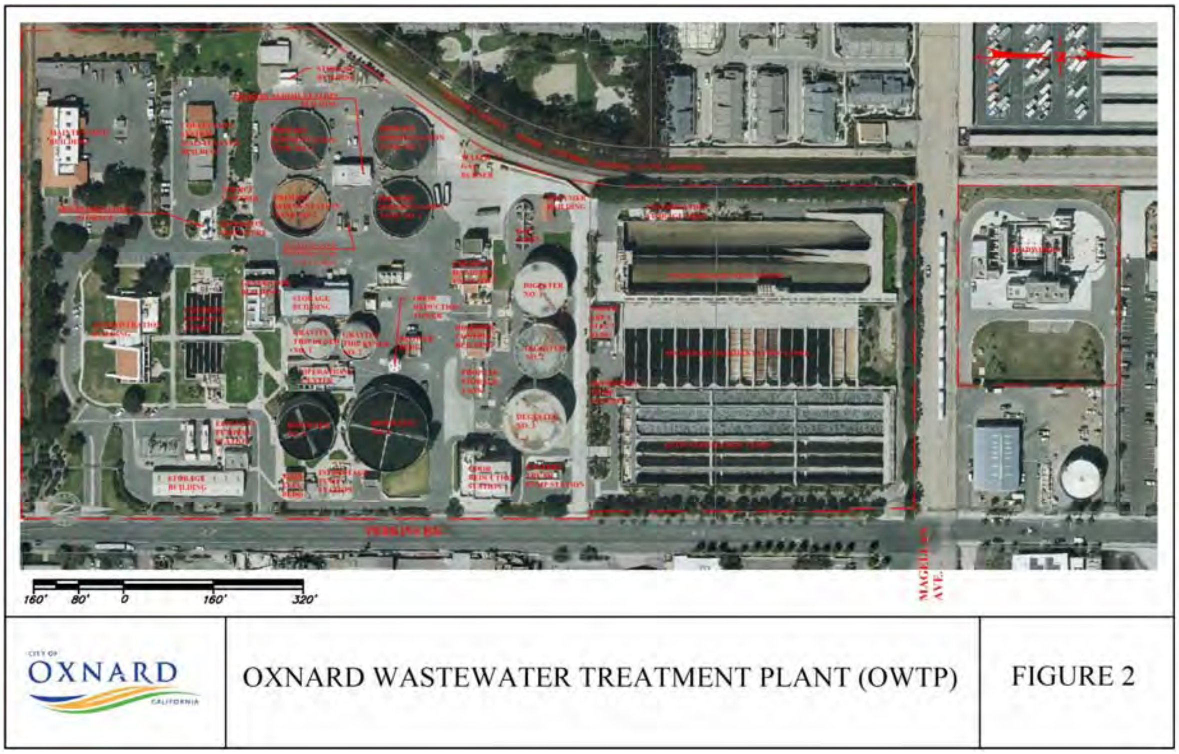
3. Facilities Information

OWTP is located at 6001 South Perkins Street Oxnard, CA. The facility is operated by the City of Oxnard. A description of the facility is provided below.

3.1. General Facility Description

The OWTP serves approximately 225,000 customers from the City of Oxnard, City of Port Hueneme and Naval Base Ventura County. The OWTP collection system, spanning more than 400 miles, brings wastewater to the plant for treatment. An aerial view of the OWTP is provided in Figures 3.2. The site includes administration buildings, illuminated outside areas for night operations, and numerous additional structures associated with plant treatment processes.

Figure 3.1 – Aerial View of OWTP

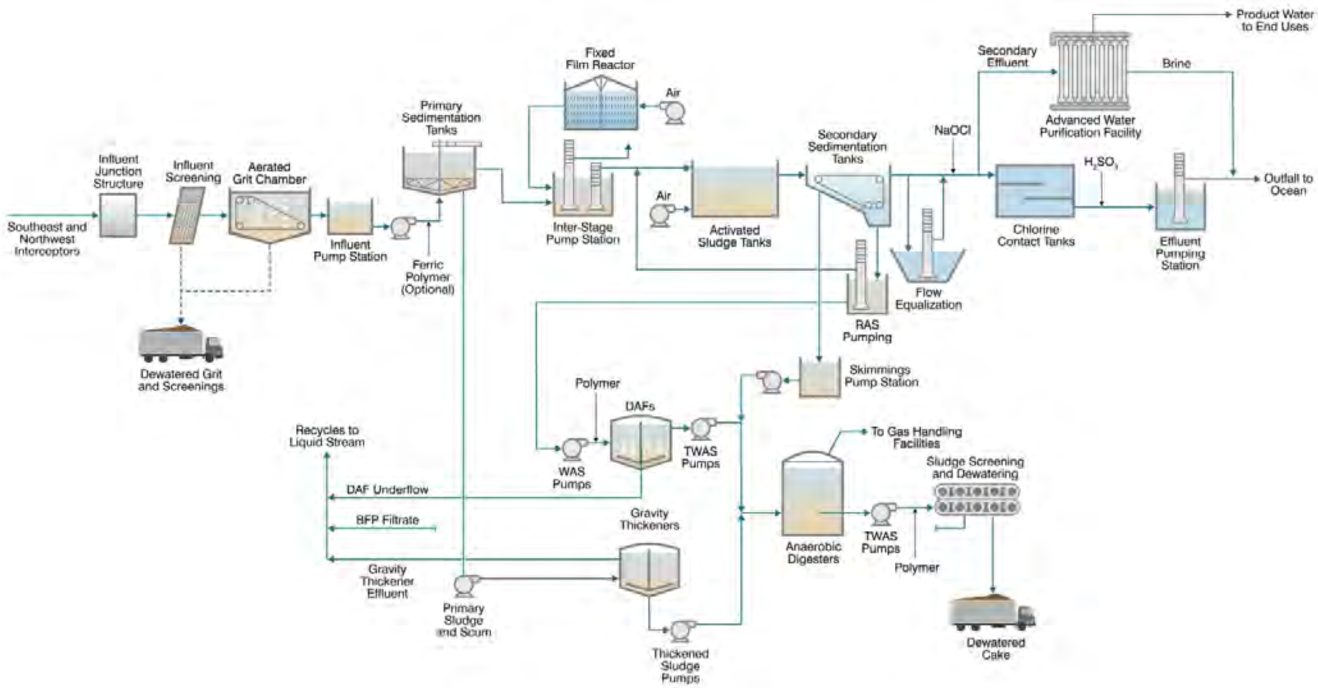


OWTP has a design capacity of 31.7 MGD, current daily flows (observed) are approximately 20 MGD.

Although the facility's operations are continuous (24 / 7 - 365 days/yr), the daytime overall operating hours of the facility when operators are present are from 8:00 AM to 5:00 PM, Monday through Friday.

A schematic of the plant operations is presented in Figure 3.2.

Figure 3.2 Oxnard Wastewater Treatment Plant Process Schematic



CITY OF OXNARD CALIFORNIA	OXNARD WASTEWATER TREATMENT PLANT PROCESS FLOW SCHEMATIC	FIGURE 1

3.2. Description of Areas Surveyed

The audit process began with a review of the entire plant's wastewater treatment processes and a discussion with plant staff to better understand their needs. A detailed review of the processes was conducted with the intent of identifying potential cost-effective energy savings measures, including the following:

- Preliminary treatment (Headworks) including mechanically cleaned bar screens, aerated grit removal, and influent pumping.
- Primary sedimentation
- Biofilters (shown as Fixed Film Reactor in Figure No. 1)
- Inter-process pumping
- Fine-bubble activated sludge
- Secondary Clarification
- Effluent Chlorine Disinfection
- Utility water system
- Anaerobic digestion
- Solids processing facilities
- Onsite cogeneration facilities

4. Historic Energy Use and Cost

During a recent 12-month period from December, 2012 through November, 2013, the facility's total electricity consumption was 10,108,710 kWh, at a cost of $762,285 and the facility's total natural gas consumption was 1,787 therms, at a cost of $1,833[2]. The total annual cost of energy at this site is approximately $764,118. Table 4.1 show the monthly breakdown of electric and gas usage and costs.

Table 4.1 Monthly Utility Usage and Cost

Month	Electricity Usage (kWh)	Demand (kW)	Electricity Costs ($)	Natural Gas (therms)	Gas Costs ($)	Total Utility Cost ($)
December-12	897,840	2,016	$53,014	139	$146	$53,160
January-13	921,564	1,728	$52,353	394	$347	$52,700
February-13	912,924	1,872	$57,185	230	$226	$57,411
March-13	799,434	1,800	$50,038	188	$181	$50,219
April-13	869,364	1,944	$54,812	118	$123	$54,935
May-13	859,158	1,944	$61,687	99	$109	$61,797
June-13	878,508	1,872	$62,331	114	$131	$62,462
July-13	762,228	2,016	$76,430	98	$116	$76,545
August-13	798,480	2,016	$84,654	97	$111	$84,765
September-13	784,152	1,872	$74,841	104	$117	$74,958
October-13	744,588	1,944	$72,071	94	$103	$72,174
November-13	880,470	1,872	$62,871	112	$123	$62,993
Total	10,108,710	22,896	$762,285	1,787	$1,833	$764,118

During a recent 12-month period from July, 2013 through June, 2014, the facility's total gas consumption related to co-generation was 187,061 therms, at a cost of $129,229. Table 4.2 show the monthly breakdown for gas usage associated with the Plant's co-generation system.

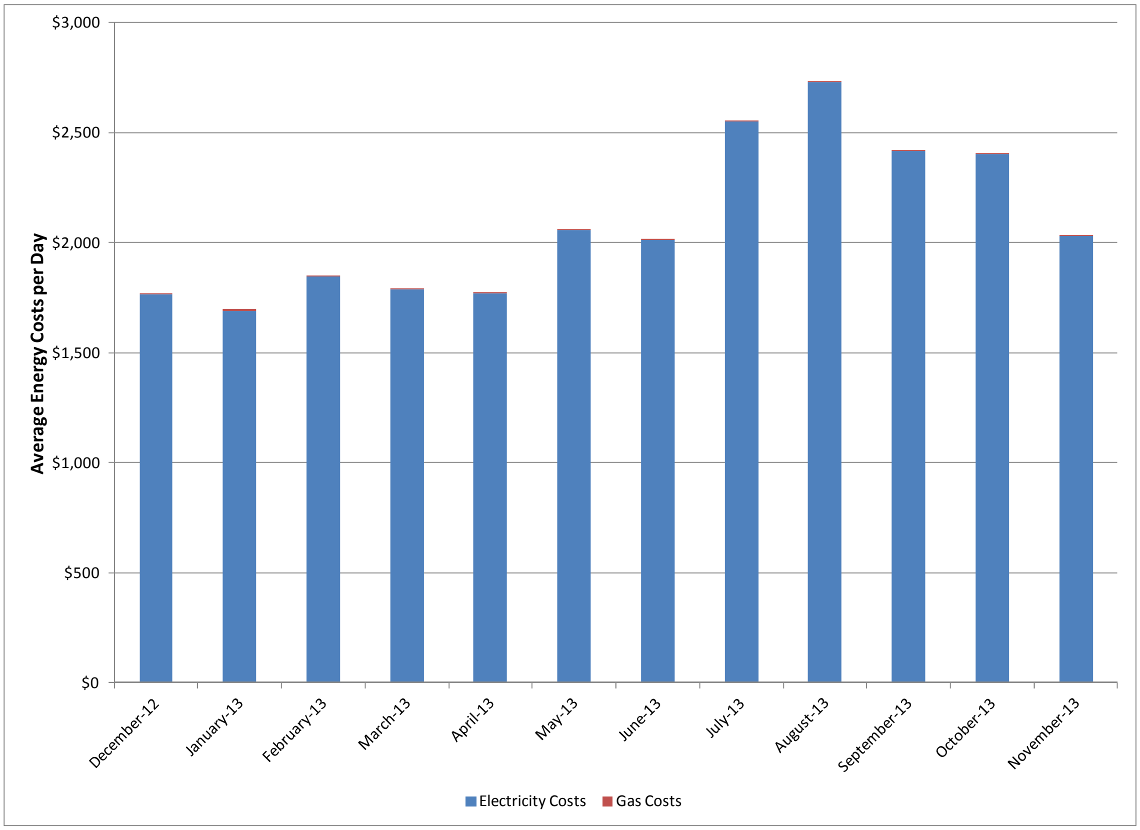
[2] This represents only the gas for general use and does not include the gas used in the co-gen system.

Table 4.2 Monthly Co-Gen Gas Usage and Cost

Month	Gas Usage (therms)	Gas Costs ($)
July-13	26,989	$17,571
August-13	26,644	$17,232
September-13	27,519	$17,893
October-13	14,947	$9,838
November-13	11,568	$7,834
December-13	12,058	$8,102
January-14	11,170	$8,214
February-14	7,811	$6,269
March-14	6,252	$5,131
April-14	11,030	$8,163
May-14	9,228	$7,049
June-14	21,845	$15,933
Total	187,061	$129,229

Figure 4.1 below depicts the total cost of energy broken down into electric and gas costs by month for the 12-month period of December, 2012 through November, 2013.

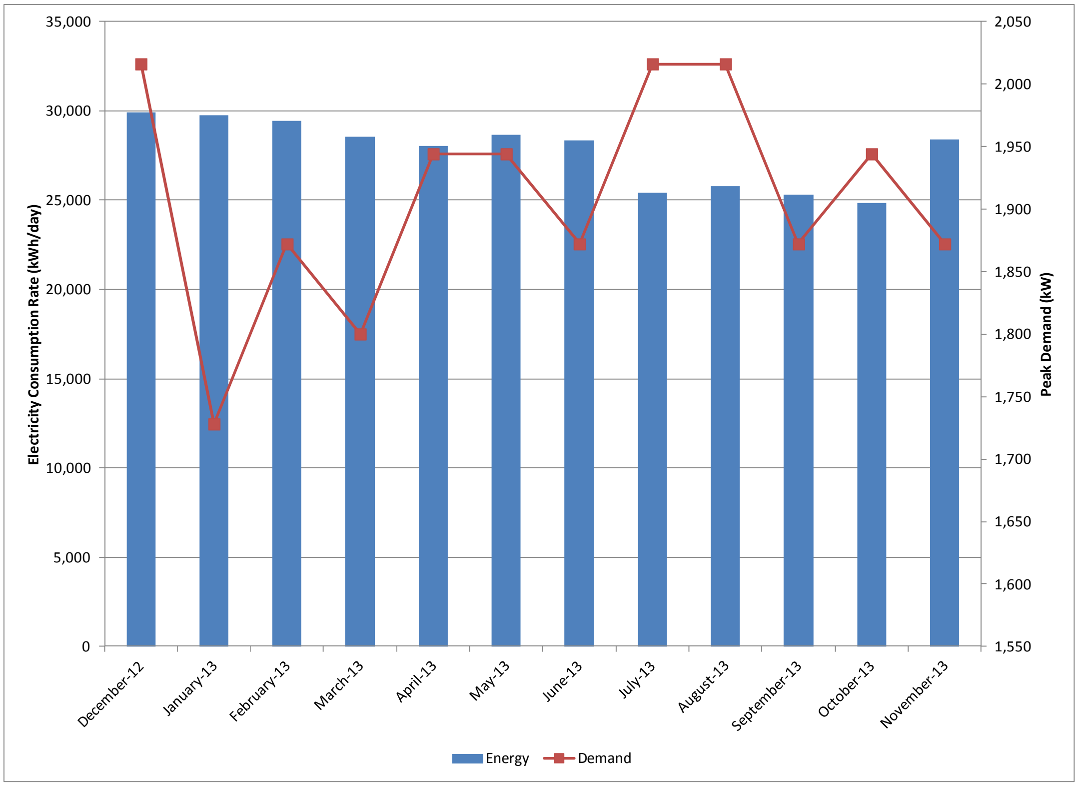
Figure 4.1: Total Monthly Energy Costs



4.1. Monthly Electricity Consumption and Demand

Figure 4.2 shows electricity consumption (kWh) and demand (kW) for 12-month period from December, 2012 through November, 2013.

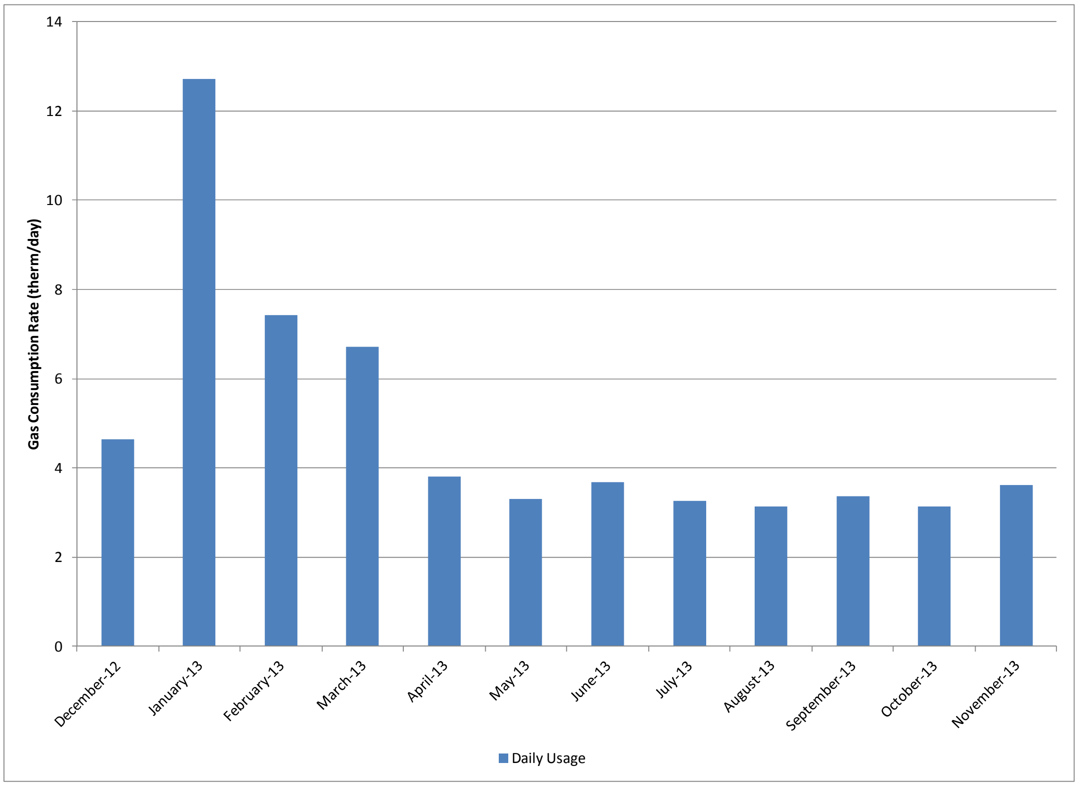
Figure 4.2: Monthly Electricity Consumption and Demand



4.2. Monthly Natural Gas Consumption

Figure 4.3 shows the total annual gas consumption history for the 12-month period from December, 2012 through November, 2013.

Figure 4.3: Monthly Natural Gas Consumption



The Oxnard WWTP uses natural gas to power its co-generation facility. Gas consumption and expenses related to the

5. Energy Efficiency Recommendations

To identify and assess the feasibility of energy efficiency and improvement opportunities, a team of engineers visited the facility and performed visual inspections of the existing equipment and site conditions. In addition the team monitored energy consumption and demand for many of the major systems and processes.

5.1. Existing Systems

At OWTP, there are several processes with significant energy demand. Section 3 above, provides a list of the plant's treatment processes. It was noted during the audit process the OWTP was interested in exploring options that would either remove the existing bio-filters (bio-towers) or at least eliminate them from the process.

5.2. Recommended Measures

This section details the recommended Energy Efficiency Measures (EEMS) of this analysis. Each measure is described in detail, including the method of analysis for estimating measure energy savings.

5.2.1. EEM # 1 Replace 2 Grit Pumps

Currently, there are eight 30 hp grit pumps that pump grit from the grit tanks to the grit dewatering unit. The grit pumps are broken up into 4 pumps for the east side and 4 pumps for the west side. The East side and west side grit tanks are alternated every 6 months with only one side in operation at a time. For each side, the existing grit pumps are operated with Pump No. 1 running 100% of the time at 24 hours per day, Pump No. 2 running 48% of the time and the remaining pumps on less than 29% of the time. The grit pumps are a torque flow style pumps equivalent to the Wemco Model C style pump. These pumps have very low efficiencies but were historically installed for their low initial capital cost and overall robustness in pumping grit and other high solids.

This measure evaluates replacing the lead pump on the east and west side with a modified torque flow pump equivalent to the Wemco Model CE pump. The Model CE pump is also designed for grit service, but is approximately twice as efficient as the Model C pump. The increased efficiency provides the opportunity to sequence the grit pumps via SCADA controls to avoid concurrent operation, thus reducing the instantaneous kW demand of the system to the load of a single pump.

Since the remaining pumps do not run full time, it is proposed under this measure to not replace them. However, given the age of the grit pumps, it may be desirable to replace all of the existing pumps with a Model CE pump under a normal capital replacement cycle.

Savings and costs are calculated under this measure for only replacing the two lead grit pumps.

Analysis EEM #1

To establish the energy baseline for this measure, the power usage of the existing pumps was monitored with power monitors from 8/5/201 through 8/27/2014. The data indicated that the lead pump runs 100% of the time (24 hrs/day) with the remaining pumps running less time. Based on this information, the total power usage for the existing condition was determined as indicated in Table 1.

To evaluate the changed conditions for this measure, the flow and pressure conditions for the existing grit pumps were used in conjunction with pump curves for the WEMCO model CE pump to determine the pump power required for a replacement pump. This power was then compared to the measured power during the monitoring period for the existing pumps to determine the net energy savings.

Table 5.1 presents the energy savings analysis for this option based on the established baseline energy usage from the monitoring period compared to the implemented measure. A total of 36,858 kWh annually can be saved by implementing this measure. In addition, 4.21 kW of power demand would be reduced by implementing this measure.

The cost to implement this measure is presented in Table 5.2. The largest cost is to purchase the new pumps and then modify the existing piping and bases to accept the new pump.

An economic summary with a simplified life cycle analysis for all 6 energy efficiency measures is presented in Table 5.20.

Table 5.1 Energy Savings Analysis for EEM#1

Existing Condition

Monitoring Period 8/5/2014 - 8/27/2014

	Total No.	Motor Size (hp)	No. In Service
GRIT Equipment			
1) Grit Pumps	8	30	4
Average Power Draw Per Pump (kW)	19.2		

	Power Used (kW)				
	Pump No. 1	Pump No. 2	Pump No. 3	Pump No. 4	Total
Average Power Demand	18.98	8.26	5.72	5.43	38.40
Pump Run Time % On	98.9%	43.8%	28.6%	28.6%	

New Condition

Monitoring Period 8/5/2014 - 8/27/2014

	Total No.	Motor Size (hp)	No. In Service
GRIT Equipment			
1) Grit Pumps	8	25	4
Average Power Draw Per Pump (kW)	14.9		

	Power Used (kW)				
	Pump No. 1	Pump No. 2	Pump No. 3	Pump No. 4	Total
Average Power Demand	14.78	8.26	5.72	5.43	34.19
Pump Run Time % On	98.9%	43.8%	28.6%	28.6%	

Existing Power Usage	38.4	kW
New Power usage	34.2	kW
Total Power Saved	4.2	kW
Pre-Installation Energy Consumption	336,367	kWh
Post-Installation Energy Consumption	299,509	kWh
Total Energy Saved	36,858	kWh
Pre-Installation Demand	38.40	kW
Post-Installation Demand	34.19	kW
Total Demand Savings	4.21	kW

Table 5.2 Costs Analysis for EEM#1

Item Description	Quantity	Unit	Unit Cost	Total Cost
Wemco Model 4 x 11- 25 hp motor	2	EA	$ 26,974	$ 53,948
Pump Installation	2	EA	$ 3,500	$ 7,000
Modify Existing Piping	2	EA	$ 2,500	$ 5,000
New Gauges and Instruments	2	EA	$ 1,500	$ 3,000
Miscellaneous Construction	0.5	EA	$ 5,000	$ 2,500
Engineering Design and Project Management	0.75	EA	$ 15,000	$ 11,250
Construction Support	0.75	EA	$ 10,000	$ 7,500
			Subtotal	$ 90,000
Contingency			20%	$ 18,000
			Total	$ 108,000

5.2.2. EEM # 2 Replace Primary Sludge Pumps

Currently, there are four 25 hp primary sludge pumps that pump primary sludge from the primary clarifiers to a gravity thickening tank. The sludge pumps are assigned one to each of four primary clarifiers. Normally three primary clarifiers are in service with one on standby. Clarifiers and pumps are rotated together in and out of service periodically. Each pump for an in service primary clarifier pumps 24 hours a day to the gravity thickener. The primary sludge pumps are torque flow style pumps equivalent to the Wemco Model C style pump. These pumps have very low efficiencies but were historically installed for their low initial capital cost, and robustness in pumping grit and high solids.

This measure evaluates replacing all four primary clarifier pumps with a screw centrifugal pump equivalent to the Wemco Model Hydrostal. The Model Hydrostal pump is also designed for high solids such as primary sludge service, but is approximately 3 to 4 times more efficient as the Model C pump.

Since the primary sludge pumps pump 24 hours per day, the primary sludge is not very thick and this service is fairly easy for the Hydrostal style pump. The increased efficiency provides the opportunity to sequence the primary sludge pumps via SCADA controls to avoid concurrent operation, thus reducing the instantaneous kW demand of the system to the load of a single pump. The pumps would likely be operated 1/3 of the time, rotating the operational function sequentially among the pumps.

Savings and costs are calculated under this measure for replacing all four of the primary sludge pumps.

Analysis EEM -2

To establish the energy baseline for this measure, the power usage of the existing pumps was monitored with power monitors from 8/5/2014 through 8/27/2014. The data indicated that 3 of the 4 pumps run 100% of the time (24 hrs/day) with the remaining pump off line when the clarifier is not in service. Based on this information, the total power usage for the existing condition was determined as indicated in Table 5.3.

To evaluate the changed condition for this measure, the flow and pressure conditions for the existing primary sludge pumps were used in conjunction with pump curves for the WEMCO model Hydrostal pump to determine the pump power required for a replacement pump. This power was then compared to the measured power during the monitoring period for the existing pumps to determine the net energy savings.

Table 5.3 presents the energy savings analysis for this option based on the established baseline energy usage from the monitoring period compared to the implemented measure. A total of 65,788 kWh annually can be saved by implementing this measure. In addition, 7.51 kW of power demand would be reduced by implementing this measure.

The cost to implement this measure is presented in Table 5.4. The largest cost is to purchase the new pumps and then modify the existing piping and bases to accept the new pump.

Table 5.3 Energy Savings Analysis for EEM#2

Existing Condition

Monitoring Period 8/5/2014 - 8/27/2014

	Total No.	Motor Size (hp)	No. In Service
Primary Clarifier Equipment			
1) Primary Sludge Pumps	4	25	3
Average Power Draw Per Pump (kW)	9.1		

	Power Used (kW)				
	Pump No. 1	Pump No. 2	Pump No. 3	Pump No. 4	Total
Average Power Demand	0.00	7.94	10.26	9.23	27.43
Pump Run Time % On	0.0%	100.0%	100.0%	100.0%	

New Condition

Monitoring Period 8/5/2014 - 8/27/2014

	Total No.	Motor Size (hp)	No. In Service
Primary Clarifier Equipment			
1) Primary Sludge Pumps	4	15	3
Average Power Draw Per Pump (kW)	6.6		

	Power Used (kW)				
	Pump No. 1	Pump No. 2	Pump No. 3	Pump No. 4	Total
Average Power Demand	0.00	6.64	6.64	6.64	19.92
Pump Run Time % On	0.0%	100.0%	100.0%	100.0%	

Existing Power Usage	27.4	kW
New Power usage	19.9	kW
Total Power Saved	7.5	kW
Pre-Installation Energy Consumption	240,287	kWh
Post-Installation Energy Consumption	174,499	kWh
Total Energy Saved	65,788	kWh
Pre-Installation Demand	27.43	kW
Post-Installation Demand	19.92	kW
Total Demand Savings	7.51	kW

Table 5.4 Costs Analysis for EEM#2

Item Description	Quantity	Unit	Unit Cost	Total Cost
Wemco Hydrostal F4K-MH 15 hp motor	4	EA	$ 28,918	$ 115,674
Pump Installation	4	EA	$ 3,500	$ 14,000
Modify Existing Piping	4	EA	$ 2,500	$ 10,000
New Gauges and Instruments	4	EA	$ 1,500	$ 6,000
Miscellaneous Construction	1	EA	$ 5,000	$ 5,000
Engineering Design and Project Management	1	EA	$ 10,000	$ 10,000
Construction Support	1	EA	$ 7,500	$ 7,500
			Subtotal	$ 168,000
Contingency			20%	$ 34,000
			Total	$ 202,000

5.2.3. Bio-filter Measures (EEM 3, 3A, 4, 4A) General Overview

Currently, the plant uses two processes in series to aerobically treat the biochemical oxygen demand (BOD) present in the wastewater leaving the primary clarifiers. The first process is a fixed film reactor called a biofilter or biotower. There are two biofilters. Biofilter No. 1 is 140 feet in diameter and Biofilter No. 2 is 100 feet in diameter. Each biofilter is approximately 26 feet tall and filled with PVC media. Water is pumped to the top of the tower with three 200 hp biofilter recirculation pumps. The water distributes onto the media and trickles down through the tower. Air is blown up through the tower in the opposite direction with four 10 hp blowers for Biofilter No. 1 and four 5 hp blower for Biofilter No. 2. Aerobic biological bacteria are grown on the media that uptake a portion of the BOD from the wastewater as the water passes over it.

The second process step is a typical activated sludge aeration basin. The aeration basin consists of 2 long serpentine basins with 3 passes each. Air is bubbled through the wastewater with fine bubble ceramic diffusers. Air is supplied to the diffusers with five 350 hp Turblex blowers. Only one basin is in service at a time with the second basin kept as a standby.

Water leaving the biofilters is pumped with three 250 hp interstage pumps to the in-service aeration basin. Water leaving the aeration basins flows to the secondary clarifiers for settling.

The physical condition and performance of the bio-filters are very poor. Inspection shows that a significant amount of wastewater pumped to the top of the biotowers is bypassing the media and falling directly down the center column. Typically, the existing bio-filters are removing less than 30% of the BOD. This is well below the desired performance level. The question is whether to replace the towers or eliminate them altogether. Eliminating them incurs overall energy savings and avoids cost of construction of new or rehabilitated towers.

In addition, the existing aeration blowers are very old and not as efficient as modern day blowers. The existing diffuser system in the activated sludge process is also very old and in need of eventual replacement. There is also very limited SCADA control of the entire process, and only one blower can be controlled automatically from SCADA with the remaining blowers controlled by hand when needed. As a result of these issues, the existing two step process runs very inefficiently.

Because the secondary process has several process steps and requires multiple pieces of equipment to operate, four options for energy efficiency measures were developed and analyzed. These measures include the following. Each of these measures is described in detail below.

- EEM #3 - Remove the biofilters and replace three of the aeration blowers
- EEM #3A - Remove the biofilters and replace three of the aeration blowers and add CEPS
- EEM #4 - Turn off the biofilters, await future demolition and add additional SCADA control for the existing blowers and aeration system.
- EEM #4A - Turn off the biofilters, await future demolition, add additional SCADA control for the existing blowers and aeration system, and add CEPS.

Chemically Enhance Primary Sedimentation

Two of the measures are the same as the original measures with the addition of chemically enhance primary sedimentation (CEPS). The concept of CEPS is to add additional chemicals to the primary clarifiers to pull additional biological load or BOD from the wastewater prior to going to the secondary process and to send that additional BOD to the anaerobic digesters where it produces energy instead of needing energy if treated in the secondary process. The concept of CEPS was evaluated previously by others in the 2014 Unit Process Evaluation and Optimization Study by Nunnley and Associates and in the 2014 Master Plan being prepared by Carollo. In both reports, it was found that the existing performance of approximately 45%-50% BOD removal in the primary clarifiers already performed at the expected levels for a chemically enhanced primary clarifier. The reason given for this was that there is so much existing ferric chloride addition occurring in the collection systems upstream of the plant for odor control reasons that this collection system chemical addition is affecting the settling in the clarifiers without any additional chemical addition at the clarifier itself.

While it is true the existing clarifier performance already meets historical design values for chemical addition, recent research has shown that adding a minor amount of polymer in addition to ferric chloride can increase typical BOD removal from 50% to 60%-65% or above. Therefore, in relation to CEPS, the energy efficiency measures that include CEPS assume the existing ferric chloride addition up stream of the facility is maintained, if not reduced, and that emulsion polymer is added directly up stream of the primary clarifiers as an additional CEPS measure.

The largest negative impact of CEPS is normally increased sludge to the digesters and the downstream dewatering and disposal facilities. A large portion of this sludge is chemical sludge that does not degrade in the digester and increases overall disposal costs. However, the largest portion of the chemical sludge is from adding ferric chloride (95% or more). In this case, the addition of ferric chloride is an existing condition at the facility. Therefore, in the energy efficiency measures, the cost impact of additional sludge production and disposal is ignored. The cost of actual polymer usage is included as an offset to the energy savings obtained. The actual type of polymer, the amount required, and the total cost of chemical is site specific and must be verified prior to implementation of any of the CEPS measure options. Plant staff has begun testing polymer addition to one of the primary clarifiers to determine this information and verify assumptions in this analysis.

For the measures that include CEPS, it is assumed that approximately 0.2 mg/l of emulsion polymer will be required at a cost of $2/lb to reliably increase the primary clarifier removal of BOD to 60%. Operation of the CEPS does not utilize any additional significant energy.

Process Modeling

To complete the analysis of each energy efficiency measure, a process model using BioWin modeling software was developed for the treatment plant. The model was calibrated against the existing performance conditions of the biofilters, aeration basins, and blowers. Alternative scenarios were then analyzed. The primary output from the model is the estimated performance of the biofilters and the air flow required to treat the wastewater entering the aeration basin under the different scenarios.

The unique character of a two step biofilter-aeration basin process not only affects the biological load entering the aeration basin, but performance of the diffused air system and its interaction with the wastewater itself. In modeling terms, the alpha factor used to determine how well the water takes up the air is affected downstream of a biofilter where the soluble BOD has been reduced versus what will occur when the biofilter is removed and highly levels of soluble BOD will enter the first stage of the aeration process. The extent to which the alpha will adjust when the biofilters are removed is unknown. For purposes of modeling alpha was adjusted to typical values seen for aeration basins without biofilters to come up with a reasonable estimate of the new airflow required once the biofilter is removed. This new estimated airflow without the biofilter is more than what would be estimated based on BOD alone without an adjustment in alpha.

In addition, the existing SCADA system has target dissolved oxygen (DO) set points that are very low for each portion of the aeration basin. The actual system almost uniformly underperforms in holding the target DO set points with real world achieved DO levels almost always below the SCADA system set points. This results in lower real existing air flows than predicted to achieve the SCADA system target DO set points. For the purposes of this analysis the existing SCADA target DO set points were utilized to determine existing and future required air flows for all BioWin models.

For the different energy efficiency measures, the existing recorded and predicted BioWin airflow estimates for the aeration basin are as follows:

- Existing recorded average air flow - 3,804 scfm
- BioWin - Existing predicted average air flow - 4,065 scfm
- BioWin - Biofilters removed, Alpha adjusted, predicted average air flow - 6,950 scfm
- BioWin - Biofilters removed, Alpha adjusted, CEPS added, predicted average air flow - 4,816 scfm

In preparing the modeling, it was noted that the existing aeration basins are run in a long serpentine pattern with all of the load sent to the entrance of aeration basin Zone 1. When the biofilter is removed, it may be more desirable to change the aeration basin operation to a step feed system or convert the serpentine basins to parallel basins. Both of these changes have process and maintenance advantages and further evaluation of these options is strongly recommended. However, for the scope of this analysis, the basins are modeled as serpentine basin and further changes are left to be considered in more detail during the final design process.

5.2.4. EEM # 3 Remove Biofilter and Replace 3 Aeration Blowers

Under this measure, the biofilters are turned off, decommissioned and ultimately removed from the plant site. In addition, three of the existing blowers are replaced with higher efficiency turbo blowers. The existing SCADA system is also replaced to accommodate full control of the new blowers and the aeration process. Proposed diffuser modifications are left as a separate capital improvements project and not considered in this measure. CEPS is not considered in this measure. The primary energy savings comes from turning off biofilter recirculation pumps and blowers and the more efficient blowers.

Analysis EEM 3

To establish the existing baseline energy usage, power monitors were installed on the biofilter equipment from 8/5/2014 to 8/27/2014. SCADA data including blower power and aeration air flow and DO levels from the plant SCADA system were collected for the same time period. Based on this data, the total power used to operate the existing secondary process was determined. During the monitoring period, this secondary process used a total of 571.7 kW on average. This is presented in Tables 5.5-5.7.

This base line energy usage measured during the monitoring period 8/5/2014-8/27/2014 was then adjusted by the influent BOD load to the facility for the month of August 2014 to the average influent BOD load conditions for the facility presented in the Carollo master plan. In this case, the average influent load during the monitoring period was 49,698 lbs/day of BOD. Per the Carollo 2014 master plan, the average annual loading for the facility is 53,167 lbs/day of BOD. The 571.7 kW was then scaled up to 600.1 kW based on the ratio of the influent BOD loading during the monitoring period and the average annual BOD loading. 600 kW was then used as the baseline power demand for the complete secondary process for all measures. This information is summarized in Tables 5.5-5.7.

To evaluate the changed condition for this measure, a process model was built using BioWin software to predict the performance of the biofilter and aeration basins in series. The model was calibrated against the current operation and then used to predict air flow requirements under the different measure options. Once new air flow requirements were developed, power usage for new high efficiency turbo blowers was calculated from blower performance curves for Neuros NX 300 turbo blowers.

For Option #3A with CEPS, the same process model was used to predict the loading to the aeration basin without the biofilter and improved BOD removal in the primary clarifier under the CEPS option. Once new air flow requirements with CEPS were developed, power usage for new high efficiency turbo blowers was calculated from blower performance curves for Neuros NX 300 turbo blowers.

Table 5 presents the energy savings analysis for this option based on the established baseline energy usage from the monitoring period compared to the implemented measure. A total of 2,175,333 kWh annually with 248 kW of demand reduction can be saved by implementing Measure #3. A total of 2,972,333 kWh annually with 339 kW of demand reduction can be saved by implementing Measure #3A.

The costs to implement these measures are presented in Table 5.8. The largest cost is to purchase the new blowers and demolition and removal of the existing biofilters. Measure #3A has an increased capital cost for the chemical addition facility and increased operations cost for the cost of the chemicals.

Table 5.5 Energy Savings Analysis (Existing Condition) for EEM#3 and 3A

Existing Condition - Measure #3 and #3A

Monitoring Period 8/5/2014 - 8/27/2014

	Total No.	Motor Size (hp)	No. In Service
Bio-Tower and Aeration Equipment			
1) Biofilter Recirculation Pumps	3	200	2
2) Biofilter Interstage Pumps	3	250	3
3) Biofilter No. 1 Blowers	4	10	4
4) Biofilter No. 2 Blowers	4	5	4
5) Aeration Blowers	5	350	1

	Power Draw (kW)
Average Power Demand	
1) Biofilter Recirculation Pumps	212.0
2) Biofilter Interstage Pumps	110.8
3) Biofilter No. 1 Blowers	22.31
4) Biofilter No. 2 Blowers	6.648
5) Aeration Blowers	220
Total Usage During Test Period (kW)	571.7
Average Aeration Air Flow (SCFM)	3563
Average Blower Pressure (psig)	7.7

Adjust for Plant Loading During Test Period Compared to Average for the Year

Monthly Average Influent BOD Concentration (mg/l)	295
Monthly Average Plant Flow (mgd)	20.2
Monthly Average BOD Loading (ppd)	49,698
Average Influent Loadings	
Plant Flow MGD	21.03
Pounds per Day BOD	52,167
Total Usage During Test Period (kW)	571.7
BOD Loading During Test Period (ppd)	49,698
Normal Annual BOD Loading (ppd)	52,167
Adjusted Base Line Energy Usage (kW)	**600.1**

Table 5.6 Energy Savings Analysis (New Condition) for EEM#3 and #3A

New Condition- Measure #3 and #3A

Monitoring Period 8/5/2014 - 8/27/2014
Primary Clarifier Equipment

Monitoring Period 8/5/2014 - 8/27/2014

	Total No.	Motor Size (hp)	No. In Service
Bio-Tower and Aeration Equipment			
1) Biofilter Recirculation Pumps	0	0	0
2) Biofilter Interstage Pumps	3	250	2
3) Biofilter No. 1 Blowers	0	0	0
4) Biofilter No. 2 Blowers	0	0	0
5) Aeration Blowers (Existing)	2	350	0
6) Aeration Blowers (Turbo)	3	300	1

Aeration Airflow Without Biofilter	Measure #3 Without CEPS	Measure #3A With CEPS
Average Aeration Air Flow (SCFM)	6950	4816
Average Blower Pressure (psig)	8	7.9
Blower Power Draw (kW)	241	150

	Total Power (kW)	
Average Power Demand	Measure #3 Without CEPS	Measure #3A With CEPS
1) Biofilter Recirculation Pumps (kW)	0.0	0.0
2) Biofilter Interstage Pumps (kW)	110.8	110.8
3) Biofilter No. 1 Blowers (kW)	0	0.0
4) Biofilter No. 2 Blowers (kW)	0	0.0
5) Aeration Blowers (kW)	241	150
Total New Power Usage	351.8	260.8

Table 5.7 Energy Savings Analysis for EEM#3 and 3A

Energy Savings Estimate	Measure #3 Without CEPS	Measure #3A With CEPS	
Existing Power Usage (kW)	600.1	600.1	kW
New Power Usage (kW)	351.8	260.8	kW
Total Power Saved (kW)	248.3	339.3	kW
Pre-Installation Energy Consumption	5,257,123	5,257,123	kWh
Post-Installation Energy Consumption	3,081,791	2,284,631	kWh
Total Energy Saved	2,175,333	2,972,493	kWh
Pre-Installation Demand	600.13	600.13	kW
Post-Installation Demand	351.80	260.80	kW
Total Demand Savings	248.33	339.33	kW

Table 5.8 Costs Analysis for EEM#3

Item Description	Quantity	Unit	Unit Cost	Total Cost
Demolition of Existing Bio Towers	1	LS	$ 479,000	$ 479,000
Replace Activated Sludge Blowers	3	EA	$ 300,000	$ 900,000
Aeration System Electrical and SCADA	0.5	LS	$ 450,000	$ 225,000
			Subtotal	$ 1,604,000
Planning and Preliminary Engineering			10%	$ 160,000
Final Design			15%	$ 241,000
Construction Management and Admin			15%	$ 241,000
Construction Contingency			30%	$ 481,000
(All values from MKA-P&S Report March 26, 2014)			Total	$ 2,727,000

5.2.5. EEM # 3A Remove Biofilter and Replace 3 Aeration Blowers With Addition of Chemical Enhanced Primary Sedimentation

This measure is the same as Measure #3 with the addition of CEPS to the primary clarifiers. In addition to the energy savings noted under Measure #3, the CEPS reduces biological loading to the aeration basin and further reduces the energy usage of the aeration basin over Measure #3. There are increased capital and chemical costs associated with this measure.

Analysis EEM 3A

Analysis for EEM 3A is presented above in Section 5.2.4. Costs for EEM 3A are presented in Table 5.9 below. The table does not reflect avoided cost of reconstruction/rehabilitation of the Bio-towers, as reflected in other engineering analyses.

Table 5.9 Costs Analysis for EEM#3A

Item Description	Quantity	Unit	Unit Cost	Total Cost
Demolition of Existing Bio Towers	1	LS	$ 479,000	$ 479,000
Replace Activated Sludge Blowers	3	EA	$ 300,000	$ 900,000
Aeration System Electrical and SCADA	0.5	LS	$ 450,000	$ 225,000
Chemical Addition to Primaries	1	LS	$ 500,000	$ 500,000
			Subtotal	$ 2,104,000
Planning and Preliminary Engineering			10%	$ 160,000
Final Design			15%	$ 241,000
Construction Management and Admin			15%	$ 241,000
Construction Contingency			30%	$ 481,000
(All values from MKA-P&S Report March 26, 2014)			Total	$ 3,227,000

5.2.6. EEM # 4 Turn Off Biofilter and Make SCADA Improvements

Under this measure, the biofilters are simply turned off and isolated to prevent reuse. The existing SCADA system is replaced to accommodate better control of the new blowers and the aeration process. Proposed diffuser modifications are left as a separate capital improvements project and not considered in this measure. CEPS is not considered in this measure. The primary energy savings comes from turning off biofilter recirculation pumps and blowers. Total capital costs for this measure are less and the total energy savings is also less.

Analysis EEM 4

The baseline energy usage for this option is the same as for Measure #3 and #3A discussed above.

To evaluate the changed condition for this measure, a process model was built using BioWin software to predict the performance of the biofilter and aeration basins in series. The model was calibrated against the current operation and then used to predict air flow requirements under the different measure options. Once new air flow requirements were developed for the condition without the biofilters, power usage for the existing blowers was scaled up to match the new air flow based on the measured power demand per air flow ratio of 0.061746 kW/scfm measured during the monitoring period.

For Option #4A with CEPS, the same process model was used to predict the loading to the aeration basin without the biofilter and improved BOD removal in the primary clarifier under the CEPS option. Once new air flow requirements were developed for the condition without the biofilters, power usage for the existing blowers was scaled up to match the new air flow based on the measured power demand per air flow ratio of 0.061746 kW/scfm measured during the monitoring period.

Tables 5.10-5.12 present the energy savings analysis for this option based on the established baseline energy usage from the monitoring period compared to the implemented measure. A total of 537,290 kWh annually with 60 kW of demand reduction can be saved by implementing Measure #4. A total of 1,681,554 kWh annually with 192 kW of demand reduction can be saved by implementing Measure #4A. Measure #4 and #4A have less demand reduction and energy savings then Measures #3 and #3A because the existing blowers are less efficient then the high speed turbo blowers included under Measure #3 and #3A.

The costs to implement these measures are presented in Table 5.13. The largest cost is to install the SCADA improvements to better control the existing blowers and aeration system. SCADA improvements are required to operate the aeration system at increased air flows because the existing system is limited and is only capable of controlling one blower. Measure #4A has an increased capital cost for the chemical addition facility and increased operations cost for the cost of the chemicals.

Table 5.10 Energy Savings Analysis (Existing Condition) for EEM#4 and #4A

Table 5.11 Energy Savings Analysis (New Condition) for EEM#4 and #4A

Existing Condition

Monitoring Period 8/5/2014 - 8/27/2014

	Total No.	Motor Size (hp)	No. In Service
Bio-Tower and Aeration Equipment			
1) Biofilter Recirculation Pumps	3	200	3
2) Biofilter Interstage Pumps	3	250	2
3) Biofilter No. 1 Blowers	4	10	4
4) Biofilter No. 2 Blowers	4	5	4
5) Aeration Blowers	5	350	1

	Power Draw (kW)
Average Power Demand	
1) Biofilter Recirculation Pumps	212.0
2) Biofilter Interstage Pumps	110.8
3) Biofilter No. 1 Blowers	22.3
4) Biofilter No. 2 Blowers	6.6
5) Aeration Blowers	220.0
Total Usage During Test Period (kW)	571.7
Average Aeration Air Flow (SCFM)	3563
Average Blower Pressure (psig)	7.7
Existing Blower Power (kW/scfm)	0.061746

Adjust for Plant Loading During Test Period Compared to Average for the Year

Monthly Average Influent BOD Concentration (mg/l)	295
Monthly Average Plant Flow (mgd)	20.2
Monthly Average BOD Loading (ppd)	49,698
Average Influent Loadings	
Plant Flow MGD	21.03
Pounds per Day BOD	52,167
Total Usage During Test Period (kW)	571.7
BOD Loading During Test Period (ppd)	49,698
Normal Annual BOD Loading (ppd)	52,167
Adjusted Base Line Energy Usage (kW)	**600.1**

New Condition			
Monitoring Period 8/5/2014 - 8/27/2014			
Primary Clarifier Equipment			
Monitoring Period 8/5/2014 - 8/27/2014	Total No.	Motor Size (hp)	No. In Service
Bio-Tower and Aeration Equipment			
1) Biofilter Recirculation Pumps	0	0	0
2) Biofilter Interstage Pumps	3	250	2
3) Biofilter No. 1 Blowers	0	0	0
4) Biofilter No. 2 Blowers	0	0	0
5) Aeration Blowers	5	350	1
	Measure #4	Measure #4A	
Aeration Airflow Without Biofilter	Without CEPS	With CEPS	
Average Aeration Air Flow (SCFM)	6950	4816	
Average Blower Pressure (psig)	8	7.9	
Blower Power Draw (kW)	429	297	
	Total Power (kW)		
	Measure #4	Measure #4A	
Average Power Demand	Without CEPS	With CEPS	
1) Biofilter Recirculation Pumps (kW)	0.0	0.0	
2) Biofilter Interstage Pumps (kW)	110.8	110.8	
3) Biofilter No. 1 Blowers (kW)	0	0.0	
4) Biofilter No. 2 Blowers (kW)	0	0.0	
5) Aeration Blowers (kW)	429	297	
Total New Power Usage	539.9	408.2	

Table 5.12 Energy Savings Analysis for EEM#4 and #4A

Energy Savings Estimate	Measure #4 Without CEPS	Measure #4A With CEPS	
Existing Power Usage (kW)	600.1	600.1	
New Power Usage (kW)	539.9	408.2	
Total Power Saved (kW)	60.2	192.0	
Pre-Installation Energy Consumption	5,257,123	5,257,123	kWh
Post-Installation Energy Consumption	4,729,834	3,575,569	kWh
Total Energy Saved	527,290	1,681,554	kWh
Pre-Installation Demand	600.13	600.13	kW
Post-Installation Demand	539.94	408.17	kW
Total Demand Savings	60.19	191.96	kW

Table 5.13 Costs Analysis for EEM#4

Item Description	Quantity	Unit	Unit Cost	Total Cost
Aeration System Electrical and SCADA	1	LS	$ 250,000	$ 250,000
			Subtotal	$ 250,000
Final Design			10%	$ 160,000
Construction Management and Admin			10%	$ 160,000
Construction Contingency			10%	$ 160,000
			Total	$ 730,000

5.2.7. EEM # 4A Turn Off Biofilter and Make SCADA Improvements With Addition of Chemical Enhanced Primary Sedimentation

This measure is the same as Measure #4 with the addition of CEPS to the primary clarifiers. In addition to the energy savings noted under Measure #4, the CEPS reduces biological loading to the aeration basin and further reduces the energy usage of the aeration basin over Measure #4. There are increased capital and chemical costs associated with this measure.

Analysis EEM 4A

Analysis for EEM 4A is presented above in Section 5.2.6. Costs for EEM 4A are presented in Table 5.14 below.

Table 5.14 Costs Analysis for EEM#4A

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Item Description	Quantity	Unit	Unit Cost	Total Cost
Aeration System Electrical and SCADA	1	LS	$ 250,000	$ 250,000
Chemical Addition to Primaries	1	LS	$ 500,000	$ 500,000
			Subtotal	$ 750,000
Final Design			10%	$ 160,000
Construction Management and Admin			10%	$ 160,000
Construction Contingency			10%	$ 160,000
			Total	$ 1,230,000

5.2.8. EEM # 5 Modify Utility Water System

The existing utility water pumping system pumps secondary effluent into an internal piping system for reuse of the water within the plant. The system consists of three 125 hp vertical turbine pumps with VFD control. The pumps maintain a system pressure of 90 psi at all times. This measure includes modifying the SCADA system to reduce the system pressure from 90 PSI to 60 PSI all day. The primary need for high pressure water is the dewatering operation which does not occur at night. The other users of the utility water such as seal water and spray water do not require 90 psi water. The energy savings achieved with this measure is a result of operation of the pumps at lower pressure for 12 hours a day.

Analysis EEM 5

To establish the energy baseline for this measure, the power usage of the existing pumps was monitored with power monitors from 8/5/201 through 8/27/2014. The data indicated that the lead pump runs 100% of the time (24 hrs/day) with the remaining pumps running less time. Based on this information, the total power usage for the existing condition was determined as indicated in Table 5.15.

To evaluate the changed condition for this measure, the reduced pressure condition of 60 psi for the 12 hour period from 6 pm to 6 am was used in conjunction with pump affinity laws to reduce actual measured pump power to the lower pressure condition. This lower pressure power condition was then compared to the measured power at full pressure during the monitoring period for the existing pumps to determine the net energy savings for the 12 hour period.

Table 5.15 presents the energy savings analysis for this option based on the established baseline energy usage from the monitoring period compared to the implemented measure. A total of 66,572kWh annually can be saved by implementing this measure. There is no demand savings for this measure because the pumps run full power 12 hours a day.

The cost to implement this measure is presented in Table 5.16. The largest cost is to modify the existing SCADA system to set pressure for the pumps based on a time clock.

Table 5.15 Energy Savings Analysis for EEM#5

Existing Condition

Monitoring Period Mar-Apr 2014			
	Total No.	No. In Service	
Number of Reclaimed Water Pumps	3	3	
Pump Design Conditions/Operating Conditions			
Flow (gpm)		Variable	
Existing Pump Head (feet)		208	90 (psi)
Power Usage		Power Used	
Pump Motor Size (hp)		125	hp
Average Power Usage Total for all Pumps(kW)		33.5	kW

New Condition

	Total No.	No. In Service	
Number of Reclaimed Water Pumps	3	3	
Pump Design Conditions/Operating Conditions			
Flow (gpm)		Variable	
New Pump Head 6 pm - 6 am (feet)		139	60 (psi)
New Pump Head 6 am - 6 pm (feet)		208	90 (psi)
Power Usage		Power Used	
Pump Motor Size (hp)		125	hp
Average Power Usage Total for all Pumps 6 pm- 6am (kW)		18.3	kW
Average Power Usage Total for all Pumps 6 pm- 6am (kW)		33.5	kW
Peak Pump Power Usage (kW)		0.0	kW

Existing Power Usage	33.5	kW
New Power Usage 6 pm to 6 am	18.3	kW
Total Power Saved	15.2	kW
Pre-Installation Energy Consumption	146,729	kWh
Post-Installation Energy Consumption	80,158	kWh
Total Energy Saved	66,572	kWh
Pre-Installation Demand	0.00	kW
Post-Installation Demand	0.00	kW
Total Demand Savings	0.00	kW

Table 5.16 Costs Analysis for EEM#5

Item Description	Quantity	Unit	Unit Cost	Total Cost
Programming Changes to SCADA	1	EA	$ 8,000	$ 8,000
Engineering Design and Project Management	1	EA	$ 8,000	$ 8,000
Construction Support	1	EA	$ 8,000	$ 8,000
			Subtotal	$ 24,000
Contingency			10%	$ 2,000
			Total	$ 26,000

5.2.9. EEM # 6 Modify Digester Mixing and Heating

The facility has 3 existing anaerobic digesters to process sludge from the primary and secondary processes. Digester No. 1 and No. 3 are in service. Digester No. 2 is not used. Digester No. 1 is 90 feet in diameter with a volume of 1.5 million gallons (mg). Digester No. 3 is 110 feet in diameter with a volume of 2.3 mg. The digesters are heated with three 50 hp heating recirculation pumps. The digesters are gas mixed with draft tubes. Digester No. 1 has two 100 hp and two 40 hp gas compressors for mixing. Digester No. 3 has three 150 hp gas compressors for mixing.

Heating

The heating recirculation pumps are torque flow style pumps equivalent to the WEMCO Model C style pump. These pumps have very low efficiencies but were historically installed for their robustness in pumping grit and high solids.

This measure evaluates replacing all three heating recirculation pumps with a screw centrifugal pump equivalent to the WEMCO Model Hydrostal. The Model Hydrostal pump is also designed for high solids such as digester sludge service, but is approximately 3 to 4 times more efficient as the Model C pump.

Savings and costs are calculated under this measure for replacing all three of the digester heating pumps.

Mixing

Gas mixing systems are less efficient than other types of digester mixing systems. In addition, the existing gas mixing system is grossly over sized. This measure proposes to replace the existing gas mixing system with a new high efficiency linear motion mixing system. The linear motion system mixing system uses a rising and plunging disk inside the digester to mix the contents. This system has been retrofitted successfully with substantial energy savings at several other digester facilities.

Savings and costs are calculated under this measure for replacing all of the gas compressors and draft tube mixers on Digesters No. 1 and No. 3.

Analysis EEM 6

To establish the energy baseline for this measure, the power usage of the existing pumps and gas compressors was monitored with power monitors from 8/5/2014 through

8/27/2014. The data indicated that 2 of the 3 heating recirculation pumps run 100% of the time (24 hrs/day) with the remaining pump off line. The data also indicate that only one gas compressor for each digester mixing systems operates 24 hrs per day. Based on this information, the total power usage for the existing condition was determined as indicated in Table 5.17.

Heating

To evaluate the changed condition for this measure, the flow and pressure conditions for the existing recirculation pumps were used in conjunction with pump curves for the WEMCO model Hydrostal pump to determine the pump power required for a replacement pump. This power was then compared to the measured power during the monitoring period for the existing pumps to determine the net energy savings.

Mixing

To evaluate the changed condition for this measure, a new mixing system using linear motion mixing was sized by the linear motion mixer manufacturer (Ovivo) for each digester. This sizing included total guaranteed mixing power for each digester. The power for the linear motion mixing was then compared to the measured power during the monitoring period for the existing gas compressors to determine the net energy savings.

Table 5.17 presents the energy savings analysis for this option based on the established baseline energy usage from the monitoring period compared to the implemented measure. A total of 1,315,257 kWh annually can be saved by implementing this measure. In addition 150 kW of power demand would be reduced by implementing this measure.

The cost to implement this measure is presented in Table 5.18. The largest cost is to purchase the new pumps and linear motion mixing system.

Table 5.17 Energy Savings Analysis for EEM#6

Existing Condition

Monitoring Period 8/5/2014 - 8/27/2014

Digester Equipment	Total No.	Motor Size (hp)	No. In Service
1) Heating Recirculation Pumps	3	50	2
2) Digester No. 1 Gas Mix Blowers	2	100	1
3) Digester No. 1 Gas Mix Blowers	2	40	0
4) Digester No. 3 Gas Mix Blowers	3	150	1

Average Power Demand	Power Draw (kW)
1) Heating Recirculation Pumps	74.6
2) Digester No. 1 Gas Mix Blowers	58.1
3) Digester No. 1 Gas Mix Blowers	0
4) Digester No. 3 Gas Mix Blowers	67.7
Total Existing Power Usage	200.3

New Condition

Monitoring Period 8/5/2014 - 8/27/2014

Digester Equipment	Total No.	Motor Size (hp)	No. In Service
1) Heating Recirculation Pumps	3	20	2
2) Digester No. 1 Linear Mixers	1	15	1
3) Digester No. 3 Linear Mixers	3	7.5	3

Average Power Demand	Power Draw (kW)
1) Digester No. 1 Recirculation Pump	13.4
2) Digester No. 3 Recirculation Pump	13.4
3) Digester No. 1 Linear Mixers	9.3
4) Digester No. 3 Linear Mixers	14.0
Total New Power Usage	50.2

Existing Power Usage	200.3	kW
New Power usage	50.2	kW
Total Power Saved	150.1	kW
Pre-Installation Energy Consumption	1,754,734	kWh
Post-Installation Energy Consumption	439,476	kWh
Total Energy Saved	1,315,257	kWh
Pre-Installation Demand	200.31	kW
Post-Installation Demand	50.17	kW
Total Demand Savings	150.14	kW

Table 5.18 Costs Analysis for EEM#6

Item Description	Quantity	Unit	Unit Cost	Total Cost
Wemco Hydrostal F4K-MH 15 hp motor	3	EA	$ 29,268	$ 87,804
Pump Installation	3	EA	$ 3,500	$ 10,500
Modify Existing Piping	3	EA	$ 2,500	$ 7,500
New Gauges and Instruments	3	EA	$ 1,500	$ 4,500
Ovivo Linear Mixer 15 hp motor (Digester No. 1)	1	EA	$ 226,038	$ 226,038
Digester No. 1 Mixer Installation	1	EA	$ 25,000	$ 25,000
Modify Existing Digester Roof	1	EA	$ 25,000	$ 25,000
Ovivo Linear Mixer 7.5 hp motor (Digester No. 3)	3	EA	$ 136,781	$ 410,343
Digester No. 3 Mixer Installation	3	EA	$ 25,000	$ 75,000
Modify Existing Digester Roof	3	EA	$ 25,000	$ 75,000
Miscellaneous Construction	1	EA	$ 15,000	$ 15,000
Engineering Design and Project Management	1	EA	$ 80,000	$ 80,000
Construction Support	1	EA	$ 80,000	$ 80,000
			Subtotal	$ 1,122,000
Contingency			10%	$ 112,000
			Total	$ 1,234,000

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Appendix A – Energy Savings Calculations

The following workbooks are attached as part of this report:

1. E5 Mechanical Audit Spreadsheet Template v4 OWTP Option A.xlsx
2. E5 Mechanical Audit Spreadsheet Template v4 OWTP Option B.xlsx
3. Oxnard Analysis Rev 4-2.xlsx

Appendix B – Project Cost Estimates

See “Cost Summary” tab in attached Excel file:

Oxnard Analysis Rev 2-4.xls

APPENDIX B - MECHANICAL AUDIT REPORT

Mechanical Audit Report

A24CMC1

Provided For:

City of Oxnard

Oxnard Wastewater Treatment Plant

6001 South Perkins Road

Oxnard, CA 93033

Provided by:

The Energy Network

Audit Performed by:

QuEST

December 17, 2014

Version 4

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TABLE OF CONTENTS

1 Executive Summary

The Energy Network is pleased with the opportunity to provide this mechanical audit report to the City of Oxnard. The Energy Network, administered by Los Angeles County, was created by the California Public Utilities Commission to help eligible public agencies in Southern California harness their collective action, save energy, reduce operating costs and protect precious resources. To expand public agency participation in utility energy efficiency programs, The Energy Network is offering a range of energy efficiency services to assist public agencies with accelerating energy retrofits.

This report describes a package of recommended energy efficiency measures for the mechanical equipment at Oxnard Wastewater Treatment Plant (OWTP) estimated to reduce total annual energy costs by $2,034. In addition to reduced energy costs, the recommendations will provide the City of Oxnard with an opportunity to modernize outdated equipment, improve reliability and comfort, and replace ozone depleting R-22 refrigerant ,which is currently being phased out under the Montreal Protocol, with environmentally friendly refrigerants.

The Energy Network's engineering consultant, QuEST, Inc., performed a mechanical energy audit of the City of Oxnard's Wastewater Treatment Plant. The facility treats wastewater and monitors the quality of the final effluent to safeguard and preserve water resources. It consists of multiple buildings and open areas containing process infrastructure to treat wastewater.

The existing energy using systems are primarily process related equipment, exterior and interior lighting, and heating, ventilating and air conditioning (HVAC) equipment at some of the plant buildings. The HVAC equipment was audited at thirteen (13) buildings throughout the plant. The HVAC systems consist primarily of small heat pumps (HP) and air conditioning (AC) units ranging in size from 3 to 5 tons. There are only five (5) units with the cooling capacity greater than 5 tons. The total installed capacity of all units is 130 tons, however several units are not operational and the capacity of all functioning units is 80 tons. Energy usage related to the surveyed mechanical equipment represents a minor portion of the facility's total energy consumption, it is estimated that the HVAC units use less than 5% of the total energy.

1.1 Recommended Measures

The following energy efficiency measures (EEMs) have been evaluated and are recommended.

- *Replace Admin Bldg (1) 10-ton Rooftop Split System Outdoor HP Unit*
- *Replace Maintenance Bldg (1) 4-ton Rooftop Single Package HP*
- *Replace Maintenance Bldg (1) 5-ton Rooftop Single Package Gas/Elec Unit*
- *Replace Operations Center (1) 4-ton and (2) 3-ton Rooftop Single Package HPs*
- *Replace Effluent Electrical Room (1) 5-ton Split System AC Condensing Unit*
- *Replace Solids Processing (1) 3-ton Rooftop Split System Outdoor HP Unit*
- *Replace North Area Electrical Bldg (1) 7.5-ton Rooftop Single Package HP*
- *Replace Storage Bldg Server Room (1) 5-ton Split System AC Condensing Unit*
- *Replace New Headworks (1) 3-ton Rooftop Single Package AC*

If all of the measures listed above are implemented, the project will realize an estimated annual electricity savings of 27,075 kWh. Since the HVAC systems consume a small portion of the total energy, this reduction does not have a significant percentage reduction in the overall facility energy consumption.

The project savings, costs and financial analyses are summarized in Table 1.1.

Energy savings includes DEER Interactive Effects and Coincident Demand Factor. See the detailed calculations for more details. This may result in negative savings due to increase in heating and/or cooling demand. Annual Cost Savings is based on applicable electric and gas service rates.

The Gross Project Cost to your agency is estimated at $93,995, which includes all construction costs plus contingency costs. The Agency is receiving an estimated $24,401 of free services through The Energy Network. The Energy Network is covering the costs for project management, audit, design, construction management support, and measurement and verification, if applicable.

Total Incentives are based on the utility incentive rates. When subtracting incentives from the Gross Project Cost, the Net Project Cost to your agency is estimated at $72,995.

See Table 1.2 for a breakdown of the various project cost components.

In addition to the savings summarized in Table 1.1 the Agency could achieve additional cost savings by installing occupancy sensors to control temperature settings for electrical rooms or other areas with occasional and/or irregular occupancy. The potential savings are around 7,000 kWh and $500 per year and the cost around $2,700. Those estimates are highly dependent on the acceptable comfort conditions, type of sensors and compatibility with the existing thermostats. More details are provided at the end of Section 5.2.

Table 1.1 Proposed Mechanical Energy Efficiency Measures

City of Oxnard Wastewater Treatment Plant

			On-Bill Annual Savings[1]			Cost Savings, Project Costs, and Utility Incentives						
EEM #	Facility	Energy Efficiency Measure (EEM) Description	Electric Savings (kWh/yr)	Peak Savings (kW)	Gas Savings (therms/yr)	Annual Electric Cost Savings[2] ($/yr)	Annual Gas Cost Savings[2] ($/yr)	Annual Maintenance Savings[6] ($/yr)	TOTAL Annual Cost Savings[2] ($/yr)	Gross Project Costs[3] ($)	Total Incentives[4] ($)	Net Project Costs ($)
EEM-1	Oxnard Wastewater Treatment Plant	Replace Admin Bldg (1) 10-ton Rooftop Split System Outdoor HP Unit	3,274	2	-	$246	$0	$228	$474	$11,396	$4,000	$7,396
EEM-2	Oxnard Wastewater Treatment Plant	Replace Maintenance Bldg (1) 4-ton Rooftop Single Package HP	1,672	1	-	$126	$0	$185	$311	$9,273	$1,600	$7,673
EEM-3	Oxnard Wastewater Treatment Plant	Replace Maintenance Bldg (1) 5-ton Rooftop Single Package Gas/Elec Unit	1,150	1	10	$86	$10	$197	$294	$9,867	$2,000	$7,867
EEM-4	Oxnard Wastewater Treatment Plant	Replace Operations Center (1) 4-ton and (2) 3-ton Rooftop Single Package HPs	6,696	2	-	$503	$0	$515	$1,018	$25,751	$4,000	$21,751
EEM-5	Oxnard Wastewater Treatment Plant	Replace Effluent Electrical Room (1) 5-ton Split System AC Condensing Unit	1,824	1	-	$137	$0	$95	$232	$4,741	$2,000	$2,741
EEM-6	Oxnard Wastewater Treatment Plant	Replace Solids Processing (1) 3-ton Rooftop Split System Outdoor HP Unit	1,141	0	-	$86	$0	$87	$172	$4,334	$1,200	$3,134
EEM-7	Oxnard Wastewater Treatment Plant	Replace North Area Electrical Bldg (1) 7.5-ton Rooftop Single Package HP	6,218	1	-	$467	$0	$323	$790	$16,159	$3,000	$13,159
EEM-8	Oxnard Wastewater Treatment Plant	Replace Storage Bldg Server Room (1) 5-ton Split System AC Condensing Unit	3,828	1	-	$288	$0	$95	$382	$4,741	$2,000	$2,741
EEM-9	Oxnard Wastewater Treatment Plant	Replace New Headworks (1) 3-ton Rooftop Single Package AC	1,272	1	-	$96	$0	$155	$250	$7,733	$1,200	$6,533
Total			**27,075**	**9.6**	**10**	**$2,034**	**$10**	**$1,880**	**$3,924**	**$93,995**	**$21,000**	**$72,995**

Notes: [1] Energy savings include adjusted for interactive effects between measures. See the detailed calculation for more details. This may result in negative savings due to increase in heating and/or cooling demand. [2] Annual Cost Savings is based on applicable IOU service rates. [3] The Agency Project Cost includes construction costs and contingency. The Energy Network cost includes project management, audit, design, construction management support, and measurement and verification. [4] Total Incentives are based on the utility incentive rates. [5] IOU Annual Savings represent savings that are eligible for IOU incentives under the rule and guidelines of their efficiency programs. [6] Annual Maintenance Cost Savings is estimated using the CEC Proposition 39 approach of assuming 2% of construction cost annually, adjusted for inflation and discount rate.

Project Financial Analysis				
Net Present Value* (NPV)	Internal Rate of Return (IRR)	Savings-to-Investment Ratio (SIR)	Return on Investment (ROI)	Simple Payback (years)
($23,566)	0.1%	0.68	-47%	18.6

Notes: NPV and SIR are discounted at a rate of 5%. Analysis is based on cost savings, net project costs, and equipment measure life equal to Effective Useful Life values for SCE measure code. Utility rate escalation and inflation are included in the life cycle cost analysis.

1.2 Project Cost Breakdown

Table 1.2 Project Cost Breakdown

Budget Component	Estimated Cost
Construction (JOC)	$85,450
Contingency	$8,545
Subtotal: Agency Gross Construction Costs	**$93,995**
SCE/SCG Incentives	$21,000
Subtotal: Agency Net Construction Costs	**$72,995**
Project Management	$960
Audit	$11,845
Design	$3,615
Construction Management Support	$5,020
M&V	$2,961
Subtotal: The Energy Network Costs	**$24,401**
TOTAL PROJECT COST	**$97,396**

1.3 Non Recommended Energy Efficiency Measures

Considering that the majority of the HVAC systems consist of small heat pumps and air conditioning units, the audit focused on retrofit options that could take advantage of the utility incentives available for the early retirement of aging, inefficient equipment. During the site survey, seven (7) HVAC units were identified as non--functioning, therefore they could not be included in the retrofit recommendation as detailed in Section 5 HVAC Systems and Recommendations. Per the utility program Equipment Eligibility Requirements, only operational units qualify for the incentive. However, a replacement with high efficiency units is recommended as a capital improvement project that would greatly improve occupants comfort and meet or exceed the current Title 24 efficiency requirements. Additionally, four (4) operational units were excluded from the recommended measures as they are less than 5 years old and meet the current minimum efficiency requirements. HVAC units excluded from the recommendations are listed in Section 5.3 Non-Recommended Measures.

2 Introduction

This section provides an overview of The Energy Network, the energy efficiency services available to participating agencies, and the Project Team that contributed to completing this report.

2.1 Program Overview

The Energy Network, administered by Los Angeles County, was created by the California Public Utilities Commission to help eligible public agencies in Southern California harness their collective action, save energy, reduce operating costs and protect precious resources.

To expand public agency participation in utility energy efficiency programs, The Energy Network is offering an unprecedented level of services. Our Turnkey Project Delivery method is aimed at minimizing strain on your agency's resources. The Network provides all of the services you need to carry out successful energy retrofit projects including project management, energy audits, retrofit design, construction management support, and expedited construction services.

Turnkey Project Delivery Services provided at no cost to your Agency include:

- Project Management
- Energy Audits
- Project Design
- Evaluating and Arranging Construction Financing
- Incentive Process Handling
- Retrofit Construction Management Support

Construction costs net of any applicable incentives would be covered by your agency, but The Energy Network offers expedited construction procurement services specifically designed to fast track energy efficiency retrofits and reduce your costs. Pools of pre-qualified mechanical and electrical contractors in your region have already been selected and awarded indefinite quantity construction contracts by the National Joint Powers Alliance® (NJPA) through a public competitively bid process.

By becoming a member of the NJPA, participating agencies can receive on call, energy retrofit construction services and be assured they are getting high quality firms that will perform work at guaranteed prices. Becoming a member of the NJPA can be done on-line at no-cost, no obligation and no liability.

Your agency saves time and money by not going through a lengthy qualification and bidding process, and the pricing for any work is transparent, detailed and guaranteed up front. And because the construction prices are set by the unit pricing in the catalog, the risk of inflated costs for change orders is greatly reduced. The Energy Network can help arrange financing for your energy efficiency projects, including utilizing our Master Lease Program financing designed specifically for public agency energy projects; and the entire utility incentive process is handled on your behalf.

After construction, The Network will help you realize your full energy savings by training your staff on the proper operation of the installed measures.

By providing unbiased expertise, project management, financing, and premium engineering services, The Energy Network addresses the common barriers that prevent many local governments and public agencies with limited resources from adopting energy saving measures. The Energy Network's services will complement and support services provided by other existing programs.

2.2 Project Team

Through The Energy Network, QuEST, Inc. performed a mechanical energy audit of the Oxnard Wastewater Treatment Plant operated by the City of Oxnard.

The project team consists of Thien Ng from the Capital Projects Management Division and Jeff Palacio from the Water Resources Division who provided invaluable assistance and access to the facility areas. The Energy Network's Project Manager is Douglas O'Brien. The personnel from QuEST that performed this audit is Franica Srdar with support from Irina Krishpinovich.

3 Facility Information

The Oxnard Wastewater Treatment Plant facility is located at 6001 South Perkins Road in Oxnard, CA. The facility is operated by the City of Oxnard. A description of the facility is provided below.

3.1 General Facility Description

The Oxnard Wastewater Treatment Plant consists of multiple buildings and open areas containing equipment and infrastructure supporting the wastewater treatment process. Following a three-step treatment process at the facility, most of the treated wastewater is discharged into the ocean.

3.2 Description of Areas Surveyed

The audit addressed mechanical equipment serving the following buildings: Administration and Laboratory, Maintenance, Collection System, Co-Generator, Operations Center, Effluent Electrical Room, Main Electrical, Small Electrical Room by Biofilter No. 1, Solids Processing, North Area Electrical, Headworks Controls, Storage and New Headworks. Majority of the buildings are small, single story buildings contain process related equipment and gear.

Administration and Laboratory building is typically occupied from 7:00 a.m. to 5:30 p.m., Monday through Friday (Admin section) and from 6:00 a.m. to 4:00 p.m., Monday through Saturday (Lab section). Maintenance building is typically occupied from 6:00 a.m. to 5:00 p.m., Monday through Friday while the Collection System building typical occupancy is from 6:00 a.m. to 4:00 p.m., Monday through Friday. Co-Generator building is typically occupied from 7:00 a.m. to 5:00 p.m., Monday through Sunday. Other buildings either do not have office or other type of space that is typically occupied, or staff is in and out thrpughout the day and night, therefore the HVCA equipment in all other buildings is scheduled on 24 hours per day, 7 days per week.

4 Historical Energy Use

4.1 Total Energy Use and Costs

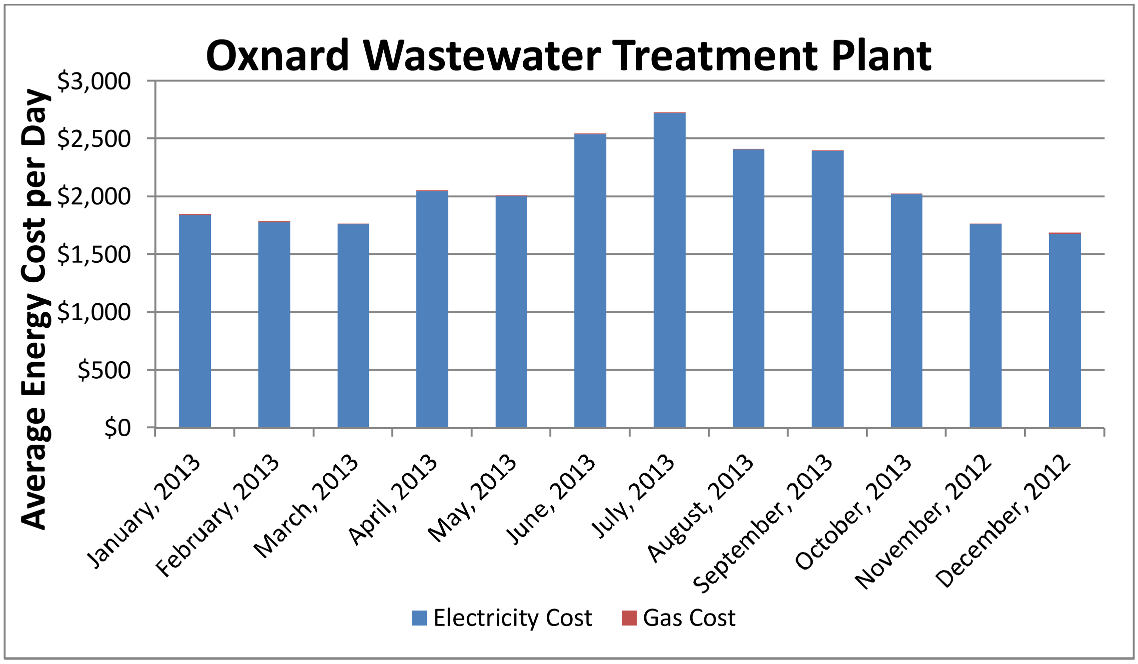
During a 12-month period from November 2012 through October 2013, the facility's total electricity consumption was 10,108,710 kWh, at a cost of $759,354, and the facility's total natural gas consumption was 1,847 therms, at a cost of $1,898. The total annual cost of energy at this site is approximately $761,251. Table 4.1 show the monthly breakdown of electric and gas usage and costs.

Table 4.1 Monthly Utility Usage and Cost

Month	Electricity Usage (kWh)	Demand (kW)	Electricity Cost ($)	Natural Gas (therms)	Gas Cost ($)	Total Utility Cost ($)
January, 2013	912,924	1,872	56,920	394	$347	$57,267
February, 2013	799,434	1,800	49,806	230	$226	$50,032
March, 2013	869,364	1,944	54,560	188	$181	$54,741
April, 2013	859,158	1,944	61,438	118	$123	$61,561
May, 2013	878,508	1,872	62,076	99	$109	$62,185
June, 2013	762,228	2,016	76,209	114	$131	$76,340
July, 2013	798,480	2,016	84,422	98	$116	$84,538
August, 2013	784,152	1,872	74,613	97	$111	$74,725
September, 2013	744,588	1,944	71,855	104	$117	$71,972
October, 2013	880,470	1,872	62,615	94	$103	$62,718
November, 2012	897,840	2,016	52,753	112	$123	$52,876
December, 2012	921,564	1,728	52,085	199	$211	$52,296
Totals	**10,108,710**	**2,016**	**$759,354**	**1,847**	**$1,898**	**$761,251**

Figure 4.1 depicts the total cost of energy broken down into electric and gas costs by month. This indicates that the daily energy cost is the highest during the summer months mostly due to higher electricity rates, especially for the summer on peak period.

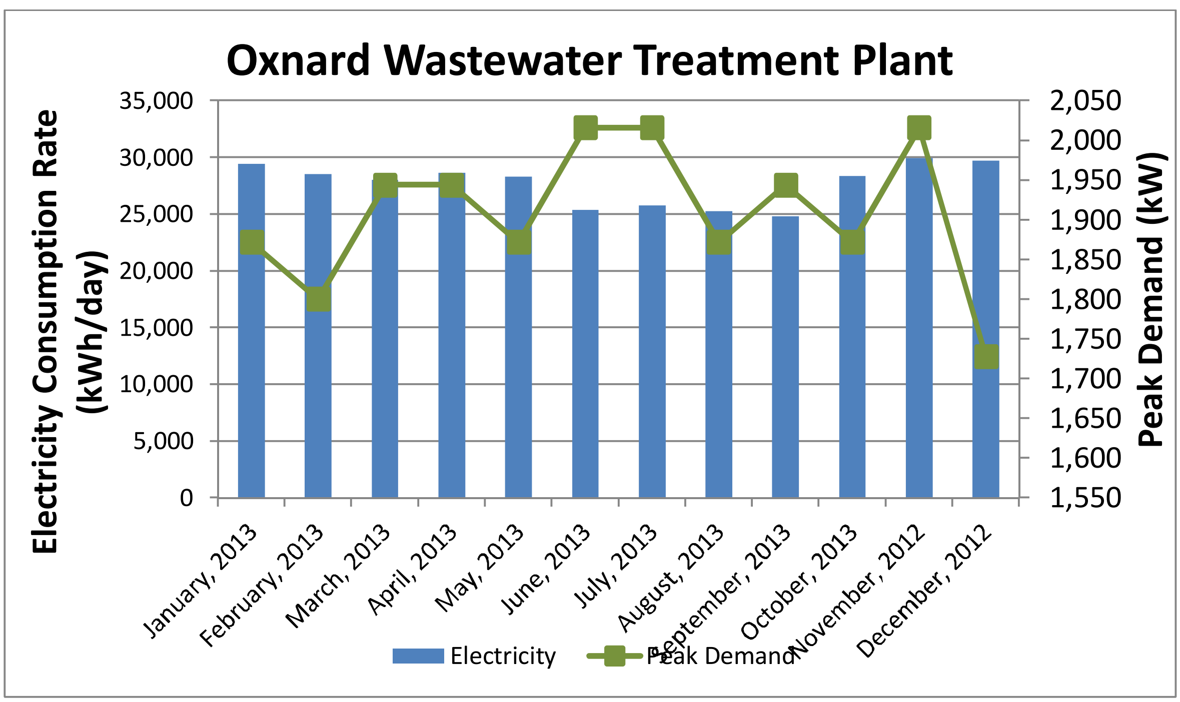
Figure 4.1: Normalized Monthly Energy Costs



4.2 Monthly Electricity Consumption and Demand

The monthly electrical data shows that there is little variance in the use of electricity since most of it is process related which is typically not subject to seasonal changes. Additionally, this facility is generating a significant portion of its electric needs and the amount of on-site generated electricity varies monthly and impacts the amount that is purchased from the utility.

Figure 4.2: Monthly Electricity Consumption and Demand

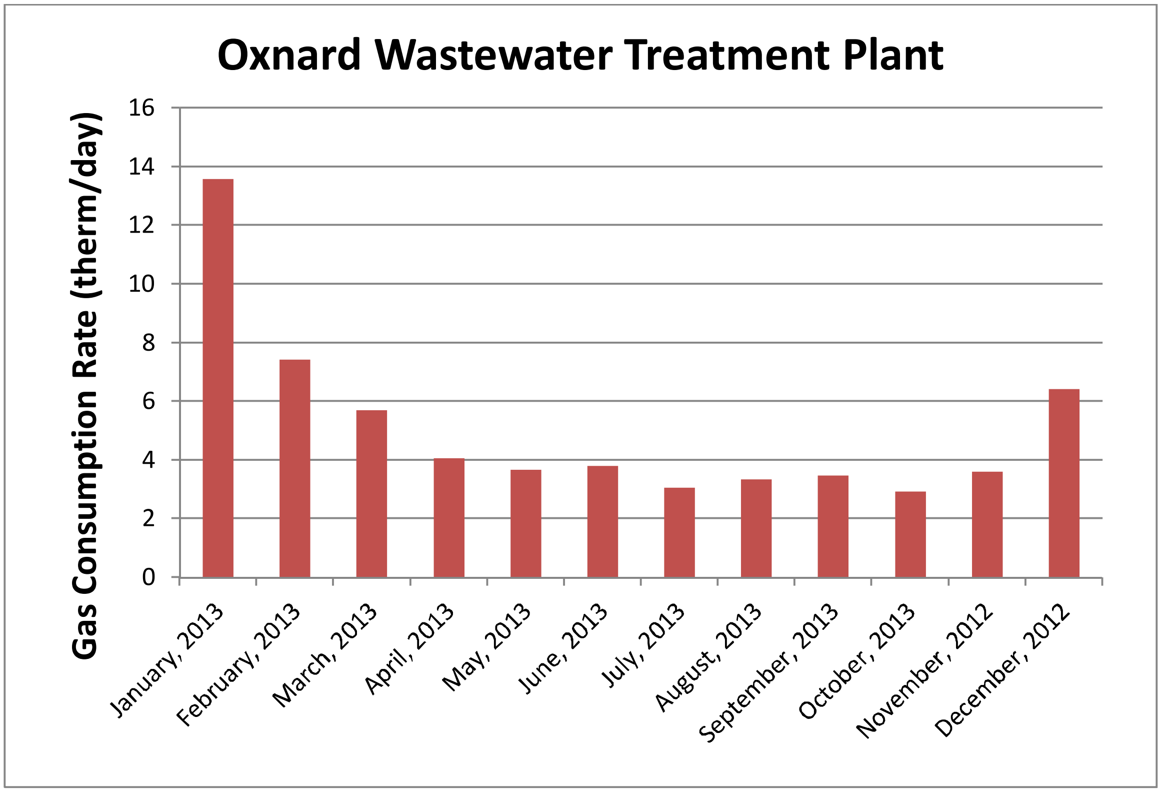


4.3 Monthly Natural Gas Consumption

The gas consumption at this facility is very small, averaging approximately 5 therms per day and as the below data shows the usage peaks in winter months.

The following figure shows the total annual gas consumption history.

Figure 4.3: Monthly Natural Gas Consumption



4.4 Energy Balance

An energy balance was not applicable in this instance as this industrial site uses the majority of energy for process associated equipment. Energy usage related to the surveyed mechanical equipment represents a minor portion of the total energy consumption.

5 HVAC Systems and Recommendations

The heating, ventilating and air conditioning (HVAC) systems are estimated to account for less than 5% of the total plant energy cost at the City of Oxnard Wastewater Treatment Plant. To identify and assess the feasibility of energy efficiency and improvement opportunities, an energy audit team visited the facility and performed visual inspections of the existing equipment and site conditions.

5.1 Existing Systems

The HVAC systems were audited at thirteen (13) buildings throughout the plant containing the total of twenty two (22) units. Majority of the HVAC systems consist of small package and split system heat pumps and air conditioning units ranging in size from 3 to 5 tons. There are five (5) units with the cooling capacity greater than 5 tons. Only one rooftop unit has electric cooling and gas heating and it is serving shop areas of the Maintenance building. The existing units range in age from over 15 years old to newer units that have been installed within the last 2 to 3 years. The HVAC systems are controlled by programmable thermostats which are maintained by a contractor.

Table 5.1 shows a summary of all HVAC equipment serving the Oxnard Wastewater Treatment Plant. In addition to the location, areas served, model numbers, capacities and efficiencies, the summary table also contains the operating hours and thermostat setpoints for each unit that were recorded during the audit.

Table 5.1 HVAC Equipment Summary

Building	HVAC Type	Unit Location	Area Served	Unit Operational (Yes/No)	Manufacturer	Model	Cooling Capacity (Tons)	EER/SEER Rating	Heating Capacity (Btu/Hr)	Heating Efficiency COP or %	Operating Hours	T-stat Settings
Administration & Laboratory	*Split System HP*	*Rooftop*	*Office*	*Yes*	*Bryant*	*575CPX120000AA--*	*10*	*10.10*	*100,000*	*3.2*	*M - F 6 am - 6:15 pm*	*72/68*
	Single Package HP	Rooftop	Lab	No	Carrier	50EQ-028---620	25	8.60	271,000	3.0	NA	NA
Maintenance	*Single Package HP*	*Rooftop*	*Office*	*Yes*	*BDP*	*655AEX048000ACBG*	*4*	*10.10*	*47,500*	*3.1*	*M - F 5:30 am - 6:00 pm*	*72/69*
	Single Package	*Rooftop*	*Shop*	*Yes*	*Bryant*	*582ANW060000AAA6*	*5*	*10.00*	*90,000*	*80.1%*	*M - F 6:00 am - 6:00 pm*	*75/65*
Collection System	Single Package HP	Rooftop	Office	No	Bryant	601AEXA060000AAA6	5	10.00	57,000	3.2	NA	NA
	Single Package HP	Rooftop	Restrooms/Showers	No	Bryant	655AEX060000AABG	5	10.00	57,000	3.2	NA	NA
Generator	Split System HP	Rooftop	Elec Room	No	Carrier	38ARZ008---601--	7	10.40	0	0.0	NA	NA
Operations Center	Single Package HP	Rooftop	Training Room	No	BDP	655AEX036000AA	3	10.10	35,400	3.1	NA	NA
	Single Package HP	*Rooftop*	*Restrooms/Showers*	*Yes*	*Bryant*	*601AEXA048000AAA6*	*4*	*10.00*	*47,000*	*3.0*	*24/7*	*73/68*
	Single Package HP	*Rooftop*	*Computer Room*	*Yes*	*Carrier*	*50TFQ004-A-611--*	*3*	*10.20*	*34,400*	*3.4*	*24/7*	*72/66*
	Single Package HP	*Rooftop*	*Office*	*Yes*	*Carrier*	*50TFQ004-A-611--*	*3*	*10.20*	*34,400*	*3.4*	*24/7*	*73/64*
Effluent Electrical Room	*Split System AC*	*Outside on concrete pad*	*Elec Room*	*Yes*	*Bryant*	*113RNA060-H*	*5*	*13.20*	*0*	*0.0*	*24/7*	*72*
	Split System HP	Outside on concrete pad	Gym	No	York	NA	NA	NA	NA	NA	NA	NA
Main Electrical	*Split System AC **	*Outside on concrete pad*	*Elec Room **	*Yes*	*Guardian*	*GCGD60S21S2B*	*5*	*13.0*	*0*	*0.0*	*24/7*	*71/35*
Small Bldg by Biofilter No. 1	*Split System AC **	*Outside on concrete pad*	*Elec Room **	*Yes*	*Payne*	*PA13NR060-H*	*5*	*13.0*	*0*	*0.0*	*24/7*	*72*
Solids Processing	*Split System HP*	*Rooftop*	*Office and Elec Room*	*Yes*	*Bryant*	*213RNA036-C*	*3*	*13.20*	*35,000*	*3.5*	*24/7*	*72/60*
North Area Electrical	*Single Package HP*	*Rooftop*	*Office*	*Yes*	*Bryant*	*549BEX090000AK*	*7.5*	*10.30*	*85,000*	*3.3*	*24/7*	*72/70*
	*Single Package HP **	*Rooftop*	*Elec Room **	*Yes*	*Bryant*	*604BEXA60000AA--0*	*5*	*13.00*	*55,000*	*3.4*	*24/7*	*70*
Headworks Controls	Split System AC	Outside wood beams	Elec Room	No	Bryant	597CN060-G	5	12	0	0.0	NA	NA
Storage	*Split System AC*	*Outside on concrete pad*	*Server Room*	*Yes*	*Bryant*	*113REA060-D*	*5*	*13*	*0*	*0.0*	*24/7*	*67/65*
New Headworks	*Single Package HP **	*Rooftop*	*Elec Room **	*Yes*	*Carrier*	*50TCQD14ACA6A0A0A0*	*12.5*	*10.30*	*142,000*	*3.2*	*24/7*	*71/70*
	Single Package AC	*Rooftop*	*Office*	*Yes*	*Carrier*	*50HJ004---621CA*	*3*	*13.00*	*0*	*0.0*	*24/7*	*70*
Total All Units							**130**		**1,090,700**			
Total Operational Units							***80***		***670,300***			

** Units under 5 years old, not recommended for replacement at this time*

Considering the type of equipment, efficiency, age and condition of some of the units, the audit focused on replacement of the existing units with new, high efficiency units. For a limited time, Southern California Edison (SCE) is partnering with local HVAC contractors and offering incentives for the HVAC Early Retirement. Currently installed and operational package or split air conditioner or heat pump systems replaced with a new high efficiency unit qualify for $400 per ton incentive. Under the HVAC Early Retirement process, an enrolled contractor submits the initial application, installs new qualifying equipment and receives incentive payment directly. This streamlined process would enable the Oxnard Wastewater Treatment Plant to upgrade the aging equipment with new, high efficiency HVAC units at a reduced cost without having to apply for a rebate.

As indicated in the table above, seven (7) units are non-functional and therefore cannot be included in the retrofit recommendations and benefit from the Early Retirement incentives. Additionally, four (4) operational units are under 5 years old so they are excluded from the replacement recommendations below. Those newer efficient units serve the following buildings/areas: Main Electrical, Electrical Room by Biofilter No. 1, North Area Electrical Room and New Headworks Office. The total of eleven (11) units is recommended for replacement as detailed in Section 5.2 Recommended Measures.

In addition to reducing energy consumption and costs, the retrofit recommendations would replace the ozone depleting refrigerant used in the existing units with environmentally friendly refrigerants. All existing units recommended for replacement contain hydrochlorofluorocarbon HCFC-22 refrigerant (also known as R-22) which is regulated as Class II controlled substance and is being phased out under the Montreal Protocol. As the production and import of R-22 is phased out over the coming years, it will become more difficult and expensive to maintain the existing R-22 systems. Since January 2010, chemical manufacturers are no longer able to produce, and companies no longer able to import, R-22 for use in new HVAC equipment but they can continue production and import of R-22 until 2020 for use in servicing existing equipment. The Clean Air Act does not allow any refrigerant to be vented into the atmosphere during installation, service, or retirement of equipment. Therefore, R-22 must be recovered and recycled (for reuse in the same system), reclaimed (reprocessed to the same purity standard as new R-22), or destroyed. After 2020, the servicing of R-22-based systems will rely solely on recycled or reclaimed refrigerants.

5.2 Recommended Measures

EEM 1: Replace Administration Building (1) 10-ton Rooftop Split System Outdoor HP Unit

This measure provides for the replacement of roof mounted outdoor unit serving the split system heat pump. The existing unit has a 10-ton cooling capacity with energy efficiency ratio (EER) of 10.1. The existing heating capacity is 100,000 Btu/hr with coefficient of performance (COP) of 3.2. This unit is approximately 10 years old and does not meet the current Title 24 minimum efficiency requirements. The recommended replacement unit would be a Carrier model 38AUQ12 or similar unit with 11.5 EER , which exceeds the Title 24 minimum efficiency and meets the SCE 2014 Qualifying Minimum Equipment Efficiencies for Commercial Air Conditioners and Heat Pumps. In addition to the efficiency improvements, further energy savings could be achieved by slightly reducing the operating hours and increasing the deadband between the cooling and heating setpoints. The unit is currently scheduled Monday to Friday from 6:00 a.m. to 6:15 p.m., the proposed schedule would start at 6:30 a.m. and stop at 5:30 p.m., more closely matching the occupancy schedule. The current Tstat setting is 72/68 ºF, it is recommended to increase the cooling setpoint to 74 ºF and keep the heating setpoint at 68 ºF.

Savings for this measure will be realized through reduced cooling and heating energy necessary to satisfy zone comfort conditions as well as reduced fan energy due to slightly shorter operating hours.

The measure would result in estimated annual electricity use and costs savings of 3,274 kWh and $474.

The project costs covered by the Agency include construction, contingency and all NJPA processing fees equal to $11,396. When subtracting out available incentives, the Net Construction cost to your agency is $7,396.

EEM 2: Replace Maintenance Bldg (1) 4-ton Rooftop Single Package HP

This measure provides for the replacement of rooftop single package heat pump. The existing unit has a 4-ton cooling capacity with seasonal energy efficiency ratio (SEER) of 10.1. The existing heating capacity is 47,500 Btu/hr with coefficient of performance (COP) of 3.1. This unit is approximately 16 years old and does not meet the current Title 24 minimum efficiency requirements. The recommended replacement unit would be a Carrier model 50HC-05 or similar unit with 12.8 EER / 15.8 SEER, which exceeds the Title 24 minimum efficiency and the SCE 2014 Qualifying Minimum Equipment Efficiencies for Commercial Air Conditioners and Heat Pumps. The recommended unit includes the economizer which would bring in cool, outside air to cool the space during favorable weather conditions and reduce the number of hours when mechanical cooling is needed.

In addition to the efficiency improvements, further energy savings could be achieved by slightly reducing the operating hours and increasing the deadband between the cooling and heating setpoints. The unit is currently scheduled Monday to Friday from 5:30 a.m. to 6:00 p.m.., the proposed schedule would remain at 5:30 a.m. and stop at 5:00 p.m., more closely matching the occupancy schedule. The current Tstat setting is 72/69 ºF, it is recommended to increase the cooling setpoint to 74 ºF and reduce the heating setpoint to 68 ºF.

Savings for this measure will be realized through reduced cooling and heating energy necessary to satisfy zone comfort conditions as well as reduced fan energy due to slightly shorter operating hours.

The measure would result in estimated annual electricity use and costs savings of 1,672 kWh and $311.

The project costs covered by the Agency include construction, contingency and all NJPA processing fees equal to $9,273. When subtracting out available incentives, the Net Construction cost to your agency is $7,673.

EEM 3: Replace Maintenance Bldg (1) 5-ton Rooftop Single Package Gas/Elec Unit

This measure provides for the replacement of rooftop single package gas/electric unit. The existing unit has a 5-ton cooling capacity with seasonal energy efficiency ratio (SEER) of 10. The existing heating capacity is 90,000 Btu/hr with gas heating efficiency of 81% . This unit is approximately 11 years old and does not meet the current Title 24 minimum efficiency requirements. The recommended replacement unit would be a Trane model YHC-060 or similar unit with 12.85 EER / 15.0 SEER , which exceeds the Title 24 minimum efficiency and the SCE 2014 Qualifying Minimum Equipment Efficiencies for Commercial Air Conditioners and Heat Pumps. The recommended unit includes the economizer which would bring in cool, outside air to cool the space during favorable weather conditions and reduce the number of hours when mechanical cooling is needed.

In addition to the efficiency improvements, further energy savings could be achieved by slightly reducing the operating hours. The unit is currently scheduled Monday to Friday from 6:00 a.m. till 6:00 p.m., the proposed schedule would remain at 6:00 a.m. and stop at 5:00 p.m., more closely matching the occupancy schedule. The current Tstat setting is 75/65 ºF, it is recommended to keep the same setpoints.

Savings for this measure will be realized through reduced cooling and heating energy necessary to satisfy zone comfort conditions as well as reduced fan energy due to slightly shorter operating hours.

The measure would result in estimated annual electricity use and costs savings of 1,150 kWh and $294.

The project costs covered by the Agency include construction, contingency and all NJPA processing fees equal to $9,867. When subtracting out available incentives, the Net Construction cost to your agency is $7,867.

EEM 4: Replace Operations Center (1) 4-ton and (2) 3-ton Rooftop Single Package HPs

This measure provides for the replacement of three (3) rooftop single package heat pumps. The existing units have a 3-ton and 4-ton cooling capacity with seasonal energy efficiency ratio (SEER) of 10.2 and 10 . The existing heating capacity is 34,400 and 47,000 Btu/hr with coefficient of performance (COP) of 3.4 and 3.0. The 3-ton units are approximately 8 years old and the 4-ton unit is estimated to be 6 years old. The existing HPs do not meet the current Title 24 minimum efficiency requirements. The recommended replacement for the 4-ton unit would be a Carrier model 50HC-05 or similar unit with 12.8 EER / 15.8 SEER, and replacement for the 3-ton units would be a Carrier model 50XT-36 12 EER / 15 SEER or similar unit with 12 EER / 15 SEER. The replacement units exceed the Title 24 minimum efficiency and meet the SCE 2014 Qualifying Minimum Equipment Efficiencies for Commercial Air Conditioners and Heat Pumps. The recommended units include the economizer which would bring in cool, outside air to cool the space during favorable weather conditions and reduce the number of hours when mechanical cooling is needed.

The units are currently scheduled 24/7 and the Tstat settings range from 73/68 to 73/64 ºF. It is recommended to increase the cooling setpoint to 74 ºF and keep the existing heating setpoints.

Savings for this measure will be realized through reduced cooling and heating energy necessary to satisfy zone comfort conditions.

The measure would result in estimated annual electricity use and costs savings of 6,696 kWh and $1,018.

The project costs covered by the Agency include construction, contingency and all NJPA processing fees equal to $25,751. When subtracting out available incentives, the Net Construction cost to your agency is $21,751.

EEM 5: Replace Effluent Electrical Room (1) 5-ton Split System AC Condensing Unit

This measure provides for the replacement of outdoor condenser serving the split system air conditioning unit. The existing unit has a 5-ton cooling capacity with seasonal energy efficiency ratio (SEER) of 13.2. This unit is approximately 7 years old and meets the current Title 24 minimum efficiency requirements. The recommended replacement unit would be a Carrier model 24ANB6-60 or similar unit with 12.5 EER / 15 SEER, which exceeds the Title 24 minimum efficiency and meets the SCE 2014 Qualifying Minimum Equipment Efficiencies for Commercial Air Conditioners and Heat Pumps. The unit is currently scheduled 24/7 and the Tstat setting is at 72 ºF. It is recommended to increase the cooling setpoint to 74 ºF.

Savings for this measure will be realized through reduced cooling and heating energy necessary to satisfy zone comfort conditions.

The measure would result in estimated annual electricity use and costs savings of 1,824 kWh and $232.

The project costs covered by the Agency include construction, contingency and all NJPA processing fees equal to $4,741. When subtracting out available incentives, the Net Construction cost to your agency is $2,741.

EEM 6: Replace Solids Processing (1) 3-ton Rooftop Split System Outdoor HP Unit

This measure provides for the replacement of roof mounted outdoor unit serving the split system heat pump. The existing unit has a 3-ton cooling capacity with seasonal energy efficiency ratio (SEER) of 13.2. The existing heating capacity is 35,000 Btu/hr with coefficient of performance (COP) of 3.5. This unit is approximately 7 years old and meets the current Title 24 minimum efficiency requirements. The recommended replacement unit would be a Carrier model 25APA5-36 or similar unit with 12.5 EER / 15.5 SEER, which exceeds the Title 24 minimum efficiency and meets the SCE 2014 Qualifying Minimum Equipment Efficiencies for Commercial Air Conditioners and Heat Pumps. The unit is currently scheduled 24/7 and the Tstat setting is 72/60 ºF. It is recommended to increase the cooling setpoint to 74 ºF and keep the existing heating setpoint.

Savings for this measure will be realized through reduced cooling and heating energy necessary to satisfy zone comfort conditions.

The measure would result in estimated annual electricity use and costs savings of 1,141 kWh and $172.

The project costs covered by the Agency include construction, contingency and all NJPA processing fees equal to $4,334. When subtracting out available incentives, the Net Construction cost to your agency is $3,134.

EEM 7: Replace North Area Electrical Bldg (1) 7.5-ton Rooftop Single Package HP

This measure provides for the replacement of rooftop single package heat pump. The existing unit has a 7.5-ton cooling capacity with energy efficiency ratio (EER) of 10.3. The existing heating capacity is 85,000 Btu/hr with coefficient of performance (COP) of 3.3. This unit is approximately 10 years old and does not meet the current Title 24 minimum efficiency requirements. The recommended replacement unit would be a Carrier model 50HC 08 or similar unit with 12.1 EER / 13 IEER, which exceeds the Title 24 minimum efficiency and SCE 2014 Qualifying Minimum Equipment Efficiencies for Commercial Air Conditioners and Heat Pumps. The unit is currently scheduled 24/7 and the Tstat setting is 72/70 ºF. It is recommended to increase the cooling setpoint to 74 ºF and reduce the heating setpoint to 68 ºF.

Savings for this measure will be realized through reduced cooling and heating energy necessary to satisfy zone comfort conditions.

The measure would result in estimated annual electricity use and costs savings of 6,218 kWh and $790.

The project costs covered by the Agency include construction, contingency and all NJPA processing fees equal to $16,159. When subtracting out available incentives, the Net Construction cost to your agency is $13,159.

EEM 8: Replace Storage Bldg Server Room (1) 5-ton Split System AC Condensing Unit

This measure provides for the replacement of outdoor condenser serving the split system air conditioning unit. The existing unit has a 5-ton cooling capacity with seasonal energy efficiency ratio (SEER) of 13. This unit is approximately 7 years old and meets the current Title 24 minimum efficiency requirements. The recommended replacement unit would be a Carrier model 24ANB6-60 or similar unit with 12.5 EER / 15 SEER, which exceeds the Title 24 minimum efficiency and meets the SCE 2014 Qualifying Minimum Equipment Efficiencies for Commercial Air Conditioners and Heat Pumps. The unit is currently scheduled 24/7 and the Tstat setting is at 67 ºF. It is recommended to increase the cooling setpoint to 72 ºF. The server room setpoint could be increased even further and provide additional energy savings as it would reduce the number of hours that the compressor needs to operate to satisfy the higher room temperature. ASHRAE's Thermal Guidelines for data centers lists the recommended dry bulb temperature up to 80.6 °F and allowable temperatures as high as 113 °F depending on the data center classification.

Savings for this measure will be realized through reduced cooling and heating energy necessary to satisfy zone comfort conditions.

The measure would result in estimated annual electricity use and costs savings of 3,828] kWh and $382.

The project costs covered by the Agency include construction, contingency and all NJPA processing fees equal to $4,741. When subtracting out available incentives, the Net Construction cost to your agency is $2,741.

EEM 9: Replace New Headworks (1) 3-ton Rooftop Single Package AC

This measure provides for the replacement of rooftop single package air conditioning unit. The existing unit has a 3-ton cooling capacity with seasonal energy efficiency ratio (SEER) of 13. This unit is approximately 7 years old and meets the current Title 24 minimum efficiency requirements. The recommended replacement unit would be a Carrier model 50XL-36 or similar unit with 12 EER / 15 SEER , which exceeds the Title 24 minimum efficiency and meets the SCE 2014 Qualifying Minimum Equipment Efficiencies for Commercial Air Conditioners and Heat Pumps. The recommended unit includes the economizer which would bring in cool, outside air to cool the space during favorable weather conditions and reduce the number of hours when mechanical cooling is needed.

The unit is currently scheduled 24/7 and the Tstat setting is at 70 ºF. It is recommended to increase the cooling setpoint to 74 ºF.

Savings for this measure will be realized through reduced cooling and heating energy necessary to satisfy zone comfort conditions.

The measure would result in estimated annual electricity use and costs savings of 1,272 kWh and $250.

The project costs covered by the Agency include construction, contingency and all NJPA processing fees equal to $7,733. When subtracting out available incentives, the Net Construction cost to your agency is $6,533.

Additional Measure to Consider: Install Occupancy Sensors for Electrical Rooms

The Agency could achieve additional cost savings by installing occupancy sensors to control temperature settings for electrical rooms and other areas with occasional and/or irregular occupancy. The recommendation is to use multi-technology wall or ceiling mounted occupancy sensors that incorporate both passive infrared and ultrasonic sensors into one unit, combining the long-range detection capabilities with the sensitivity to minor movements. New technology sensors provide much better controls than older models of occupancy sensors. Incorporating this technology with the existing or new HVAC thermostats, a room becomes aware that it is occupied and adjusts the interior environment accordingly without the need for programming schedules. For example, cooling set points for electrical rooms could be maintained at higher temperatures than the current settings but the set points would be adjusted automatically to the lower predetermined level when the room is physically occupied. Once a room is vacant, the sensor signals the HVAC controls to automatically perform a setback.

Energy savings are highly depended on the increased set points and the number of actual occupied hours in each area that is a candidate for HVAC occupancy sensors. Additional energy savings, above the savings accounted under the unit replacement and increasing the set points outlined in the above EEMs, are estimated to range from 800 kWh up to 1,500 kWh annually per electrical room. This estimate assumes that the thermostat could be maintained up to 80 ºF during the unoccupied time and when the occupancy is detected the set point is adjusted to 74 ºF. Increasing the room temperature even further would provide additional energy savings as it would reduce the number of hours that the compressor needs to operate to satisfy the higher room temperature. The estimated savings assumed that the higher set points would average 12 hours per day, some electrical rooms are probably mostly unoccupied while others have more frequent and longer occupancy where the temperature would need to be maintained at the lower level most of the time.

The facility personnel would determine the appropriate set points and areas where the occupancy sensors would provide energy savings benefits while still providing comfort levels when the areas are occupied. Although new sensors provide an adjustable “Verify Occupancy” time settings to allow random in and out occupancy for brief intervals without triggering the HVAC unit to occupied mode, electrical rooms that have very frequent in and out occupancy are probably not good candidates for this technology. Frequent room temperature changes would cause the HVAC units to cycle more than necessary and could shorten the equipment life.

Estimated costs depend on the type of sensor and compatibility with the existing thermostat, range from $300 to more than $600 per occupancy sensor for a complete purchase and setup, including installation, wiring, and programming.

The following areas are candidates for the occupancy sensor technology, however the facility personnel would determine the applicability based on the typical occupancy patterns: Effluent Electrical Room, Main Electrical Building, Small Electrical Building by Biofilter No. 1, North Area Electrical Room, Server Room and New Headworks Electrical Room. If occupancy sensors could be implemented in all of those buildings, the savings potential is around 7,000 kWh and $500 per year with the estimated costs around $2,700.

5.3 Non-Recommended Measures

The following retrofit options were not recommended as the existing energy equipment is not operational and does not qualify for the utility incentive. Additionally, once those units are replaced and brought back into service the energy use and costs for the OWTP would increase. However, a replacement with high efficiency units is recommended as a capital improvement project that would greatly improve occupants comfort, especially the Laboratory unit, and meet or exceed the current Title 24 efficiency requirements. The following non-functional units were excluded from the recommended measures:

- Laboratory Building - (1) 25-ton Single Package HP
- Collection System - (2) 5-ton Single Package HPs
- Generator - (1) 7-ton Split System HP
- Operations Center – (1) 3-ton Single Package HP
- Effluent Electrical Room - (1) 3 to 5-ton Split System HP (nameplate not available to verify the existing unit size)
- Headworks Controls - (1) 5-ton Split System AC

The following operational units were excluded from the recommended measures as they are less than 5 years old and meet the current minimum efficiency requirements:

- Main Electrical - Building - (1) 5-ton Split System AC
- Small Electrical Room by Biofilter No. 1 - (1) 5-ton Split System AC
- North Area Electrical Building - (1) 5-ton Single Package HP
- New Headworks - (1) 12.5-ton Single Package HP

6 Demand Response

Demand response (DR) programs address electric supply or price concerns that can be forecasted the day ahead or the day of an event, enabling a facility to curtail energy use during times of peak demand in return for an incentive. Considering that the installed capacity of all operational HVAC equipment is less than 100 kW and offers very a limited potential for DR programs, this facility was not evaluated for voluntary load curtailment actions.

7 Mechanical Analysis Methodology

7.1 Analytical Methodology and Assumptions

Annual energy savings are calculated by subtracting the post-project estimated energy consumption from the pre-project estimated energy consumption. Pre and post energy consumption are estimated using custom bin analysis.

Data used to develop the baseline energy consumption models include information obtained from the site surveys, mechanical schedules and utility data. Specifically, the following data was collected and used:

- Annual facility electricity and gas usage
- Design data including quantities, schematics, layouts, flow rates, and capacities
- Information from site surveys including mechanical and electrical equipment nameplate data and discussions with building engineering staff

- Operation schedules and setpoints obtained during the site survey and additionally provided by the facility
- Data sheets from equipment vendors

The baseline energy models were developed based on engineering calculations using the collected information and temperature bins. Temperature bins were arranged in 2°F intervals using annual hourly outdoor air dry bulb temperature data from Title 24 compliant CZ2010 weather data for Oxnard, CA. Because weather conditions, occupancy, and other factors vary from year to year, the estimated annual energy consumption is not expected to represent the actual energy consumption over the past year.

Once the baseline energy consumption was established, the expected energy consumption after implementation of an EEM was estimated by modifying input parameters in the models to reflect improvements to the efficiency and control of the equipment. As stated above, the estimated proposed energy consumption was then subtracted from the estimated baseline energy consumption to calculate the energy savings. Energy cost savings were then calculated by multiplying the energy savings by the appropriate energy rate.

The peak demand calculation was applicable for this measure and was calculated based upon the DEER peak demand definition as stated in the CPUC decision:

"Peak is defined as the average grid level impact for the measure from 2 p.m. to 5 p.m. during the three consecutive weekday period containing the weekday with the hottest temperature of the year".

An important step in the energy audit process is to take into account the interactive effects of installing various EEMs. 'Interactive effects' occur if two or more energy efficiency measures are installed and the realized savings are different than the sum of the estimated savings for the individual measures as stand-alone EEMs.

Consider the example of two EEMs; #1 where a new, more efficient chiller is installed and #2, where a new building automation system (BAS) is installed to shut off the air handler served by the chiller. Implementing either measure will save energy. However if both are installed, the realized savings will be less than the sum of the two measures estimated independently.

This interactive effect is accounted for by 'cascading' the calculations. In this process the proposed case for one measure is used as the baseline for the next measure. Depending on the order of implementation, savings from each individual measure will vary. The California Energy Commission's *Guide to Preparing Feasibility Studies for Energy Efficiency Projects* recommends analyzing measures that affect heating and cooling load first (such as installing controls to reduce hours of operation), then working "upward" to analyze improvements to the mechanical equipment. When reviewing the results of this report, please note that the best estimate of actual savings will be for the entire package of measures recommended. The savings of individual measures may be more or less than shown if not all of the other measures are implemented.

7.2 Project Cost Estimates

The project cost estimate is the sum of the construction cost estimate and the soft costs associated with the construction project. These cost components are described below.

Gross Project Costs: Gross Project Cost includes all costs including costs borne by the Agency and costs covered through the Energy Network services. The Agency cost includes construction and contingency costs. The Energy Network services provided at no cost to the

Agency includes project management, audit, design, construction management support, and measurement and verification

Total Incentives: total amount ($) of utility incentives available for the project.

Net Project Costs: Net Project costs are equal to the Gross Project Costs less the Total Incentives

7.2.1 Agency Project Costs and Incentives

Gross Construction Costs: The construction costs for each measure include direct labor, materials, equipment, the contractor's adjustment factor and all task order processing fees. These costs were estimated primarily from ezIQC Construction Task Catalogue (July 2013, HVAC Energy Efficiency), some contractor quotes and engineering estimates from similar projects. This estimate assumes a like for like replacement and additional potential costs such as curb adapters for rooftop units, indoor unit coil modifications for split systems, any ductwork adjustments and system repining are not included in the cost estimate.

Net Construction Costs: Gross Project Costs less the Total Incentives

Contingency: The contingency is included to cover potential increases in project scope that may occur due to unforeseen site conditions found during construction but missed in the initial audit, or refinements that occur when preparing the scope of work document.

7.2.2 The Energy Network Costs (provided at no cost to Agency)

Project Management: The Project Management cost covers the estimated cost for The Energy Network Project Manager to provide project management throughout the project.

Audit: The audit cost is the estimated cost to perform this audit and complete this report.

Design: The design costs cover the development of the project work scope that includes performance based project specifications

Construction Management Support by Consultant: The Energy Network's consultant will assist the Agency by providing Construction Management Support during construction performed by the contractor assigned from the pool of ezIQC contractors selected by the National Joint Powers Alliance. Construction Management Support will include review of submittals if applicable, assistance with coordination, progress review, monitoring of quantities and types of equipment installed, observation of controls commissioning if applicable, and document management.

Measurement & Verification (M&V): This is the cost of developing a M&V plan and performing M&V after the project is completed. Only a portion of projects will be selected to receive M&V.

7.3 Cost Effectiveness Analysis

The EEMs have been evaluated both for their technical feasibility, and for their overall financial benefit. This section describes the cost-effectiveness evaluation methods used in this report and the assumptions used to evaluate each of the recommended measures.

A Life Cycle Cost Analysis (LCCA) is employed for each measure. The LCCA methodology is based on the one laid out by the California Energy Commission Proposition 39 Program. The LCCA takes discount rate, inflation, utility rate escalation, and annual maintenance cost savings into account over the entire estimate life cycle of each measure. The measure LCCA cost streams are aggregated together into one project cost stream so that the agency can review the cost effectiveness of implementing all recommended measures at the same time in one project bundle. The program seeks to recommend project bundles to the agency that have a Savings-to-Investment Ratio (SIR) greater than 1.1, which is in line with the CA Proposition 39 program goals for public schools. There is more detail below on the financial metrics that go into these cost effectiveness calculations.

Energy savings includes DEER Interactive Effects and Coincident Demand Factor. See the detailed calculation for more details. This may result in negative savings due to increase in heating and/or cooling demand.

The Annual Cost Savings for each energy efficiency measure identified in this report have been evaluated using current utility rates the Agency pays for electricity and natural gas.

7.3.1 Financial Metrics Definitions

Lifecycle Analysis expressed as the Net Present Value (NPV): The NPV is a measure of the present value dollars of the net cost savings for a given energy project over its lifetime, including initial project costs, with discounting applied to cash flows that occur in the future. NPV is simply the present value (PV) of future cash flows minus the purchase price. NPV takes into account the time value of money and indicates what a project's lifetime cash flow is worth today. NPV is determined by calculating the amount of money in today's dollars that would have to be invested at the discount rate to reproduce the savings cash flow from the EEM and then subtracting the EEM implementation cost. If the NPV is greater than zero, the project is considered to be cost effective.

Savings-to-Investment Ratio (SIR) is the value of benefits from a project divided by its cost. Per CEC Proposition 39:

SIR = NPV / (Project Installation Cost – Rebates – Other Grants – Non-energy Benefits)

TEN does not use "Non-energy Benefits" in its financial models.

Internal Rate of Return (IRR): The internal rate of return is the interest rate that would be required to produce the financial savings from an EEM if the cost for implementing the EEM had been invested. In effect, the IRR is the discount rate which yields a Net Present Value of zero. Attractive projects have an IRR greater than the cost of money.

Return on Investment (ROI) is the annual percentage return from a project, where annual cost savings include the net present value of both utility cost savings and maintenance cost savings over the life of the project, per CEC Proposition 39 Guidelines. ROI is calculated as follows:

ROI = [Annual Cost Savings ($/yr) - Project Cost] / Project Cost ($)

Simple Payback Period: The simple payback period is the amount of time required to recover the initial costs of a project from its savings; it is calculated as Net Project Cost ($) / Annual Cost Savings ($/yr). A project is economically acceptable if the payback period is less than the length of the project life. A simple payback period ignores the time value of money and assumes that future savings occur in even amounts each year. The simple payback period is equal to the investment costs divided by the annual savings. For example, a $1,000 investment that saves $500 each year has a two-year simple payback period.

7.3.2 Financial Metrics Calculations

This section describes the assumptions used in the Analysis.

NPV assumes energy cost savings and project costs in the detailed audit calculation. Equipment measure life is based on Effective Useful Life values for each measure based on stipulated values for the SCE measure code, as shown in the "Analysis - Incentive Calc" worksheet. Per CEC Proposition 39:

Net Present Value = Energy Cost Savings + Maintenance Savings

Gross Project Cost is based the total construction costs for each measure include direct labor, materials, equipment, the contractor’s adjustment factor and all task order processing fees. The agency cost includes construction and contingency costs. The Energy Network cost includes project management, audit, design, construction management support, and measurement and verification.

Annual Cost Savings is based on electric service rates shown in the detailed audit calculation.

Discount Rate is assumed to be 5%, which is the value listed in CEC Proposition 39 Guidelines.

***NPV Term or Useful Measure* Life** = Depends on effective useful life of EEM; the Effective Useful Life values are either taken from the SCE measure code if applicable, or from the 2007 ASHRAE Handbook- HVAC Applications, Table 4 in Chapter 36.

Appendix A – Energy Savings Calculations

Electronic calculations are attached.

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Appendix B – Project Cost Estimates

EEM IMPLEMENTATION COST ESTIMATE		DATE:	9/29/2014
PROJECT:	City of Oxnard - OWTP	BASIS OF ESTIMATE (check all that apply):	
LOCATION:	6001 South Perkins Road Drive, Oxnard CA 93033	☐	R.S. MEANS
		☐	DODGE
RCx PROVIDER:	The Energy Network and QuEST	☐	MFG'S QUOTES
		☑	ENGINEERING ESTIMATE
MEASURE:	Replace 10-ton Rooftop Split System HP	☑	OTHER (eGordian NJPA)

		Quantity		*Material*		*Labor*		
Item Number	**Description of Items**	**No. of Units**	**Unit of Measure**	**Cost per Unit**	**Total**	**Cost per Unit**	**Total**	**Total Cost** incl. O&P and contingency
1	Demo	1	each		$ -	$ 600	$ 600	$ 600
2	10 Ton 13 SEER Outdoor Heat Pump Unit	1	each	$ 7,400.00	$ 7,400	$ 850	$ 850	$ 8,250
3	Winterstart Control	1	each		$ -	$ 160	$ 160	$ 160
4	Corrosion protection for coils and cabinet (mat & labor total)	1	each	$ 850.00	$ 850		$ -	$ 850
5	Crane (est. average cost, will depend on how many units are done at the same time)	1	each	$ 500.00	$ 500		$ -	$ 500
					$ -		$ -	$ -
					$ -		$ -	$ -
				TOTAL	$ 8,750		$ 1,610	**$ 10,360**

Note:
Costs indicated in this table are opinions of probable cost, and should not be considered bid costs.

EEM IMPLEMENTATION COST ESTIMATE		DATE:	9/29/2014
PROJECT:	City of Oxnard - OWTP	BASIS OF ESTIMATE (check all that apply):	
LOCATION:	6001 South Perkins Road Drive, Oxnard CA 93033	☐	R.S. MEANS
		☐	DODGE
RCx PROVIDER:	The Energy Network and QuEST	☐	MFG'S QUOTES
		☑	ENGINEERING ESTIMATE
MEASURE:	Replace 4-ton Rooftop Single Package HP	☑	OTHER (eGordian NJPA)

		Quantity		*Material*		*Labor*		
Item Number	**Description of Items**	**No. of Units**	**Unit of Measure**	**Cost per Unit**	**Total**	**Cost per Unit**	**Total**	**Total Cost** incl. O&P and contingency
1	Demo	1	each		$ -	$ 490	$ 490	$ 490
2	4 Ton Packaged Rooftop High Efficiency Heat Pump w/Economizer	1	each	$ 6,022.00	$ 6,022	$ 915	$ 915	$ 6,940
3	Corrosion protection for coils and cabinet (mat & labor total)	1	each	$ 1,000.00	$ 1,000		$ -	$ 1,000
4	Crane (included above)				$ -		$ -	$ -
					$ -		$ -	$ -
					$ -		$ -	$ -
				TOTAL	$ 7,022		$ 1,405	**$ 8,430**

Note:
Costs indicated in this table are opinions of probable cost, and should not be considered bid costs.

EEM IMPLEMENTATION COST ESTIMATE		DATE: 9/29/2014	
PROJECT:	City of Oxnard - OWTP	BASIS OF ESTIMATE (check all that apply):	
LOCATION:	6001 South Perkins Road Drive, Oxnard CA 93033	☐	R.S. MEANS
		☐	DODGE
RCx PROVIDER:	The Energy Network and QuEST	☐	MFG'S QUOTES
		☑	ENGINEERING ESTIMATE
MEASURE:	Replace 5-ton Rooftop Single Package Gas/Electric Unit	☑	OTHER (eGordian NJPA)

		Quantity		*Material*		*Labor*		
Item Number	**Description of Items**	**No. of Units**	**Unit of Measure**	**Cost per Unit**	**Total**	**Cost per Unit**	**Total**	**Total Cost incl. O&P and contingency**
1	Demo	1	each		$ -	$ 170	$ 170	$ 170
2	5 Ton, High Efficiency, Gas Heat, Electric Cooling, DX Unitary Package Rooftop Unit	1	each	$ 6,325.00	$ 6,325	$ 325	$ 325	$ 6,650
3	Factory Installed Economizer	1	each	$ 650.00	$ 650	$ -	$ -	$ 650
4	Corrosion protection for coils and cabinet (mat & labor total)	1	each	$ 1,000.00	$ 1,000	$ -	$ -	$ 1,000
5	Crane (est. average cost, will depend on how many units are done at the same time)	1	each	$ 500.00	$ 500		$ -	$ 500
					$ -		$ -	$ -
					$ -		$ -	$ -
				TOTAL	$ 8,475		$ 495	**$ 8,970**

Note:
Costs indicated in this table are opinions of probable cost, and should not be considered bid costs.

EEM IMPLEMENTATION COST ESTIMATE		DATE: 9/29/2014	
PROJECT:	City of Oxnard - OWTP	BASIS OF ESTIMATE (check all that apply):	
LOCATION:	6001 South Perkins Road Drive, Oxnard CA 93033	☐	R.S. MEANS
		☐	DODGE
RCx PROVIDER:	The Energy Network and QuEST	☐	MFG'S QUOTES
		☑	ENGINEERING ESTIMATE
MEASURE:	Replace 3-ton Rooftop Single Package HP	☑	OTHER (eGordian NJPA)

		Quantity		*Material*		*Labor*		
Item Number	**Description of Items**	**No. of Units**	**Unit of Measure**	**Cost per Unit**	**Total**	**Cost per Unit**	**Total**	**Total Cost incl. O&P and contingency**
1	Demo	1	each		$ -	$ 425	$ 425	$ 430
2	3 Ton Packaged Rooftop High Efficiency Heat Pump w/Economizer	1	each	$ 5,265.00	$ 5,265	$ 790	$ 790	$ 6,060
4	Corrosion protection for coils and cabinet (mat & labor total)	1	each	$ 1,000.00	$ 1,000		$ -	$ 1,000
5	Crane (included above)				$ -		$ -	$ -
					$ -		$ -	$ -
					$ -		$ -	$ -
				TOTAL	$ 6,265		$ 1,215	**$ 7,490**

Note:
Costs indicated in this table are opinions of probable cost, and should not be considered bid costs.

EEM IMPLEMENTATION COST ESTIMATE	DATE: 9/29/2014
PROJECT: City of Oxnard - OWTP	BASIS OF ESTIMATE (check all that apply):
LOCATION: 6001 South Perkins Road Drive, Oxnard CA 93033	☐ R.S. MEANS ☐ DODGE ☐ MFG'S QUOTES
RCx PROVIDER: The Energy Network and QuEST	☑ ENGINEERING ESTIMATE
MEASURE: Replace 5-ton Condensing Unit (on the ground)	☑ OTHER (eGordian NJPA)

		Quantity		*Material*		*Labor*		
Item Number	**Description of Items**	**No. of Units**	**Unit of Measure**	**Cost per Unit**	**Total**	**Cost per Unit**	**Total**	**Total Cost incl. O&P and contingency**
1	Demo	1	each		$ -	$ 447	$ 447	$ 450
2	5 Ton 13 SEER Outdoor AC Unit	1	each	$ 1,610.00	$ 1,610	$ 635	$ 635	$ 2,250
3	Winterstart Control	1	each	$ 98.00	$ 80		$ -	$ 80
4	Add for 14 SEER	1	each	$ 337.00	$ 337		$ -	$ 340
5	Add for 15 SEER (assumed same add as 14 SEER)	1	each	$ 337.00	$ 337		$ -	$ 340
6	Corrosion protection for coils and cabinet	1	each	$ 850.00	$ 850		$ -	$ 850
					$ -		$ -	$ -
				TOTAL	$ 3,214		$ 1,082	**$ 4,310**

Note:
Costs indicated in this table are opinions of probable cost, and should not be considered bid costs.

EEM IMPLEMENTATION COST ESTIMATE	DATE: 9/29/2014
PROJECT: City of Oxnard - OWTP	BASIS OF ESTIMATE (check all that apply):
LOCATION: 6001 South Perkins Road Drive, Oxnard CA 93033	☐ R.S. MEANS ☐ DODGE ☐ MFG'S QUOTES
RCx PROVIDER: The Energy Network and QuEST	☑ ENGINEERING ESTIMATE
MEASURE: Replace 3-ton Rooftop Split System HP	☑ OTHER (eGordian NJPA)

		Quantity		*Material*		*Labor*		
Item Number	**Description of Items**	**No. of Units**	**Unit of Measure**	**Cost per Unit**	**Total**	**Cost per Unit**	**Total**	**Total Cost incl. O&P and contingency**
1	Demo	1	each		$ -	$ 340	$ 340	$ 340
2	3 Ton 13 SEER Outdoor Heat Pump Unit	1	each	$ 1,151.00	$ 1,151	$ 515	$ 515	$ 1,670
3	Winterstart Control	1	each	$ 98.00	$ 98		$ -	$ 100
4	Add for 14 SEER	1	each	$ 242.00	$ 242		$ -	$ 240
5	Add for 15 SEER (assumed same add as 14 SEER)	1	each	$ 242.00	$ 242		$ -	$ 240
6	Crane (est. average cost, will depend on how many units are done at the same time)	1	each	$ 500.00	$ 500		$ -	$ 500
7	Corrosion protection for coils and cabinet	1	each	$ 850.00	$ 850		$ -	$ 850
				TOTAL	$ 3,083		$ 855	**$ 3,940**

Note:
Costs indicated in this table are opinions of probable cost, and should not be considered bid costs.

EEM IMPLEMENTATION COST ESTIMATE		DATE: 9/29/2014	
PROJECT:	City of Oxnard - OWTP	BASIS OF ESTIMATE (check all that apply):	
LOCATION:	6001 South Perkins Road Drive, Oxnard CA 93033	☐	R.S. MEANS
		☐	DODGE
RCx PROVIDER:	The Energy Network and QuEST	☐	MFG'S QUOTES
		☑	ENGINEERING ESTIMATE
MEASURE:	Replace 7.5-ton Rooftop Single Package HP	☑	OTHER (eGordian NJPA)

		Quantity		*Material*		*Labor*		
Item Number	**Description of Items**	**No. of Units**	**Unit of Measure**	**Cost per Unit**	**Total**	**Cost per Unit**	**Total**	**Total Cost incl. O&P and contingency**
1	Demo	1	each		$ -	$ 595	$ 595	$ 600
2	7.5 Ton Packaged Rooftop Heat Pump	1	each	$ 10,167.00	$ 10,167	$ 1,110	$ 1,110	$ 11,280
3	Factory Installed Economizer	1	each	$ 1,805.00	$ 1,805		$ -	$ 1,810
4	Corrosion protection for coils and cabinet (mat & labor total)	1	each	$ 1,000.00	$ 1,000		$ -	$ 1,000
5	Crane (included above)				$ -		$ -	$ -
					$ -		$ -	$ -
					$ -		$ -	$ -
				TOTAL	$ 12,972		$ 1,705	**$ 14,690**

Note:
Costs indicated in this table are opinions of probable cost, and should not be considered bid costs.

EEM IMPLEMENTATION COST ESTIMATE		DATE: 9/29/2014	
PROJECT:	City of Oxnard - OWTP	BASIS OF ESTIMATE (check all that apply):	
LOCATION:	6001 South Perkins Road Drive, Oxnard CA 93033	☐	R.S. MEANS
		☐	DODGE
RCx PROVIDER:	The Energy Network and QuEST	☐	MFG'S QUOTES
		☑	ENGINEERING ESTIMATE
MEASURE:	Replace 3-ton Rooftop Single Package AC	☑	OTHER (eGordian NJPA)

		Quantity		*Material*		*Labor*		
Item Number	**Description of Items**	**No. of Units**	**Unit of Measure**	**Cost per Unit**	**Total**	**Cost per Unit**	**Total**	**Total Cost incl. O&P and contingency**
1	Demo	1	each		$ -	$ 148	$ 148	$ 150
2	3 Ton, High Efficiency, Cooling Only DX Unitary Package Rooftop Unit	1	each	$ 5,075.00	$ 5,075	$ 300	$ 300	$ 5,380
3	Corrosion protection for coils and cabinet (mat & labor total)	1	each	$ 1,000.00	$ 1,000		$ -	$ 1,000
4	Crane (est. average cost, will depend on how many units are done at the same time)	1	each	$ 500.00	$ 500		$ -	$ 500
					$ -		$ -	$ -
					$ -		$ -	$ -
				TOTAL	$ 6,575		$ 448	**$ 7,030**

Note:
Costs indicated in this table are opinions of probable cost, and should not be considered bid costs.

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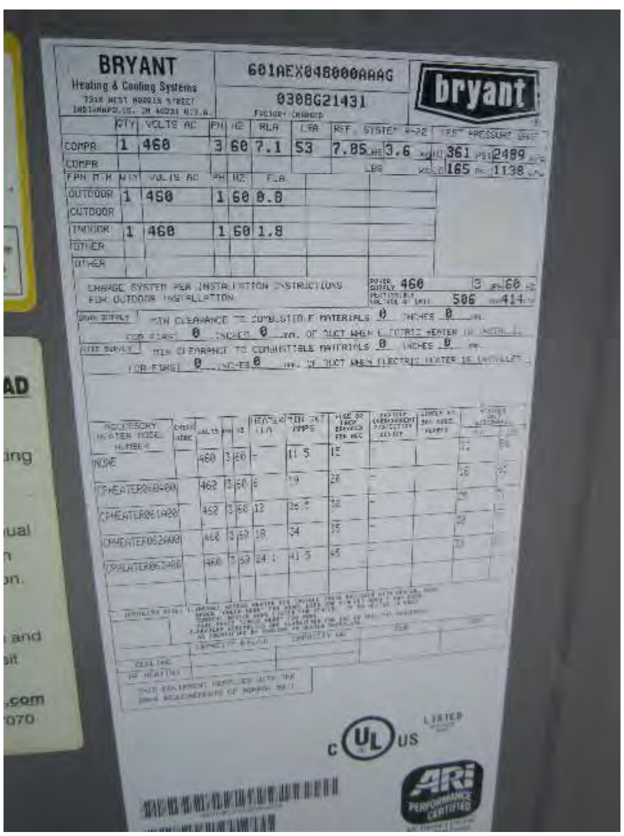
Appendix C – Photos

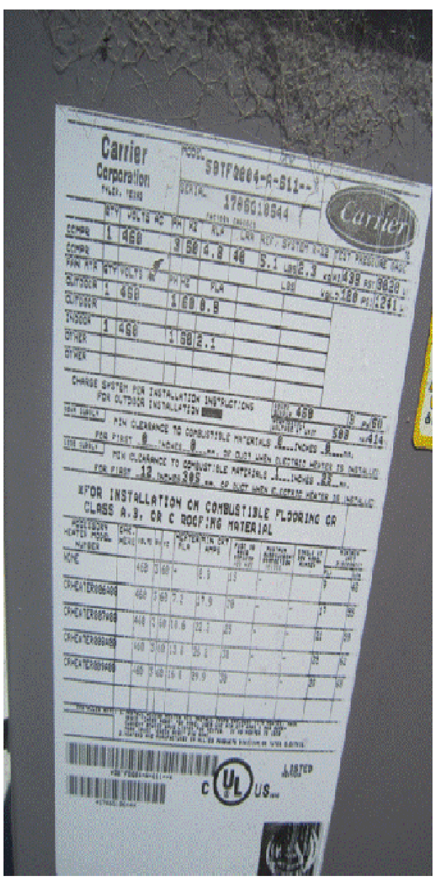
- Administration Building (1) 10-ton Rooftop Split System HP

- Maintenance Building (1) 4-ton Rooftop Single Package HP

- Maintenance Bldg (1) 5-ton Rooftop Single Package Gas/Elec Unit

- Operations Center (1) 4-ton and (2) 3-ton Rooftop Single Package HPs




Carrier Corporation
Carrier


Carrier Corporation
Carrier

• Effluent Electrical Room (1) 5-ton Condensing Unit for Split System AC

• Solids Processing (1) 3-ton Rooftop Outdoor Unit for Split System HP

- North Area Electrical Bldg (1) 7.5-ton Rooftop Single Package HP

- Storage Bldg Server Room (1) 5-ton Condensing Unit for Split System AC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ARI

• New Headworks (1) 3-ton Rooftop Single Package AC

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APPENDIX C - OXNARD WASTEWATER TREATMENT PLANT ENERGY EVALUATION REPORT

OXNARD WASTEWATER TREATMENT PLANT

ENERGY EVALUATION REPORT

July 2013

07/23/2013

07/23/2013

07/23/2013

2700 Ygnacio Valley Road, Suite 300 ▪ Walnut Creek, California 94598 ▪ P. 925.932.1710 ▪ F. 925.930.0208

OXNARD WASTEWATER TREATMENT PLANT

ENERGY EVALUATION REPORT

TABLE OF CONTENTS

Page No.

CHAPTER 5 - FUNDING SOURCES

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION AND BACKGROUND

1.1 INTRODUCTION

The purpose of this report is to summarize energy efficiency opportunities, including providing an assessment of biogas enhancement through the addition of alternative feedstocks to the City of Oxnard (City) Wastewater Treatment Plant (OWTP) anaerobic digesters, opportunities for replacement cogeneration facilities, and renewable energy production with photovoltaic systems. Planning level project cost estimates are presented for each of these opportunities, in addition to potential funding sources.

The City's resolution number 14,398 approving the final draft City of Oxnard Energy Action Plan (EAP) and confirmation of implementation of three EAP programs is included in Appendix A.

1.2 BACKGROUND

With rising energy costs on the horizon, projected shortfalls in power production from the power utilities, and the State's current goal to reduce greenhouse gas emissions, it is prudent for the City to investigate potential green energy sources. The OWTP currently consumes approximately 2,200 kilowatts (kW) daily. At an average current electrical power cost of approximately 11 cents per kW-hr (kWh), the annual average power bill for treatment would amount to approximately $2 million per year if all of this power were purchased from the local electric utility, Southern California Edison (SCE). Recognizing this as a significant potential operating expense and understanding the value of the digester gas produced on-site as part of the process of treating wastewater solids, the City has operated a cogeneration system utilizing on-site produced digester gas and natural gas for many years. The existing cogeneration system, consisting of three aging 500 kW engine generators, produce on average approximately 700 kW of electricity for the plant, reducing the power purchased from SCE. Through a dedicated effort to utilize the engine generators to reduce peak period power demands for the plant, the City has been able to realize significant benefit from the existing engine generators by reducing the purchased power costs to approximately $850,000 per year, or an effective power cost rate of $0.074/kWh of energy purchased.

Although the OWTP is a major consumer of power, it also provides some promising opportunities to producing power from green energy sources. While there are many green energy generation options, the systems most viable at the OWTP are:

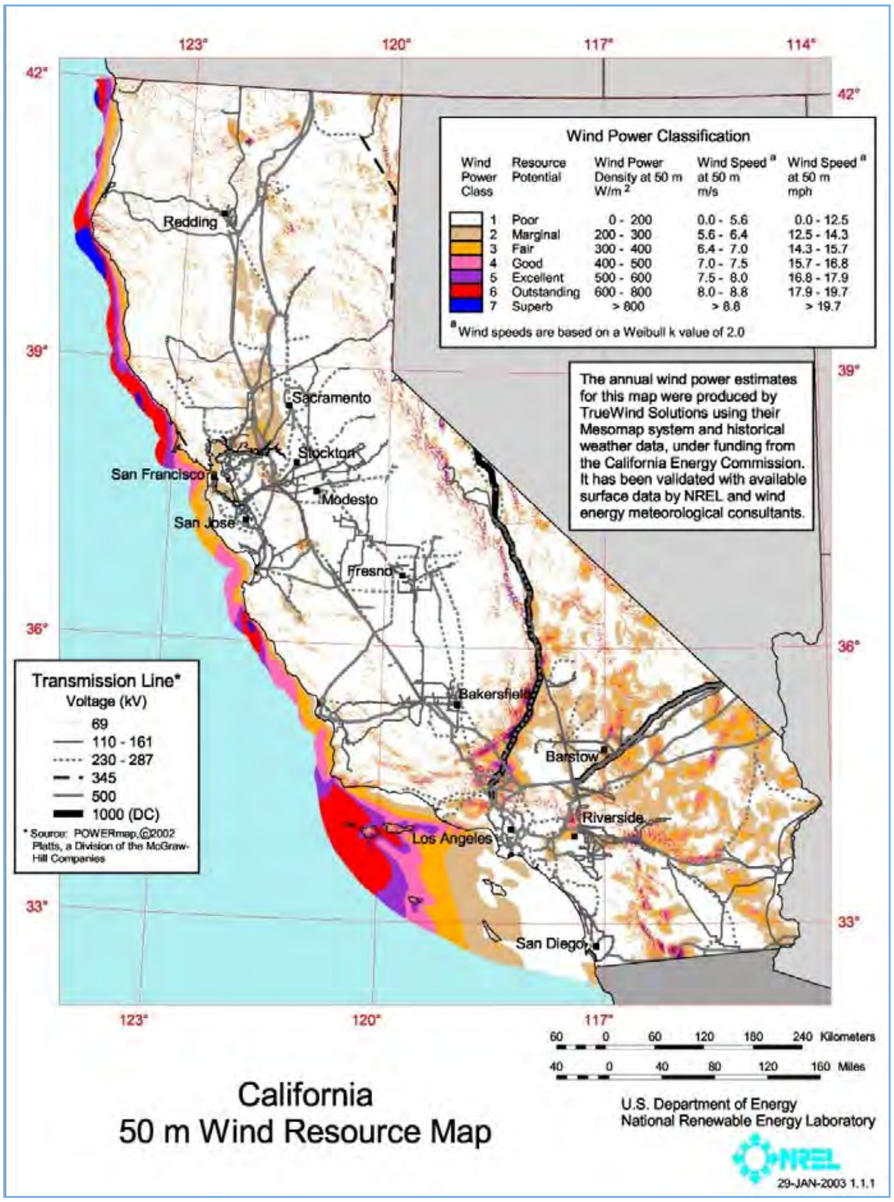
- Digester gas generation.

- Digester gas to fuel a replacement cogeneration system.
- Available roof, parking and basin areas for solar power using photovoltaic (PV) cells.

Other alternatives such as hydro generation and wind generation do not appear cost effective on this site.

Wind potential maps show very low potential for the Oxnard area (See Figure 1.1), meaning there is very little potential for generating a viable amount of wind energy, which would not justify the cost of an installation, as there would be no payback.

Figure 1.1 California Wind Resources Map



Hydro energy depends on having a suitable location where a significant flow is always being let down in pressure. Typical installations are pressure turnouts from supply aqueducts such as Metropolitan Water District's (MWD's) supply system down into City's. There are to our knowledge no areas with significant flows where pressure is being wasted through PRV's at the OWTP.

1.2.1 Existing Utility Demand

Table 1.1 summarizes the energy use and heat demand for the OWTP. While the City has a cogeneration system onsite, the system is currently at the end of its useful life, having been operated continuously since installation in the mid 1980s. The system consists of three 500 kW engine generator systems that are no longer made. The OWTP is also supplied by power purchased from SCE. Currently, most of the digester gas produced by the plants anaerobic digesters is utilized within the three engines, two of which are continuously operated at an output of approximately 350 kW each. The third engine is utilized during utility on peak periods; noon-6 pm, Monday-Friday during the summer period to control plant demand and to benefit from reducing purchases during very expensive on-peak utility periods.

The potential benefits of onsite renewable energy production include:

- Improved power supply reliability and redundancy.
- Reduced operational costs and stabilization of energy expenditures.
- Revenue stream from energy cost reduction from produced energy used at the plant.
- Reduced emissions of greenhouse gases.
- Greater flexibility in adapting to current and future greenhouse gas emissions regulations.

Table 1.1 Energy Demand Versus Power Produced[1,2]
Energy Evaluation
City of Oxnard

Average Heat Demand, million BTU/hr[1] (for heating anaerobic digesters)	2.6
Peak Heat Demand, million BTU/hr[1]	4.0
Average Cogeneration Heat produced BTU/hr	4.0
Average purchase of natural gas for Cogeneration (therms/hr)	17.8
Average Power Purchased, kW[2]	1306
Average Cogeneration Production from Existing Engines, kW	870

Notes:
(1) Information based on historical data from July 2011 through June 2012.
(2) Information derived from Southern California Edison (SCE) billing summaries for 2012.

1.2.2 Existing Anaerobic Digestion Facility

Primary and waste activated sludges are stabilized in mesophilic anaerobic digesters. Characteristics of the digesters are shown in Table 1.2.

Table 1.2 Anaerobic Digester Characteristics
Energy Evaluation
City of Oxnard

Parameter	Unit	Digester 1	Digester 2	Digester 3
Diameter	ft	90	90	100
Operating depth	ft	33	33	33
Operating volume	gallons	1,570,000	1,570,000	2,350,000
Mixing system	-	draft tube & gas	draft tube & gas	draft tube & gas

Based on flows, the OWTP operates two of their three digesters, and those are run in parallel. Performance data from 2012 was analyzed to determine the performance of the digesters. Hydraulic loads are summarized in Table 1.3 and volatile solids loading is shown in Table 1.4.

Table 1.3 Digester Hydraulic Loading (2012)
Energy Evaluation
City of Oxnard

Parameter	Unit	Digester 1	Digester 2[(1)]	Digester 3
Hydraulic Capacity				
20 day HRT	gallons/day	78,500	78,500	117,300
15 day HRT	gallons/day	104,700	104,700	156,400
Hydraulic Load				
Average month	gallons/day	61,500	---	87,500
Maximum month	gallons/day	75,300[(2)]	---	95,400[(3)]
Remaining Capacity – 20 day HRT				
Average month	gallons/day	17,100	78,500	29,800
Maximum month	gallons/day	29,400	78,500	61,000
Remaining Capacity – 15 day HRT				
Average month	gallons/day	43,200	78,500	68,900
Maximum month	gallons/day	29,400	104,700	61,000

Notes:
(1) Digester 2 was out of service during 2012 and remains so currently.
(2) Maximum month occurred during September.
(3) Maximum month occurred during June.

Table 1.4	**Digester Volatile Solids Loading (2012) Energy Evaluation City of Oxnard**			
Parameter	**Unit**	**Digester 1**	**Digester 2(1)**	**Digester 3**
Volatile solids load				
Average month	pounds per day	13,000	---	18,800
Maximum month	pounds per day	21,800(2)	---	23,900(2)
Volatile solids loading rate				
Average month	pounds per day/ cubic foot	0.06	---	0.06
Maximum month	pounds per day/ cubic foot	0.10(2)	---	0.08(2)

Notes:
(1) Digester 2 was out of service during 2012 and remains so currently.
(2) Maximum month occurred during September.

1.2.3 Digester Gas Production Projections

Anaerobic digestion is a biological process subject to a number of variables that affect digester gas production and use. For example, the net digester gas available for cogeneration varies with the season. Less digester gas is available in the winter because more gas is needed for heating the digesters in the cooler temperatures (the digesters must be maintained at a minimum temperature of 95 degrees Fahrenheit for maintaining optimum biological processes and biosolids regulatory requirements). Other factors affecting digester gas production include wastewater flows and loads received at the OWTP, the performance of the digestion process, the operation of the digesters (e.g. series or parallel operation), and co-digestion of sludge with higher energy wastes, such as fats, oils, and grease (FOG). Digester gas production is roughly proportionate to influent flows and loadings. If either flows or waste strengths vary, then digester gas production follows. In addition, digesters can experience a drop in digester gas production from process upsets, decreased detention time, poor mixing, or excessive grit and rag buildup in the digester tanks.

Monthly digester gas production data from 2012 was analyzed and is summarized in Table 1.5. Specific gas production appears lower than expected. Typical values range from 12 standard cubic feet per pound (scf/lb) to 17 scf/lb of volatile solids destroyed. Although Digester 3 clearly shows a higher specific gas production, this is likely the result of the FOG injection.

Table 1.5	Digester Gas Production (2012) Energy Evaluation City of Oxnard			
Parameter	**Unit**	**Digester 1**	**Digester 2(1)**	**Digester 3**
Gas production				
Average	cubic feet per month	3,248,500	---	7,034,400
Maximum	cubic feet per month	4,137,400(2)	---	7,461,400(3)
Average	cubic feet per day	108,300	---	234,500
Maximum	cubic feet per day	137,900	---	248,700
Specific gas production	cubic feet per pound of VS destroyed			
Average		8.50	---	12.34
Maximum		11.77(4)	---	15.20(5)

Notes:
(1) Digester 2 was out of service during 2012 and remains so currently.
(2) Maximum month occurred during April.
(3) Maximum month occurred during September.
(4) Maximum month occurred during May.
(5) Maximum month occurred during January.

1.2.4 Emission Regulations

1.2.4.1 Emissions Regulations

The existing engines have a valid Ventura County Air Pollution Control District (VAPCD) permit to operate, which is attached as Appendix A

Future operation of the existing or replacement engine-generators will likely be impacted by more restrictive emission requirements. Recently, the South Coast Air Quality Management District (SCAQMD) and the San Joaquin Valley Air Pollution Control District (SJVAPCD) and the Bay Area Air Quality Management District (BAAQMD) have tightened the emission limits for nitrogen oxides (NO_x), volatile organic compounds (VOCs), and carbon monoxide (CO). All air districts have historically followed the lead of these three air districts in tightening emission regulations, especially for any new equipment, so it is likely that the similar restrictions will be adopted by the VAPCD in the future. While this is not anticipated to present significant issues with compliance in the near term, it should be considered a possibility at some point during the life of any new power generator system. Such changes to the emission regulations would likely require modifications to the existing engine generator systems to comply with more stringent emission regulations should these engines be kept in operation for the foreseeable future.

1.2.4.2 Greenhouse Gas Emissions Considerations

The California Air Resources Board (CARB) adopted the Global Warming Solutions Act in response to Assembly Bill 32 (AB 32) in September 2006. This Act was the first regulatory program in the U.S. to require public and private agencies statewide to reduce greenhouse gas (GHG) emissions. The GHGs included under AB 32 are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated gases. The Act does not affect wastewater treatment facility process emissions, but it does cover onsite general stationary combustion sources such as cogeneration engines. An agency must report their annual (calendar year) emissions if it emits over 10,000 metric tons of CO_2 equivalent emissions from its stationary combustion units and they have an aggregate maximum rated heat input capacity of 12 million British thermal unit (Btu) per hour or greater.

In addition, the U.S. EPA's Mandatory GHG Reporting Rule (Reporting Rule) was adopted October 30, 2009. The Reporting Rule explicitly states that centralized domestic wastewater treatment systems are not required to report; however, any stationary combustion of fossil fuels taking place at a wastewater treatment facility may be considered a "large" source of GHGs if emitting a total of 25,000 metric tons of CO_2 equivalent emissions or more per calendar year.

The City's 2012 onsite stationary combustion of natural gas and biogas resulted in approximately 4,800 metric tons of CO_2 equivalent emissions including biogenic CO_2 (i.e., CO_2 from biogas combustion). This is well below each of the reporting thresholds discussed above.

BIOGAS ENHANCEMENT EVALUATION

2.1 INTRODUCTION

This analysis has focused on the Oxnard Wastewater Treatment Plant (OWTP) and the ability of its anaerobic digesters to produce more digester gas. The OWTP currently co-digests fats, oils, and grease (FOG) with primary and waste activated sludges. The FOG is brought in from grease trap/interceptor pumping by City of Oxnard (City) crews. This practice has a number of advantages:

- Assures that the FOG is not discharged to the sewers – reducing the FOG related stoppages and required cleaning.
- Controls the quality of the hauled-in materials because it is accomplished by City staff.
- Adds highly degradable material to the digesters which significantly increases the digester gas production and hence the biogenic electrical production.
- Minimally increases the sludge destruction, reducing the amount of biosolids that must be dewatered, hauled, and disposed, or beneficially used.
- Provides tipping fees for the hauled-in material.
- Assures that grease traps are pumped at regular intervals.

We recommend that the City continue this practice and increase it to the extent that staff is available to pump and haul the FOG to the OWTP. To offset Southern California Edison (SCE) costs, the City should aim to maximize cogeneration of electricity between noon and 6:00 p.m. when energy costs are the highest. Maximizing cogeneration can be accomplished by feeding FOG into the digesters so gas production is at its highest during this time-frame. To make better use of the gas production from FOG, we recommend a receiving and storage facility so the gas can be produced when it is needed for electrical power generation. Options for such a facility are evaluated further in this report.

The City does have additional digester capacity that could be used to produce additional digester gas. Other feedstocks that can be used include:

- Food processing wastes – this includes out dated or out of specification soft drink syrup, salad dressing, glycerin, frappuccino mix, cheese waste, or spoiled strawberries. These can be directly fed to the digesters.

- Source separated food wastes – such as restaurant scraps – this does help reduce the load on the sewer system, but requires restaurant training and a receiving and "macerating" system usually off site.

- Material recycling facility (MRF) separated food waste – Requires separation at the MRF and a separate processing system for the food wastes.

These feedstocks can be co-digested with the OWTP's sludge or independently, such as in Digester 2.

With the increased emphasis on removal of organics from landfills to comply with the States adopted goal of diverting 75 percent of materials from landfills, use of existing digester capacity to digest organics is getting increased attention. However, food waste digestion will require further investigation into issues, including the types and amounts available in the Oxnard area, preprocessing requirements, and regulatory impacts. There are also organic wastes such as wood wastes and green wastes. However, these do not digest well in OWTP digesters.

Organic wastes can also be diverted to biofuel development and composting. Biofuel development is typically limited to rendering materials and yellow grease, which is sourced, separated from oil fryers, and refined to biodiesel. Composting is an excellent way to breakdown wood or green wastes and can be used for food wastes and FOG. It is not energy producing and a market for the compost product has to be developed.

Energy can be derived from organic waste through thermal conversion. These technologies include incineration, gasification, and pyrolysis, the latter two have gained attention because of their energy potential and low emissions. These processes involve applying a controlled amount of air/oxygen to heat the organics. Most of the volatile solids are converted by gasification to syngas. Pyrolysis generates an energy containing char in addition to the syngas. The syngas can be combusted to generate electricity or further refined to create a fuel. The char can replace coal usage.

We recommend conducting a feasibility analysis to determine the types and amounts of available organic materials in Oxnard. Based on this information, a further analysis should be completed to determine the best solution for the City to divert and process these organic wastes.

2.2 EXISTING FOG CONTROL PROGRAM

The City has a FOG Control Program that requires food establishments to install grease traps or interceptors prior to discharging their wastewater into collection system. The City program has jurisdiction over about 600 food establishments, of which less than 50 percent use the City's service. About four 3,000-gallon truckloads are delivered to the OWTP per week on average.

The truck offloads directly into the Digester 3 sludge recirculation system, upstream of the draft tube-gas mixing system. FOG is conveyed directly from the truck in a “slug load” into the digestion system. This type of loading can make digesters vulnerable to process upsets, including inadequate solids destruction and foaming events, which can lead to odor and vector issues. In addition, slug loading limits the ability to get good mixing and to produce the gas when it is needed for power generation.

Typical programs offload FOG into storage tanks. The material is ground and mixed in the tank prior to metering it into the digestion process at a slow and constant input rate or based on when the gas is needed. These receiving stations are usually located near the digestion process.

2.2.1 FOG Collection Revenue

Trap sizes range from 750-4,750 gallons, for which the City currently charges $200 per trap/interceptor, regardless of size. The charge for this service is significantly different between the smaller and larger traps. Table 2.1 shows the cost per gallon for this service based on trap sizes found in the City’s 2007 Sewer System Master Plan (SSMP).

Table 2.1 Grease Trap Cleaning Cost
Energy Evaluation
City of Oxnard

Trap Size (gallons)	Cost per Gallon
750	$0.27
1,000	$0.20
1,200	$0.17
1,250	$0.16
1,500	$0.13
1,750	$0.11
2,250	$0.09
3,000	$0.07
4,750	$0.04

The City’s trap cleaning service fee of $200 per trap does not appear to generate enough revenue to cover the associated operational costs. Their cost to provide this service is estimated to be $306 per trap. This was calculated based on the following parameters:

- $250,000 for the truck, amortized over five years.
- $50 per hour labor.
- One person providing service.

- Four hours to clean, haul, and deliver FOG to OWTP.
- 10 mile round-trip between OWTP and food establishment.
- 4 miles per gallon fuel consumption.

The costs for the trap cleaning service appear to exceed the service fee by over 50 percent. We recommend restructuring this service fee to be based on a per gallon charge, which is consistent with others in the industry. Based on data from the City's SSMP, we estimate that a cost of $0.25 per gallon can completely offset the costs for providing this service. However, this per gallon cost will significantly increase the cleaning expense for those with large capacity traps.

2.3 FOG RECEIVING STATION DESIGN ALTERNATIVES

FOG receiving stations are designed based the amount of material that can be delivered and fed into the digester in a single day. Two approaches were considered for a FOG receiving station. The first approach considered sizing it based on doubling the current program. The second option was sized based on the capacity of the existing digesters to process FOG.

2.3.1 Option 1 – Station Design Based on Digester Feed Limit

Co-digestion of FOG is limited by 1) the ratio of volatile solids in FOG to those in sludge, 2) the volatile solids loading rate, and 3) hydraulic retention time.

2.3.1.1 FOG to Sludge Volatile Solids Ratio

Based on empirical date from both discussions with FOG system operators and literature review of articles on FOG systems, an upper limit of 30 percent FOG volatile solids to total volatile solids feed to a digester has been established. Loading rates greater than 30 percent make the digester more susceptible to upsets.

2.3.1.2 Volatile Solids Loading Rate

Co-digestion of FOG can increase the digester volatile solids loading rate. Typical design criteria for digester volatile solids loading rate (VSLR) is to maintain levels below 0.15 pounds per day of VS/cubic foot (ppd/cf) of digester feed. The addition of FOG has been shown to increase digester performance. This allows the VSLR to be raised to 0.20 ppd VS/cf without upsetting the digestion process.

2.3.1.3 Hydraulic Retention Time

The digestion hydraulic loading rate can limit the amount of FOG that can be digested. Anaerobic digesters are designed typically with a 20 day hydraulic retention time (HRT) at average month conditions with one digester out of service and 15 days at maximum month with all digesters in service.

Table 2.2 shows the comparison between the three design criteria above.

Table 2.2	**Digester Feed Limit Evaluation Energy Evaluation City of Oxnard**					
	VS Ratio		**VSLR**		**HRT**	
Criteria	***Dig 1***	***Dig 3***	**Dig 1**	**Dig 3**	**Dig 1**	**Dig 3**
FOG VS Ratio, %	***30***	***30***	222	234	52	63
VSLR, ppd/cf	***0.08***	***0.08***	0.20	0.20	0.14	0.15
HRT, days (average month)	***22***	***23***	12	12	20	20

Note:
(1) Digester two assumed to be out of service.

Table 2.2 shows that the volatile solids ratio criterion governs the design. FOG receiving station design criteria based on maintaining a 30 percent ratio of volatile solids in FOG to those in the feed sludge are shown in Table 2.3. Figure 2.1 shows a layout of a 24,100-gallon receiving station.

Table 2.3	**Digester Feed Limit FOG Station Design Criteria Energy Evaluation City of Oxnard**	
Parameter	**Unit**	**Value**
Capacity	gallons/day	24,100
Unload time	minutes	15
Transfer/Mixing pump(1)	gpm	350
Feed pump(2)	gpm	10

Notes:
(1) Based on unloading a 5,000-gallon truck with a constant speed pump.
(2) Variable speed pump for flexible feed control and to optimize digester gas production.

2.3.2 Option 2 – Double the Current FOG Collection

Four truckloads can be delivered to the OWTP each week under the current collection program. This option doubles this amount of delivered FOG. However, under the current program, FOG is collected and fed into the digester as dictated by the City crew's schedule, which may not be conducive to maximizing cogeneration to offset SCE purchases.

The City's power costs are the highest between noon and 6:00 p.m. FOG should be fed into the digesters to maximize gas production during this time-frame, and subsequently

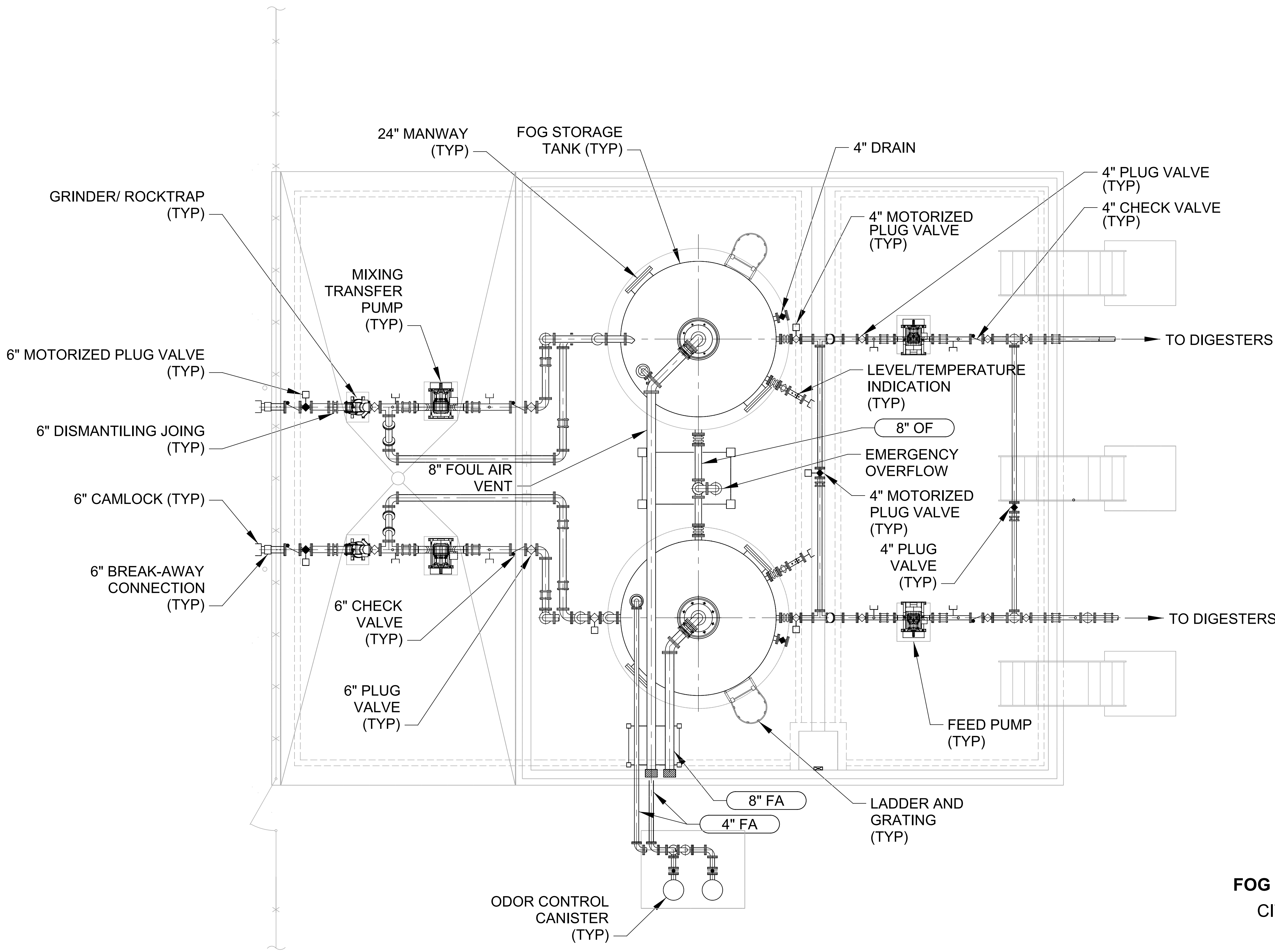


Figure No. 2.1

FOG STATION LAYOUT

CITY OF OXNARD

maximize cogeneration of electricity. This strategy will provide the best opportunity to consistently offset SCE purchases.

To maximize the use of the gas production from FOG, we recommend that the City construct a receiving and storage facility. Deliveries would be made Monday-Friday and at most two trucks would be offloaded in a single day. Design criteria for this option are summarized in Table 2.4. The digester feed pump would have variable speed controls to allow staff to optimize digester gas production between noon and 6:00 p.m., during which they could maximize cogeneration of electricity. This station would only have one train.

Table 2.4 FOG Station Design Criteria for Double the Current Collection Program
Energy Evaluation
City of Oxnard

Parameter	Unit	Value
Capacity	gallons/day	6,000
Unload time	minutes	15
Transfer pump(1)	gpm	200
Mixing pump(1)	gpm	50
Feed pump(2)	gpm	20

Notes:
(1) Constant speed pump.
(2) Variable speed pump for flexible feed control and to optimize digester gas production.

2.3.3 Design Considerations

With a significant increase in biogas expected from the co-digestion facility, the digester gas handling systems (collection piping and flare) need to be evaluated to confirm that they are capable of handling any increased load. In addition, the cogeneration system should be able to process the increased load.

2.3.4 Digester Gas Generation Estimation

The addition of FOG will increase biogas production through the digestion of readily degradable fats in the feed. This biogas production was estimated with following assumptions:

- 5 percent total solids.
- 95 percent volatile solids.
- 90 percent volatile solids reduction.

- 20 cubic feet of gas per pound of volatile solid reduced.

The digester gas production estimates are summarized in Table 2.5.

Table 2.5 Estimate of Digester Gas Generation From FOG
Energy Evaluation
City of Oxnard

FOG Feed (gpd)	FOG Addition (ppd)	Digester Gas Production From FOG (cf/day)
24,100	10,000	171,700
2,400(1)	1,000	17,100
4,800(2)	2,000	34,200

Note:
(1) Based on current collection program with four truckloads of FOG delivered on a five days per week schedule.
(2) Based on double the current collection program for a total of eight truckloads of FOG delivered on a five days per week schedule.

2.4 FOG STATION FACILITY COMPONENTS

FOG is typically ground and stored in a continuously mixed and heated storage tank before being metered slowly into the digestion process. Metering allows a constant input rate and avoids slug loads to the digester, which can prevent full digestion of the FOG. The main components of the FOG station include:

- Transfer and mixing pump.
- Grinder.
- Storage tank.
- Feed pump.

2.4.1 Transfer and Mixing Pumps

Transfer pumps are used to pull FOG from the truck, through a grinder, and push it into the storage tank. These pumps are sized based on a desired time to empty a truck, which is between 10-15 minutes, which results in pump capacities between 200-350 gpm. Larger stations can employ these pumps for dual use – transfer and mixing. This flow rate would be too large for stations with smaller storage capacities, as in Options 2. Two pumps are used for this option– one for FOG transfer and one for tank mixing.

Rotary lobe and centrifugal chopper pumps are common pumps used for transfer and mixing applications. A comparison of these pumps relative to these duties is shown in Table 2.6.

OWTP staff indicated a preference for the rotary lobe style pump, so it was used to develop the FOG station cost estimates.

Table 2.6 Transfer/Mixing Pump Comparison
Energy Evaluation
City of Oxnard

Option	Pros	Cons
Rotary Lobe	• Lower life cycle cost • Operates at lower speed • Easier to prime • Main application is for sludge-like material	• Requires upstream grinder and rock trap • Higher horsepower
Centrifugal Chopper	• Lower horsepower • Upstream grinder is not required	• Higher life-cycle cost

2.4.2 Grinders

A grinder or macerator is necessary while offloading FOG to minimize ragging in the storage tanks and damage to pumps. A grinder with a built-in rock trap is preferable because they are easier to maintain. The Vogelsang Roto-cut unit was considered for cost estimating purposes.

2.4.3 Storage Tanks

Storage (equalization) tanks are used to store the FOG as it is pumped from the trucks so it can be metered into the digesters at a slow rate, which allows for a steady gas production rate from the digesters. The tanks are insulated and heat-traced, which keeps the FOG at a higher temperature and reduces the chance of plugging the FOG pipelines.

The four options considered for this study and a comparison between them is shown in Table 2.7.

Due to the high corrosion near the ocean, City staff expressed a preference for stainless steel tanks, which were used for cost estimating purposes.

Table 2.7	Storage Tank Comparison Energy Evaluation City of Oxnard	
Option	**Pros**	**Cons**
Cross-linked polyethylene	• Lower capital cost • Will no corrode • Integrally molded flanged outlet for ease of maintenance • Generally lighter than a steel tank	• Higher capital cost • Less structural integrity than non-composite tanks • Less fire resistance than non-composite tanks • Difficult to repair leaks
FRP	• Will not corrode • Generally lighter than a steel tank • Easier to repair	• High capital cost • Less structural integrity than non-composite tanks • Less fire resistance than non-composite tanks
Carbon Steel	• Lower capital cost • Better structural integrity than composite tanks • Better fire resistance than composite tanks • Easier to repair	• Can corrode over time and become susceptible to leaks if not maintained • Requires coating maintenance
Stainless Steel	• Corrosion issues minimized • No coating maintenance • Same structural integrity and fire resistance as carbon steel	• Highest capital cost (2x carbon steel) • Repairs are more difficult

2.4.4 Digester Feed Pumps

The feed pumps are used to pump the FOG from the storage tanks into the digesters at a relatively steady rate. The two styles of pumps that were evaluated for this application were rotary lobe pumps and progressing cavity pumps.

The rotary lobe pump is easier to maintain, and is able to run dry for short time periods without being damaged. The progressing cavity pumps are O&M expensive and labor intensive to repair the rotor and stator. A comparison of the two pumps is shown in Table 2.8.

Table 2.8	**Digester Feed Pump Comparison Energy Evaluation City of Oxnard**	
Option	**Pros**	**Cons**
Rotary Lobe	• Lower life cycle cost • Operates at lower speed • Easier to prime • Main application is for sludge-like material	• Requires upstream grinder and rock trap • Higher horsepower • Wears faster at higher pressures
Progressing Cavity	• Works well with high pressures	• Larger footprint • Higher maintenance cost for replacement of stator or rotor

Rotary lobe pumps were used for cost estimating purposes.

2.4.5 Odor Control System

Odor control on the storage tanks is very important, as odor from the FOG can be unpleasant. Each time the tank is filled with FOG, it expels an equal volume of air through the tank vents. This air should be captured and diverted through an odor control unit. Granular activated carbon (GAC) units are typical. Two GAC styles were evaluated:

- A skid-mounted canister system that would be located on grade near the tanks.
- A manhole style that would be located on the top of each tank.

It is easier and safer to wash and replace media at grade in the skid-mount canisters. Additionally, two large (one per two tanks) or four redundant canisters (allowing bypass) could be used in the skid-mounted setup, whereas four individual inserts would be required for the manhole type; therefore, if one manhole-type odor control unit is out of service, the entire tank will be out of service. A comparison of the two types is presented in Table 2.9.

Skid mounted canisters were used for cost estimating purposes.

Table 2.9 GAC Odor Control Unit Comparison Energy Evaluation City of Oxnard		
Option	**Pros**	**Cons**
Skid Mounted Canister	• Easier and safer to replace • Can use larger single unit • Can have redundant unit	• Additional piping
Manhole Insert	• No additional piping	• One unit per tank • Difficult to maintain on top of tank • Added weight to tank • If unit is out of service, so is the tank

2.4.6 Pipe Material

The piping material that was considered is glass lined ductile iron pipe. Glass lined pipe reduces the clogging issues associated with FOG, as the inside of the pipe is very smooth.

2.5 ESTIMATED COSTS

The construction costs for each option were estimated using the following contingencies:

- 25 percent estimating contingency.
- 15 percent general contractor overhead, profit, and risk.
- 6 percent escalation to midpoint.
- 8 percent sales tax applied to 50 percent of the direct costs.

The estimated construction costs for each option are summarized below:

- Option 1: Build a 25,000 gallon capacity receiving station. This size facility can accommodate the FOG that the existing digesters can process based on historical sludge flows. The maximum number of trucks this facility could accommodate is five 5,000-gallon trucks, back-to-back. The construction cost for this facility was estimated to be $2,600,000.
- Option 2: Build a 6,000 gallon capacity receiving station. This size is based on doubling the current program and would receive eight trucks of FOG per week. The maximum number of trucks assumed to be unloaded in a day is two. The construction cost for this facility was estimated to be $1,400,000. For a minimal equipment cost of

an additional $50,000, the tank size could be increased to the maximum of 15,000 gallons to allow for future expansion.

GREEN ENERGY OPPORTUNITIES

3.1 COGENERATION

Cogeneration equipment was sized to efficiently and economically utilize the digester gas generated at the Oxnard Wastewater Treatment Plant (OWTP). Various types of cogeneration technologies can be employed to produce power from digester gas. The following section summarizes each of the technologies and presents the specific model and size of the technology considered for the OWTP.

3.2 CONVENTIONAL RECIPROCATING ENGINES

Reciprocating engines, developed more than 100 years ago, were the first of the fossil fuel-driven distributed generation (DG) technologies. Reciprocating engines can be found in applications ranging from fractional horsepower units to 60-megawatt (MW) baseload electric power plants.

The engine cooling water and exhaust heat from reciprocating engines can be recovered in heat exchangers and used to provide heat for digester heating and/or facility hot water heating. Several lean burn reciprocating engine suppliers have new generation, high efficiency, low emission units available for use with biogas including Cummins, Waukesha, Caterpillar (MWM), and GE/Jenbacher. These new engines have efficiencies of approximately 40 percent, which stays nearly constant throughout the typical operating range of 50-100 percent engine load. These engines typically convert approximately 40 percent (as a percentage of fuel input energy) to electrical output and 40-45 percent to recoverable engine cooling water and exhaust heat. The total overall efficiency of these reciprocating engines is approximately 80-85 percent. The engines are lean-burn, spark-ignited, low emission gas engines and have digester gas burning experience. The GE/Jenbacher 852 kW and 1,137 kW engine generator units were used in the economic evaluation. Each were assumed to be housed in the existing cogeneration building.

Reciprocating engines have the greatest emissions of the cogeneration technologies. Ventura County Air Pollution Control District (VAPCD) requires an air containment discharge permit for operational use. Lean burn engines can currently meet the requirements, however, it is expected in the near future that post combustion (catalyst) after-treatment technology will be required to meet the required emission rates when fueled with digester gas in the appropriate size range. New engines if provided with adequately redundant fuel treatment can easily be configured with such treatment devices.

3.3 FUEL CELLS

Fuel cells utilize the hydrogen present in the methane-rich digester gas as a fuel source in an electrochemical process. The process converts the elemental carbon and hydrogen from the methane into carbon dioxide and hydrogen and in the process releases electrons which are captured as direct current (DC) electricity.

The fuel cells evaluated typically convert, as a percentage of fuel input power, 40-45 percent to electrical output and approximately 25 percent to recoverable exhaust heat for a total overall efficiency of approximately 65-70 percent.

Two manufacturers currently offer fuel cells for large-scale power generation with experience on digester gas, United Technologies Corporation (UTC) and Fuel Cell Energy (FCE). One other manufacturer, Bloom Energy is currently selling similar fuel cell but it has no experience with operation on digester gas and does not offer heat recovery. Both FCE and UTC manufacturers have provided fuel cells for applications utilizing digester gas; however, only FCE has units currently in operation. Many of these units operating on biogas are located in California. FCE utilizes a more efficient fuel cell technology than UTC, providing 40-45 percent fuel-to-electricity efficiency versus UTC's 35-40 percent. FCE produces three unit sizes: 300 kW, 1,400 kW and 2,800 kW. UTC produces 400 kW units. The FCE 1,400 kW fuel cell was used in the economic evaluation.

As an electrochemical process, fuel cells produce significantly less pollutant byproducts than combustion technologies. Fuel cells have approximately 1/100th the emissions generated by engine-generators. Fuel cells are exempt for air permit requirements.

3.4 MICROTURBINES

Microturbines are essentially small gas turbines operating at very high rpm to produce power and heat.

Microturbines are extremely low emission technologies and typically do not require an air permit for operation.

Microturbines evaluated typically convert 29 percent to electrical output (as a percentage of fuel input energy) and 29 percent to recoverable exhaust heat for a total overall efficiency of approximately 58 percent.

There are currently several commercial manufacturers offering microturbine power generating units. Only two, FlexEnergy (formally Ingersoll Rand) and Capstone, have experience utilizing digester gas as a fuel source. FlexEnergy offers 250 kW modular units. The Capstone units come in 30, 65 and multiples of 200 kW sizes.

Ingersoll Rand and Capstone have shipped world-wide more than 100 units operating on both natural gas and digester gas. Several dozens of 30 kW and 70 kW units and two

250 kW units are operating on digester gas. Two 250 kW units are in operation on a medium BTU gas at a Oil/Gas Producer in Grand Isle, LA and eight 250 kW units have recently been sold for operation on a medium BTU gas in both the United States and China.

For the purposes of this study, FlexEnergy 250 kW units were utilized in the economic model. Microturbines are exempt for air permit requirements.

3.5 ALTERNATIVE BENEFIT COMPARISON

A summary of the advantages and disadvantages for the three cogeneration systems as well as the no cogeneration option is included in Table 3.1.

Table 3.1 Alternative Benefit Comparison Energy Evaluation City of Oxnard

Alternative	Advantages	Disadvantages
Alternative 0 - No Cogeneration	• Simple operation • No capital costs	• No on-site renewable power generation • Does not take advantage of digester gas resource or reduce facility carbon footprint
Alternatives 1 & 2 - Two 852 kW or One 1,137 kW Reciprocating Engine Cogeneration Systems	• Proven technology utilizing biogas for over 40 years • New generation engines have very high efficiency, rivaling fuel cells	• Requires dedicated building for sound and weather protection • Complex equipment • Frequent operator attention required for operations and maintenance • Requires fuel treatment
Alternative 3 - Three 250 kW Microturbine Cogeneration System	• Ultra low emissions • Simplified electrical interconnection • Low operator attention for operations and maintenance	• Lowest electrical efficiency • Requires extensive fuel treatment
Alternative 4 - 1,400 kW Fuel Cell Cogeneration System	• Ultra Low emissions • Highest efficiency • Simplified electrical interconnection • Low operator attention for operations and maintenance	• Highest O&M costs • High capital costs • Requires extensive fuel treatment

3.6 COGENERATION

The following cogeneration alternatives were evaluated:

- **Alternative 0: Base Case – No Cogeneration System.** Assumes the existing cogeneration engines would be retired from service and not new cogeneration system would be installed to replace them. This represents the base case for the OWTP and presents the costs associated with utilizing digester gas to provide for OWTP heating needs and purchased power from SCE to provide the OWTP power needs.
- **Alternative 1: Two New 852 kW Engine Generator Cogeneration Systems with a New FOG Receiving Facility.** Assumes two new 852 kW reciprocating engine generator cogeneration systems will be installed to replace the existing cogeneration system. The new systems would include new gas treatment equipment and all required heat recovery and electrical interconnection equipment.
- **Alternative 2: New 1,137 kW Engine Generator Cogeneration System with a New FOG Receiving Facility.** Assumes a new 1,137 kW reciprocating engine generator cogeneration system will be installed to replace the existing cogeneration system. The new system would include new gas treatment equipment and all required heat recovery and electrical interconnection equipment.
- **Alternative 3: Three New 250 kW Microturbine Cogeneration Systems with a New FOG Receiving Facility.** Assumes three new 250 kW microturbine generator cogeneration systems will be installed to replace the existing cogeneration system. The new systems would include new gas treatment equipment and all required heat recovery and electrical interconnection equipment.
- **Alternative 4: New 1,400 kW Fuel Cell Cogeneration System with a New FOG Receiving Facility.** Assumes a new 1,400 kW fuel cell generator cogeneration system will be installed to replace the existing cogeneration system. The new system would include new gas treatment equipment and all required heat recovery and electrical interconnection equipment.

3.6.1 Life Cycle Cost Evaluation

3.6.1.1 Criteria and Financial Assumptions

Assumptions used for the life cycle cost analysis are shown in Table 3.2.

Table 3.2	Criteria and Financial Assumptions Energy Evaluation City of Oxnard
Inflation (capital costs)	4.0%
Inflation (electricity costs)	5.0%
Inflation (natural gas costs)	4.0%
Inflation (O&M costs)	3.0%
Gross discount rate	5.0%
Digester Gas LHV, Btu/scf	580 Btu/scf
Engine availability percentage	90.0%
Microturbine availability percentage	95.0%
Fuel Cell availability percentage	95.0%
O&M rate for new engine alternatives $/kWh	$0.015
O&M rate for microturbine alternatives $/kWh	$0.015
O&M rate for fuel cell unit $/kWh	$0.040
O&M rate for fuel treatment system $/million Btu	$0.900
FOG Tipping Fee $/gallon	$0.050
Green Power Credit $/kWh	$0.005

3.6.1.2 Alternative Life Cycle Benefit Comparison

To evaluate the benefits and costs of these alternatives, both the projected capital costs of the installation and the yearly operations and maintenance (O&M) costs were calculated. The evaluation takes into account the value of, or purchase of electrical power. The method selected for this analysis was to determine the total present worth of the project. Each alternative was then compared to the base case alternative, no cogeneration.

Total project capital costs, including design and construction costs, for each alternative were estimated. Capital and life cycle costs are presented in Appendix A and B, respectively.

3.6.1.3 Qualitative Summary

Table 3.3 ranks the cogeneration alternatives utilizing weighted economic and non-economic criteria.

Table 3.3 Cogeneration Study Alternatives - Rating Matrix
Energy Efficiency Evaluation
City of Oxnard

Ranking Criteria		Present Worth of Life Cycle Cost[3]	Energy/ Greenhouse Gas Regulations	Protection Against Energy Price Volatility	Reliability/ Redundancy	O&M Complexity	Length of Permit Application Process	Proven Biogas Cogeneration Technology	Footprint	Efficient Use of Resources	Total Weighted Score[1]
Weighting Factor[2]		**5**	**5**	**3**	**4**	**4**	**3**	**3**	**3**	**5**	–
Project Alt.	**Description**										
0	Base Case, No Cogeneration	1	1	1	1	5	5	5	5	1	87
1	Two 852 kW Reciprocating Engine System	5	3	5	4	4	2	4	2	4	131
2	1,137 kW Reciprocating Engine System	4	3	3	2	4	2	4	3	4	115
3	Three 250 kW Microturbine System	2	3	2	4	3	4	2	4	2	99
4	1,400 kW Fuel Cell System	3	5	4	2	2	4	2	3	4	115

Notes:
(1) Total Weighted Score equals the sum of each criteria's weighted factor multiplied by its individual ranking for each respective alternative; highest value is most desirable/beneficial, lowest value is least desirable/beneficial.
(2) Weighting Factors: 5 - More Important, 1 - Less Important.
(3) Present worth of life cycle costs are based on the worst case digester gas projection as shown in Table 5.

Table 3.4 presents the cost estimates, along with the estimated 20-year net benefit and simple payback periods, for the alternatives described above.

Table 3.4 Cost Estimates for the Cogeneration Alternatives
Energy Efficiency Evaluation
City of Oxnard

	Estimated Net Project Cost ($)	Present Worth of Net Benefit compared to No Cogeneration ($)	Payback Period (years)
Alternative 1	$10,880,000	$22,100,000	8
Alternative 2	$9,070,000	$16,100,000	8
Alternative 3	$10,785,000	$9,400,000	11
Alternative 4	$13,370,000	$13,300,000	10

SOLAR EVALUATION

4.1 SOLAR PHOTOVOLTAIC CELLS

Photovoltaic (PV) systems convert light energy to electrical energy. PV cells consist of a junction between two thin layers of dissimilar semiconducting materials, known respectively as ‘p’ (positive) type and ‘n’ (negative) type semiconductors. ‘P’ type conductors consist of doped silicon with a deficit of free electrons; and ‘n’ type conductors consist of material with an excess of free electrons. A p-n junction is set up by joining these dissimilar semiconductors, which sets up an electric field in the region of the junction, due to the joining of the positive and negative layers.

Light consists of a stream of tiny particles of energy called photons. When light falls in the region of the p-n junction, the photons provide energy for the electrons from the ‘n’ type conductor to move to the ‘p’ type conductor. This movement of electrons induces direct current (DC) power. The DC power is converted to alternating current (AC) with inverters, since AC power is required to be compatible with the power grid. Typical DC to AC derating factors are 80 percent for most of today’s systems.

Solar power systems are available in the following configurations:

- Fixed panels. Fixed panels generate the least amount of electricity per panel but have low project and maintenance costs.
- Single-axis tracking panels. This arrangement consists of an automatic tracking system that tilts the angle of the PV cells on one axis (up or down) as the sun tracks over the horizon. Single tracking systems can generate up to 30 percent more than fixed panels, but the tracking system makes it more expensive than fixed panels, and requires more maintenance due to moving parts.
- Dual-axis concentrators. A dual-axis system can track up and down as well as left and right. The PV cells focus the sunlight on a small but efficient solar panel. However, their effectiveness requires high solar insolation (a measure of solar radiation energy). The insolation values at the Oxnard Wastewater Treatment Plant (OWTP) are not high enough to support the dual-axis system.
- Cylindrical reflective panels. This type of solar power system utilizes a solar panel installed within a tube. They have a very high output relative to square footage of area installed because the panels inside the tube generate electricity from both the sun’s direct rays as well as the rays reflected off the roof. However, similar to the dual-axis system, the cylindrical reflective panels need a high insolation value to justify its higher cost compared to PV cells, so this arrangement was not considered further for this facility plan.

The angle of solar incidence plays a significant role in the amount of electricity generated in the solar cell. In fixed cells, the 'perfect' angle is only incident on the solar cell for a small portion of the day, thus fixed cells are unable to generate as much electricity as single-axis tracking panels (which can "track" the solar rays in one axis) or dual-axis panels, which can move in two planes.

4.2 SOLAR EVALUATION

An economic analysis (provided in Appendix D) was prepared for the City of Oxnard (City) to evaluate the feasibility of installing solar panels at various locations in terms of the initial investment, maintenance (10 percent of initial investment), potential grants, projected benefits (net revenue), and payback time. The analysis considered three scenarios of solar panel layouts. The first scenario evaluated four potential layouts located at the existing OWTP: Activated Sludge Tanks, Flow Equalization Basins, and Secondary Sedimentation Tanks and Concrete covered area as shown in Figure 4.1. The second scenario evaluated consists of four rooftop mounted systems and four carport structures at the OWTP whose locations are shown in Figure 4.2. The third scenario evaluated was the City's Material Recovery Facility (MRF) roof as shown in Figure 4.3, an arbitrary one-acre ground mounted system, which could be located at the MRF or at the recently constructed AWPF, and an arbitrary one-acre carport system, which could be located at the MRF or at the recently constructed AWPF. The potential incentives evaluated included the California Solar Initiative performance-based incentive for Southern California Edison based on Step 9 revised PBI rates (Senate Bill 585) of $0.114/kilowatt hour (kWh) which is applicable for the first five years of system operation only. To determine the net revenue produced by each system the plant electricity usage and cost data was utilized to determine an average commercial electricity rate of $0.075/kWh.

4.2.1 Solar Evaluation Methods and Assumptions

The first step to determining the size of a solar system is to determine the square footage available for the area under consideration. Once the total area that is available is known a factor must be applied using trigonometry to obtain an effective available area so the output of each panel is maximized by minimizing the shading of individual cells. The next step is to determine the number of panels that fit into the effective area and to calculate a total kW-dc output for the system. A third party calculation tool (PV (photovoltaic) Watts-Version 2), developed by the National Renewable Energy Laboratory (NREL) contains a database for solar radiation based on longitude and latitude, was used to determine the approximate energy output of the system (kWh) over the course of the year.

The average 60 cell panel has dimensions of approximately 3 feet (ft) by 5 ft and has a nominal power output of 240 Watts (W). It was assumed the panels would be mounted fixed tilt at an angle of 34.2 degrees with southern orientation to maximize solar exposure.

Basins layout – Map

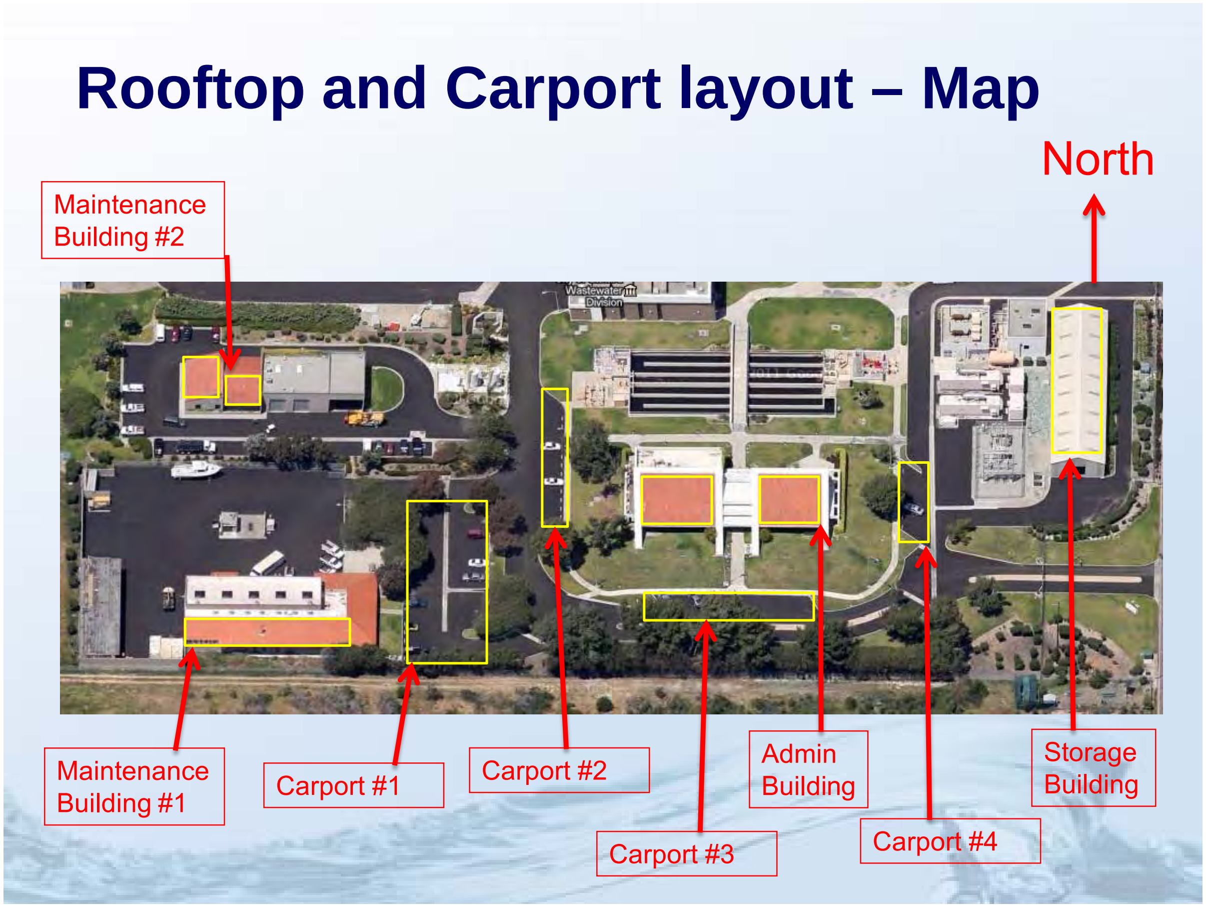
SOLAR SCENARIO 1: POTENTIAL SOLAR PANEL BASIN'S AREA LOCATIONS

FIGURE 4.1

CITY OF OXNARD
ENERGY EVALUATION

carollo

pw://Carollo/Documents/Client/CA/Oxnard/8533A10/Deliverables/Energy Evaluation./EE_Figure 4.1



SOLAR SCENARIO 2: CARPORTS AND ROOFTOPS AT WWTP

FIGURE 4.2

CITY OF OXNARD
ENERGY EVALUATION

pw://Carollo/Documents/Client/CA/Oxnard/8533A10/Deliverables/Energy Evaluation./EE_Figure 4.2

MRF layout – Map

SOLAR SCENARIO 3: MRF ROOFTOP

FIGURE 4.3

CITY OF OXNARD
ENERGY EVALUATION

4.2.2 Solar Scenario 1: Basin's Area

All of the basin areas have a large area available for mounting the solar panels. Therefore, the basins solar system output ratings were large compared to the smaller carport and rooftop systems, which in turn made the energy produced by each system quite significant. The major issue with the solar systems at the basin areas is the structural requirements and costs of the support structure. The basins are open channels and therefore the materials of the support system would need to be water and corrosion resistant. Because the basins are open channels and wide, for example the Flow Equalization Basin is approximately 60 feet, then the supports will need to be larger to make the long spans as there is no convenient location to locate a support column in the middle of the structure. These two issues add significant structural costs to the total system costs (see Appendix D), making the support structure account for approximately 60 percent of the total system costs (Figure 4.5).

4.2.3 Solar Scenario 2: Carports and Rooftops at OWTP

The carports and rooftops identified at the OWTP had much smaller areas available for mounting the solar panels as compared to the basin areas. The smaller areas produced solar systems with much smaller outputs in terms of power, energy, and revenue generated. However, because rooftop and carport solar systems are very common installations the costs of the support structure only accounts for approximately 25 percent of the total system costs (Figure 4.4). This makes the carport and rooftop solar systems much more cost effective in terms of payback time. One distinct disadvantage of the carports and rooftops is the fact that the systems are distributed over a larger area across the site, which makes connecting the systems to the plant distribution system more difficult.

4.2.4 Solar Scenario 3: MRF Rooftop and Miscellaneous One Acre Rooftop and Carport

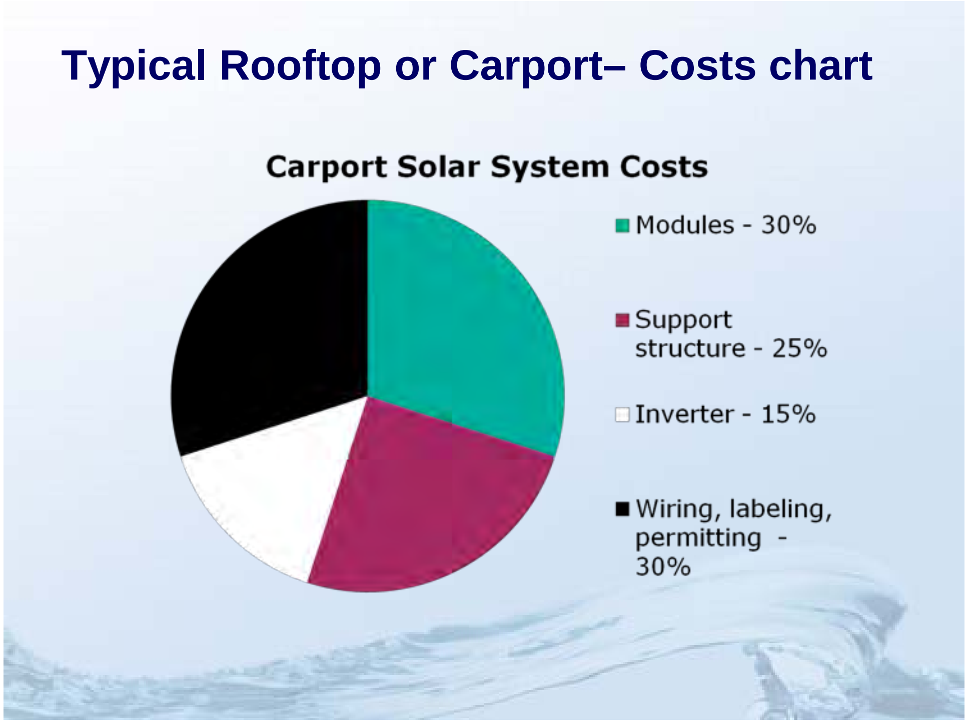
The MRF rooftop has the largest area available for mounting solar panels of the locations evaluated. The power and energy output of this system are therefore the greatest of all the systems. Because the MRF has a flat roof, the support structure for the associated solar system is comparable to the other rooftop locations in terms of the percentage of total system costs. This makes the MRF one of the most cost effective systems as well as one of the largest potential systems available. The one acre rooftop and carport structure are very similar to the carport and rooftop systems at the OWTP, but because they have a much larger area than the OWTP locations evaluated, the overall energy and revenue generated are greater.

4.2.5 Solar Scenario Summary

A summary of the information discussed above is provided in Table 4.1.

Table 4.1	**Solar Scenarios – Comparison and Payback Summary(1)** **Energy Evaluation** **City of Oxnard**		
Location	**Size [kW-dc]**	**Upfront Capital Cost**	**Payback [Years]**
Sedimentation Basins- Concrete	176	$1,519,380)	>20
Sedimentation Basins- Tanks	561	$6,450,120	>20
Activated Sludge Tanks	320	$3,679,080	>20
Flow Equalization Basins	517	$5,945,040	>20
Maintenance Building #1	21	$81,880	17
Maintenance Building #2	14	$54,280	18
Admin Building	27	$103,040	18
Storage Building	57	$219,880	18
Carport #1	74	$284,280	17
Carport #2	30	$113,160	18
Carport #3	28	$107,640	18
Carport #4	16	$61,640	18
MRF Roof	846	$3,242,080	17
1 Acre Ground Mount	391	$1,500,520	18
1 Acre Carport	391	$1,500,520	18

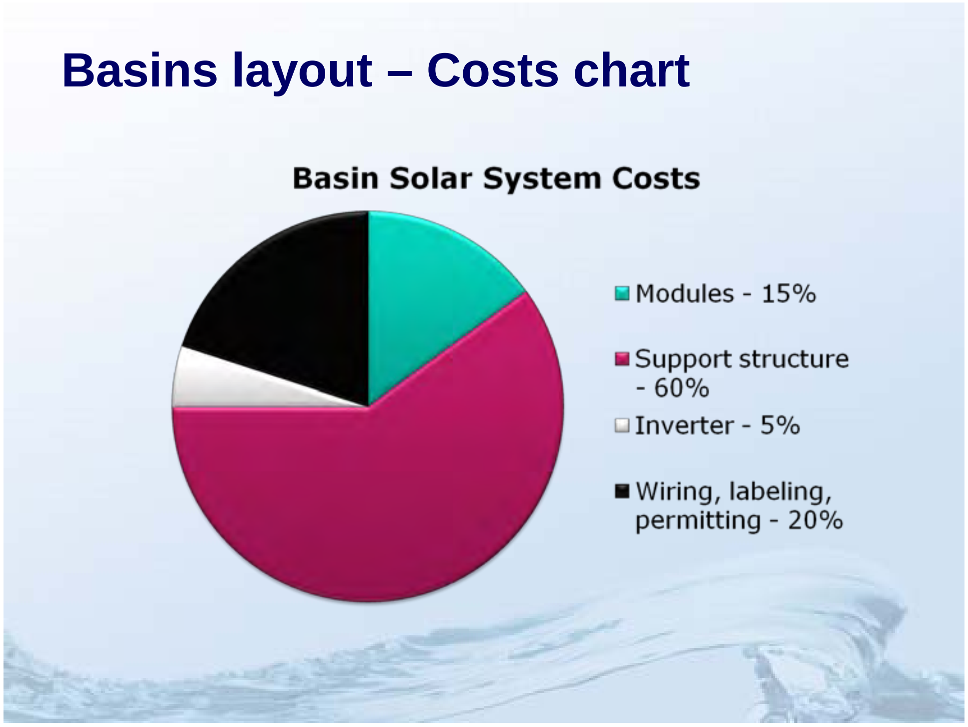
Note:
(1) Detailed calculations are shown in Appendix-D.



Typical Rooftop or Carport Costs Breakdown

FIGURE 4.4

CITY OF OXNARD
ENERGY EVALUATION



Typical Basin Layout Cost Breakdown

FIGURE 4.5

CITY OF OXNARD
ENERGY EVALUATION

FUNDING SOURCES

5.1 INTRODUCTION

Development of an effective funding strategy for green energy projects requires a clear understanding of the goals and objectives of the overall green energy plan, as well as a clear understanding of the opportunities surrounding each project. Further, all of the various types of renewable energy projects, waste-to-energy projects, and energy demand reduction projects require different funding strategies. A detailed funding strategy is not currently included herein, but can be developed after the City selects their preferred green energy project(s). Following is a high-level summary of the types of funding available for renewable energy projects, waste-to-energy projects, and energy demand reduction projects.

5.2 BACKGROUND ON GREEN ENERGY GRANT PROGRAMS

5.2.1 Innovation

Grants are generally made available by federal or state agencies for the express purpose of changing the “status quo” and advancing specific objectives of those agencies. A few grant programs are more like “entitlements” where funding is awarded to a city or a region based on a formula that might be tied to population or demographics. Most grants, however, are won through competition. The successful applicants must show that they are doing something innovative and beyond the standard operating procedure. For example, the grant programs to advance solar were much more robust 10-15 years ago as the solar industry was in its infancy and it was risky for cities to install the new technology. Today, the solar market is relatively mature, prices of panels have fallen significantly, Feed-In-Tariff programs are well established, and there are far fewer grant programs/incentives to install solar.

5.2.2 Integration

Green energy projects must be integrated with other sustainability or environmental efforts, such as air quality improvements, water quality improvements, and waste reduction, to gain the most from grant programs. This integration with other efforts shows funding agencies that other stakeholders support the project and that it will provide multiple benefits to the community. Integration can also allow greater access to funding. For example, the successful expansion of the fats, oils and grease (FOG) program could result in fewer pollutants entering the storm drain system and could ultimately contribute to improved water quality. Solid waste inputs to the landfill would also be reduced. Any or all of these benefits could be supported with grants from agencies with an interest in green energy, water quality, solid waste reduction or integrated sustainability initiatives. A highly competitive grant application clearly explains these connections through references of planning documents and letters of support from other stakeholders. The key to integrating green energy projects with other environmental efforts is to lay this groundwork early on in the planning process and be sure to engage potential community partners.

5.2.3 Timing

Grants are “perishable,” that is, they are only available for a specific window of time. Solicitations might be one-time events, or might recur annually. Most are dependent upon state or federal appropriations. Furthermore, a project must be in the right state of readiness to align with the grant opportunity. For example, some grants require that CEQA documents and plans are complete at the time of application, or that significant matching funds are secured, and partners are fully committed.

5.2.4 Partners

It can be beneficial to work in partnership with others to implement green energy projects. Partners can expand the reach or effectiveness of the effort and increase access to funding. For example, agricultural producers have unique access to grant programs that incentivize participation in biofuel projects. Non-profits may have access to grants for outreach about pollution prevention or sustainability. Some grant programs target public-private partnerships.

5.3 SUMMARY OF POTENTIAL FUNDING OPPORTUNITIES

5.3.1 Fats Oils and Grease

5.3.1.1 Federal:

- Environmental Protection Agency (EPA) – Office of Solid Waste and Emergency Response (OSWER): EPA has funded several “fat-to-fuel” projects or studies through the conservation fund to support biodiesel and anaerobic digester facilities. http://www.epa.gov/oswer/iwg/index.html

- EPA – Pollution Prevention Program: Grant program supports technical assistance projects to help businesses identify better environmental strategies and solutions for reducing or eliminating waste at the source. http://www.epa.gov/p2/pubs/grants/ppis/2013rfpp2grant.pdf

- EPA - Water Quality Improvement Grants (various). http://water.epa.gov/grants_funding/

5.3.1.2 State:

- California Energy Commission - Process Energy - Agriculture Loan Solicitation: The California Energy Commission is offering below market rate loan funds for the purchase of proven cost-effective energy efficient and renewable generation emerging technologies applicable to the agricultural and food processing industries. http://www.energy.ca.gov/process/agriculture/loan_solicitation/index.html

- California Energy Commission - Renewable Energy and Conservation Planning Grants (RECPG): This program funds plans to develop or revise rules and policies that facilitate development of eligible renewable energy resources, and their associated electric transmission facilities, and the processing of permits for eligible renewable energy resources. http://www.energy.ca.gov/contracts/PON-12-403_NOPA.pdf

- California Public Utilities Commission (CPUC) - Self Generation Incentive Program (SGIP): The CPUC's SGIP provides incentives to support existing, new, and emerging distributed energy resources. Qualifying technologies include wind turbines, waste heat to power technologies, pressure reduction turbines, internal combustion engines, microturbines, gas turbines, fuel cells, and advanced energy storage systems. http://www.cpuc.ca.gov/PUC/energy/DistGen/sgip/

- California Air Quality Board- - Air Quality Improvement Program: Incentive program administered by the Air Resources Board to fund clean vehicle and equipment projects, research on biofuels production and the air quality impacts of alternative fuels, and workforce training. http://www.arb.ca.gov/msprog/aqip/aqip.htm

- California Air Quality Board- - Carl Moyer Memorial Air Quality Standards Attainment Program provides grants for cleaner-than-required engines and equipment. Grants are administered by local air districts. http://www.arb.ca.gov/msprog/moyer/moyer.htm

- Cal-FOG Workgroup: The California Fats, Oils, and Grease work group (Cal FOG) was formed in 2001 as a result of increased regulatory focus on FOG-related sanitary sewer overflows (SSOs). The work group consists of wastewater agencies, regulators, consulting firms, and restaurant and related industry representatives. The focus of the work group is to utilize collective resources to develop FOG control tools and to provide technical support and information to the work group members. http://www.calfog.org/index.html

5.3.1.3 Private:

Partnerships with FOG service providers: Several private businesses offer FOG collection services, where the restaurant installs a grease recovery system and pays for a pickup service. The FOG providers often have biofuel systems that convert the grease to fuel. List of FOG haulers: http://www.calfog.org/Hauler.html

5.3.2 Cogeneration

5.3.2.1 Federal:

Department of Energy - Energy Efficiency Block Grants: Grants can be used for energy efficiency and conservation programs and projects communitywide, as well as renewable energy installations on government buildings. Availability varies from year to year. http://www1.eere.energy.gov/wip/eecbg.html

EPA – Clean Water State Revolving Fund – Green Project Reserve: The Green Project Reserve, or GPR, requires all Clean Water State Revolving Fund (CWSRF) programs to direct a portion of their capitalization grant toward projects that address green infrastructure, water efficiency, energy efficiency, or other environmentally innovative activities. CWSRF can forgive a portion of the loan principal. http://water.epa.gov/grants_funding/cwsrf/Green-Project-Reserve.cfm

5.3.2.2 State:

- California Energy Commission Energy Conservation Assistance Act (ECAA) program: Low interest low program for cities and schools to implement energy efficiency and renewable energy projects. http://www.energy.ca.gov/efficiency/financing/
- California Energy Commission – RECPG: (see above).
- CPUC – SGIP: (see above).
- California Air Quality Board – Air Quality Improvement Program: (see above).
- California Air Quality Board – Carl Moyer Memorial Air Quality (see above).
- Proposition 39 – Clean Energy Job Creation Fund: The Governor's May 2013 budget revision continued to direct the funds from the Clean Energy Job Creation Fund (Prop 39) entirely into schools. The LAO analysis states that this goes against the language in the bill, and indicates an opportunity for someone to litigate if this is how the Fund ends up being spent. The bill indicated that at least some of the funds would be available for energy efficiency and renewable energy projects at municipal buildings and facilities.

5.3.2.3 Utilities:

- Southern California Gas (So Cal Gas)
  - Only utility currently allowing digester gas into natural gas pipeline.
  - Co-Generation Project Grants: So Cal Gas has awarded grant funding to specific cogeneration projects in the past but does not appear to have an ongoing grant program for co-generation.

5.3.3 Solar Photovoltaic

5.3.3.1 Federal:

- Department of Energy - Energy Efficiency Block Grants: (see above).

5.3.3.2 State:

- CPUC, California Solar Initiative: Rebates for solar installation and Net Energy Metering (approximately 84 MW remaining for rebate in So Cal Edison, non-residential category)
  - Expected Performance-Based Buydowns: One-time payment based on estimated performance for systems under 30 kilowatts (kW) at $0.90/Watt (W).
  - Performance-Based Incentives (PBI): Monthly performance based payments for systems 30 kW and larger at $0.114/kilowatt hour (kWh).
- Proposition 39: (see above).
- CPUC - (SGIP): (see above).
- CA Cap and Trade and Renewable Energy Portfolio.
  - Renewable Energy Certificates (RECs): A REC represents the property rights to the environmental, social, and other non-power qualities of renewable electricity generation. A REC, and its associated attributes and benefits, can be sold separately from the underlying physical electricity associated with a renewable-based generation source. The City could sell RECs to entities regulated under the Cap.

5.3.3.3 Utilities:

- Southern California Edison (SCE).
  - California Solar Initiative - Renewable Energy Project Grants (see above).
  - Feed-in Tariffs: The California feed-in tariff allows eligible customer-generators to enter into 10-, 15- or 20-year standard contracts with their utilities to sell the electricity produced by small renewable energy systems (up to 3 megawatts). [1]http://www.cpuc.ca.gov/PUC/energy/Renewables/hot/feedintariffs.htm

5.3.3.4 Private

- Power purchase agreements

[1] The CPUC is currently in the process of implementing several statutory revisions to the Section 399.20 renewable feed-in tariff (FIT) program. As of May 9, 2013, the original FIT program as authorized by AB 1969 and implemented by Commission Decision (D.) 07-07-027 is still in effect. The revised FIT program (utilizing the renewable market adjusting tariff, or ReMAT) will become effective upon adoption of the revised standard contract and tariffs for each utility.

– PPA’s: Private Solar Energy Providers will finance and install solar panels on city facilities. City agrees to buy back power from Provider over 15-25 years.
– Bond PPAs: Municipality issues taxable bonds for the solar project and enters a 15-25 year lease-purchase agreement with Solar Provider.

APPENDIX A – CITY EAP RESOLUTION AND VENTURA AIR POLLUTION CONTROL DISTRICT (VAPCD) PERMIT TO OPERATE

CITY COUNCIL OF THE CITY OF OXNARD

RESOLUTION NO. 14,398

RESOLUTION OF THE CITY COUNCIL OF THE CITY OF OXNARD APPROVING COMPLETION OF THE FINAL DRAFT OF THE CITY OF OXNARD ENERGY ACTION PLAN (EAP) AND CONFIRMATION OF IMPLEMENTATION OF THREE EAP PROGRAMS

WHEREAS, the California Global Warming Solutions Act of 2006 (known as AB 32) sets a mandate for the reduction of greenhouse gas emissions in California, and the Sustainable Communities and Climate Protection Act of 2008 (known as SB 375) requires emissions reductions through coordinated regional planning that integrates transportation, housing, and land-use policy; and

WHEREAS, because of the diversity of California's topography and different local climates, the effects of a changing climate on California communities are complex and will differ from community to community; and

WHEREAS, the Southern California Edison (SCE) 2010-12 Strategic Plan established the Energy Action Plan (EAP) as a planning tool to identify and quantify programs to use energy more efficiently and reduce greenhouse gas (GHG) emissions from local government operations and within their respective communities; and

WHEREAS, the 2030 General Plan, Programs SC-3.2 and SC-3.3 call for the completion of a City Government and Community EAP, respectively, and the EAP information contributes towards several other programs within Goal SC-3 "Energy Generation and Increased Efficiency"; and

WHEREAS, the calculations and expression of electricity and natural gas past and projected consumption in millions of tons of CO2 Equivalent (MTCO2e) contributes to the development of an inventory and monitoring of GHG emissions and development of an Oxnard Climate Action Adaptation Plan that are Policies SC-1.1 and SC-1.3 of the 2030 General Plan, respectively; and

WHEREAS, on October 1, 2009, the California Public Utilities Commission authorized SCE to conduct a solicitation for energy efficiency strategic planning activities, pursuant to which the City of Oxnard applied and received a grant of $275,000 to develop an Oxnard City Government and Community EAP; and

WHEREAS, in 2011 and utilizing the SCE funding, the City of Oxnard contracted with a team of qualified energy planning consulting firms to assist in preparing the Oxnard EAP; and

WHEREAS, in 2012, the consultants and City staff conducted a comprehensive analysis of City Government and community electricity and natural gas consumption between 2005 and 2010, projected electricity and natural gas consumption to 2020, identified a feasible reduction target with consideration for the mild Oxnard climate, and identified 18 City Government and 17 Community programs to achieve the target; and

WHEREAS, the consultants and City staff identified and involved City Government and community stakeholders, developed an EAP website seeking community input, distributed an Earth Day Promotional Flyer in English and Spanish, distributed a press release that resulted in several local newspaper articles, and held two community workshops on May 14, 2012; and

WHEREAS, the Planning Commission conducted a public comment session on the Final Draft EAP at its meetings on May 2, 2013 and June 6, 2013; and

WHEREAS, the City Council of the City of Oxnard received a summary report on EAP findings and programs, made comments on June 18, 2013, and will consider authorization and funding of individual EAP programs on a case by case basis; and

WHEREAS, Public Resources Codes 21102 and 21150 statutorily exempt from the California Environmental Quality Act (CEQA) a feasibility or planning study of possible future actions that have not been adopted or funded; and

WHEREAS, in order to achieve "Platinum Level" partner status under SCE's Energy Leader Program, SCE requests that the City Council commit to implementing three EAP programs identified in the EAP; and

WHEREAS, the 2030 General Plan, Chapter 9, Table 9-3, identifies three Initial Implementation Policies that effectively implement three corresponding EAP programs as shown below, and that the environmental effects of these three previously adopted, but not yet implemented, Implementation Measures were reviewed by the certified 2030 General Plan Final Program Environmental Impact Report in compliance with CEQA.

2030 General Plan Implementation Measure		EAP City or Community Program	
5.0	Purchase and use recycled materials and alternative and renewable energy sources as feasible in City operations.	G-11	Develop Energy-Efficient Product Procurement Policy
6.0	Work with local utility providers to create a public outreach program supporting energy conservation.	C-2	Additional Outreach to Residents
7.0	Provide information to businesses about how to reduce waste and pollution and conserve resources.	C-1	Additional Outreach to Commercial and Industrial Customers

NOW, THEREFORE, THE CITY COUNCIL OF THE CITY OF OXNARD DOES HEREBY RESOLVE AS FOLLOWS:

1. The Final Draft EAP dated April, 2013 is hereby approved as to form and content and attached hereto as Exhibit A, and made part of this Resolution.
2. The City of Oxnard commits to implementing EAP program C-1, C-2, and G-11 in partial satisfaction of the SCE Partnership Program Platinum level requirements.

PASSED AND ADOPTED this 25 day of June 2013, by the following vote:

AYES: Councilmembers Flynn, Ramirez, MacDonald, Padilla and Perello.

NOES: None.

ABSENT: None.

Tim Flynn, Mayor

ATTEST:

Daniel Martinez, City Clerk

APPROVED AS TO FORM:

FOR

Alan Holmberg, City Attorney

Ventura County
Air Pollution
Control District

669 County Square Drive
Ventura, California 93003

tel 805/645-1400
fax 805/645-1444
www.vcapcd.org

Michael Villegas
Air Pollution Control Officer

PERMIT TO OPERATE
Number 01137

Valid October 1, 2012 to September 30, 2013

This Permit Has Been Issued To The Following:

Company Name / Address:

City of Oxnard-Wastewater Division
6001 S. Perkins Rd.
Oxnard, CA 93033

Facility Name / Address:

Oxnard Wastewater Treatment Plant
6001 South Perkins Road
Oxnard, CA 93033

Permission Is Hereby Granted To Operate The Following:

2 - 500 BHP Caterpillar Effluent Pump Natural Gas Engines, Model G-398, Rich Burn (as defined in VCAPCD Rule 74.9), each equipped with NSCR 3-Way Catalytic Converter, Oxygen Sensor, and Air/Fuel Ratio Controller, for Rule 74.9 compliance, (Engines Nos. 1 & 3).
3 - 800 BHP Waukesha Electrical Generator Waste Gas Engines (as defined in VCAPCD Rule 74.9), Model P9390G, Rich Burn, equipped with Pre-Stratified Charge for Rule 74.9 compliance (Engines Nos. E7610.00, E7710.00 & E7810.00).
2 - 24000 Cubic Feet Per Hour Varec, Model 239, Waste Gas Burners (24 MMBTU/Hr on Natural Gas), 6" Feed Size, used for Digester Gas Incineration
1 - 48000 Cubic Feet Per Minute Air Capacity Odor Reduction Tower, B.F. Goodrich/Media Koro-Z, for odor reduction and H2S control
1 - Headworks Facilities controlled by a 25,000 SCFM US Filter LO/Pro Odor Control System consisting of a three-stage absorption system using Sodium Hydroxide and Sodium Hypochlorite for hydrogen sulfide removal; and equipped with a hydrogen sulfide analyzer.
1 - Odor Reduction Station (Solids Processing Building and Eastern Trunk Pump Station), Calvert FRP Fine Mist Tower, 10 Feet Diameter x 37 Feet High, 22,000 CFM Capacity, equipped with an Interscan Model LD-17 H2S Analyzer

Emergency Standby Diesel Engines For Electricity Generators

1 - 2250 BHP General Motors Emergency Standby Diesel Engine, Model 16-567-E4, Serial No. 66-HI-1082, no EPA Family Name, Model Year 1966
1 - 2250 BHP General Motors Emergency Standby Diesel Engine, Model 16-567-E-4, Serial No. 66-HI-1161, no EPA Family Name, Model Year 1966
1 - 2172 BHP Caterpillar Emergency Standby Diesel Engine, Model 3512B TA, Serial No. 1GZ02501, EPA Family Name 5CPXL58-6ERK, Model Year 2005
1 - 263 BHP Caterpillar Emergency Standby Diesel Engine, Model 3208, Serial No. 5YF00565, no EPA family Name, Model Year 1989

1 - 636 BHP Caterpillar Emergency Standby Diesel Engine, Model C15, Serial No. FSE00892, EPA Family Name 7CPXL15.2ESK, ARB Executive Order U-R-001-0308

1 - 250 BHP Cummins Emergency Standby Diesel Engine, Model QSB7-G3, Serial No. 73123393, EPA Family Name ACEXL0409AAB, Tier 3, CARB Executive Order No. U-R-002-0516, Located at Advanced Water Purification Site at 5700 South Perkins Road in Oxnard

Emergency Standby Diesel Engine For Air Compressor

1 - 139 BHP (104 KW) John Deere Emergency Diesel Engine, Model 4045HF275C, Serial No. PE 4045H376314, EPA Family Name 5JDXL06.8078, Model Year 2005

This Permit Has Been Issued Subject To The Following Conditions:

1. Permitted Emissions

	Tons/Year	Pounds/Hour
Reactive Organics	10.18	8.36
Nitrogen Oxides	15.33	27.76
Particulate Matter	1.16	1.61
Sulfur Oxides	2.54	1.69
Carbon Monoxide	145.35	84.54
Chlorine	0.75	0.52
Hydrogen Sulfide	9.47	2.16

2. Annual fuel consumption in the Caterpillar internal combustion engines, the Waukesha internal combustion engines, and the Varec Waste Gas Burners shall not exceed the following:

   a) Total natural gas consumption in the two (2) 500 HP Caterpillar internal combustion engines (Engine Nos. 1 & 3) shall not exceed 5.0 million cubic feet per year.

   b) Total digester waste gas consumption in the three (3) 800 HP Waukesha internal combustion engines (Engine Nos. E7610.00, E7710.00, & E7810.00) shall not exceed 155.00 million cubic feet per year.

   c) Incineration of digester gas in the Varec Waste Gas Burners shall not exceed 146.0 million cubic feet per year.

   In order to comply with this condition, permittee shall maintain and operate meters to measure and record gas consumption. The meters shall be operated and calibrated according to manufacturer's specifications. The gas meter records shall be summed on a monthly basis. The monthly totals shall be summed for the previous twelve calendar (12) months. Gas consumption totals for any twelve (12) calendar month rolling period in excess of the above limits shall be considered a violation of this condition.

3. Prior to exceeding any of the above limits, permittee shall submit an application to the APCD to increase those limits. Any request

to increase fuel use in the two (2) 500 HP Caterpillar internal combustion engines (Engines Nos. 1 & 3) shall be subject to APCD Rule 26.

4. Permittee shall comply with APCD Rule 74.9, "Stationary Internal Combustion Engines". This includes, but is not limited to, the following permit conditions.

5. Pursuant to Rule 74.9.F, Reporting Requirements, within 45 days of the end date of each permit renewal period, the operator of a permitted engine subject to the provisions of the rule shall provide the District with the following information:

   a) Engine manufacturer, model number, operator identification number and location of each engine.

   b) A summary of maintenance reports during the renewal period, including quarterly screening data if applicable.

   For each engine exempt pursuant to Subsection D.2, total annual operating hours shall be reported annually. For each engine exempt pursuant to subsection D.3, total annual hours of maintenance operaton shall be reported annually. Reports shall be provided to the District after every calendar year by February 15.

6. Emissions of oxides of nitrogen (NOx) from each of the two (2) 500 HP Caterpillar internal combustion engines (Engines Nos. 1 & 3) shall not exceed 25 parts per million (ppmv) as corrected to 15% oxygen.

7. Emissions of oxides of nitrogen (NOx) from each of the three (3) 800 HP Waukesha internal combustion engines (Engines Nos. E7610.00, E7710.00, & E7810.00) shall not exceed 50 parts per million (ppmv) as corrected to 15% oxygen. This condition is applied for APCD Rule 74.9.B.1 compliance. As of January 1, 1997, the NOx limits are 25 parts per million (ppmv) as corrected to 15% oxygen for rich burn engines fired on natural gas and 50 parts per million (ppmv) as corrected to 15% oxygen for rich burn engines fired on waste gas. As detailed in VCAPCD Rule 74.9.I.11, waste gas is defined as fuel gas produced at either waste water/sewage treatment facilities or landfills containing no more than 25 percent by volume supplemental gas.

8. Emissions from each engine shall not exceed 4500 ppm carbon monoxide, as corrected to 15% oxygen, pursuant to APCD Rule 74.9.B.1.

9. Emissions from each engine shall not exceed 250 ppm reactive organic compounds, as corrected to 15% oxygen, pursuant to APCD Rule 74.9.B.1.

10. In order to comply with the engine emission Conditions, permittee shall perform a source test every 24 months as required by VCAPCD

Rule 74.9. In addition, the NSCR system on the Caterpillar engines shall be maintained and operated with a minimum temperature rise across the catalyst of 15 degrees Fahrenheit.

11. Hydrogen Sulfide emissions from the Odor Reduction Tower shall not exceed 5 ppm by volume.

12. Hydrogen Sulfide emissions from the Odor Reduction Station shall not exceed 4 ppm by volume at the Solids Processing Building.

13. Hydrogen sulfide emissions from the 25,000 CFM US Filter LO/PRO Odor Control System three-stage absorption system controlling the Headworks Facilities shall not exceed 3 ppm by volume. The chlorine concentration at the outlet of the 25,000 CFM US Filter LO/PRO Odor Control System three-stage absorption system controlling the Headworks Facilities shall not exceed 0.1 ppm by volume. This condition is applied pursuant to Rule 51, "Nuisance"; and Rule 54, "Sulfur Compounds".

    In order to comply with this condition, permittee shall maintain the control system parameters (i.e., pH of scrubbing solution, ORP of the scrubbing solution, pressure drop across the control system, and space velocity through the control system) at values that ensure that the above hydrogen sulfide and chlorine concentrations are not exceeded.

    Permittee, upon request of the District, shall conduct testing to ascertain the hydrogen sulfide and chlorine emissions from the 25,000 CFM US Filter LO/PRO Odor Control System three-stage absorption system controlling the Headworks Facilities, using APCD approved methods.

14. Permittee shall install and maintain a continuous hydrogen sulfide analyzer at the outlet of the 25,000 SCFM US Filter LO/PRO Odor Control System three-stage absorption system controlling the Headworks Facilities to monitor the hydrogen sulfide concentration in ppm by volume at the outlet of the 25,000 SCFM US Filter LO/PRO Odor Control System three-stage absorption system controlling the Headworks Facilities. The analyzer shall be installed, operated, and calibrated according to the manufacturer's specifications. This condition is applied to ensure compliance with Rule 51, "Nuisance"; and Rule 54, "Sulfur Compounds".

15. Permittee shall install and maintain pH and ORP (oxidation reduction potential) measuring and monitoring devices to measure and record the pH and ORP of the scrubbing solution in the 25,000 SCFM US Filter LO/PRO Odor Control System three-stage absorption system controlling the Headworks Facilities. Permittee shall also install and maintain pressure monitoring devices to monitor the pressure drop across the 25,000 SCFM US Filter LO/PRO Odor Control System three-stage absorption system controlling the Headworks. All devices shall be installed, operated, and calibrated according to the manufacturer's specifications. This condition is applied to

ensure compliance with the requirements of Rule 51, "Nuisance"; and Rule 54, "Sulfur Compounds".

16. The stack height of the 25,000 SCFM US Filter LO/PRO Odor Control System three-stage absorption system controlling the Headworks Facilities shall be no less than 9 meters (29.5 feet). The stack diameter of at the outlet of the 25,000 SCFM US Filter LO/PRO Odor Control System three-stage absorption system controlling the Headworks Facilities shall not exceed 0.9 meters (2.95 feet). The stack gas exit velocity from the 25,000 SCFM US Filter LO/PRO Odor Control System three-stage absorption system controlling the Headworks Facilities shall be no less than 18.5 meters per second (60.7 feet per second). This condition is applied pursuant to Rule 51, "Nuisance"; and pursuant to Rule 54, "Sulfur Compounds".

17. All operations shall comply with the requirements of Rule 51, "Nuisance".

18. All equipment shall be maintained and operated in a manner that ensures compliance with all applicable Rule and permit conditions.

19. Permittee shall maintain records showing, for the 25,000 SCFM US Filter LO/PRO Odor Control System three-stage absorption system controlling the Headworks Facilities, on a monthly basis, a log of operating time for the control system, and monitoring equipment; records of the readings from the monitoring equipment showing the pressure drop across the control system; records of the readings from the monitoring equipment showing the hydrogen sulfide concentrations, pH of the scrubbing solution in the control system, and ORP of the scrubbing solution in the control system; and a log for the control system and monitoring equipment detailing all routine and non-routine maintenance performed. All records shall be compiled into monthly reports and shall be made available to APCD personnel upon request. All records shall be retained for at least two years and shall be made available to APCD personnel upon request.

20. The Hydrogen Sulfide analyzer on the Odor Reduction Tower shall be maintained in good working order at all times. The Hydrogen Sulfide analyzers on the Odor Reduction Station shall be maintained in good working order at all times. Malfunctions are subject to APCD Rule 32 (Breakdowns), as are all other air pollution related breakdowns at the plant. Analyzer outputs shall be continuously recorded on strip charts, or shall be recorded using an electronic data acquisition/storage system. Records or strip charts shall be maintained on site for at least two years and shall be made available to APCD personnel upon request.

21. When sodium hypochlorite is used, chlorine emissions from the Odor Reduction Station (Solids Processing Building and Eastern Trunk Pump Station Odor Reduction Station) shall not exceed 2 ppm by volume. Scrubber drain pH shall be maintained between 8.0 and 9.0 to ensure compliance with this requirement. Operation of the

Solids Processing Building and Eastern Trunk Pump Station Odor Reduction Station using sodium hypochlorite shall be limited to 2562 hours per year. In order to demonstrate compliance with this condition, the permittee shall maintain records of the hours of operation when using sodium hypochlorite and upon the request of the District, shall measure the chlorine emissions from the Odor Reduction Station (Solids Processing Building and Eastern Trunk Pump Station Odor Reduction Station).

22. Under no circumstances shall raw digester gas be vented to the atmosphere without prior approval from the APCD. All digester gas produced at the plant shall be flared, or disposed of in an alternative manner approved by the APCD.

23. Hydrogen Sulfide content of produced digester gas shall not exceed 100 ppm.

24. Hydrogen Sulfide content and heat content of the produced digester gas (in grains/100 cu. ft.) shall be determined by analytical means every 6 months, by an independent laboratory or the laboratory at the City of Oxnard Wastewater Treatment Facility, with results kept on file for inspection by APCD personnel for at least 2 years.

25. Annual hours of operation for maintenance and testing of each emergency engine shall not exceed 20 hours per year, except for the 2172 BHP and 636 BHP Caterpillar Emergency Standby Diesel Engines, which shall not exceed 50 hours per year. This limit does not include emergency operation when electrical line service has failed. When not being operated for maintenance or testing, the emergency engine shall only be used during a failure or loss of all or part of normal electrical power service to the facility. This condition is applied pursuant to the California ARB Airborne Toxic Control Measure (ATCM) for Stationary Compression Ignition Engines.

In order to comply with this condition, the engine shall be equipped with a non-resettable hour meter and the permittee shall maintain a log that differentiates operation during maintenance and testing from emergency operation. These records shall be compiled into a monthly total. The monthly operating hour records shall be summed for the previous 12 months. Total operating hours for any of these 12 month periods, excluding emergency operation, in excess of the specified annual limit shall be considered a violation of this condition.

26. The emergency diesel engine(s) shall be operated in compliance with all applicable requirements of the California ARB Airborne Toxic Control Measure (ATCM) for Stationary Compression Ignition Engines, Section 93115 through 93115.15, Title 17, California Code of Regulations. This includes, but is not limited to, the following permit conditions.

27. Pursuant to Section 93115.5(b) of the ATCM for Stationary Compression Ignition Engines, effective January 1, 2006, no owner

or operator of an in-use emergency standby stationary diesel-fueled engine shall add to the engine or any fuel tank directly attached to the engine any fuel unless the fuel is CARB diesel fuel or another fuel that meets the requirements of Section 93115.5(b) of the ATCM.

28. Pursuant to Rule 74.9.D.3, an emergency engine is exempt from Rule 74.9, "Stationary Internal Combustion Engines", provided that it is operated during either an emergency or maintenance operation. Maintenance operation is limited to 50 hours per calendar year and is defined as "the use of an emergency standby engine and fuel system during testing, repair, and routine maintenance to verify its readiness for emergency standby use".

29. Permittee shall maintain records for the Hydrogen Sulfide analyzers on the Odor Reduction Tower and the Odor Reduction Station. Permittee shall maintain records of the hours of operation of the Solids Processing Building and Eastern Trunk Pump Station Odor Reduction Station when using sodium hypochlorite. Such records shall include the date and time. These records shall be compiled on a monthly basis. The compiled records shall be maintained for at least two years and shall be made available to APCD personnel upon request.

30. Permittee shall maintain records as required by VCAPCD Rule 74.9.E, and the monthly fuel consumption and hours of operation (when applicable) of the internal combustion engines. Permittee shall also maintain records showing the amount of digester gas produced and the disposition of this gas (amount expended to engines; amount expended to flare). All records shall be compiled into monthly reports and shall be maintained for at least two years.

31. Pursuant to Rule 74.9.F, Reporting Requirements, within 45 days of the end date of each permit renewal period, the operator of a permitted engine subject to the provisions of the rule shall provide the District with the following information:

    a) Engine manufacturer, model number, operator identification number and location of each engine.

    b) A summary of maintenance reports during the renewal period, including quarterly screening data if applicable.

    For each engine exempt pursuant to Subsection D.2, total annual operating hours shall be reported annually. For each engine exempt pursuant to subsection D.3, total annual hours of maintenance operaton shall be reported annually. Reports shall be provided to the District after every calendar year by February 15.

32. A log of engine operation for the emergency engine shall be maintained based on readings from a non-resettable hour meter. The log shall differentiate operation during maintenance and testing from operation during an emergency. The hours of operation shall

be totaled on a monthly basis and shall be summed for the previous 12 months.

This data shall be maintained for a minimum of three (3) years from the date of each entry and shall be made available to the APCD upon request.

33. On and after October 19, 2013, the two 500 BHP Caterpillar Effluent Pump Natural Gas Engines shall comply with 40 CFR Part 63, Subpart ZZZZ, National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines (RICE NESHAP). This includes, but is not limited to, the following requirements for non-emergency 4 stroke rich burn spark ignited engines rated at less than or equal to 500 BHP that commenced construction before June 12, 2006:

    Pursuant to 40 CFR Part 63.6603, Table 2d, the permittee shall meet the following requirements:

    a) Change oil and filter every 1,440 hours of operation, or annually, whichever comes first. Permittee shall have the option to utilize an oil analysis program as described in 40 CFR Part 63.6625(i) in order to extend the specified oil change requirement; and
    b) Inspect spark plugs every 1,440 hours of operation, or annually, whichever comes first, and replace as necessary; and
    c) Inspect all hoses and belts every 1,440 hours of operation, or annually, whichever comes first, and replace as necessary.

    During periods of startup, the permittee shall minimize the RICE time spent at idle and minimize the RICE startup time at startup to a period needed for appropriate and safe loading of the engine, not to exceed 30 minutes. The permittee shall operate and maintain the RICE and after-treatment control device (if any) according to the manufacturer's emission related instructions, or the permittee's own operation and maintenance plan which must provide to the extent practicable for the maintenance and operation of the engine in a manner consistent with good air pollution control practice for minimizing emissions.

    The permittee shall keep the records of RICE maintenance (oil, spark plugs, hoses and belts) required by the RICE operation and maintenance plan. The hours of operation records and maintenance records shall be maintained for 5 years following the date of each occurrence and shall be made available to the APCD upon request.

34. On and after October 19, 2013, the three 800 BHP Waukesha Electrical Generator Waste Gas Engines shall comply with 40 CFR Part 63, Subpart ZZZZ, National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines (RICE NESHAP). This includes, but is not limited to, the following requirements for non-emergency spark ignited engines fired on landfill gas or digester gas that commenced construction

before June 12, 2006:

Pursuant to 40 CFR Part 63.6603, Table 2d, the permittee shall meet the following requirements:

a) Change oil and filter every 1,440 hours of operation, or annually, whichever comes first. Permittee shall have the option to utilize an oil analysis program as described in 40 CFR Part 63.6625(i) in order to extend the specified oil change requirement; and
b) Inspect spark plugs every 1,440 hours of operation, or annually, whichever comes first, and replace as necessary; and
c) Inspect all hoses and belts every 1,440 hours of operation, or annually, whichever comes first, and replace as necessary.

During periods of startup, the permittee shall minimize the RICE time spent at idle and minimize the RICE startup time at startup to a period needed for appropriate and safe loading of the engine, not to exceed 30 minutes. The permittee shall operate and maintain the RICE and after-treatment control device (if any) according to the manufacturer's emission related instructions, or the permittee's own operation and maintenance plan which must provide to the extent practicable for the maintenance and operation of the engine in a manner consistent with good air pollution control practice for minimizing emissions.

The permittee shall keep the records of RICE maintenance (oil, spark plugs, hoses and belts) required by the RICE operation and maintenance plan. The hours of operation records and maintenance records shall be maintained for 5 years following the date of each occurrence and shall be made available to the APCD upon request.

Note that for the purposes of the RICE NESHAP, the subject engine(s) shall combust no less than 10% landfill gas or digester gas of the gross heat input on an annual basis.

35. The following condition regarding the RICE NESHAP applies to the following "existing" emergency diesel engines:

a) Two 2250 BHP General Motors
b) 2172 BHP Caterpillar
c) 263 BHP Caterpillar
d) 139 BHP John Deere

On and after May 3, 2013, these engines shall comply with 40 CFR Part 63, Subpart ZZZZ, National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines (RICE NESHAP). This includes, but is not limited to, the following requirements for emergency compression ignition engines that commenced construction before June 12, 2006:

Pursuant to 40 CFR Part 63.6603, Table 2d, the permittee shall meet the following requirements:

a) Change oil and filter every 500 hours of operation, or annually, whichever comes first. Permittee shall have the option to utilize an oil analysis program as described in 40 CFR Part 63.6625(i) in order to extend the specified oil change requirement; and
b) Inspect air cleaner every 1,000 hours of operation, or annually, whichever comes first, and replace as necessary; and
c) Inspect all hoses and belts every 500 hours of operation, or annually, whichever comes first, and replace as necessary.

If an emergency RICE is operating during an emergency and it is not possible to perform the above maintenance, or if performing the maintenance would otherwise pose an unacceptable risk under federal, state, or local law, the maintenance can be delayed and should be performed as soon as practicable after the emergency has ended or the unacceptable risk has abated. All such maintenance delays shall be reported to the APCD Compliance Division.

During periods of startup, the permittee shall minimize the RICE time spent at idle and minimize the RICE startup time at startup to a period needed for appropriate and safe loading of the engine, not to exceed 30 minutes. The permittee shall operate and maintain the RICE and after-treatment control device (if any) according to the manufacturer's emission related instructions, or the permittee's own operation and maintenance plan which must provide to the extent practicable for the maintenance and operation of the engine in a manner consistent with good air pollution control practice for minimizing emissions.

Pursuant to 40 CFR Parts 63.6640(f) and 63.6675, the RICE cannot be used for peak shaving, as part of a financial arrangement to supply power into the grid, or as a part of a demand response program, unless specifically allowed by this permit. There is no time limit on the use of emergency RICE in emergency situations.

Pursuant to 40 CFR Parts 63.6655 and 63.6660, the RICE shall be equipped and operated with a non-resettable hour meter. The permittee must document how many hours are spent for emergency operation, including what classified the operation as emergency and how many hours are spent for non-emergency operation, including operation for maintenance and testing. In addition, the permittee shall keep the records of RICE maintenance (oil, air cleaner, hoses and belts) required by the RICE operation and maintenance plan. The hours of operation records and maintenance records shall be maintained for 5 years following the date of each occurrence and shall be made available to the APCD upon request.

36. The 636 BHP Caterpillar and the 250 BHP Cummins emergency diesel engines is exempt from 40 CFR Part 63, Subpart ZZZZ, National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines (RICE NESHAP) because they were constructed on or after June 12, 2006.

Within 30 days after receipt of this permit, the permittee may petition the Hearing Board to review any new or modified condition (Rule 22).

This permit, or a copy, shall be posted reasonably close to the subject equipment and shall be accessible to inspection personnel (Rule 19). This permit is not transferable from one location to another unless the equipment is specifically listed as being portable (Rule 20).

This Permit to Operate shall not be construed to allow any emission unit to operate in violation of any state or federal emission standard or any rule of the District.

Terri Thomas
Engineering Division

For:

Michael Villegas
Air Pollution Control Officer

APPENDIX B – PRELIMINARY SUMMARY OF COGENERATION ALTERNATIVES EVALUATION

Oxnard Preliminary Summary of Cogeneration Alternatives Evaluation

carollo
Engineers...Working Wonders With Water™

Date/time: 6/5/13 3:55 PM

Alternative	No Cogeneration - Base Case Operation	Two 852 kW Engine Generator Cogeneration	One 1,137 kW Engine Generator Cogeneration	Three 250 kW Microturbine Cogeneration System w/ FOG	One 1,400 kW Fuel Cell Cogeneration System w/ FOG
Average Net Power Generated (kW)	0	1,534	1,023	694	1,176
Estimated Project Cost [1] (2013 dollars)	$0	$13,313,020	$10,993,232	$12,135,427	$17,449,612
Estimated SGIP Grant Funding (2013 dollars)	$0	$2,433,600	$1,923,300	$1,350,000	$4,080,000
Estimated Net Project Cost (2013 dollars)	$0	$10,879,420	$9,069,932	$10,785,427	$13,369,612
20-year Average Digester Gas Consumed (scfd)	146,897	514,468	359,919	349,960	444,629
20-year Average Natural Gas Consumed (scfd)	0	3,249	0	0	0
20-year Average Annual NOx Emissions (lb/yr)	3,576	27,774	20,830	5,585	6,565
20-year Average Annual CO Emissions (lb/yr)	11,714	106,821	79,111	9,337	7,972
20-year Average Annual Energy CO2e Value [2] (metric-tons/yr)	10,111	8,262	9,306	10,063	8,746
20-Year Average Annual Costs/(Revenues)					
Natural gas costs	$0	$42,792	$0	$0	$0
Electricity cost savings	$0	($2,809,777)	($1,908,767)	($1,365,948)	($2,307,405)
Revenue for green power credit	($15,673)	($88,842)	($62,153)	($43,276)	($80,620)
O&M costs for Cogeneration & fuel treatment facilities	$0	$421,835	$289,397	$228,482	$743,929
20-Year Present Worth of Costs/(Revenues)					
Natural gas costs	$0	$476,791	$0	$0	$0
Base Cost for electricity	$40,052,817	$40,052,817	$40,052,817	$40,052,817	$40,052,817
Revenue for displaced electricity	$0	($30,829,906)	($20,943,696)	($14,987,681)	($25,406,145)
Revenue for green power credit	($226,042)	($1,281,329)	($896,411)	($624,150)	($1,167,020)
Revenue for FOG tipping fee	$0	($8,760,000)	($8,760,000)	($8,760,000)	($8,760,000)
O&M costs for fuel treatment facilities	$0	$1,581,139	$1,106,157	$1,075,549	$1,366,794
O&M costs for cogeneration facilities	$0	$3,192,754	$2,168,935	$1,510,179	$7,074,968
Estimated Project Cost [1] (2013 dollars)	$0	$13,313,020	$10,993,232	$12,135,427	$13,369,612
Total 20-Year Present Worth of Energy Cost [3]	**$39,826,775**	**$17,745,286**	**$23,721,034**	**$30,402,141**	**$26,531,026**
Present Worth of Net Benefit Compared to No Cogeneration System		**$22,081,489**	**$16,105,742**	**$9,424,634**	**$13,295,750**
Simple Payback Period of Cogeneration System, years		**8**	**8**	**11**	**10**

Note & Assumptions:

(1) This includes estimated construction cost plus cost for engineering, administration, contingencies and construction management
(2) CO2 equivalent (CO2e) emissions represent metric tons of Carbon Dioxide associated with purchased energy usage at the facility for Natural Gas and Electricity; based on EPA standards for overall emissions from regional power generation facilities, including CO2, N2O and CH4 emissions
(3) Total 20-year present worth of energy costs is the sum of the Present Worth values listed above
(4) Project Assumptions:

Inflation (capital costs)	4.0%	
Inflation (electricity costs)	5.0%	
Inflation (natural gas costs)	4.0%	
Inflation (O&M costs)	3.0%	
Gross discount rate	5.0%	
Digester Gas LHV, Btu/scf	580	
Engine availability percentage	90.0%	
Microturbine availability percentage	95.0%	
Fuel Cell availability percentage	95.0%	
O&M rate for new engine alternatives $/kWh	$0.015	
O&M rate for microturbine alternatives $/kWh	$0.015	
O&M rate for fuel cell unit $/kWh	$0.040	
O&M rate for fuel treatment system $/million Btu	$0.900	
FOG Tipping Fee $/gallon	$0.050	
Green Power Credit $/kWh	$0.005	

(5) Project Data:

2012 ave. elect cost, $/kWhr	$0.105	Estimated
2012 ave. elect savings for existing generation, $/kWhr	$0.161	Based on current purchased energy costing $0.074/kWh on average
Est. 2012 ave. elect savings for new generation, $/kWhr	$0.133	Assumed to be less than existing due to not having a redundant unit
2012 NG cost, $/therm, HHV	$0.818	

Oxnard Cogeneration Study
Alternative 0
No Cogeneration - Base Case Operation

Life Cycle Present Worth of Annual Costs

Year	**Average**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
Operation Data											
Average Digester Gas Available (million Btus)	72,563	72,563	72,563	72,563	72,563	72,563	72,563	72,563	72,563	72,563	72,563
Boiler Fuel Consumed (million Btus)	31,098	31,098	31,098	31,098	31,098	31,098	31,098	31,098	31,098	31,098	31,098
New Cogen Fuel Consumed (million Btus)	-	-	-	-	-	-	-	-	-	-	-
Total Fuel Consumed (million Btus)	31,098	31,098	31,098	31,098	31,098	31,098	31,098	31,098	31,098	31,098	31,098
Natural Gas Consumed (million Btus)	-	-	-	-	-	-	-	-	-	-	-
Digester Gas Consumed (million Btus)	31,098	31,098	31,098	31,098	31,098	31,098	31,098	31,098	31,098	31,098	31,098
Flared Digester Gas (million Btus)	41,465	41,465	41,465	41,465	41,465	41,465	41,465	41,465	41,465	41,465	41,465
Cogen Heat Generated (million Btus)	-	-	-	-	-	-	-	-	-	-	-
Peak Electricity Required by Plant (kW)	2,722	2,722	2,722	2,722	2,722	2,722	2,722	2,722	2,722	2,722	2,722
Average Electricity Required by Plant (kW)	2,177	2,177	2,177	2,177	2,177	2,177	2,177	2,177	2,177	2,177	2,177
Parasitic Electrical Usage (kW)	-	-	-	-	-	-	-	-	-	-	-
Electricity Generated (MW-hrs)	-	-	-	-	-	-	-	-	-	-	-
Electricity Purchased (MW-hrs)	19,073	19,073	19,073	19,073	19,073	19,073	19,073	19,073	19,073	19,073	19,073
Required plant heat - (million Btus)	24,878	24,878	24,878	24,878	24,878	24,878	24,878	24,878	24,878	24,878	24,878
Excess boiler heat req'd (million Btus)	24,878	24,878	24,878	24,878	24,878	24,878	24,878	24,878	24,878	24,878	24,878
Daily peak heat demand, million Btu/hr	3.97	3.97	3.97	3.97	3.97	3.97	3.97	3.97	3.97	3.97	3.97
Cogen heating capacity, million Btu/hr	-	-	-	-	-	-	-	-	-	-	-
Excess (Required boiler make up) peak day, million Btu/hr	(3.97)	(3.97)	(3.97)	(3.97)	(3.97)	(3.97)	(3.97)	(3.97)	(3.97)	(3.97)	(3.97)
Costs/(Revenues) for project											
Natural gas costs	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Base Cost for electricity	$ 3,650,335	$ 2,207,912	$ 2,318,307	$ 2,434,222	$ 2,555,934	$ 2,683,730	$ 2,817,917	$ 2,958,813	$ 3,106,753	$ 3,262,091	$ 3,425,195
Cost Savings from generated electricity	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Revenue for Green Power Credit	$ (15,673)	$ (12,461)	$ (13,084)	$ (13,738)	$ (14,425)	$ (15,146)	$ (15,903)	$ (16,698)	$ (17,533)	$ (18,410)	$ (19,330)
Revenue for FOG tipping fee	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
O&M costs for fuel treatment facilities	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
O&M costs for engine generator facilities	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Annual Costs	$ 3,629,734	$ 2,195,451	$ 2,305,224	$ 2,420,485	$ 2,541,509	$ 2,668,584	$ 2,802,014	$ 2,942,114	$ 3,089,220	$ 3,243,681	$ 3,405,865
Present Worth of Annual Costs	$ 1,991,339	$ 1,991,339	$ 1,991,339	$ 1,991,339	$ 1,991,339	$ 1,991,339	$ 1,991,339	$ 1,991,339	$ 1,991,339	$ 1,991,339	$ 1,991,339
TOTAL PRESENT WORTH	$39,826,775										
Annualized Total Project Capital Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Annualized Total Project Benefit	$ 20,601	$ 12,461	$ 13,084	$ 13,738	$ 14,425	$ 15,146	$ 15,903	$ 16,698	$ 17,533	$ 18,410	$ 19,330
COST FOR ELECTRICITY											
Power Generation Cost, $/kWh	$0.000	$0.000	$0.000	$0.000	$0.000	$0.000	$0.000	$0.000	$0.000	$0.000	$0.000
Power Purchase Cost, $/kWh	$0.191	$0.116	$0.122	$0.128	$0.134	$0.141	$0.148	$0.155	$0.163	$0.171	$0.180
TOTAL COST OF OPTION	**$ 39,826,775**										

Oxnard Cogeneration Study
Alternative 0
No Cogeneration - Base Case Operation

		Life Cycle Present Worth of Annual Costs									
Year	**Average**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**
Operation Data											
Average Digester Gas Available (million Btus)	72,563	72,563	72,563	72,563	72,563	72,563	72,563	72,563	72,563	72,563	72,563
Boiler Fuel Consumed (million Btus)	31,098	31,098	31,098	31,098	31,098	31,098	31,098	31,098	31,098	31,098	31,098
New Cogen Fuel Consumed (million Btus)	-	-	-	-	-	-	-	-	-	-	-
Total Fuel Consumed (million Btus)	31,098	31,098	31,098	31,098	31,098	31,098	31,098	31,098	31,098	31,098	31,098
Natural Gas Consumed (million Btus)	-	-	-	-	-	-	-	-	-	-	-
Digester Gas Consumed (million Btus)	31,098	31,098	31,098	31,098	31,098	31,098	31,098	31,098	31,098	31,098	31,098
Flared Digester Gas (million Btus)	41,465	41,465	41,465	41,465	41,465	41,465	41,465	41,465	41,465	41,465	41,465
Cogen Heat Generated (million Btus)	-	-	-	-	-	-	-	-	-	-	-
Peak Electricity Required by Plant (kW)	2,722	2,722	2,722	2,722	2,722	2,722	2,722	2,722	2,722	2,722	2,722
Average Electricity Required by Plant (kW)	2,177	2,177	2,177	2,177	2,177	2,177	2,177	2,177	2,177	2,177	2,177
Parasitic Electrical Usage (kW)	-	-	-	-	-	-	-	-	-	-	-
Electricity Generated (MW-hrs)	-	-	-	-	-	-	-	-	-	-	-
Electricity Purchased (MW-hrs)	19,073	19,073	19,073	19,073	19,073	19,073	19,073	19,073	19,073	19,073	19,073
Required plant heat - (million Btus)	24,878	24,878	24,878	24,878	24,878	24,878	24,878	24,878	24,878	24,878	24,878
Excess boiler heat req'd (million Btus)	24,878	24,878	24,878	24,878	24,878	24,878	24,878	24,878	24,878	24,878	24,878
Daily peak heat demand, million Btu/hr	3.97	3.97	3.97	3.97	3.97	3.97	3.97	3.97	3.97	3.97	3.97
Cogen heating capacity, million Btu/hr	-	-	-	-	-	-	-	-	-	-	-
Excess (Required boiler make up) peak day, million Btu/hr	(3.97)	(3.97)	(3.97)	(3.97)	(3.97)	(3.97)	(3.97)	(3.97)	(3.97)	(3.97)	(3.97)
Costs/(Revenues) for project											
Natural gas costs	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Base Cost for electricity	$ 3,650,335	$ 3,596,455	$ 3,776,278	$ 3,965,092	$ 4,163,346	$ 4,371,514	$ 4,590,090	$ 4,819,594	$ 5,060,574	$ 5,313,602	$ 5,579,282
Cost Savings from generated electricity	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Revenue for Green Power Credit	$ (15,673)	$ (20,297)	$ (21,312)	$ (22,377)	$ (23,496)	$ (24,671)	$ (25,905)	$ (27,200)	$ (28,560)	$ (29,988)	$ (31,487)
Revenue for FOG tipping fee	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
O&M costs for fuel treatment facilities	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
O&M costs for engine generator facilities	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Annual Costs	$ 3,629,734	$ 3,576,158	$ 3,754,966	$ 3,942,715	$ 4,139,850	$ 4,346,843	$ 4,564,185	$ 4,792,394	$ 5,032,014	$ 5,283,615	$ 5,547,795
Present Worth of Annual Costs	$ 1,991,339	$ 1,991,339	$ 1,991,339	$ 1,991,339	$ 1,991,339	$ 1,991,339	$ 1,991,339	$ 1,991,339	$ 1,991,339	$ 1,991,339	$ 1,991,339
TOTAL PRESENT WORTH	$39,826,775										
Annualized Total Project Capital Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Annualized Total Project Benefit	$ 20,601	$ 20,297	$ 21,312	$ 22,377	$ 23,496	$ 24,671	$ 25,905	$ 27,200	$ 28,560	$ 29,988	$ 31,487
COST FOR ELECTRICITY											
Power Generation Cost, $/kWh	$0.000	$0.000	$0.000	$0.000	$0.000	$0.000	$0.000	$0.000	$0.000	$0.000	$0.000
Power Purchase Cost, $/kWh	$0.191	$0.189	$0.198	$0.208	$0.218	$0.229	$0.241	$0.253	$0.265	$0.279	$0.293
TOTAL COST OF OPTION	**$ 39,826,775**										

Oxnard Cogeneration Study
Alternative 0
No Cogeneration - Base Case Operation

Year		**Average**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
			Life Cycle Present Worth of Annual Costs									
Existing Units	0 kW per unit											
Number of Units			0	0	0	0	0	0	0	0	0	0
Number of Units Operating			0	0	0	0	0	0	0	0	0	0
Fuel rate, Btu/kW-hr			13,758	13,758	13,758	13,758	13,758	13,758	13,758	13,758	13,758	13,758
Cogeneration heat recovery/fuel input			40%	40%	40%	40%	40%	40%	40%	40%	40%	40%
Power output, kW			-	-	-	-	-	-	-	-	-	-
Operating hours per year			7,744	7,744	7,744	7,744	7,744	7,744	7,744	7,744	7,744	7,744
Project cost estimate		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Plant CO_2e Emissions												
Plant Electricity Usage, metric-ton/yr		6,291	6,291	6,291	6,291	6,291	6,291	6,291	6,291	6,291	6,291	6,291
Plant Natural Gas Usage, metric-ton/yr		-	-	-	-	-	-	-	-	-	-	-
Plant Digester Gas Usage for Boiler, metric-ton/yr												
CO_2 Emissions (Biogenic)		1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650
CH_4 and N_2O Emissions		9	9	9	9	9	9	9	9	9	9	9
Plant Digester Gas Usage for Cogeneration, metric-ton/yr												
CO_2 Emissions (Biogenic)		-	-	-	-	-	-	-	-	-	-	-
CH_4 and N_2O Emissions		-	-	-	-	-	-	-	-	-	-	-
Plant Digester Gas Flare, metric-ton/yr												
CO_2 Emissions (Biogenic)		2,159	2,159	2,159	2,159	2,159	2,159	2,159	2,159	2,159	2,159	2,159
CH_4 and N_2O Emissions		2	2	2	2	2	2	2	2	2	2	2
ssions (Electricity + Stationary Combustion), metric-ton/yr:		10,111	10,111	10,111	10,111	10,111	10,111	10,111	10,111	10,111	10,111	10,111
shold Check - Stationary Combustion ONLY), metric-ton/yr:		3,820	3,820	3,820	3,820	3,820	3,820	3,820	3,820	3,820	3,820	3,820
Plant Emissions of NOx and CO												
Cogen lb/MWh												
NOx 2.10 (NOx at 0.65 g/bhp-hr)		-	-	-	-	-	-	-	-	-	-	-
CO 8.10 (CO at 2.5 g/bhp-hr)		-	-	-	-	-	-	-	-	-	-	-
Boiler lb/Mbtu												
NOx 0.035 (boiler 30 ppmv, 3% O2)		1,088	1,088	1,088	1,088	1,088	1,088	1,088	1,088	1,088	1,088	1,088
CO 0.110 (boiler at 150 ppmv, 3% O2)		3,421	3,421	3,421	3,421	3,421	3,421	3,421	3,421	3,421	3,421	3,421
Flare lb/Mbtu (Estimate for enclosed flare)												
NOx 0.06		2,488	2,488	2,488	2,488	2,488	2,488	2,488	2,488	2,488	2,488	2,488
CO 0.2		8,293	8,293	8,293	8,293	8,293	8,293	8,293	8,293	8,293	8,293	8,293
Total, lb/yr												
NOx		3,576	3,576	3,576	3,576	3,576	3,576	3,576	3,576	3,576	3,576	3,576
CO		11,714	11,714	11,714	11,714	11,714	11,714	11,714	11,714	11,714	11,714	11,714

Oxnard Cogeneration Study
Alternative 0
No Cogeneration - Base Case Operation

		Life Cycle Present Worth of Annual Costs									
Year	**Average**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**
Existing Units 0 kW per unit											
Number of Units		0	0	0	0	0	0	0	0	0	0
Number of Units Operating		0	0	0	0	0	0	0	0	0	0
Fuel rate, Btu/kW-hr		13,758	13,758	13,758	13,758	13,758	13,758	13,758	13,758	13,758	13,758
Cogeneration heat recovery/fuel input		40%	40%	40%	40%	40%	40%	40%	40%	40%	40%
Power output, kW		-	-	-	-	-	-	-	-	-	-
Operating hours per year		7,744	7,744	7,744	7,744	7,744	7,744	7,744	7,744	7,744	7,744
Project cost estimate	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Plant CO_2e Emissions											
Plant Electricity Usage, metric-ton/yr	6,291	6,291	6,291	6,291	6,291	6,291	6,291	6,291	6,291	6,291	6,291
Plant Natural Gas Usage, metric-ton/yr	-	-	-	-	-	-	-	-	-	-	-
Plant Digester Gas Usage for Boiler, metric-ton/yr											
CO_2 Emissions (Biogenic)	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650
CH_4 and N_2O Emissions	9	9	9	9	9	9	9	9	9	9	9
Plant Digester Gas Usage for Cogeneration, metric-ton/yr											
CO_2 Emissions (Biogenic)	-	-	-	-	-	-	-	-	-	-	-
CH_4 and N_2O Emissions	-	-	-	-	-	-	-	-	-	-	-
Plant Digester Gas Flare, metric-ton/yr											
CO_2 Emissions (Biogenic)	2,159	2,159	2,159	2,159	2,159	2,159	2,159	2,159	2,159	2,159	2,159
CH_4 and N_2O Emissions	2	2	2	2	2	2	2	2	2	2	2
ssions (Electricity + Stationary Combustion), metric-ton/yr:	10,111	10,111	10,111	10,111	10,111	10,111	10,111	10,111	10,111	10,111	10,111
shold Check - Stationary Combustion ONLY), metric-ton/yr:	3,820	3,820	3,820	3,820	3,820	3,820	3,820	3,820	3,820	3,820	3,820
Plant Emissions of NOx and CO											
Cogen lb/MWh											
NOx 2.10 (NOx at 0.65 g/bhp-hr)	-	-	-	-	-	-	-	-	-	-	-
CO 8.10 (CO at 2.5 g/bhp-hr)	-	-	-	-	-	-	-	-	-	-	-
Boiler lb/Mbtu											
NOx 0.035 (boiler 30 ppmv, 3% O2)	1,088	1,088	1,088	1,088	1,088	1,088	1,088	1,088	1,088	1,088	1,088
CO 0.110 (boiler at 150 ppmv, 3% O2)	3,421	3,421	3,421	3,421	3,421	3,421	3,421	3,421	3,421	3,421	3,421
Flare lb/Mbtu (Estimate for enclosed flare)											
NOx 0.06	2,488	2,488	2,488	2,488	2,488	2,488	2,488	2,488	2,488	2,488	2,488
CO 0.2	8,293	8,293	8,293	8,293	8,293	8,293	8,293	8,293	8,293	8,293	8,293
Total, lb/yr											
NOx	3,576	3,576	3,576	3,576	3,576	3,576	3,576	3,576	3,576	3,576	3,576
CO	11,714	11,714	11,714	11,714	11,714	11,714	11,714	11,714	11,714	11,714	11,714

Oxnard Cogeneration Study
Alternative 1
Two 852 kW Engine Generator Cogeneration System w/ FOG

Life Cycle Present Worth of Annual Costs

Year	Average	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Operation Data											
Average Digester Gas Available (million Btus)	108,913	108,913	108,913	108,913	108,913	108,913	108,913	108,913	108,913	108,913	108,913
Boiler Fuel Consumed (million Btus)	-	-	-	-	-	-	-	-	-	-	-
New Cogen Fuel Consumed (million Btus)	112,162	112,162	112,162	112,162	112,162	112,162	112,162	112,162	112,162	112,162	112,162
Total Fuel Consumed (million Btus)	112,162	112,162	112,162	112,162	112,162	112,162	112,162	112,162	112,162	112,162	112,162
Natural Gas Consumed (million Btus)	3,249	3,249	3,249	3,249	3,249	3,249	3,249	3,249	3,249	3,249	3,249
Digester Gas Consumed (million Btus)	108,913	108,913	108,913	108,913	108,913	108,913	108,913	108,913	108,913	108,913	108,913
Flared Digester Gas (million Btus)	-	-	-	-	-	-	-	-	-	-	-
Cogen Heat Generated (million Btus)	47,108	47,108	47,108	47,108	47,108	47,108	47,108	47,108	47,108	47,108	47,108
Peak Electricity Required by Plant (kW)	2,722	2,722	2,722	2,722	2,722	2,722	2,722	2,722	2,722	2,722	2,722
Average Electricity Required by Plant (kW)	2,177	2,177	2,177	2,177	2,177	2,177	2,177	2,177	2,177	2,177	2,177
Parasitic Electrical Usage (kW)	170	170	170	170	170	170	170	170	170	170	170
Electricity Generated (MW-hrs)	11,876	11,876	11,876	11,876	11,876	11,876	11,876	11,876	11,876	11,876	11,876
Electricity Purchased (MW-hrs)	7,197	7,197	7,197	7,197	7,197	7,197	7,197	7,197	7,197	7,197	7,197
Required plant heat - (million Btus)	24,878	24,878	24,878	24,878	24,878	24,878	24,878	24,878	24,878	24,878	24,878
Excess boiler heat req'd (million Btus)	-	-	-	-	-	-	-	-	-	-	-
Daily peak heat demand, million Btu/hr	3.97	3.97	3.97	3.97	3.97	3.97	3.97	3.97	3.97	3.97	3.97
Cogen heating capacity, million Btu/hr	5.38	5.38	5.38	5.38	5.38	5.38	5.38	5.38	5.38	5.38	5.38
Excess (Required boiler make up) peak day, million Btu/hr	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41
Costs/(Revenues) for project											
Natural gas costs	$ 42,792	$ 28,741	$ 29,890	$ 31,086	$ 32,329	$ 33,623	$ 34,967	$ 36,366	$ 37,821	$ 39,334	$ 40,907
Base Cost for electricity	$ 3,650,335	$ 2,207,912	$ 2,318,307	$ 2,434,222	$ 2,555,934	$ 2,683,730	$ 2,817,917	$ 2,958,813	$ 3,106,753	$ 3,262,091	$ 3,425,195
Cost Savings from generated electricity	$ (2,809,777)	$ (1,699,499)	$ (1,784,474)	$ (1,873,697)	$ (1,967,382)	$ (2,065,751)	$ (2,169,039)	$ (2,277,491)	$ (2,391,365)	$ (2,510,933)	$ (2,636,480)
Revenue for Green Power Credit	$ (88,842)	$ (70,633)	$ (74,165)	$ (77,873)	$ (81,767)	$ (85,855)	$ (90,148)	$ (94,655)	$ (99,388)	$ (104,357)	$ (109,575)
Revenue for FOG tipping fee	$ (607,380)	$ (482,895)	$ (507,040)	$ (532,392)	$ (559,011)	$ (586,962)	$ (616,310)	$ (647,125)	$ (679,482)	$ (713,456)	$ (749,129)
O&M costs for fuel treatment facilities	$ 139,714	$ 103,991	$ 107,111	$ 110,324	$ 113,634	$ 117,043	$ 120,554	$ 124,171	$ 127,896	$ 131,733	$ 135,685
O&M costs for engine generator facilities	$ 282,121	$ 209,987	$ 216,286	$ 222,775	$ 229,458	$ 236,342	$ 243,432	$ 250,735	$ 258,257	$ 266,005	$ 273,985
Total Annual Costs	$ 390,038	$ 297,603	$ 305,916	$ 314,445	$ 323,195	$ 332,169	$ 341,374	$ 350,813	$ 360,492	$ 370,415	$ 380,588
Present Worth of Annual Costs	$ 221,613	$ 269,935	$ 264,262	$ 258,695	$ 253,232	$ 247,870	$ 242,608	$ 237,444	$ 232,376	$ 227,403	$ 222,522
TOTAL PRESENT WORTH	$4,432,266										
Annualized Total Project Capital Cost	$ 900,218	$ 900,218	$ 900,218	$ 900,218	$ 900,218	$ 900,218	$ 900,218	$ 900,218	$ 900,218	$ 900,218	$ 900,218
Annualized Total Project Benefit	$ 2,360,079	$ 1,010,091	$ 1,112,173	$ 1,219,559	$ 1,332,521	$ 1,451,343	$ 1,576,325	$ 1,707,782	$ 1,846,043	$ 1,991,458	$ 2,144,390
COST FOR ELECTRICITY											
Power Generation Cost, $/kWh	$0.105	$0.099	$0.099	$0.100	$0.101	$0.101	$0.102	$0.102	$0.103	$0.104	$0.105
Power Purchase Cost, $/kWh	$0.191	$0.116	$0.122	$0.128	$0.134	$0.141	$0.148	$0.155	$0.163	$0.171	$0.180
TOTAL COST OF OPTION	**$ 15,311,686**										

Oxnard Cogeneration Study
Alternative 1
Two 852 kW Engine Generator Cogeneration System w/ FOG

Life Cycle Present Worth of Annual Costs

Year	Average	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Operation Data											
Average Digester Gas Available (million Btus)	108,913	108,913	108,913	108,913	108,913	108,913	108,913	108,913	108,913	108,913	108,913
Boiler Fuel Consumed (million Btus)	-	-	-	-	-	-	-	-	-	-	-
New Cogen Fuel Consumed (million Btus)	112,162	112,162	112,162	112,162	112,162	112,162	112,162	112,162	112,162	112,162	112,162
Total Fuel Consumed (million Btus)	112,162	112,162	112,162	112,162	112,162	112,162	112,162	112,162	112,162	112,162	112,162
Natural Gas Consumed (million Btus)	3,249	3,249	3,249	3,249	3,249	3,249	3,249	3,249	3,249	3,249	3,249
Digester Gas Consumed (million Btus)	108,913	108,913	108,913	108,913	108,913	108,913	108,913	108,913	108,913	108,913	108,913
Flared Digester Gas (million Btus)	-	-	-	-	-	-	-	-	-	-	-
Cogen Heat Generated (million Btus)	47,108	47,108	47,108	47,108	47,108	47,108	47,108	47,108	47,108	47,108	47,108
Peak Electricity Required by Plant (kW)	2,722	2,722	2,722	2,722	2,722	2,722	2,722	2,722	2,722	2,722	2,722
Average Electricity Required by Plant (kW)	2,177	2,177	2,177	2,177	2,177	2,177	2,177	2,177	2,177	2,177	2,177
Parasitic Electrical Usage (kW)	170	170	170	170	170	170	170	170	170	170	170
Electricity Generated (MW-hrs)	11,876	11,876	11,876	11,876	11,876	11,876	11,876	11,876	11,876	11,876	11,876
Electricity Purchased (MW-hrs)	7,197	7,197	7,197	7,197	7,197	7,197	7,197	7,197	7,197	7,197	7,197
Required plant heat - (million Btus)	24,878	24,878	24,878	24,878	24,878	24,878	24,878	24,878	24,878	24,878	24,878
Excess boiler heat req'd (million Btus)	-	-	-	-	-	-	-	-	-	-	-
Daily peak heat demand, million Btu/hr	3.97	3.97	3.97	3.97	3.97	3.97	3.97	3.97	3.97	3.97	3.97
Cogen heating capacity, million Btu/hr	5.38	5.38	5.38	5.38	5.38	5.38	5.38	5.38	5.38	5.38	5.38
Excess (Required boiler make up) peak day, million Btu/hr	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41
Costs/(Revenues) for project											
Natural gas costs	$ 42,792	$ 42,543	$ 44,245	$ 46,015	$ 47,855	$ 49,770	$ 51,760	$ 53,831	$ 55,984	$ 58,223	$ 60,552
Base Cost for electricity	$ 3,650,335	$ 3,596,455	$ 3,776,278	$ 3,965,092	$ 4,163,346	$ 4,371,514	$ 4,590,090	$ 4,819,594	$ 5,060,574	$ 5,313,602	$ 5,579,282
Cost Savings from generated electricity	$ (2,809,777)	$ (2,768,304)	$ (2,906,719)	$ (3,052,055)	$ (3,204,658)	$ (3,364,891)	$ (3,533,136)	$ (3,709,792)	$ (3,895,282)	$ (4,090,046)	$ (4,294,548)
Revenue for Green Power Credit	$ (88,842)	$ (115,054)	$ (120,807)	$ (126,847)	$ (133,189)	$ (139,849)	$ (146,841)	$ (154,183)	$ (161,893)	$ (169,987)	$ (178,487)
Revenue for FOG tipping fee	$ (607,380)	$ (786,585)	$ (825,914)	$ (867,210)	$ (910,571)	$ (956,099)	$ (1,003,904)	$ (1,054,099)	$ (1,106,804)	$ (1,162,144)	$ (1,220,252)
O&M costs for fuel treatment facilities	$ 139,714	$ 139,755	$ 143,948	$ 148,267	$ 152,715	$ 157,296	$ 162,015	$ 166,875	$ 171,882	$ 177,038	$ 182,349
O&M costs for engine generator facilities	$ 282,121	$ 282,204	$ 290,671	$ 299,391	$ 308,372	$ 317,624	$ 327,152	$ 336,967	$ 347,076	$ 357,488	$ 368,213
Total Annual Costs	$ 390,038	$ 391,015	$ 401,701	$ 412,651	$ 423,871	$ 435,364	$ 447,136	$ 459,192	$ 471,536	$ 484,174	$ 497,110
Present Worth of Annual Costs	$ 221,613	$ 217,732	$ 213,031	$ 208,417	$ 203,889	$ 199,445	$ 195,084	$ 190,804	$ 186,603	$ 182,480	$ 178,434
TOTAL PRESENT WORTH	$4,432,266										
Annualized Total Project Capital Cost	$ 900,218	$ 900,218	$ 900,218	$ 900,218	$ 900,218	$ 900,218	$ 900,218	$ 900,218	$ 900,218	$ 900,218	$ 900,218
Annualized Total Project Benefit	$ 2,360,079	$ 2,305,222	$ 2,474,359	$ 2,652,223	$ 2,839,258	$ 3,035,932	$ 3,242,736	$ 3,460,184	$ 3,688,820	$ 3,929,210	$ 4,181,955
COST FOR ELECTRICITY											
Power Generation Cost, $/kWh	$0.105	$0.105	$0.106	$0.107	$0.107	$0.108	$0.109	$0.110	$0.111	$0.111	$0.112
Power Purchase Cost, $/kWh	$0.191	$0.189	$0.198	$0.208	$0.218	$0.229	$0.241	$0.253	$0.265	$0.279	$0.293
TOTAL COST OF OPTION	**$ 15,311,686**										

Operation Data											
Average Digester Gas Available (million Btus)	108,913	108,913	108,913	108,913	108,913	108,913	108,913	108,913	108,913	108,913	108,913
Boiler Fuel Consumed (million Btus)	-	-	-	-	-	-	-	-	-	-	-
New Cogen Fuel Consumed (million Btus)	112,162	112,162	112,162	112,162	112,162	112,162	112,162	112,162	112,162	112,162	112,162
Total Fuel Consumed (million Btus)	112,162	112,162	112,162	112,162	112,162	112,162	112,162	112,162	112,162	112,162	112,162
Natural Gas Consumed (million Btus)	3,249	3,249	3,249	3,249	3,249	3,249	3,249	3,249	3,249	3,249	3,249
Existing Units 852 kW per unit											
Number of Units		2	2	2	2	2	2	2	2	2	2
Number of Units Operating		2	2	2	2	2	2	2	2	2	2
Fuel rate, Btu/kW-hr		8,500	8,500	8,500	8,500	8,500	8,500	8,500	8,500	8,500	8,500
Cogeneration heat recovery/fuel input		42%	42%	42%	42%	42%	42%	42%	42%	42%	42%
Power output, kW		1,704	1,704	1,704	1,704	1,704	1,704	1,704	1,704	1,704	1,704
Operating hours per year		7,744	7,744	7,744	7,744	7,744	7,744	7,744	7,744	7,744	7,744
Project cost estimate	$13,313,020	$13,313,020	$0	$0	$0	$0	$0	$0	$0	$0	$0
Grant, 2009 dollars		($2,433,600)									
Net Project Costs, 2009 dollars	$10,879,420										
Plant CO_2e Emissions											
Plant Electricity Usage, metric-ton/yr	2,374	2,374	2,374	2,374	2,374	2,374	2,374	2,374	2,374	2,374	2,374
Plant Natural Gas Usage, metric-ton/yr	212	212	212	212	212	212	212	212	212	212	212
Plant Digester Gas Usage for Boiler, metric-ton/yr											
CO_2 Emissions (Biogenic)	-	-	-	-	-	-	-	-	-	-	-
CH_4 and N_2O Emissions	-	-	-	-	-	-	-	-	-	-	-
Plant Digester Gas Usage for Cogeneration, metric-ton/yr											
CO_2 Emissions (Biogenic)	5,671	5,671	5,671	5,671	5,671	5,671	5,671	5,671	5,671	5,671	5,671
CH_4 and N_2O Emissions	5	5	5	5	5	5	5	5	5	5	5
Plant Digester Gas Flare, metric-ton/yr											
CO_2 Emissions (Biogenic)	-	-	-	-	-	-	-	-	-	-	-
CH_4 and N_2O Emissions	-	-	-	-	-	-	-	-	-	-	-
ssions (Electricity + Stationary Combustion), metric-ton/yr:	8,262	8,262	8,262	8,262	8,262	8,262	8,262	8,262	8,262	8,262	8,262
shold Check - Stationary Combustion ONLY), metric-ton/yr:	5,888	5,888	5,888	5,888	5,888	5,888	5,888	5,888	5,888	5,888	5,888
Plant Emissions of NOx and CO											
Cogen lb/MWh											
NOx 2.10 (NOx at 0.65 g/bhp-hr)	27,774	27,774	27,774	27,774	27,774	27,774	27,774	27,774	27,774	27,774	27,774
CO 8.10 (CO at 2.5 g/bhp-hr)	106,821	106,821	106,821	106,821	106,821	106,821	106,821	106,821	106,821	106,821	106,821
Boiler lb/Mbtu											
NOx 0.035 (boiler 30 ppmv, 3% O2)	-	-	-	-	-	-	-	-	-	-	-
CO 0.110 (boiler at 150 ppmv, 3% O2)	-	-	-	-	-	-	-	-	-	-	-
Flare lb/Mbtu (Estimate for enclosed flare)											
NOx 0.06	-	-	-	-	-	-	-	-	-	-	-
CO 0.2	-	-	-	-	-	-	-	-	-	-	-
Total, lb/yr											
NOx	27,774	27,774	27,774	27,774	27,774	27,774	27,774	27,774	27,774	27,774	27,774
CO	106,821	106,821	106,821	106,821	106,821	106,821	106,821	106,821	106,821	106,821	106,821

Operation Data											
Average Digester Gas Available (million Btus)	108,913	108,913	108,913	108,913	108,913	108,913	108,913	108,913	108,913	108,913	108,913
Boiler Fuel Consumed (million Btus)	-	-	-	-	-	-	-	-	-	-	-
New Cogen Fuel Consumed (million Btus)	112,162	112,162	112,162	112,162	112,162	112,162	112,162	112,162	112,162	112,162	112,162
Total Fuel Consumed (million Btus)	112,162	112,162	112,162	112,162	112,162	112,162	112,162	112,162	112,162	112,162	112,162
Natural Gas Consumed (million Btus)	3,249	3,249	3,249	3,249	3,249	3,249	3,249	3,249	3,249	3,249	3,249
Existing Units 852 kW per unit											
Number of Units		2	2	2	2	2	2	2	2	2	2
Number of Units Operating		2	2	2	2	2	2	2	2	2	2
Fuel rate, Btu/kW-hr		8,500	8,500	8,500	8,500	8,500	8,500	8,500	8,500	8,500	8,500
Cogeneration heat recovery/fuel input		42%	42%	42%	42%	42%	42%	42%	42%	42%	42%
Power output, kW		1,704	1,704	1,704	1,704	1,704	1,704	1,704	1,704	1,704	1,704
Operating hours per year		7,744	7,744	7,744	7,744	7,744	7,744	7,744	7,744	7,744	7,744
Project cost estimate	$13,313,020	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Grant, 2009 dollars											
Net Project Costs, 2009 dollars	$10,879,420										
Plant CO_2e Emissions											
Plant Electricity Usage, metric-ton/yr	2,374	2,374	2,374	2,374	2,374	2,374	2,374	2,374	2,374	2,374	2,374
Plant Natural Gas Usage, metric-ton/yr	212	212	212	212	212	212	212	212	212	212	212
Plant Digester Gas Usage for Boiler, metric-ton/yr											
CO_2 Emissions (Biogenic)	-	-	-	-	-	-	-	-	-	-	-
CH_4 and N_2O Emissions	-	-	-	-	-	-	-	-	-	-	-
Plant Digester Gas Usage for Cogeneration, metric-ton/yr											
CO_2 Emissions (Biogenic)	5,671	5,671	5,671	5,671	5,671	5,671	5,671	5,671	5,671	5,671	5,671
CH_4 and N_2O Emissions	5	5	5	5	5	5	5	5	5	5	5
Plant Digester Gas Flare, metric-ton/yr											
CO_2 Emissions (Biogenic)	-	-	-	-	-	-	-	-	-	-	-
CH_4 and N_2O Emissions	-	-	-	-	-	-	-	-	-	-	-
ssions (Electricity + Stationary Combustion), metric-ton/yr:	8,262	8,262	8,262	8,262	8,262	8,262	8,262	8,262	8,262	8,262	8,262
shold Check - Stationary Combustion ONLY), metric-ton/yr:	5,888	5,888	5,888	5,888	5,888	5,888	5,888	5,888	5,888	5,888	5,888
Plant Emissions of NOx and CO											
Cogen lb/MWh											
NOx 2.10 (NOx at 0.65 g/bhp-hr)	27,774	27,774	27,774	27,774	27,774	27,774	27,774	27,774	27,774	27,774	27,774
CO 8.10 (CO at 2.5 g/bhp-hr)	106,821	106,821	106,821	106,821	106,821	106,821	106,821	106,821	106,821	106,821	106,821
Boiler lb/Mbtu											
NOx 0.035 (boiler 30 ppmv, 3% O2)	-	-	-	-	-	-	-	-	-	-	-
CO 0.110 (boiler at 150 ppmv, 3% O2)	-	-	-	-	-	-	-	-	-	-	-
Flare lb/Mbtu (Estimate for enclosed flare)											
NOx 0.06	-	-	-	-	-	-	-	-	-	-	-
CO 0.2	-	-	-	-	-	-	-	-	-	-	-
Total, lb/yr											
NOx	27,774	27,774	27,774	27,774	27,774	27,774	27,774	27,774	27,774	27,774	27,774
CO	106,821	106,821	106,821	106,821	106,821	106,821	106,821	106,821	106,821	106,821	106,821

Oxnard Cogeneration Study
Alternative 2
One 1,137 kW Engine Generator Cogeneration System w/ FOG

Life Cycle Present Worth of Annual Costs

Year	Average	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Operation Data											
Average Digester Gas Available (million Btus)	108,913	108,913	108,913	108,913	108,913	108,913	108,913	108,913	108,913	108,913	108,913
Boiler Fuel Consumed (million Btus)	-	-	-	-	-	-	-	-	-	-	-
New Cogen Fuel Consumed (million Btus)	76,195	76,195	76,195	76,195	76,195	76,195	76,195	76,195	76,195	76,195	76,195
Total Fuel Consumed (million Btus)	76,195	76,195	76,195	76,195	76,195	76,195	76,195	76,195	76,195	76,195	76,195
Natural Gas Consumed (million Btus)	-	-	-	-	-	-	-	-	-	-	-
Digester Gas Consumed (million Btus)	76,195	76,195	76,195	76,195	76,195	76,195	76,195	76,195	76,195	76,195	76,195
Flared Digester Gas (million Btus)	32,718	32,718	32,718	32,718	32,718	32,718	32,718	32,718	32,718	32,718	32,718
Cogen Heat Generated (million Btus)	32,002	32,002	32,002	32,002	32,002	32,002	32,002	32,002	32,002	32,002	32,002
Peak Electricity Required by Plant (kW)	2,722	2,722	2,722	2,722	2,722	2,722	2,722	2,722	2,722	2,722	2,722
Average Electricity Required by Plant (kW)	2,177	2,177	2,177	2,177	2,177	2,177	2,177	2,177	2,177	2,177	2,177
Parasitic Electrical Usage (kW)	114	114	114	114	114	114	114	114	114	114	114
Electricity Generated (MW-hrs)	8,068	8,068	8,068	8,068	8,068	8,068	8,068	8,068	8,068	8,068	8,068
Electricity Purchased (MW-hrs)	11,005	11,005	11,005	11,005	11,005	11,005	11,005	11,005	11,005	11,005	11,005
Required plant heat - (million Btus)	24,878	24,878	24,878	24,878	24,878	24,878	24,878	24,878	24,878	24,878	24,878
Excess boiler heat req'd (million Btus)	-	-	-	-	-	-	-	-	-	-	-
Daily peak heat demand, million Btu/hr	4.61	4.61	4.61	4.61	4.61	4.61	4.61	4.61	4.61	4.61	4.61
Cogen heating capacity, million Btu/hr	3.65	3.65	3.65	3.65	3.65	3.65	3.65	3.65	3.65	3.65	3.65
Excess (Required boiler make up) peak day, million Btu/hr	(0.96)	(0.96)	(0.96)	(0.96)	(0.96)	(0.96)	(0.96)	(0.96)	(0.96)	(0.96)	(0.96)
Costs/(Revenues) for project											
Natural gas costs	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Base Cost for electricity	$ 3,650,335	$ 2,207,912	$ 2,318,307	$ 2,434,222	$ 2,555,934	$ 2,683,730	$ 2,817,917	$ 2,958,813	$ 3,106,753	$ 3,262,091	$ 3,425,195
Cost Savings from generated electricity	$ (1,908,767)	$ (1,154,521)	$ (1,212,247)	$ (1,272,860)	$ (1,336,503)	$ (1,403,328)	$ (1,473,494)	$ (1,547,169)	$ (1,624,527)	$ (1,705,754)	$ (1,791,041)
Revenue for Green Power Credit	$ (62,153)	$ (49,415)	$ (51,885)	$ (54,480)	$ (57,204)	$ (60,064)	$ (63,067)	$ (66,220)	$ (69,531)	$ (73,008)	$ (76,658)
Revenue for FOG tipping fee	$ (607,380)	$ (482,895)	$ (507,040)	$ (532,392)	$ (559,011)	$ (586,962)	$ (616,310)	$ (647,125)	$ (679,482)	$ (713,456)	$ (749,129)
O&M costs for fuel treatment facilities	$ 97,743	$ 72,752	$ 74,934	$ 77,182	$ 79,498	$ 81,883	$ 84,339	$ 86,869	$ 89,475	$ 92,160	$ 94,924
O&M costs for engine generator facilities	$ 191,653	$ 142,650	$ 146,930	$ 151,338	$ 155,878	$ 160,554	$ 165,371	$ 170,332	$ 175,442	$ 180,705	$ 186,126
Total Annual Costs	$ 1,150,898	$ 736,483	$ 768,999	$ 803,011	$ 838,592	$ 875,814	$ 914,756	$ 955,499	$ 998,130	$ 1,042,738	$ 1,089,418
Present Worth of Annual Costs	$ 636,390	$ 668,011	$ 664,290	$ 660,639	$ 657,058	$ 653,546	$ 650,100	$ 646,719	$ 643,404	$ 640,151	$ 636,960
TOTAL PRESENT WORTH	$12,727,802										
Annualized Total Project Capital Cost	$ 750,492	$ 750,492	$ 750,492	$ 750,492	$ 750,492	$ 750,492	$ 750,492	$ 750,492	$ 750,492	$ 750,492	$ 750,492
Annualized Total Project Benefit	$ 1,748,945	$ 720,937	$ 798,817	$ 880,719	$ 966,850	$ 1,057,425	$ 1,152,670	$ 1,252,822	$ 1,358,132	$ 1,468,861	$ 1,585,286
COST FOR ELECTRICITY											
Power Generation Cost, $/kWh	$0.119	$0.114	$0.114	$0.115	$0.115	$0.116	$0.116	$0.117	$0.117	$0.118	$0.118
Power Purchase Cost, $/kWh	$0.191	$0.116	$0.122	$0.128	$0.134	$0.141	$0.148	$0.155	$0.163	$0.171	$0.180
TOTAL COST OF OPTION	**$ 21,797,734**										

Oxnard Cogeneration Study
Alternative 2
One 1,137 kW Engine Generator Cogeneration System w/ FOG

Life Cycle Present Worth of Annual Costs

Year	Average	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Operation Data											
Average Digester Gas Available (million Btus)	108,913	108,913	108,913	108,913	108,913	108,913	108,913	108,913	108,913	108,913	108,913
Boiler Fuel Consumed (million Btus)	-	-	-	-	-	-	-	-	-	-	-
New Cogen Fuel Consumed (million Btus)	76,195	76,195	76,195	76,195	76,195	76,195	76,195	76,195	76,195	76,195	76,195
Total Fuel Consumed (million Btus)	76,195	76,195	76,195	76,195	76,195	76,195	76,195	76,195	76,195	76,195	76,195
Natural Gas Consumed (million Btus)	-	-	-	-	-	-	-	-	-	-	-
Digester Gas Consumed (million Btus)	76,195	76,195	76,195	76,195	76,195	76,195	76,195	76,195	76,195	76,195	76,195
Flared Digester Gas (million Btus)	32,718	32,718	32,718	32,718	32,718	32,718	32,718	32,718	32,718	32,718	32,718
Cogen Heat Generated (million Btus)	32,002	32,002	32,002	32,002	32,002	32,002	32,002	32,002	32,002	32,002	32,002
Peak Electricity Required by Plant (kW)	2,722	2,722	2,722	2,722	2,722	2,722	2,722	2,722	2,722	2,722	2,722
Average Electricity Required by Plant (kW)	2,177	2,177	2,177	2,177	2,177	2,177	2,177	2,177	2,177	2,177	2,177
Parasitic Electrical Usage (kW)	114	114	114	114	114	114	114	114	114	114	114
Electricity Generated (MW-hrs)	8,068	8,068	8,068	8,068	8,068	8,068	8,068	8,068	8,068	8,068	8,068
Electricity Purchased (MW-hrs)	11,005	11,005	11,005	11,005	11,005	11,005	11,005	11,005	11,005	11,005	11,005
Required plant heat - (million Btus)	24,878	24,878	24,878	24,878	24,878	24,878	24,878	24,878	24,878	24,878	24,878
Excess boiler heat req'd (million Btus)	-	-	-	-	-	-	-	-	-	-	-
Daily peak heat demand, million Btu/hr	4.61	4.61	4.61	4.61	4.61	4.61	4.61	4.61	4.61	4.61	4.61
Cogen heating capacity, million Btu/hr	3.65	3.65	3.65	3.65	3.65	3.65	3.65	3.65	3.65	3.65	3.65
Excess (Required boiler make up) peak day, million Btu/hr	(0.96)	(0.96)	(0.96)	(0.96)	(0.96)	(0.96)	(0.96)	(0.96)	(0.96)	(0.96)	(0.96)
Costs/(Revenues) for project											
Natural gas costs	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Base Cost for electricity	$ 3,650,335	$ 3,596,455	$ 3,776,278	$ 3,965,092	$ 4,163,346	$ 4,371,514	$ 4,590,090	$ 4,819,594	$ 5,060,574	$ 5,313,602	$ 5,579,282
Cost Savings from generated electricity	$ (1,908,767)	$ (1,880,593)	$ (1,974,623)	$ (2,073,354)	$ (2,177,022)	$ (2,285,873)	$ (2,400,167)	$ (2,520,175)	$ (2,646,184)	$ (2,778,493)	$ (2,917,418)
Revenue for Green Power Credit	$ (62,153)	$ (80,491)	$ (84,516)	$ (88,742)	$ (93,179)	$ (97,838)	$ (102,729)	$ (107,866)	$ (113,259)	$ (118,922)	$ (124,868)
Revenue for FOG tipping fee	$ (607,380)	$ (786,585)	$ (825,914)	$ (867,210)	$ (910,571)	$ (956,099)	$ (1,003,904)	$ (1,054,099)	$ (1,106,804)	$ (1,162,144)	$ (1,220,252)
O&M costs for fuel treatment facilities	$ 97,743	$ 97,772	$ 100,705	$ 103,726	$ 106,838	$ 110,043	$ 113,345	$ 116,745	$ 120,247	$ 123,855	$ 127,570
O&M costs for engine generator facilities	$ 191,653	$ 191,710	$ 197,461	$ 203,385	$ 209,487	$ 215,771	$ 222,245	$ 228,912	$ 235,779	$ 242,853	$ 250,138
Total Annual Costs	$ 1,150,898	$ 1,138,268	$ 1,189,391	$ 1,242,898	$ 1,298,900	$ 1,357,519	$ 1,418,879	$ 1,483,111	$ 1,550,353	$ 1,620,750	$ 1,694,454
Present Worth of Annual Costs	$ 636,390	$ 633,830	$ 630,760	$ 627,748	$ 624,793	$ 621,895	$ 619,052	$ 616,263	$ 613,527	$ 610,844	$ 608,211
TOTAL PRESENT WORTH	$12,727,802										
Annualized Total Project Capital Cost	$ 750,492	$ 750,492	$ 750,492	$ 750,492	$ 750,492	$ 750,492	$ 750,492	$ 750,492	$ 750,492	$ 750,492	$ 750,492
Annualized Total Project Benefit	$ 1,748,945	$ 1,707,696	$ 1,836,395	$ 1,971,703	$ 2,113,955	$ 2,263,503	$ 2,420,719	$ 2,585,992	$ 2,759,729	$ 2,942,361	$ 3,134,337
COST FOR ELECTRICITY											
Power Generation Cost, $/kWh	$0.119	$0.119	$0.120	$0.120	$0.121	$0.121	$0.122	$0.122	$0.123	$0.124	$0.124
Power Purchase Cost, $/kWh	$0.191	$0.189	$0.198	$0.208	$0.218	$0.229	$0.241	$0.253	$0.265	$0.279	$0.293
TOTAL COST OF OPTION	**$ 21,797,734**										

Oxnard Cogeneration Study
Alternative 2
One 1,137 kW Engine Generator Cogeneration System w/ FOG

			Life Cycle Present Worth of Annual Costs									
Year		**Average**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
GE/Jenbacher	1,137 kW per unit											
Number of Units			1	1	1	1	1	1	1	1	1	1
Number of Units Operating			1	1	1	1	1	1	1	1	1	1
Fuel rate, Btu/kW-hr			8,500	8,500	8,500	8,500	8,500	8,500	8,500	8,500	8,500	8,500
Cogeneration heat recovery/fuel input			42%	42%	42%	42%	42%	42%	42%	42%	42%	42%
Power output, kW			1,137	1,137	1,137	1,137	1,137	1,137	1,137	1,137	1,137	1,137
Operating hours per year			7,884	7,884	7,884	7,884	7,884	7,884	7,884	7,884	7,884	7,884
Project cost estimate		$10,993,232	$10,993,232	$0	$0	$0	$0	$0	$0	$0	$0	$0
SGIP Grant			($1,923,300)									
Net Project Costs		$9,069,932										
Plant CO_2e Emissions												
Plant Electricity Usage, metric-ton/yr		3,630	3,630	3,630	3,630	3,630	3,630	3,630	3,630	3,630	3,630	3,630
Plant Natural Gas Usage, metric-ton/yr		-	-	-	-	-	-	-	-	-	-	-
Plant Digester Gas Usage for Boiler, metric-ton/yr												
CO_2 Emissions (Biogenic)		-	-	-	-	-	-	-	-	-	-	-
CH_4 and N_2O Emissions		-	-	-	-	-	-	-	-	-	-	-
Plant Digester Gas Usage for Cogeneration, metric-ton/yr												
CO_2 Emissions (Biogenic)		3,967	3,967	3,967	3,967	3,967	3,967	3,967	3,967	3,967	3,967	3,967
CH_4 and N_2O Emissions		4	4	4	4	4	4	4	4	4	4	4
Plant Digester Gas Flare, metric-ton/yr												
CO_2 Emissions (Biogenic)		1,704	1,704	1,704	1,704	1,704	1,704	1,704	1,704	1,704	1,704	1,704
CH_4 and N_2O Emissions		2	2	2	2	2	2	2	2	2	2	2
ssions (Electricity + Stationary Combustion), metric-ton/yr:		9,306	9,306	9,306	9,306	9,306	9,306	9,306	9,306	9,306	9,306	9,306
shold Check - Stationary Combustion ONLY), metric-ton/yr:		5,677	5,677	5,677	5,677	5,677	5,677	5,677	5,677	5,677	5,677	5,677
Plant Emissions of NOx and CO												
Cogen	lb/MWh											
NOx	2.10 (NOx at 0.65 g/bhp-hr)	18,867	18,867	18,867	18,867	18,867	18,867	18,867	18,867	18,867	18,867	18,867
CO	8.10 (CO at 2.5 g/bhp-hr)	72,567	72,567	72,567	72,567	72,567	72,567	72,567	72,567	72,567	72,567	72,567
Boiler	lb/Mbtu											
NOx	0.035 (boiler 30 ppmv, 3% O2)	-	-	-	-	-	-	-	-	-	-	-
CO	0.110 (boiler at 150 ppmv, 3% O2)	-	-	-	-	-	-	-	-	-	-	-
Flare	lb/Mbtu (Estimate for enclosed flare)											
NOx	0.06	1,963	1,963	1,963	1,963	1,963	1,963	1,963	1,963	1,963	1,963	1,963
CO	0.2	6,544	6,544	6,544	6,544	6,544	6,544	6,544	6,544	6,544	6,544	6,544
Total, lb/yr												
NOx		20,830	20,830	20,830	20,830	20,830	20,830	20,830	20,830	20,830	20,830	20,830
CO		79,111	79,111	79,111	79,111	79,111	79,111	79,111	79,111	79,111	79,111	79,111

Oxnard Cogeneration Study
Alternative 2
One 1,137 kW Engine Generator Cogeneration System w/ FOG

Life Cycle Present Worth of Annual Costs

Year		**Average**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**
GE/Jenbacher	1,137 kW per unit											
Number of Units			1	1	1	1	1	1	1	1	1	1
Number of Units Operating			1	1	1	1	1	1	1	1	1	1
Fuel rate, Btu/kW-hr			8,500	8,500	8,500	8,500	8,500	8,500	8,500	8,500	8,500	8,500
Cogeneration heat recovery/fuel input			42%	42%	42%	42%	42%	42%	42%	42%	42%	42%
Power output, kW			1,137	1,137	1,137	1,137	1,137	1,137	1,137	1,137	1,137	1,137
Operating hours per year			7,884	7,884	7,884	7,884	7,884	7,884	7,884	7,884	7,884	7,884
Project cost estimate		$10,993,232	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
SGIP Grant												
Net Project Costs		$9,069,932										
Plant CO_2e Emissions												
Plant Electricity Usage, metric-ton/yr		3,630	3,630	3,630	3,630	3,630	3,630	3,630	3,630	3,630	3,630	3,630
Plant Natural Gas Usage, metric-ton/yr		-	-	-	-	-	-	-	-	-	-	-
Plant Digester Gas Usage for Boiler, metric-ton/yr												
CO_2 Emissions (Biogenic)		-	-	-	-	-	-	-	-	-	-	-
CH_4 and N_2O Emissions		-	-	-	-	-	-	-	-	-	-	-
Plant Digester Gas Usage for Cogeneration, metric-ton/yr												
CO_2 Emissions (Biogenic)		3,967	3,967	3,967	3,967	3,967	3,967	3,967	3,967	3,967	3,967	3,967
CH_4 and N_2O Emissions		4	4	4	4	4	4	4	4	4	4	4
Plant Digester Gas Flare, metric-ton/yr												
CO_2 Emissions (Biogenic)		1,704	1,704	1,704	1,704	1,704	1,704	1,704	1,704	1,704	1,704	1,704
CH_4 and N_2O Emissions		2	2	2	2	2	2	2	2	2	2	2
ssions (Electricity + Stationary Combustion), metric-ton/yr:		9,306	9,306	9,306	9,306	9,306	9,306	9,306	9,306	9,306	9,306	9,306
shold Check - Stationary Combustion ONLY), metric-ton/yr:		5,677	5,677	5,677	5,677	5,677	5,677	5,677	5,677	5,677	5,677	5,677
Plant Emissions of NOx and CO												
Cogen	lb/MWh											
NOx	2.10 (NOx at 0.65 g/bhp-hr)	18,867	18,867	18,867	18,867	18,867	18,867	18,867	18,867	18,867	18,867	18,867
CO	8.10 (CO at 2.5 g/bhp-hr)	72,567	72,567	72,567	72,567	72,567	72,567	72,567	72,567	72,567	72,567	72,567
Boiler	lb/Mbtu											
NOx	0.035 (boiler 30 ppmv, 3% O2)	-	-	-	-	-	-	-	-	-	-	-
CO	0.110 (boiler at 150 ppmv, 3% O2)	-	-	-	-	-	-	-	-	-	-	-
Flare	lb/Mbtu (Estimate for enclosed flare)											
NOx	0.06	1,963	1,963	1,963	1,963	1,963	1,963	1,963	1,963	1,963	1,963	1,963
CO	0.2	6,544	6,544	6,544	6,544	6,544	6,544	6,544	6,544	6,544	6,544	6,544
Total, lb/yr												
NOx		20,830	20,830	20,830	20,830	20,830	20,830	20,830	20,830	20,830	20,830	20,830
CO		79,111	79,111	79,111	79,111	79,111	79,111	79,111	79,111	79,111	79,111	79,111

Oxnard Cogeneration Study
Alternative 3
Three 250 kW Microturbine Cogeneration System w/ FOG

Life Cycle Present Worth of Annual Costs

Year	Average	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Operation Data											
Average Digester Gas Available (million Btus)	108,913	108,913	108,913	108,913	108,913	108,913	108,913	108,913	108,913	108,913	108,913
Boiler Fuel Consumed (million Btus)	-	-	-	-	-	-	-	-	-	-	-
New Cogen Fuel Consumed (million Btus)	74,087	74,087	74,087	74,087	74,087	74,087	74,087	74,087	74,087	74,087	74,087
Total Fuel Consumed (million Btus)	74,087	74,087	74,087	74,087	74,087	74,087	74,087	74,087	74,087	74,087	74,087
Natural Gas Consumed (million Btus)	-	-	-	-	-	-	-	-	-	-	-
Digester Gas Consumed (million Btus)	74,087	74,087	74,087	74,087	74,087	74,087	74,087	74,087	74,087	74,087	74,087
Flared Digester Gas (million Btus)	34,826	34,826	34,826	34,826	34,826	34,826	34,826	34,826	34,826	34,826	34,826
Cogen Heat Generated (million Btus)	28,894	28,894	28,894	28,894	28,894	28,894	28,894	28,894	28,894	28,894	28,894
Peak Electricity Required by Plant (kW)	2,722	2,722	2,722	2,722	2,722	2,722	2,722	2,722	2,722	2,722	2,722
Average Electricity Required by Plant (kW)	2,177	2,177	2,177	2,177	2,177	2,177	2,177	2,177	2,177	2,177	2,177
Parasitic Electrical Usage (kW)	56	56	56	56	56	56	56	56	56	56	56
Electricity Generated (MW-hrs)	5,773	5,773	5,773	5,773	5,773	5,773	5,773	5,773	5,773	5,773	5,773
Electricity Purchased (MW-hrs)	13,299	13,299	13,299	13,299	13,299	13,299	13,299	13,299	13,299	13,299	13,299
Required plant heat - (million Btus)	24,878	24,878	24,878	24,878	24,878	24,878	24,878	24,878	24,878	24,878	24,878
Excess boiler heat req'd (million Btus)	-	-	-	-	-	-	-	-	-	-	-
Daily peak heat demand, million Btu/hr	4.61	4.61	4.61	4.61	4.61	4.61	4.61	4.61	4.61	4.61	4.61
Cogen heating capacity, million Btu/hr	3.30	3.30	3.30	3.30	3.30	3.30	3.30	3.30	3.30	3.30	3.30
Excess (Required boiler make up) peak day, million Btu/hr	(1.31)	(1.31)	(1.31)	(1.31)	(1.31)	(1.31)	(1.31)	(1.31)	(1.31)	(1.31)	(1.31)
Costs/(Revenues) for project											
Natural gas costs	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Base Cost for electricity	$ 3,650,335	$ 2,207,912	$ 2,318,307	$ 2,434,222	$ 2,555,934	$ 2,683,730	$ 2,817,917	$ 2,958,813	$ 3,106,753	$ 3,262,091	$ 3,425,195
Cost Savings from generated electricity	$ (1,365,948)	$ (826,196)	$ (867,506)	$ (910,881)	$ (956,425)	$ (1,004,246)	$ (1,054,459)	$ (1,107,182)	$ (1,162,541)	$ (1,220,668)	$ (1,281,701)
Revenue for Green Power Credit	$ (43,276)	$ (34,406)	$ (36,127)	$ (37,933)	$ (39,830)	$ (41,821)	$ (43,912)	$ (46,108)	$ (48,413)	$ (50,834)	$ (53,375)
Revenue for FOG tipping fee	$ (607,380)	$ (482,895)	$ (507,040)	$ (532,392)	$ (559,011)	$ (586,962)	$ (616,310)	$ (647,125)	$ (679,482)	$ (713,456)	$ (749,129)
O&M costs for fuel treatment facilities	$ 95,039	$ 70,739	$ 72,861	$ 75,047	$ 77,298	$ 79,617	$ 82,005	$ 84,466	$ 87,000	$ 89,610	$ 92,298
O&M costs for microturbine facilities	$ 133,444	$ 99,324	$ 102,304	$ 105,373	$ 108,534	$ 111,790	$ 115,144	$ 118,598	$ 122,156	$ 125,821	$ 129,595
Total Annual Costs	$ 1,657,617	$ 1,034,477	$ 1,082,800	$ 1,133,436	$ 1,186,500	$ 1,242,108	$ 1,300,385	$ 1,361,462	$ 1,425,474	$ 1,492,564	$ 1,562,884
Present Worth of Annual Costs	$ 913,336	$ 938,301	$ 935,363	$ 932,481	$ 929,654	$ 926,880	$ 924,160	$ 921,491	$ 918,873	$ 916,305	$ 913,786
TOTAL PRESENT WORTH	$18,266,714										
Annualized Total Project Capital Cost	$ 892,440	$ 892,440	$ 892,440	$ 892,440	$ 892,440	$ 892,440	$ 892,440	$ 892,440	$ 892,440	$ 892,440	$ 892,440
Annualized Total Project Benefit	$ 1,100,278	$ 280,994	$ 343,067	$ 408,346	$ 476,994	$ 549,182	$ 625,091	$ 704,911	$ 788,840	$ 877,087	$ 969,872
COST FOR ELECTRICITY											
Power Generation Cost, $/kWh	$0.184	$0.178	$0.179	$0.179	$0.180	$0.180	$0.181	$0.182	$0.182	$0.183	$0.184
Power Purchase Cost, $/kWh	$0.191	$0.116	$0.122	$0.128	$0.134	$0.141	$0.148	$0.155	$0.163	$0.171	$0.180
TOTAL COST OF OPTION	**$ 29,052,141**										

Oxnard Cogeneration Study
Alternative 3
Three 250 kW Microturbine Cogeneration System w/ FOG

Life Cycle Present Worth of Annual Costs

Year	**Average**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**
Operation Data											
Average Digester Gas Available (million Btus)	108,913	108,913	108,913	108,913	108,913	108,913	108,913	108,913	108,913	108,913	108,913
Boiler Fuel Consumed (million Btus)	-	-	-	-	-	-	-	-	-	-	-
New Cogen Fuel Consumed (million Btus)	74,087	74,087	74,087	74,087	74,087	74,087	74,087	74,087	74,087	74,087	74,087
Total Fuel Consumed (million Btus)	74,087	74,087	74,087	74,087	74,087	74,087	74,087	74,087	74,087	74,087	74,087
Natural Gas Consumed (million Btus)	-	-	-	-	-	-	-	-	-	-	-
Digester Gas Consumed (million Btus)	74,087	74,087	74,087	74,087	74,087	74,087	74,087	74,087	74,087	74,087	74,087
Flared Digester Gas (million Btus)	34,826	34,826	34,826	34,826	34,826	34,826	34,826	34,826	34,826	34,826	34,826
Cogen Heat Generated (million Btus)	28,894	28,894	28,894	28,894	28,894	28,894	28,894	28,894	28,894	28,894	28,894
Peak Electricity Required by Plant (kW)	2,722	2,722	2,722	2,722	2,722	2,722	2,722	2,722	2,722	2,722	2,722
Average Electricity Required by Plant (kW)	2,177	2,177	2,177	2,177	2,177	2,177	2,177	2,177	2,177	2,177	2,177
Parasitic Electrical Usage (kW)	56	56	56	56	56	56	56	56	56	56	56
Electricity Generated (MW-hrs)	5,773	5,773	5,773	5,773	5,773	5,773	5,773	5,773	5,773	5,773	5,773
Electricity Purchased (MW-hrs)	13,299	13,299	13,299	13,299	13,299	13,299	13,299	13,299	13,299	13,299	13,299
Required plant heat - (million Btus)	24,878	24,878	24,878	24,878	24,878	24,878	24,878	24,878	24,878	24,878	24,878
Excess boiler heat req'd (million Btus)	-	-	-	-	-	-	-	-	-	-	-
Daily peak heat demand, million Btu/hr	4.61	4.61	4.61	4.61	4.61	4.61	4.61	4.61	4.61	4.61	4.61
Cogen heating capacity, million Btu/hr	3.30	3.30	3.30	3.30	3.30	3.30	3.30	3.30	3.30	3.30	3.30
Excess (Required boiler make up) peak day, million Btu/hr	(1.31)	(1.31)	(1.31)	(1.31)	(1.31)	(1.31)	(1.31)	(1.31)	(1.31)	(1.31)	(1.31)
Costs/(Revenues) for project											
Natural gas costs	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Base Cost for electricity	$ 3,650,335	$ 3,596,455	$ 3,776,278	$ 3,965,092	$ 4,163,346	$ 4,371,514	$ 4,590,090	$ 4,819,594	$ 5,060,574	$ 5,313,602	$ 5,579,282
Cost Savings from generated electricity	$ (1,365,948)	$ (1,345,786)	$ (1,413,075)	$ (1,483,729)	$ (1,557,916)	$ (1,635,811)	$ (1,717,602)	$ (1,803,482)	$ (1,893,656)	$ (1,988,339)	$ (2,087,756)
Revenue for Green Power Credit	$ (43,276)	$ (56,044)	$ (58,846)	$ (61,789)	$ (64,878)	$ (68,122)	$ (71,528)	$ (75,105)	$ (78,860)	$ (82,803)	$ (86,943)
Revenue for FOG tipping fee	$ (607,380)	$ (786,585)	$ (825,914)	$ (867,210)	$ (910,571)	$ (956,099)	$ (1,003,904)	$ (1,054,099)	$ (1,106,804)	$ (1,162,144)	$ (1,220,252)
O&M costs for fuel treatment facilities	$ 95,039	$ 95,067	$ 97,919	$ 100,856	$ 103,882	$ 106,999	$ 110,208	$ 113,515	$ 116,920	$ 120,428	$ 124,041
O&M costs for microturbine facilities	$ 133,444	$ 133,483	$ 137,488	$ 141,612	$ 145,861	$ 150,237	$ 154,744	$ 159,386	$ 164,168	$ 169,093	$ 174,165
Total Annual Costs	$ 1,657,617	$ 1,636,590	$ 1,713,848	$ 1,794,833	$ 1,879,725	$ 1,968,716	$ 2,062,008	$ 2,159,809	$ 2,262,341	$ 2,369,837	$ 2,482,538
Present Worth of Annual Costs	$ 913,336	$ 911,315	$ 908,890	$ 906,513	$ 904,180	$ 901,892	$ 899,647	$ 897,445	$ 895,285	$ 893,167	$ 891,088
TOTAL PRESENT WORTH	$18,266,714										
Annualized Total Project Capital Cost	$ 892,440	$ 892,440	$ 892,440	$ 892,440	$ 892,440	$ 892,440	$ 892,440	$ 892,440	$ 892,440	$ 892,440	$ 892,440
Annualized Total Project Benefit	$ 1,100,278	$ 1,067,425	$ 1,169,989	$ 1,277,819	$ 1,391,181	$ 1,510,357	$ 1,635,642	$ 1,767,345	$ 1,905,792	$ 2,051,326	$ 2,204,304
COST FOR ELECTRICITY											
Power Generation Cost, $/kWh	$0.184	$0.184	$0.185	$0.186	$0.187	$0.187	$0.188	$0.189	$0.190	$0.190	$0.191
Power Purchase Cost, $/kWh	$0.191	$0.189	$0.198	$0.208	$0.218	$0.229	$0.241	$0.253	$0.265	$0.279	$0.293
TOTAL COST OF OPTION	**$ 29,052,141**										

Oxnard Cogeneration Study
Alternative 3
Three 250 kW Microturbine Cogeneration System w/ FOG

		Life Cycle Present Worth of Annual Costs									
Year	**Average**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
Ingersoll Rand 250 kW per unit											
Number of Units		3	3	3	3	3	3	3	3	3	3
Number of Units Operating		3	3	3	3	3	3	3	3	3	3
Fuel rate, Btu/kW-hr		11,870	11,870	11,870	11,870	11,870	11,870	11,870	11,870	11,870	11,870
Cogeneration heat recovery/fuel input		39%	39%	39%	39%	39%	39%	39%	39%	39%	39%
Power output, kW		750	750	750	750	750	750	750	750	750	750
Operating hours per year		8,322	8,322	8,322	8,322	8,322	8,322	8,322	8,322	8,322	8,322
Project cost estimate	$12,135,427	$12,135,427	$0	$0	$0	$0	$0	$0	$0	$0	$0
SGIP Grant		($1,350,000)									
Net Project Costs	$10,785,427										
Plant CO_2e Emissions											
Plant Electricity Usage, metric-ton/yr	4,386	4,386	4,386	4,386	4,386	4,386	4,386	4,386	4,386	4,386	4,386
Plant Natural Gas Usage, metric-ton/yr	-	-	-	-	-	-	-	-	-	-	-
Plant Digester Gas Usage for Boiler, metric-ton/yr											
CO_2 Emissions (Biogenic)	-	-	-	-	-	-	-	-	-	-	-
CH_4 and N_2O Emissions	-	-	-	-	-	-	-	-	-	-	-
Plant Digester Gas Usage for Cogeneration, metric-ton/yr											
CO_2 Emissions (Biogenic)	3,858	3,858	3,858	3,858	3,858	3,858	3,858	3,858	3,858	3,858	3,858
CH_4 and N_2O Emissions	4	4	4	4	4	4	4	4	4	4	4
Plant Digester Gas Flare, metric-ton/yr											
CO_2 Emissions (Biogenic)	1,813	1,813	1,813	1,813	1,813	1,813	1,813	1,813	1,813	1,813	1,813
CH_4 and N_2O Emissions	2	2	2	2	2	2	2	2	2	2	2
ssions (Electricity + Stationary Combustion), metric-ton/yr:	10,063	10,063	10,063	10,063	10,063	10,063	10,063	10,063	10,063	10,063	10,063
shold Check - Stationary Combustion ONLY), metric-ton/yr:	5,677	5,677	5,677	5,677	5,677	5,677	5,677	5,677	5,677	5,677	5,677
Plant Emissions of NOx and CO											
Cogen lb/MWh											
NOx 0.56 (per Ingersoll Rand microturbine)	3,495	3,495	3,495	3,495	3,495	3,495	3,495	3,495	3,495	3,495	3,495
CO 0.38 (per Ingersoll Rand microturbine)	2,372	2,372	2,372	2,372	2,372	2,372	2,372	2,372	2,372	2,372	2,372
Boiler lb/Mbtu											
NOx 0.035 (boiler 30 ppmv, 3% O2)	-	-	-	-	-	-	-	-	-	-	-
CO 0.110 (boiler at 150 ppmv, 3% O2)	-	-	-	-	-	-	-	-	-	-	-
Flare lb/Mbtu (Estimate for enclosed flare)											
NOx 0.06	2,090	2,090	2,090	2,090	2,090	2,090	2,090	2,090	2,090	2,090	2,090
CO 0.2	6,965	6,965	6,965	6,965	6,965	6,965	6,965	6,965	6,965	6,965	6,965
Total, lb/yr											
NOx	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585
CO	9,337	9,337	9,337	9,337	9,337	9,337	9,337	9,337	9,337	9,337	9,337

Oxnard Cogeneration Study
Alternative 3
Three 250 kW Microturbine Cogeneration System w/ FOG

Year	**Average**	**Life Cycle Present Worth of Annual Costs** 2025	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**
Ingersoll Rand 250 kW per unit											
Number of Units		3	3	3	3	3	3	3	3	3	3
Number of Units Operating		3	3	3	3	3	3	3	3	3	3
Fuel rate, Btu/kW-hr		11,870	11,870	11,870	11,870	11,870	11,870	11,870	11,870	11,870	11,870
Cogeneration heat recovery/fuel input		39%	39%	39%	39%	39%	39%	39%	39%	39%	39%
Power output, kW		750	750	750	750	750	750	750	750	750	750
Operating hours per year		8,322	8,322	8,322	8,322	8,322	8,322	8,322	8,322	8,322	8,322
Project cost estimate	$12,135,427	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
SGIP Grant											
Net Project Costs	$10,785,427										
Plant CO_2e Emissions											
Plant Electricity Usage, metric-ton/yr	4,386	4,386	4,386	4,386	4,386	4,386	4,386	4,386	4,386	4,386	4,386
Plant Natural Gas Usage, metric-ton/yr	-	-	-	-	-	-	-	-	-	-	-
Plant Digester Gas Usage for Boiler, metric-ton/yr											
CO_2 Emissions (Biogenic)	-	-	-	-	-	-	-	-	-	-	-
CH_4 and N_2O Emissions	-	-	-	-	-	-	-	-	-	-	-
Plant Digester Gas Usage for Cogeneration, metric-ton/yr											
CO_2 Emissions (Biogenic)	3,858	3,858	3,858	3,858	3,858	3,858	3,858	3,858	3,858	3,858	3,858
CH_4 and N_2O Emissions	4	4	4	4	4	4	4	4	4	4	4
Plant Digester Gas Flare, metric-ton/yr											
CO_2 Emissions (Biogenic)	1,813	1,813	1,813	1,813	1,813	1,813	1,813	1,813	1,813	1,813	1,813
CH_4 and N_2O Emissions	2	2	2	2	2	2	2	2	2	2	2
ssions (Electricity + Stationary Combustion), metric-ton/yr:	10,063	10,063	10,063	10,063	10,063	10,063	10,063	10,063	10,063	10,063	10,063
shold Check - Stationary Combustion ONLY), metric-ton/yr:	5,677	5,677	5,677	5,677	5,677	5,677	5,677	5,677	5,677	5,677	5,677
Plant Emissions of NOx and CO											
Cogen lb/MWh											
NOx 0.56 (per Ingersoll Rand microturbine)	3,495	3,495	3,495	3,495	3,495	3,495	3,495	3,495	3,495	3,495	3,495
CO 0.38 (per Ingersoll Rand microturbine)	2,372	2,372	2,372	2,372	2,372	2,372	2,372	2,372	2,372	2,372	2,372
Boiler lb/Mbtu											
NOx 0.035 (boiler 30 ppmv, 3% O2)	-	-	-	-	-	-	-	-	-	-	-
CO 0.110 (boiler at 150 ppmv, 3% O2)	-	-	-	-	-	-	-	-	-	-	-
Flare lb/Mbtu (Estimate for enclosed flare)											
NOx 0.06	2,090	2,090	2,090	2,090	2,090	2,090	2,090	2,090	2,090	2,090	2,090
CO 0.2	6,965	6,965	6,965	6,965	6,965	6,965	6,965	6,965	6,965	6,965	6,965
Total, lb/yr											
NOx	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585
CO	9,337	9,337	9,337	9,337	9,337	9,337	9,337	9,337	9,337	9,337	9,337

Oxnard Cogeneration Study
Alternative 4
One 1,400 kW Fuel Cell Cogeneration System w/ FOG

Life Cycle Present Worth of Annual Costs

Year	**Average**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
Operation Data											
Average Digester Gas Available (million Btus)	108,913	108,913	108,913	108,913	108,913	108,913	108,913	108,913	108,913	108,913	108,913
Boiler Fuel Consumed (million Btus)	5,763	6,798	6,302	5,785	5,247	4,685	6,798	6,302	5,785	5,247	4,685
New Cogen Fuel Consumed (million Btus)	88,365	88,365	88,365	88,365	88,365	88,365	88,365	88,365	88,365	88,365	88,365
Total Fuel Consumed (million Btus)	94,128	95,163	94,667	94,150	93,611	93,049	95,163	94,667	94,150	93,611	93,049
Natural Gas Consumed (million Btus)	-	-	-	-	-	-	-	-	-	-	-
Digester Gas Consumed (million Btus)	94,128	95,163	94,667	94,150	93,611	93,049	95,163	94,667	94,150	93,611	93,049
Flared Digester Gas (million Btus)	14,785	13,750	14,246	14,763	15,301	15,863	13,750	14,246	14,763	15,301	15,863
Cogen Heat Generated (million Btus)	20,268	19,440	19,837	20,250	20,681	21,131	19,440	19,837	20,250	20,681	21,131
Peak Electricity Required by Plant (kW)	2,722	2,722	2,722	2,722	2,722	2,722	2,722	2,722	2,722	2,722	2,722
Average Electricity Required by Plant (kW)	2,177	2,177	2,177	2,177	2,177	2,177	2,177	2,177	2,177	2,177	2,177
Parasitic Electrical Usage (kW)	140	140	140	140	140	140	140	140	140	140	140
Electricity Generated (MW-hrs)	9,787	10,486	10,136	9,787	9,437	9,088	10,486	10,136	9,787	9,437	9,088
Electricity Purchased (MW-hrs)	9,286	8,587	8,937	9,286	9,636	9,985	8,587	8,937	9,286	9,636	9,985
Required plant heat - (million Btus)	24,878	24,878	24,878	24,878	24,878	24,878	24,878	24,878	24,878	24,878	24,878
Excess boiler heat req'd (million Btus)	4,611	5,438	5,041	4,628	4,197	3,748	5,438	5,041	4,628	4,197	3,748
Daily peak heat demand, million Btu/hr	4.61	4.61	4.61	4.61	4.61	4.61	4.61	4.61	4.61	4.61	4.61
Cogen heating capacity, million Btu/hr	2.31	2.22	2.26	2.31	2.36	2.41	2.22	2.26	2.31	2.36	2.41
Excess (Required boiler make up) peak day, million Btu/hr	(2.30)	(2.39)	(2.35)	(2.30)	(2.25)	(2.20)	(2.39)	(2.35)	(2.30)	(2.25)	(2.20)
Costs/(Revenues) for project											
Natural gas costs	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Base Cost for electricity	$ 3,650,335	$ 2,207,912	$ 2,318,307	$ 2,434,222	$ 2,555,934	$ 2,683,730	$ 2,817,917	$ 2,958,813	$ 3,106,753	$ 3,262,091	$ 3,425,195
Cost Savings from generated electricity	$ (2,307,405)	$ (1,500,550)	$ (1,523,059)	$ (1,544,066)	$ (1,563,367)	$ (1,580,738)	$ (1,915,125)	$ (1,943,852)	$ (1,970,663)	$ (1,995,297)	$ (2,017,467)
Revenue for Green Power Credit	$ (80,620)	$ (69,166)	$ (70,078)	$ (70,917)	$ (71,674)	$ (72,340)	$ (88,275)	$ (89,439)	$ (90,510)	$ (91,476)	$ (92,326)
Revenue for FOG tipping fee	$ (607,380)	$ (482,895)	$ (507,040)	$ (532,392)	$ (559,011)	$ (586,962)	$ (616,310)	$ (647,125)	$ (679,482)	$ (713,456)	$ (749,129)
O&M costs for fuel treatment facilities	$ 120,708	$ 90,862	$ 93,100	$ 95,370	$ 97,669	$ 99,995	$ 105,334	$ 107,929	$ 110,560	$ 113,225	$ 115,922
O&M costs for fuel cell facilities	$ 623,221	$ 494,413	$ 493,968	$ 493,052	$ 491,636	$ 489,691	$ 573,161	$ 572,645	$ 571,582	$ 569,940	$ 567,686
Total Annual Costs	$ 1,182,518	$ 740,576	$ 805,199	$ 875,269	$ 951,186	$ 1,033,376	$ 876,702	$ 958,969	$ 1,048,240	$ 1,145,027	$ 1,249,881
Present Worth of Annual Costs	$ 658,071	$ 671,724	$ 695,561	$ 720,086	$ 745,279	$ 771,121	$ 623,056	$ 649,068	$ 675,705	$ 702,948	$ 730,780
TOTAL PRESENT WORTH	$13,161,414										
Annualized Total Project Capital Cost	$ 1,106,269	$ 1,106,269	$ 1,106,269	$ 1,106,269	$ 1,106,269	$ 1,106,269	$ 1,106,269	$ 1,106,269	$ 1,106,269	$ 1,106,269	$ 1,106,269
Annualized Total Project Benefit	$ 1,361,548	$ 361,067	$ 406,839	$ 452,685	$ 498,479	$ 544,085	$ 834,946	$ 893,575	$ 952,245	$ 1,010,795	$ 1,069,045
COST FOR ELECTRICITY											
Power Generation Cost, $/kWh	$0.179	$0.155	$0.160	$0.166	$0.172	$0.179	$0.162	$0.167	$0.173	$0.180	$0.187
Power Purchase Cost, $/kWh	$0.191	$0.116	$0.122	$0.128	$0.134	$0.141	$0.148	$0.155	$0.163	$0.171	$0.180
TOTAL COST OF OPTION	**$ 26,531,026**										

Oxnard Cogeneration Study
Alternative 4
One 1,400 kW Fuel Cell Cogeneration System w/ FOG

Life Cycle Present Worth of Annual Costs

Year	Average	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Operation Data											
Average Digester Gas Available (million Btus)	108,913	108,913	108,913	108,913	108,913	108,913	108,913	108,913	108,913	108,913	108,913
Boiler Fuel Consumed (million Btus)	5,763	6,798	6,302	5,785	5,247	4,685	6,798	6,302	5,785	5,247	4,685
New Cogen Fuel Consumed (million Btus)	88,365	88,365	88,365	88,365	88,365	88,365	88,365	88,365	88,365	88,365	88,365
Total Fuel Consumed (million Btus)	94,128	95,163	94,667	94,150	93,611	93,049	95,163	94,667	94,150	93,611	93,049
Natural Gas Consumed (million Btus)	-	-	-	-	-	-	-	-	-	-	-
Digester Gas Consumed (million Btus)	94,128	95,163	94,667	94,150	93,611	93,049	95,163	94,667	94,150	93,611	93,049
Flared Digester Gas (million Btus)	14,785	13,750	14,246	14,763	15,301	15,863	13,750	14,246	14,763	15,301	15,863
Cogen Heat Generated (million Btus)	20,268	19,440	19,837	20,250	20,681	21,131	19,440	19,837	20,250	20,681	21,131
Peak Electricity Required by Plant (kW)	2,722	2,722	2,722	2,722	2,722	2,722	2,722	2,722	2,722	2,722	2,722
Average Electricity Required by Plant (kW)	2,177	2,177	2,177	2,177	2,177	2,177	2,177	2,177	2,177	2,177	2,177
Parasitic Electrical Usage (kW)	140	140	140	140	140	140	140	140	140	140	140
Electricity Generated (MW-hrs)	9,787	10,486	10,136	9,787	9,437	9,088	10,486	10,136	9,787	9,437	9,088
Electricity Purchased (MW-hrs)	9,286	8,587	8,937	9,286	9,636	9,985	8,587	8,937	9,286	9,636	9,985
Required plant heat - (million Btus)	24,878	24,878	24,878	24,878	24,878	24,878	24,878	24,878	24,878	24,878	24,878
Excess boiler heat req'd (million Btus)	4,611	5,438	5,041	4,628	4,197	3,748	5,438	5,041	4,628	4,197	3,748
Daily peak heat demand, million Btu/hr	4.61	4.61	4.61	4.61	4.61	4.61	4.61	4.61	4.61	4.61	4.61
Cogen heating capacity, million Btu/hr	2.31	2.22	2.26	2.31	2.36	2.41	2.22	2.26	2.31	2.36	2.41
Excess (Required boiler make up) peak day, million Btu/hr	(2.30)	(2.39)	(2.35)	(2.30)	(2.25)	(2.20)	(2.39)	(2.35)	(2.30)	(2.25)	(2.20)
Costs/(Revenues) for project											
Natural gas costs	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Base Cost for electricity	$ 3,650,335	$ 3,596,455	$ 3,776,278	$ 3,965,092	$ 4,163,346	$ 4,371,514	$ 4,590,090	$ 4,819,594	$ 5,060,574	$ 5,313,602	$ 5,579,282
Cost Savings from generated electricity	$ (2,307,405)	$ (2,444,239)	$ (2,480,902)	$ (2,515,121)	$ (2,546,560)	$ (2,574,856)	$ (3,119,537)	$ (3,166,330)	$ (3,210,003)	$ (3,250,128)	$ (3,286,241)
Revenue for Green Power Credit	$ (80,620)	$ (112,664)	$ (114,150)	$ (115,517)	$ (116,750)	$ (117,834)	$ (143,791)	$ (145,687)	$ (147,432)	$ (149,006)	$ (150,390)
Revenue for FOG tipping fee	$ (607,380)	$ (786,585)	$ (825,914)	$ (867,210)	$ (910,571)	$ (956,099)	$ (1,003,904)	$ (1,054,099)	$ (1,106,804)	$ (1,162,144)	$ (1,220,252)
O&M costs for fuel treatment facilities	$ 120,708	$ 122,111	$ 125,119	$ 128,169	$ 131,259	$ 134,385	$ 141,560	$ 145,047	$ 148,583	$ 152,165	$ 155,789
O&M costs for fuel cell facilities	$ 623,221	$ 664,450	$ 663,852	$ 662,620	$ 660,717	$ 658,103	$ 770,280	$ 769,587	$ 768,159	$ 765,952	$ 762,922
Total Annual Costs	$ 1,182,518	$ 1,039,529	$ 1,144,283	$ 1,258,033	$ 1,381,442	$ 1,515,213	$ 1,234,699	$ 1,368,112	$ 1,513,076	$ 1,670,442	$ 1,841,112
Present Worth of Annual Costs	$ 658,071	$ 578,849	$ 606,838	$ 635,392	$ 664,497	$ 694,137	$ 538,695	$ 568,479	$ 598,776	$ 629,572	$ 660,853
TOTAL PRESENT WORTH	$13,161,414										
Annualized Total Project Capital Cost	$ 1,106,269	$ 1,106,269	$ 1,106,269	$ 1,106,269	$ 1,106,269	$ 1,106,269	$ 1,106,269	$ 1,106,269	$ 1,106,269	$ 1,106,269	$ 1,106,269
Annualized Total Project Benefit	$ 1,361,548	$ 1,450,657	$ 1,525,727	$ 1,600,790	$ 1,675,636	$ 1,750,032	$ 2,249,122	$ 2,345,214	$ 2,441,229	$ 2,536,892	$ 2,631,902
COST FOR ELECTRICITY											
Power Generation Cost, $/kWh	$0.179	$0.170	$0.176	$0.182	$0.189	$0.196	$0.179	$0.185	$0.192	$0.199	$0.206
Power Purchase Cost, $/kWh	$0.191	$0.189	$0.198	$0.208	$0.218	$0.229	$0.241	$0.253	$0.265	$0.279	$0.293
TOTAL COST OF OPTION	**$ 26,531,026**										

Oxnard Cogeneration Study
Alternative 4
One 1,400 kW Fuel Cell Cogeneration System w/ FOG

			Life Cycle Present Worth of Annual Costs									
Year		**Average**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
FCE DFC1400	1,400 kW per unit											
Number of Units			1	1	1	1	1	1	1	1	1	1
Number of Units Operating			1	1	1	1	1	1	1	1	1	1
Fuel rate, Btu/kW-hr			7,584	7,819	8,069	8,335	8,619	7,584	7,819	8,069	8,335	8,619
Cogeneration heat recovery/fuel input			22%	22%	23%	23%	24%	22%	22%	23%	23%	24%
Power output, kW			1,400	1,358	1,316	1,274	1,232	1,400	1,358	1,316	1,274	1,232
Operating hours per year			8,322	8,322	8,322	8,322	8,322	8,322	8,322	8,322	8,322	8,322
Project cost estimate		$17,449,612	$17,449,612	$0	$0	$0	$0	$0	$0	$0	$0	$0
SGIP Grant			($4,080,000)									
Net Project Costs		$13,369,612										
Plant CO_2e Emissions												
Plant Electricity Usage, metric-ton/yr		3,063	2,832	2,947	3,063	3,178	3,293	2,832	2,947	3,063	3,178	3,293
Plant Natural Gas Usage, metric-ton/yr		-	-	-	-	-	-	-	-	-	-	-
Plant Digester Gas Usage for Boiler, metric-ton/yr												
CO_2 Emissions (Biogenic)		306	361	334	307	278	249	361	334	307	278	249
CH_4 and N_2O Emissions		2	2	2	2	2	1	2	2	2	2	1
Plant Digester Gas Usage for Cogeneration, metric-ton/yr												
CO_2 Emissions (Biogenic)		4,601	4,601	4,601	4,601	4,601	4,601	4,601	4,601	4,601	4,601	4,601
CH_4 and N_2O Emissions		4	4	4	4	4	4	4	4	4	4	4
Plant Digester Gas Flare, metric-ton/yr												
CO_2 Emissions (Biogenic)		770	716	742	769	797	826	716	742	769	797	826
CH_4 and N_2O Emissions		1	1	1	1	1	1	1	1	1	1	1
ssions (Electricity + Stationary Combustion), metric-ton/yr:		8,746	8,517	8,632	8,746	8,861	8,976	8,517	8,632	8,746	8,861	8,976
shold Check - Stationary Combustion ONLY), metric-ton/yr:		5,684	5,685	5,684	5,684	5,683	5,682	5,685	5,684	5,684	5,683	5,682
Plant Emissions of NOx and CO												
Cogen lb/MWh												
NOx 0.50	(Assumed for Mercury 50 Gas Turbine)	5,476	5,825	5,651	5,476	5,301	5,126	5,825	5,651	5,476	5,301	5,126
CO 0.40	(Assumed for Mercury 50 Gas Turbine)	4,381	4,660	4,521	4,381	4,241	4,101	4,660	4,521	4,381	4,241	4,101
Boiler lb/Mbtu												
NOx 0.035	(boiler 30 ppmv, 3% O2)	202	238	221	202	184	164	238	221	202	184	164
CO 0.110	(boiler at 150 ppmv, 3% O2)	634	748	693	636	577	515	748	693	636	577	515
Flare lb/Mbtu	(Estimate for enclosed flare)											
NOx 0.06		887	825	855	886	918	952	825	855	886	918	952
CO 0.2		2,957	2,750	2,849	2,953	3,060	3,173	2,750	2,849	2,953	3,060	3,173
Total, lb/yr												
NOx		6,565	6,888	6,726	6,564	6,403	6,242	6,888	6,726	6,564	6,403	6,242
CO		7,972	8,158	8,063	7,970	7,878	7,789	8,158	8,063	7,970	7,878	7,789

Oxnard Cogeneration Study
Alternative 4
One 1,400 kW Fuel Cell Cogeneration System w/ FOG

Life Cycle Present Worth of Annual Costs

Year	**Average**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**
FCE DFC1400 1,400 kW per unit											
Number of Units		1	1	1	1	1	1	1	1	1	1
Number of Units Operating		1	1	1	1	1	1	1	1	1	1
Fuel rate, Btu/kW-hr		7,584	7,819	8,069	8,335	8,619	7,584	7,819	8,069	8,335	8,619
Cogeneration heat recovery/fuel input		22%	22%	23%	23%	24%	22%	22%	23%	23%	24%
Power output, kW		1,400	1,358	1,316	1,274	1,232	1,400	1,358	1,316	1,274	1,232
Operating hours per year		8,322	8,322	8,322	8,322	8,322	8,322	8,322	8,322	8,322	8,322
Project cost estimate	$17,449,612	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
SGIP Grant											
Net Project Costs	$13,369,612										
Plant CO_2e Emissions											
Plant Electricity Usage, metric-ton/yr	3,063	2,832	2,947	3,063	3,178	3,293	2,832	2,947	3,063	3,178	3,293
Plant Natural Gas Usage, metric-ton/yr	-	-	-	-	-	-	-	-	-	-	-
Plant Digester Gas Usage for Boiler, metric-ton/yr											
CO_2 Emissions (Biogenic)	306	361	334	307	278	249	361	334	307	278	249
CH_4 and N_2O Emissions	2	2	2	2	2	1	2	2	2	2	1
Plant Digester Gas Usage for Cogeneration, metric-ton/yr											
CO_2 Emissions (Biogenic)	4,601	4,601	4,601	4,601	4,601	4,601	4,601	4,601	4,601	4,601	4,601
CH_4 and N_2O Emissions	4	4	4	4	4	4	4	4	4	4	4
Plant Digester Gas Flare, metric-ton/yr											
CO_2 Emissions (Biogenic)	770	716	742	769	797	826	716	742	769	797	826
CH_4 and N_2O Emissions	1	1	1	1	1	1	1	1	1	1	1
ssions (Electricity + Stationary Combustion), metric-ton/yr:	8,746	8,517	8,632	8,746	8,861	8,976	8,517	8,632	8,746	8,861	8,976
shold Check - Stationary Combustion ONLY), metric-ton/yr:	5,684	5,685	5,684	5,684	5,683	5,682	5,685	5,684	5,684	5,683	5,682
Plant Emissions of NOx and CO											
Cogen lb/MWh											
NOx 0.50 (Assumed for Mercury 50 Gas Turbine)	5,476	5,825	5,651	5,476	5,301	5,126	5,825	5,651	5,476	5,301	5,126
CO 0.40 (Assumed for Mercury 50 Gas Turbine)	4,381	4,660	4,521	4,381	4,241	4,101	4,660	4,521	4,381	4,241	4,101
Boiler lb/Mbtu											
NOx 0.035 (boiler 30 ppmv, 3% O2)	202	238	221	202	184	164	238	221	202	184	164
CO 0.110 (boiler at 150 ppmv, 3% O2)	634	748	693	636	577	515	748	693	636	577	515
Flare lb/Mbtu (Estimate for enclosed flare)											
NOx 0.06	887	825	855	886	918	952	825	855	886	918	952
CO 0.2	2,957	2,750	2,849	2,953	3,060	3,173	2,750	2,849	2,953	3,060	3,173
Total, lb/yr											
NOx	6,565	6,888	6,726	6,564	6,403	6,242	6,888	6,726	6,564	6,403	6,242
CO	7,972	8,158	8,063	7,970	7,878	7,789	8,158	8,063	7,970	7,878	7,789

Input data for Life Cycle Cost Analysis

Lastest revision = 2/26/2009

GENERAL ASSUMPTIONS

Annual ave. plant heat load, electrical demand, gas production are ratioed to plant flow for duration of project.

FINANCIAL ASSUMPTIONS

Present worth year		2013	
First year of evaluation		2015	
Project duration, years		20	
Inflation (capital costs)		4.0%	
Inflation (electricity costs)		5.0%	
Inflation (natural gas costs)		4.0%	
Inflation (O&M costs)		3.0%	
Gross discount rate		5.0%	
Digester Gas LHV, Btu/scf		580	
Existing Engine availability percentage		85%	
Engine availability percentage		90%	
Microturbine availability percentage		95%	
Fuel Cell availability percentage		95%	
O&M rate for existing engines $/kWh	$	0.040	
O&M rate for new engine alternatives $/kWh	$	0.015	Typical for new engine maintenance for DG fueled unit with DG treatment
O&M rate for microturbine alternatives $/kWh	$	0.015	From previous project discussions with the mfg for DG fueled unit
O&M rate for fuel cell unit $/kWh	$	0.040	
O&M rate for fuel treatment system $/million Btu	$	0.900	
FOG Tipping Fee $/gallon	$	0.050	
Green Power Credit $/kWh	$	0.005	
NOx offset costs $/ton	$	-	
CO offset costs $/ton	$	-	
Grant Incentive (1 = yes, 0 = no)		0	
NG Usage (when appropriate) (1 = yes, 0 = no)		1	
CO_2 Electricity Emissions factor, lb/MWh		724.12	The Climate Registry GRP V1.1, EPA eGrid 2007 FL State
CH_4 Electricity Emissions factor, lb/MWh		0.03024	The Climate Registry GRP V1.1, EPA eGrid 2007 FL State
N_2O Electricity Emissions factor, lb/MWh		0.00808	The Climate Registry GRP V1.1, EPA eGrid 2007 FL State
CO_2 Emissions factor for Stationary Combustion of N.G., kg/MMBtu		53.06	The Climate Registry GRP V1.1, Table 12.1
CH_4 Emissions factor for Stationary Combustion of N.G., kg/MMBtu			
Engine Generators		0.5669	The Climate Registry GRP V1.1, Table 12.7
Turbines		0.0038	The Climate Registry GRP V1.1, Table 12.7
Fuel Cells		0.0009	The Climate Registry GRP V1.1, Table 12.7
N_2O Emissions factor for Stationary Combustion of N.G., kg/MMBtu		0.0009	The Climate Registry GRP V1.1, Table 12.7
CO_2 Emissions factor for Stationary Combustion of Digester Gas in Boile		53.06	The Climate Registry GRP V1.1, Table 12.1
CH_4 Emissions factor for Stationary Combustion of Digester Gas in Boile		0.0009	The Climate Registry GRP V1.1, Table 12.7
N_2O Emissions factor for Stationary Combustion of Digester Gas in Boile		0.0009	The Climate Registry GRP V1.1, Table 12.7
CO_2 Emissions factor for Stationary Combustion of Digester Gas (Bioge		52.07	The Climate Registry GRP V1.1, Table 12.2
CH_4 Emissions factor for Stationary Combustion of Digester Gas, kg/MM		0.0009	US EPA Proposed Mandatory Reporting Rule, Table C-3
N_2O Emissions factor for Stationary Combustion of Digester Gas, kg/MM		0.0001	US EPA Proposed Mandatory Reporting Rule, Table C-3

Forcasting Assumptions

Year			2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Process Data													
Average plant flow (million gallons/day)			20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5
Plant electrical cons. Baseload, ann. average (kw-hr/day)			52,254	52,254	52,254	52,254	52,254	52,254	52,254	52,254	52,254	52,254	52,254
Plant electrical demand, ann. average (kw)			2,177	2,177	2,177	2,177	2,177	2,177	2,177	2,177	2,177	2,177	2,177
Plant electrical demand, ann. peak (kw)			2,722	2,722	2,722	2,722	2,722	2,722	2,722	2,722	2,722	2,722	2,722
Scenario 2													
Average digester gas available (scf/day)		0%	342,762	342,762	342,762	342,762	342,762	342,762	342,762	342,762	342,762	342,762	342,762
Average digester gas heating value (million Btu/hr)			8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3
Average plant heat load (million Btu/hr)			2.63	2.63	2.63	2.63	2.63	2.63	2.63	2.63	2.63	2.63	2.63
Peak plant heat load (million Btu/hr)			3.97	3.97	3.97	3.97	3.97	3.97	3.97	3.97	3.97	3.97	3.97
Scenario 1													
Average digester gas available (scf/day)		0%	514,468	514,468	514,468	514,468	514,468	514,468	514,468	514,468	514,468	514,468	514,468
Average digester gas heating value (million Btu/hr)			12.4	12.4	12.4	12.4	12.4	12.4	12.4	12.4	12.4	12.4	12.4
Average plant heat load (million Btu/hr)			2.84	2.84	2.84	2.84	2.84	2.84	2.84	2.84	2.84	2.84	2.84
Peak plant heat load (million Btu/hr)			4.61	4.61	4.61	4.61	4.61	4.61	4.61	4.61	4.61	4.61	4.61

Cost Data													
Electricity ($/MWh)	Sensitivity	1.00	115.76	121.55	127.63	134.01	140.71	147.75	155.13	162.89	171.03	179.59	188.56
Natural Gas - Low Use ($/MMBtu)	Factor	1.00	8.85	9.20	9.57	9.95	10.35	10.76	11.19	11.64	12.11	12.59	13.09
Electricity - Existing Engine Savings($/MWh)	Sensitivity	1.00	170.45	178.97	187.92	197.31	207.18	217.54	228.41	239.83	251.83	264.42	277.64

Electricity ($/MWh)	105.00	$/MWh	115.76	121.55	127.63	134.01	140.71	147.75	155.13	162.89	171.03	179.59	188.56
Natural Gas - Low Use ($/MMBtu, LHV)	8.18	$/MMBtu	8.85	9.20	9.57	9.95	10.35	10.76	11.19	11.64	12.11	12.59	13.09
Electricity - Existing Engine Savings ($/MW	160.66	$/MWh	170.45	178.97	187.92	197.31	207.18	217.54	228.41	239.83	251.83	264.42	277.64

Projected Data	Current 2013	1st year 2015	future 2034												
Plant flow, mgd		20.5	20.5	Scenario 1	342,762	342,762	342,762	342,762	342,762	342,762	342,762	342,762	342,762	342,762	342,762
Gas prod., scfd		514,468	514,468	Scenario 2	514,468	514,468	514,468	514,468	514,468	514,468	514,468	514,468	514,468	514,468	514,468
Gas prod., scfm		357	357												
Elect usage, kWh/d		52,254	52,254												
Average elect demand, kW		2,177	2,177												
Peak elect demand, kW		2,722	2,722	assumed at 25% more than average						Scenario 1	Scenario 2				
Ave. elect cost, $/kWhr	0.105							Average Heat Demand, million Btu/hr		2.63	2.84				
Ave. elect savings existing, $/	0.161							Peak Heat Demand, million Btu/hr		3.97	4.61				
NG cost, $/therm, HHV	0.818														

Forcasting Assumptions

Year		2026	2027	2028	2029	2030	2031	2032	2033	2034
Process Data										
Average plant flow (million gallons/day)		20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5
Plant electrical cons. Baseload, ann. average (kw-hr/day)		52,254	52,254	52,254	52,254	52,254	52,254	52,254	52,254	52,254
Plant electrical demand, ann. average (kw)		2,177	2,177	2,177	2,177	2,177	2,177	2,177	2,177	2,177
Plant electrical demand, ann. peak (kw)		2,722	2,722	2,722	2,722	2,722	2,722	2,722	2,722	2,722
Scenario 2										
Average digester gas available (scf/day)	0%	342,762	342,762	342,762	342,762	342,762	342,762	342,762	342,762	342,762
Average digester gas heating value (million Btu/hr)		8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3
Average plant heat load (million Btu/hr)		2.63	2.63	2.63	2.63	2.63	2.63	2.63	2.63	2.63
Peak plant heat load (million Btu/hr)		3.97	3.97	3.97	3.97	3.97	3.97	3.97	3.97	3.97
Scenario 1										
Average digester gas available (scf/day)	0%	514,468	514,468	514,468	514,468	514,468	514,468	514,468	514,468	514,468
Average digester gas heating value (million Btu/hr)		12.4	12.4	12.4	12.4	12.4	12.4	12.4	12.4	12.4
Average plant heat load (million Btu/hr)		2.84	2.84	2.84	2.84	2.84	2.84	2.84	2.84	2.84
Peak plant heat load (million Btu/hr)		4.61	4.61	4.61	4.61	4.61	4.61	4.61	4.61	4.61

Cost Data

			2026	2027	2028	2029	2030	2031	2032	2033	2034
Electricity ($/MWh)	Sensitivity	1.00	197.99	207.89	218.29	229.20	240.66	252.70	265.33	278.60	292.53
Natural Gas - Low Use ($/MMBtu)	Factor	1.00	13.62	14.16	14.73	15.32	15.93	16.57	17.23	17.92	18.64
Electricity - Existing Engine Savings($/MWh)	Sensitivity	1.00	291.52	306.10	321.40	337.47	354.34	372.06	390.67	410.20	430.71

			2026	2027	2028	2029	2030	2031	2032	2033	2034
Electricity ($/MWh)	105.00	$/MWh	197.99	207.89	218.29	229.20	240.66	252.70	265.33	278.60	292.53
Natural Gas - Low Use ($/MMBtu, LHV)	8.18	$/MMBtu	13.62	14.16	14.73	15.32	15.93	16.57	17.23	17.92	18.64
Electricity - Existing Engine Savings ($/MW	160.66	$/MWh	291.52	306.10	321.40	337.47	354.34	372.06	390.67	410.20	430.71

Projected Data	Current 2013	1st year 2015	future 2034										
Plant flow, mgd		20.5	20.5	Scenario 1	342,762	342,762	342,762	342,762	342,762	342,762	342,762	342,762	342,762
Gas prod., scfd		514,468	514,468	Scenario 2	514,468	514,468	514,468	514,468	514,468	514,468	514,468	514,468	514,468
Gas prod., scfm		357	357										
Elect usage, kWh/d		52,254	52,254										
Average elect demand, kW		2,177	2,177										
Peak elect demand, kW		2,722	2,722	assumed at									
Ave. elect cost, $/kWhr	0.105												
Ave. elect savings existing, $/	0.161												
NG cost, $/therm, HHV	0.818												

APPENDIX C – PROJECT COST ESTIMATES

Engineers...Working Wonders With Water®

PROJECT SUMMARY

Project:	**Cogeneration Project - Three 250 KW Microturbines**	**Estimate Class:**	**Detailed Design**
Client:	**Oxnard**	**PM:**	
Location:	**Oxnard, CA**	**PE**	
Zip Code:	**93030**	**Date:**	**4/25/2013**
Carollo Job #	**8533A10**	**By:**	**TGM**
		Reviewed:	

NO.	DESCRIPTION		TOTAL
01	Engine-Generators, Switchgear and systems		$2,505,000
02	Gas Conditioning		$1,357,000
03	Metal Building (946K X 0.74 = 700K)		$700,000
04	Yard Piping & Paving		$524,000
05	Eletrical Power Connections		$215,000
	SUBTOTAL		**$5,301,000**
	Additions		
	FOG System	$1,312,479	
			$1,312,479
	TOTAL DIRECT COST		**$6,613,479**
	Contingency (except EG and Gas Cond equip. cost)	10.0%	$384,098
	Subtotal		**$6,997,577**
	General Contractor Overhead, Profit & Risk	15.0%	$1,049,637
	Subtotal		**$8,047,213**
	Escalation to Mid-Point	6.0%	$482,833
	Subtotal		**$8,530,046**
	Sales Tax (Based on 50% of Direct Costs)	8.00%	$264,539
	Estimated Construction Cost		**$8,794,585**
	Design, Construction Management, Admn.	25.0%	$2,198,646
	ESTIMATED PROJECT COST		**$10,993,232**

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Carollo Engineers have no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Carollo Engineers cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.

Footnotes:

1) The above estimate of probable construction costs includes zero dollars for mitigation of hazardous or potentially hazardous materials.

2) The above estimate of probable construction costs is based on selection of GE JMS 416 1137 KW engine-generator.

Engineers...Working Wonders With Water®

PROJECT SUMMARY

Project:	**Cogeneration Project - Two 850 KW Engines**	**Estimate Class:**	**Detailed Design**
Client:	**Oxnard**	**PM:**	
Location:	**Oxnard, CA**	**PE**	
Zip Code:	**93030**	**Date:**	**4/25/2013**
Carollo Job #	**8533A10**	**By:**	**TGM**
		Reviewed:	

NO.	DESCRIPTION		TOTAL
01	Engine-Generators, Switchgear and systems		$3,814,544
02	Gas Conditioning		$1,357,000
03	Metal Building		$850,000
04	Yard Piping & Paving		$524,000
05	Eletrical Power Connections		$215,000
	SUBTOTAL		**$6,760,544**
	Additions		
	FOG System	$1,312,479	
			$1,312,479
	TOTAL DIRECT COST		**$8,073,023**
	Contingency (except EG and Gas Cond equip. cost)	10.0%	$399,082
	Subtotal		**$8,472,105**
	General Contractor Overhead, Profit & Risk	15.0%	$1,270,816
	Subtotal		**$9,742,920**
	Escalation to Mid-Point	6.0%	$584,575
	Subtotal		**$10,327,495**
	Sales Tax (Based on 50% of Direct Costs)	8.00%	$322,921
	Estimated Construction Cost		**$10,650,416**
	Design, Construction Management, Admn.	25.0%	$2,662,604
	ESTIMATED PROJECT COST		**$13,313,020**

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Carollo Engineers have no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Carollo Engineers cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.

Footnotes:
1) The above estimate of probable construction costs includes zero dollars for mitigation of hazardous or potentially hazardous materials.

2) The above estimate of probable construction costs is based on selection of GE JMS 416 1137 KW engine-generator.

PROJECT SUMMARY

Project:	**Cogeneration Project - Three 250 KW Microturbines**	**Estimate Class:**	**Detailed Design**
Client:	**Oxnard**	**PM:**	
Location:	**Oxnard, CA**	**PE**	
Zip Code:	**93030**	**Date:**	**4/25/2013**
Carollo Job #	**8533A10**	**By:**	**TGM**
		Reviewed:	

NO.	DESCRIPTION			TOTAL
01	Microturbine-Generators, Switchgear and systems			$3,049,000
02	Gas Conditioning			$1,357,000
03	Metal Building (900K X 0.74 = 700K)			$700,000
04	Yard Piping & Paving			$629,000
06	Eletrical Power Connections			$250,000
		SUBTOTAL		**$5,985,000**
	Additions			
	FOG System		$1,312,479	
				$1,312,479
		TOTAL DIRECT COST		**$7,297,479**
	Contingency (except EG and Gas Cond equip. cost)		10.0%	$427,248
		Subtotal		**$7,724,727**
	General Contractor Overhead, Profit & Risk		15.0%	$1,158,709
		Subtotal		**$8,883,436**
	Escalation to Mid-Point		6.0%	$533,006
		Subtotal		**$9,416,442**
	Sales Tax (Based on 50% of Direct Costs)		8.00%	$291,899
	Estimated Construction Cost			**$9,708,341**
	Design, Construction Management,Admn		25.0%	$2,427,085
	TOTAL ESTIMATED CONSTRUCTION COST			**$12,135,427**

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Carollo Engineers have no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Carollo Engineers cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.

Footnotes: 1) The above estimate of probable construction costs includes zero dollars for mitigation of hazardous or potentially hazardous materials.

Engineers...Working Wonders With Water®

PROJECT SUMMARY

Project:	**Cogeneration Project - One 1,400 KW Fuel Cell**	**Estimate Class:**	**4**
Job #:	**Oxnard**	**PM:**	
Location:	**Oxnard, CA**	**PE**	
Zip Code:	**93030**	**Date:**	**4/25/2013**
Carollo Job #	**8533A10**	**By:**	**TGM**
		Reviewed:	

NO.	DESCRIPTION		TOTAL
01	Demolition		$0
02	Yard		$285,434
03	Fuel Cell Facility		$2,754,602
			$0
			$0
			$0
			$0
			$0
			$0
			$0
	FOG System		$1,312,479
			$0
			$0
	TOTAL DIRECT COST		**$4,352,514**
	Contingency	10.0%	$435,251
	Subtotal		**$4,787,766**
	General Contractor Overhead, Profit & Risk	15.0%	$718,165
	Subtotal		**$5,505,930**
	Escalation to Mid-Point	6.0%	$330,356
	Subtotal		**$5,836,286**
	Sales Tax (Based on Materials)	8.0%	$466,903
	Subtotal		**$6,303,189**
	Bid Market Allowance	0.0%	$0
	Subtotal		**$6,303,189**
	Fuel Cell Procurement		$5,512,500
	Subtotal		**$11,815,689**
	DGFCS Prepurchase		$2,144,000
	TOTAL ESTIMATED CONSTRUCTION COST		**$13,959,689**
	Engineering, Legal & Administration Fees	25.0%	$3,489,922
	Owner's Reserve for Change Orders	0.0%	$0
	TOTAL ESTIMATED PROJECT COST		**$17,449,612**

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Carollo Engineers have no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Carollo Engineers cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary form the costs presented as shown.

APPENDIX D – SOLAR PHOTO VOLTAIC CALCULATIONS

APPENDIX D – SOLAR PHOTOVOLTAIC CALCULATIONS

Location	Effective Area Available [sq ft]	One Panel Area [sq ft]
Activated Sludge Tanks	20004.20235	15
Flow Equalization Basins	32310.15829	15
Secondary Sedimentation Basins - Concrete	11013.54961	15
Secondary Sedimentation Basins - Basins	35063.54569	15
Maintenance Building #1	1348.597911	15
Maintenance Building #2	899.0652741	15
Admin Building	1685.747389	15
Storage Building	3596.261097	15
Carport #1	4635.80532	15
Carport #2	1854.322128	15
Carport #3	1755.986864	15
Carport #4	1011.448433	15
MRF roof	52874.09901	15
1 acre ground mount	24476.97572	15
1 acre carport	24476.97572	15

Location	Total Panels in Area	Effective Panels
Activated Sludge Tanks	1333.61349	1333
Flow Equalization Basins	2154.010553	2154
Secondary Sedimentation Basins - Concrete	734.2366405	734
Secondary Sedimentation Basins - Basins	2337.569713	2337
Maintenance Building #1	89.90652741	89
Maintenance Building #2	59.93768494	59
Admin Building	112.3831593	112
Storage Building	239.7507398	239
Carport #1	309.053688	309
Carport #2	123.6214752	123
Carport #3	117.0657909	117
Carport #4	67.42989556	67
MRF roof	3524.939934	3524
1 acre ground mount	1631.798382	1631
1 acre carport	1631.798382	1631

Location	Solar Panel Output [W-dc]	System Output [kW-dc]
Activated Sludge Tanks	240	319.92
Flow Equalization Basins	240	516.96
Secondary Sedimentation Basins - Concrete	240	176.16
Secondary Sedimentation Basins - Basins	240	560.88
Maintenance Building #1	240	21.36
Maintenance Building #2	240	14.16
Admin Building	240	26.88
Storage Building	240	57.36
Carport #1	240	74.16
Carport #2	240	29.52
Carport #3	240	28.08
Carport #4	240	16.08
MRF roof	240	845.76
1 acre ground mount	240	391.44
1 acre carport	240	391.44

	Activated Sludge Tanks	Flow Equalization Basins Pump Station	Secondary Sedimentation Concrete	Secondary Sedimentation Tanks
Solar PV System Output Rating (kW-ac)	255.94	413.57	140.93	448.70
AC to DC Derating Factor	0.8	0.8	0.8	0.8
Solar PV System Output Rating (kW-dc)	319.92	516.96	176.16	560.88
Module Pricing ($/W-dc peak)	$ 1.50	$ 1.50	$ 1.50	$ 1.50
Module Price % of Installed Cost	15%	15%	20%	15%
Installed System Per Unit Cost ($/W-dc peak)	$ 10.00	$ 10.00	$ 7.50	$ 10.00
Estimated Installation Cost	$ 3,199,200	$ 5,169,600	$ 1,321,200	$ 5,608,800
Contingency (15%)	$ 479,880	$ 775,440	$ 198,180	$ 841,320
Total Installation Cost	$ 3,679,080	$ 5,945,040	$ 1,519,380	$ 6,450,120

	Maintenance Building #1	Maintenance Building #2	Admin Building	Storage Building
Solar PV System Output Rating (kW-ac)	17.09	11.33	21.50	45.89
AC to DC Derating Factor	0.8	0.8	0.8	0.8
Solar PV System Output Rating (kW-dc)	21.36	14.16	26.88	57.36
Module Pricing ($/W-dc peak)	$ 1.00	$ 1.00	$ 1.00	$ 1.00
Module Price % of Installed Cost	30%	30%	30%	30%
Installed System Per Unit Cost ($/W-dc peak)	$ 3.33	$ 3.33	$ 3.33	$ 3.33
Estimated Installation Cost	$ 71,200	$ 47,200	$ 89,600	$ 191,200
Contingency (15%)	$ 10,680	$ 7,080	$ 13,440	$ 28,680
Total Installation Cost	$ 81,880	$ 54,280	$ 103,040	$ 219,880

	Carport #1	Carport #2	Carport #3	Carport #4
Solar PV System Output Rating (kW-ac)	59.33	23.62	22.46	12.86
AC to DC Derating Factor	0.8	0.8	0.8	0.8
Solar PV System Output Rating (kW-dc)	74.16	29.52	28.08	16.08
Module Pricing ($/W-dc peak)	$ 1.00	$ 1.00	$ 1.00	$ 1.00
Module Price % of Installed Cost	30%	30%	30%	30%
Installed System Per Unit Cost ($/W-dc peak)	$ 3.33	$ 3.33	$ 3.33	$ 3.33
Estimated Installation Cost	$ 247,200	$ 98,400	$ 93,600	$ 53,600
Contingency (15%)	$ 37,080	$ 14,760	$ 14,040	$ 8,040
Total Installation Cost	$ 284,280	$ 113,160	$ 107,640	$ 61,640

	MRF Roof	1 Acre Groundmount	1 Acre Carport
Solar PV System Output Rating (kW-ac)	676.61	313.15	313.15
AC to DC Derating Factor	0.8	0.8	0.8
Solar PV System Output Rating (kW-dc)	845.76	391.44	391.44
Module Pricing ($/W-dc peak)	$ 1.00	$ 1.00	$ 1.00
Module Price % of Installed Cost	30%	30%	30%
Installed System Per Unit Cost ($/W-dc peak)	$ 3.33	$ 3.33	$ 3.33
Estimated Installation Cost	$ 2,819,200	$ 1,304,800	$ 1,304,800
Contingency (15%)	$ 422,880	$ 195,720	$ 195,720
Total Installation Cost	$ 3,242,080	$ 1,500,520	$ 1,500,520

Location	Estimated Cost of System	Estimated Yearly Revenue (Plant Rate)	Estimated Yearly Rebates (CSI)
Activated Sludge Tanks	$3,679,080	$35,983	$54,694
Flow Equalization Basins	$5,945,040	$58,145	$88,380
Secondary Sedimentation Basins	$7,969,500 (Total) $1,519,380 (Concrete) $6,450,120 (Tanks)	$82,898 (Total) $19,813 (Concrete) $63,085 (Tanks)	$126,005 (Total) $30,116 (Concrete) $95,889 (Tanks)

Location	Estimated Cost of System	Estimated Yearly Revenue	Estimated Yearly Rebates (CSI)
Maintenance Building #1	$81,880	$2,402	$3,652
Maintenance Building #2	$54,280	$1,593	$2,421
Admin Building	$103,040	$3,023	$4,595
Storage Building	$219,880	$6,452	$9,806

Location	Estimated Cost of System	Estimated Yearly Revenue	Estimated Yearly Rebates (CSI)
Carport #1	$284,280	$8,341	$12,678
Carport #2	$113,160	$3,320	$5,047
Carport #3	$107,640	$3,158	$4,801
Carport #4	$61,640	$1,808	$2,749

Location	Estimated Cost of System	Estimated Yearly Revenue	Estimated Yearly Rebates (CSI)
MRF Roof	$3,242,080	$95,130	$144,595
1 Acre Ground Mount	$1,500,520	$44,030	$66,920
1 Acre Carport	$1,500,520	$44,030	$66,920

Oxnard Preliminary Summary of Solar Alternatives Evaluation

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Alternative	Existing Cogen only	Activated Sludge Tanks	Flow Equalization Basins	Secondary Sedimentation Basins-Concrete	Secondary Sedimentation Basins - Tanks
Average Net Power Generated (kW)	633	688	721	663	729
Estimated Project Cost [(1)] (2013 dollars)	$0	$3,679,080	$5,945,040	$1,519,380	$6,450,120
20-Year Present Worth of Costs/(Revenues)					
Natural gas costs	$2,284,557	$2,284,557	$2,284,557	$2,284,557	$2,284,557
Base Cost for electricity	$40,052,817	$40,052,817	$40,052,817	$40,052,817	$40,052,817
Revenue for displaced electricity	($17,826,207)	($19,176,830)	($20,008,684)	($18,569,901)	($20,194,104)
Revenue for green power credit	($527,436)	($536,172)	($541,553)	($532,247)	($542,752)
Revenue from CSI funding	$0	($221,271)	($357,552)	($121,838)	($387,929)
O&M costs for solar facilities	$0	$443,567	$955,682	$244,245	$1,036,875
O&M costs for cogeneration facilities	$4,133,203	$4,133,203	$4,133,203	$4,133,203	$4,133,203
Estimated Project Cost [(1)] (2013 dollars)	$0	$3,679,080	$5,945,040	$1,519,380	$6,450,120
Total 20-Year Present Worth of Energy Cost [(3)]	**$28,116,934**	**$30,658,951**	**$32,463,510**	**$29,010,216**	**$32,832,787**
Present Worth of Net Benefit Compared to No Cogeneration System		**($2,542,016)**	**($4,346,575)**	**($893,281)**	**($4,715,852)**
Simple Payback Period of Cogeneration System, years		**65**	**74**	**49**	**74**

Note & Assumptions:

(1) This includes estimated construction cost plus cost for engineering, administration, contingencies and construction management
(3) Total 20-year present worth of energy costs is the sum of the Present Worth values listed above
(4) Project Assumptions:

Inflation (capital costs)	4.0%	
Inflation (electricity costs)	5.0%	
Inflation (natural gas costs)	4.0%	
Inflation (O&M costs)	3.0%	
Green Power Credit $/kWh	$0.005	

(5) Project Data:

2012 ave. elect cost, $/kWhr	$0.105	Estimated
2012 ave. elect savings for existing generation, $/kWhr	$0.161	Based on current purchased energy costing $0.074/kWh on average
Est. 2012 ave. elect savings for solar generation, $/kWhr	$0.161	Assumed to be less than existing due to not having a redundant unit

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Alternative	Existing Cogen only	Maintence Building #1	Maintenance Building #2	Admin Building	Storage Building
Average Net Power Generated (kW)	633	636	635	637	643
Estimated Project Cost [(1)] (2013 dollars)	$0	$81,880	$54,280	$103,040	$219,880
20-Year Present Worth of Costs/(Revenues)					
Natural gas costs	$2,284,557	$2,284,557	$2,284,557	$2,284,557	$2,284,557
Base Cost for electricity	$40,052,817	$40,052,817	$40,052,817	$40,052,817	$40,052,817
Revenue for displaced electricity	($17,826,207)	($17,916,384)	($17,885,986)	($17,939,688)	($18,068,366)
Revenue for green power credit	($527,436)	($528,019)	($527,823)	($528,170)	($529,002)
Revenue from CSI funding	$0	($14,774)	($9,794)	($18,591)	($39,673)
O&M costs for solar facilities	$0	$9,872	$8,726	$16,564	$35,346
O&M costs for cogeneration facilities	$4,133,203	$4,133,203	$4,133,203	$4,133,203	$4,133,203
Estimated Project Cost [(1)] (2013 dollars)	$0	$81,880	$54,280	$103,040	$219,880
Total 20-Year Present Worth of Energy Cost [(3)]	**$28,116,934**	**$28,103,152**	**$28,109,980**	**$28,103,731**	**$28,088,763**
Present Worth of Net Benefit Compared to No Cogeneration System		**$13,783**	**$6,954**	**$13,203**	**$28,172**
Simple Payback Period of Cogeneration System, years		**17**	**18**	**18**	**18**

Note & Assumptions:

(1) This includes estimated construction cost plus cost for engineering, administration, contingencies and construction management
(3) Total 20-year present worth of energy costs is the sum of the Present Worth values listed above
(4) Project Assumptions:

Inflation (capital costs)	4.0%	
Inflation (electricity costs)	5.0%	
Inflation (natural gas costs)	4.0%	
Inflation (O&M costs)	3.0%	
Green Power Credit $/kWh	$0.005	
(5) Project Data:		
2012 ave. elect cost, $/kWhr	$0.105	Estimated
2012 ave. elect savings for existing generation, $/kWhr	$0.161	Based on current purchased energy costing $0.074/kWh on average
Est. 2012 ave. elect savings for solar generation, $/kWhr	$0.161	Assumed to be less than existing due to not having a redundant unit

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Alternative	Existing Cogen only	Carport No. 1	Carport No. 2	Carport No. 3	Carport No. 4
Average Net Power Generated (kW)	633	646	638	638	636
Estimated Project Cost [(1)] (2013 dollars)	$0	$284,280	$113,160	$107,640	$61,640
20-Year Present Worth of Costs/(Revenues)					
Natural gas costs	$2,284,557	$2,284,557	$2,284,557	$2,284,557	$2,284,557
Base Cost for electricity	$40,052,817	$40,052,817	$40,052,817	$40,052,817	$40,052,817
Revenue for displaced electricity	($17,826,207)	($18,139,291)	($17,950,833)	($17,944,753)	($17,894,091)
Revenue for green power credit	($527,436)	($529,461)	($528,242)	($528,203)	($527,875)
Revenue from CSI funding	$0	($51,292)	($20,417)	($19,421)	($11,121)
O&M costs for solar facilities	$0	$34,274	$18,191	$17,303	$9,909
O&M costs for cogeneration facilities	$4,133,203	$4,133,203	$4,133,203	$4,133,203	$4,133,203
Estimated Project Cost [(1)] (2013 dollars)	$0	$284,280	$113,160	$107,640	$61,640
Total 20-Year Present Worth of Energy Cost [(3)]	**$28,116,934**	**$28,069,088**	**$28,102,435**	**$28,103,144**	**$28,109,038**
Present Worth of Net Benefit Compared to No Cogeneration System		**$47,847**	**$14,499**	**$13,790**	**$7,896**
Simple Payback Period of Cogeneration System, years		**17**	**18**	**18**	**18**

Note & Assumptions:

(1) This includes estimated construction cost plus cost for engineering, administration, contingencies and construction management
(3) Total 20-year present worth of energy costs is the sum of the Present Worth values listed above
(4) Project Assumptions:

Inflation (capital costs)	4.0%	
Inflation (electricity costs)	5.0%	
Inflation (natural gas costs)	4.0%	
Inflation (O&M costs)	3.0%	
Green Power Credit $/kWh	$0.005	

(5) Project Data:

2012 ave. elect cost, $/kWhr	$0.105	Estimated
2012 ave. elect savings for existing generation, $/kWhr	$0.161	Based on current purchased energy costing $0.074/kWh on average
Est. 2012 ave. elect savings for solar generation, $/kWhr	$0.161	Assumed to be less than existing due to not having a redundant unit

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Alternative	Existing Cogen only	MRF roof	1 acre ground mount	1 acre carport	0
Average Net Power Generated (kW)	633	778	700	700	633
Estimated Project Cost [1] (2013 dollars)	$0	$3,242,080	$1,500,520	$1,500,520	$0
20-Year Present Worth of Costs/(Revenues)					
Natural gas costs	$2,284,557	$2,284,557	$2,284,557	$2,284,557	$2,284,557
Base Cost for electricity	$40,052,817	$40,052,817	$40,052,817	$40,052,817	$40,052,817
Revenue for displaced electricity	($17,826,207)	($21,396,797)	($19,478,769)	($19,478,769)	($17,826,207)
Revenue for green power credit	($527,436)	($550,532)	($538,125)	($538,125)	($527,436)
Revenue from CSI funding	$0	($584,964)	($270,737)	($270,737)	$0
O&M costs for solar facilities	$0	$390,880	$241,213	$241,213	$0
O&M costs for cogeneration facilities	$4,133,203	$4,133,203	$4,133,203	$4,133,203	$4,133,203
Estimated Project Cost [1] (2013 dollars)	$0	$3,242,080	$1,500,520	$1,500,520	$0
Total 20-Year Present Worth of Energy Cost [3]	**$28,116,934**	**$27,571,244**	**$27,924,679**	**$27,924,679**	**$28,116,934**
Present Worth of Net Benefit Compared to No Cogeneration System		**$545,691**	**$192,256**	**$192,256**	**$0**
Simple Payback Period of Cogeneration System, years		**17**	**18**	**18**	**#DIV/0!**

Note & Assumptions:

(1) This includes estimated construction cost plus cost for engineering, administration, contingencies and construction management
(3) Total 20-year present worth of energy costs is the sum of the Present Worth values listed above
(4) Project Assumptions:

Inflation (capital costs)	4.0%	
Inflation (electricity costs)	5.0%	
Inflation (natural gas costs)	4.0%	
Inflation (O&M costs)	3.0%	
Green Power Credit $/kWh	$0.005	

(5) Project Data:

2012 ave. elect cost, $/kWhr	$0.105	Estimated
2012 ave. elect savings for existing generation, $/kWhr	$0.161	Based on current purchased energy costing $0.074/kWh on average
Est. 2012 ave. elect savings for solar generation, $/kWhr	$0.161	Assumed to be less than existing due to not having a redundant unit

APPENDIX D - PRELIMINARY IDENTIFICATION OF IMMEDIATE NEEDS FOR THE OXNARD WASTEWATER TREATMENT PLANT AND COLLECTION SYSTEM SEWERS AND LIFT STATIONS

MEMORANDUM

Date: September 26, 2014

To: Thien Ng (Oxnard)

From: Liberato Tortorici (KEH)

Cc: Jeff Miller (Oxnard)
John Jardin (KEH)
Mike Wilson (KEH)

Reviewed By: Ken Hume (KEH)
Ray Fakhoury (KEH)

Subject: Preliminary Identification of Immediate Needs for the Oxnard Wastewater Treatment Plant and Collection System Sewers and Lift Stations.

1. INTRODUCTION

Task 3 (Plant Optimization) of the Wastewater Operations Support Contract involves working closely with City staff to identify and prioritize immediate repair and maintenance needs for the City's wastewater treatment plant.

2. FOCUS OF MEMORANDUM

This Technical Memorandum focuses on the preliminary identification of immediate needs at the Oxnard Wastewater Treatment Plant (OWTP), and the City's Sewerage Collection System and Sewerage Lift Stations that should be considered for further investigation and implementation.

The **i**mmediate needs presented in this Technical Memorandum include our team's recommended order of priority, opinion of probable implementation costs, and a risk assessment opinion for each Immediate Needs project.

3. IMMEDIATE NEEDS ASSESSMENT APPROACH

The preliminary list of potential Immediate Needs presented herein were identified based on input and information collected from the OWTP operations and maintenance staff; interviews with OWTP staff; limited site observations and inspections by OWTP staff and our team of the OWTP facilities and collection system facilities; input received from OWTP staff at workshops conducted on August 27 and 28, 2014; and review of previous assessment reports and studies completed for the OWTP and collection system facilities. These previous reports and studies are listed below.

- Oxnard Wastewater Treatment Plant – Initial (Level 1) Assessment Study by Malcolm Pirnie, Inc. (February 2001).

- Oxnard Wastewater Treatment Plan – Level 2 Assessment Study by Malcolm Pirnie, Inc. (March 2006.)
- Oxnard Wastewater Treatment Plant – Revised Centrifuge Study Report by Malcolm Pirnie, Inc. (June 2007).
- Oxnard Wastewater Treatment Plant – Unit Process and Optimization Study by Penfield & Smith and Michael K Nunley & Associates (June 2011).

On August 21, 2014 KEH submitted a draft version of this technical memorandum for City review and subsequently conducted workshops on August 27th and August 28th to solicit input and comments from City staff. This final Technical Memorandum reflects input and comments provided by City staff at the workshops.

4. IMMEDIATE NEEDS PRIORITY CATEGORIES

Three categories of immediate needs have been identified and are recommended by our team for prioritizing immediate needs identified herein. Definitions of these priority categories are provided below.

4.1 Priority 1 Immediate Needs

In March 2014 the Wastewater Division staff made a presentation to the City Council entitled the *Oxnard Wastewater Treatment Plant Assessment and Optimization Bio-Tower Update.* This update identified that **safety** related repairs and improvements should be considered as high priority items, and recommended that **safety** related repairs and improvements be addressed immediately. Our team reviewed the information presented to the City council and reviewed these recommendations with City staff. These recommendations along with additional items discussed during our discussions with City staff have been categorized as Priority 1 Immediate Needs. The Priority 1 Immediate Needs are listed in Table 1.

4.2 Priority 2 Immediate Needs

In response to complaints lodged by the general public in late 2013 about odors being generate and released from the sewerage collection system within the Oxnard Community the Wastewater Division staff immediately implemented measures to reduce the odors and eliminate odor complaints. The City's immediate response to the odor complaints, which was met with positive reaction from the Oxnard Community, are reflective of the City's commitment to foster and maintain "good neighbor" relationships throughout the Oxnard Community and underscores the importance to **avoid public nuisances** in order to avoid potential claims against the City.

KEH recommends that the proactive **Avoidance of Public Nuisances** such as odors beyond the OWTP fence line and odors from the sewerage collection system and pump stations, wastewater spills, and by-pass of partially treated effluent to the ocean outfall be categorized as Priority 2 Immediate Needs. The Priority 2 Immediate Needs are listed in Table 2.

4.3 Priority 3 Immediate Needs

KEH recommends that **Operability/Maintenance Enhancement** improvements and upgrades not related to safety issues or public nuisance issues but which can potentially increase plant efficiencies, reduce costs and/or help protect the City's investment in the existing treatment plant and collection system facilities be categorized as Priority 3 Immediate Needs. The Priority 3 Immediate Needs are listed in Table 3.

5. ESTIMATES OF PROBABLE IMPLEMENTATION COSTS

The estimates of probable implementation costs presented herein include preliminary design costs, construction costs total capital costs. The basis for preparation of these estimates are as follows.

5.1 Estimates of Probable Pre-Design Investigations Costs

In cases where identified Immediate Needs projects are not yet fully developed enough to generate complete project definitions and/or accurate and reliable estimates of probable construction and total capital costs, it is recommended that pre-design investigations be undertaken to fully define the project needs and to estimate the construction and capital costs before any detailed design efforts are initiated. The pre-design activities and estimated pre-design investigation budgets are identified in the attached Tables 1, 2 and 3.

5.2 Estimates of Probable Construction Costs

The estimates of Probable Construction Costs identified in Tables 1, 2 and 3 were generated as follows:

- Inflation adjustments of previous estimates identified in the Oxnard Wastewater Treatment Plant – Level 1 and/or Level 2 Assessment Studies identified under Part 3.
- Inflation and prorated "size" adjustments of similar projects competed previously by our team.
- Recent equipment cost estimates obtained from equipment manufacturers.
- These estimates include a contingency factor of 30% to 35% depending on our team's opinion on the level of project detail and definition currently available for each project.

5.3 Estimates of Probable Total Capital Costs

The estimates of Probable Capital Cost identified in Tables 1, 2 and 3 were generated by applying a 40% mark-up on the estimates of probable construction costs. The additional 40% includes the following markups.

- Design Services: 12.5%
- Office Support Services during Construction and Start-up: 6%
- Construction Management and Inspection Services: 12.5%
- City Administration and Permitting: 6%
- Project Contingencies: 3%

The 3% project contingency markup is in addition to the 30% to 35% construction contingencies included in the estimates of probable construction costs.

6. RISK ASSESSMENT CATEGORIES

Our team recommends that risk assessment impact be categorized in the following categories described below.

6.1 **High Risk** (**H**) is assigned to projects where there is potential for serious personnel injury or death; the potential for general personnel health and safety infractions; the potential for public nuisances that could result in complaints or claims filed against the City; and the potential for regulatory non-compliance fines that could be levied against the City.

6.2 **Moderate Risk** (**M**) is assigned to projects where the potential for minor personnel injury might exist; and where the City's ability to provide continued unit process reliability and redundancy could be seriously compromised.

6.3 **Low Risk (L)** is assigned to projects where the City's ability to provide a cost efficient and effective treatment and overall system operation and performance could be compromised.

7. PRELIMINARY LIST OF IMMEDIATE NEEDS

The lists of Priority 1, 2 and 3 Immediate Needs provided in Tables 1, 2 and 3 include a Priority Number, Project Title, Impact Area, General Description, Estimates of Probable Costs, and a Risk Assessment Value.

7.1 Priority 1 Immediate Needs – Safety

The Priority 1 Immediate Needs provided in Table 1 identifies eleven projects. Further discussion for some of the projects shown in Table 1 is provided below.

Priority 1.1 – Arc Flash Pre-Design Studies

The completion of the Arc Flash pre-design investigations is of paramount importance to the City because there is the potential for serious bodily injury or death to plant personnel. The Arc Flash studies are being performed by Carollo Engineers under the Public Works Department Master Plan Update Contract. Since the results from the Arc Flash study will not be available for several months, our team in collaboration with City staff have identified several precautionary measures that can be implemented immediately by City to reduce the potential for serious bodily injury. These measures are presented below.

1. Post arc flash warning signs on all entrances to all buildings identified in Table 1, Priority Improvement 1.1.

2. Install weather proof cabinets on the exterior of buildings at main access door to each buildings, and equip the cabinets with Class 3 Personal Protective Equipment (PPE).

3. Train OWTP operators on the use of PPE and the procedures to be followed if they need to access MCC panels in the absence of a qualified electrician.

4. Post signs on all MCC's in all buildings identified in Table 1, Priority Improvement 1.1 that will prohibit unauthorized access and the opening of any panel doors unless done by a qualified electrician, and that will require the qualified electrician to be properly outfitted with the appropriate Class 3 PPE including, but not limited to, protective face shields, and protective clothing.

Priority 1.6 – Bio-Filter Removal Pre-Design

The recommended pre-design investigations identified in Table 1will require close coordination with OWTP operations staff, Prouyses and Carollo Engineers to ensure that all interim improvements, particularly those related to SCADA, will be compatible with the master plan recommendations so that the potential for additional costs to the City are minimized.

Priority 1.7 – Primary Clarifier Access Catwalk Improvements

During the aforementioned workshops replacement of the access cat walks was identified as a top priority that should be implemented as soon as possible.

Until the replacement of access catwalks are completed, the City should implement the following recommendations.

1. Install chains and caution signs on all access stairways to the primary clarifiers to prohibit unauthorized access.

2. Do not allow access to the catwalks unless there is another authorized individual present.

Priority 1.10 – HVAC/Air Handling Unit Replacement

During the aforementioned workshops replacement of the HVAC/Air Handling Units that serve the Laboratory was identified as a top priority that should be implemented as soon as possible.

Priority 1.11 – Belt Filter Press Building Air Quality Assessment

During the aforementioned workshops an assessment of the air quality within the building during operation was identified as a top priority that should be undertaken as soon as possible.

7.2 Priority 2 Immediate Needs – Avoidance of Public Nuisances

The list of Priority 2 Immediate Needs provided in Table 1 identifies five projects. These are listed below and further expanded and defined in Table 2.

Priority 2.1 – Collection System Magnesium Hydroxide Addition Pre-Design Investigations

Priority 2.2 – Secondary Sedimentation Tanks "Sea Gull" Netting

Priority 2.3 – Primary Effluent Emergency Storage Pre-Design Investigations

Priority 2.4 – Headworks Area Odor Control Optimization Pre-Design Investigations

Priority 2.5 – Influent Screens Odor Control Pre-Design Investigations

7.3 Priority 3 Immediate Needs

The list of Priority 3 Immediate Needs provided in Table 1 identifies eleven projects. These are listed below and further expanded and defined in Table 3.

Priority 3.1 – 3WHP Improvements

Priority 3.2 – RAS/WAS Flow Meter Upgrades

Priority 3.3 – Gravity Thickener Improvements

Priority 3.4 – Effluent Conveyance Improvements Pre-Design Investigations

During the aforementioned workshops power supply redundancy for the effluent pumps was identified as a critical item that needs to be included in the pre-design investigations. Power supply redundancy options to be investigated will include all electrical driven pumps, combination of electrical driven and engine driven pumps; and standby power for electrical driven pumps.

Priority 3.5 – AST Area Walkways Lighting Replacements

Priority 3.6 – Cell Phone Coverage Booster Antenna

During the aforementioned workshops expandable and reliable cell phone coverage throughout the entire plant was identified as a safety concern and a top priority that should be implemented as soon as possible.

Priority 3.7 – DAF Polymer Improvements

Priority 3.8 – Digester Improvements

Priority 3.9 – Sludge Dewatering Improvements

Priority 3.10 – Primary Clarifier Improvements

Priority 3.11 – Co-Gen Cooling Water Improvements

8. ESTIMATES OF PROBABLE IMPLEMENTATION COSTS

A summary of the estimates of probable pre-design investigations costs, construction costs and total capital costs for the Priority 1, 2 and 3 Immediate Needs Improvements listed in Tables 1, 2 and 3 are shown in Table 4. All estimates of probable costs are based on July 2014 dollars and may need to be adjusted the based on the anticipated final implementation schedules that will be identified in the final technical memorandum. The implementation schedules will be discussed with the City at the upcoming workshop to review this draft technical memorandum.

The estimates of probable construction costs and probable total capital costs for projects requiring pre-design design investigations cannot be finalized until this work is completed.

Table 4. Summary of Immediate Needs Probable Costs

Improvements Category	Pre-Design Investigations Cost Estimates	Construction Cost Estimates	Capital Cost Estimates
Priority 1	$157,644	$4,409,200	$6,172,900
Priority 2	$135,442	$51,500	$72,100
Priority 3	$148,280	$14,078,800	$19,710,300
Additional Costs Based on Predesign Investigations		TBD	TBD

9. IMPLEMENTATION SCHEDULES

Each of the Priority 1, 2 and 3 Immediate Needs projects identified in Tables 1, 2 and 3 include Risk Assessment Values that have been assigned to help establish the top priority projects for immediate implementation by the City. The Risk Assessment Categories are identified as High (H), Moderate (M) and Low (L) as defined under Part 6, and were assigned based on input from City staff at the workshops conducted on August 27th and August 28th.

It is suggested that the City review all Immediate Needs projects identified with High Risk Values and prioritize these projects based on the City's capacity to fund the identified estimates of probable construction costs and probable total capital costs. This prioritization may require the City to undertake a comprehensive funding analysis to establish a realistic expenditure schedule that can match the City's budget constraints, and to identify potential funding mechanisms that the City's maybe need to pursue.

Our immediate attention regarding schedules for implementation focuses on High (H) and Moderate (M) priority pre-design investigations that need to be completed before design and construction of these High and Moderate priority projects can move forward. These pre-design investigations are listed below in the order they appear in Tables 1, 2 and 3. The time-lines for implementation of these High and Moderate priority pre-design investigations are shown in Figure 1.

- Priority 1.1 – Arc Flash Pre-Design Investigations

  This is being undertaken by Carollo as part of their Master Planning efforts. However, the pre-cautionary measures identified under Part 7.1 should be undertaken by the City as soon as possible.

- Priority 1.3 – Electrical Vault Repairs Pre-Design Investigations

- Priority 1.6 – Biofilter Removal Pre-Design Investigations
  - 1.6.1 – Advance Primary Treatment Polymer Addition

- 1.6.2 – Biofilter Removal Contingency Plan

- Priority 1.11 – Belt Filter Press Building Air Quality Assessment
- Priority 2.1 – Collection System Magnesium Hydroxide Addition Pre-Design Investigations
- Priority 2.3 – Primary Effluent Emergency Storage Pre-Design Investigations
- Priority 2.4 – Headworks Odor Control Optimization Pre-Design Investigations
- Priority 2.5 – Influent Screens Odor Containment Pre-Design Investigations
- Priority 3.4 – Effluent Conveyance Pre-Design Investigations
- Priority 3.5 – AST Walkway Lights Pre-Design Investigations
- Priority 3.6 – Cell Phone Coverage Pre-Design Investigations
- Priority 3.9 – Sludge Dewatering Pre-Design Investigations
- Priority 3.10 – Primary Clarifier Covers and Odor Control Pre-Design Investigations

10. OTHER "NEEDS SURVEY" IMPROVEMENTS

In addition to the immediate needs presented in this technical memorandum, the City's OWTP and collection system staffs have identified other upgrade and improvement needs. These improvements should be part of the long term master planning efforts that the City is currently undertaking. A preliminary list of these additional needs is provided below.

7.1 Staffing and Training

1. Update CRP Training and conduct training courses.
2. Update General and Activity Specific Training and conduct training courses.
3. Train operators on OWTP laboratory sample analysis procedures.
4. Replace aging personnel chairs and computer work stations

7.2 Collection System Vehicles

1. Replace aging collection system and maintenance vehicle fleet.
2. Purchase additional "Vactor" truck(s).
3. Purchase additional "Camera" truck(s).
4. Install new "tablet" map-book technology in essential collection system vehicles.

7.3 Maintenance Materials and Spare Parts

1. Conduct an inventory of spare parts, tools and maintenance materials and restock inventory.
2. Assess storage requirements and increase number of storage cabinets and storage shelves.
3. Assess purchasing rules and procedures.
   - Increase purchase order (PO) limits
   - Accelerate the PO process.

7.4 Co-Generation Facilities

1. Conduct a focused assessment of all co-generation facilities as part of the global Master Planning effort.
2. Replace co-generation facilities identified in the global Master Planning effort, including improvements to the cooling water system identified under item 3.11 of the Priority 3 Immediate Needs identified in Table 3.

7.5 Lift Stations

1. Conduct a focused assessment of lift station power reliability and redundancy as part of the global Master Planning effort.
2. Upgrade Collection System lift station power supply and power redundancy facilities identified in the global Master Planning effort.

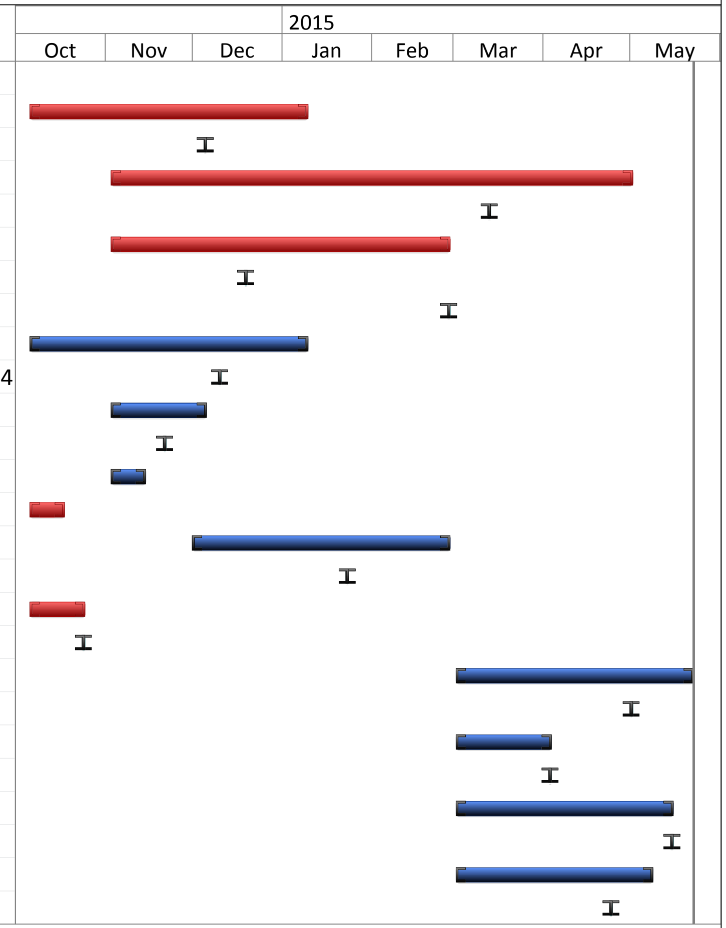
7.6 Central Trunk Sewer

1. Conduct a focused condition assessment of the Central Trunk Sewer as part of the global Master Planning effort.

We recommend that the City review these additional needs with Carollo Engineers in a workshop setting to ensure that these needs are included in the Master Plan update effort.

Figure 1
Preliminary Implementation Schedule
Immediate Needs Technical Memorandums

ID		Task Name	Duration	Start	Finish
1					
2		**1.6 Advanced Primary Treatment Polymer Addition**	**70 days**	**Mon 10/6/14**	**Fri 1/9/15**
3		Draft TM	1 day	Fri 12/5/14	Fri 12/5/14
4		**1.6 Biofilter Removal Contingency Plan**	**130 days**	**Mon 11/3/14**	**Fri 5/1/15**
5		Draft TM	1 day	Fri 3/13/15	Fri 3/13/15
6		**2.1 Magnesium Hydroxide Addition**	**85 days**	**Mon 11/3/14**	**Fri 2/27/15**
7		Design for "Turnkey" Interim Installation	1 day	Fri 12/19/14	Fri 12/19/14
8		Conceptual Design for Permenant System	1 day	Fri 2/27/15	Fri 2/27/15
9		**3.9 Sludge Dewatering**	**70 days**	**Mon 10/6/14**	**Fri 1/9/15**
10		Update Centrifuge Study TM	1 day	Wed 12/10/14	Wed 12/10/14
11		**1.3 Electrical Vault Repairs**	**25 days**	**Mon 11/3/14**	**Fri 12/5/14**
12		Draft TM	1 day	Fri 11/21/14	Fri 11/21/14
13		**3.5 AST Walkways Lights**	**10 days**	**Mon 11/3/14**	**Fri 11/14/14**
14		**3.6 Cell Phone Coverage**	**10 days**	**Mon 10/6/14**	**Fri 10/17/14**
15		**3.10 Primary Clarifiers Cover & Odor Control**	**65 days**	**Mon 12/1/14**	**Fri 2/27/15**
16		Draft TM	1 day	Fri 1/23/15	Fri 1/23/15
17		**1.11 BFP Building Air Quality Assesment**	**15 days**	**Mon 10/6/14**	**Fri 10/24/14**
18		Assessment TM	1 day	Fri 10/24/14	Fri 10/24/14
19		**2.3 Primary Effluent Emergency Storage**	**60 days**	**Mon 3/2/15**	**Fri 5/22/15**
20		Draft TM	1 day	Fri 5/1/15	Fri 5/1/15
21		**2.4 Headworks Odor Control Optimatization**	**25 days**	**Mon 3/2/15**	**Fri 4/3/15**
22		Assessment TM	1 day	Fri 4/3/15	Fri 4/3/15
23		**2.5 Influent Screen Odor Control Containment Optimization**	**55 days**	**Mon 3/2/15**	**Fri 5/15/15**
24		Assessment TM	1 day	Fri 5/15/15	Fri 5/15/15
25		**3.4 Effluent Conveyance**	**50 days**	**Mon 3/2/15**	**Fri 5/8/15**
26		Draft TM	1 day	Fri 4/24/15	Fri 4/24/15



Project: ImmediateNeedsSchedul
Date: Fri 9/26/14

Task	Inactive Task	Start-only
Split	Inactive Milestone	Finish-only
Milestone	Inactive Summary	Deadline
Summary	Manual Task	Critical
Project Summary	Duration-only	Critical Split
External Tasks	Manual Summary Rollup	Progress
External Milestone	Manual Summary	

Table 1
Priority 1 - Immediate Needs (Safety)

Priority Number	Project Title	Impact Areas	Description	Estimated Predesign Budget	Estimated Construction Costs	Total Capital Costs	Risk Value
1.1	Arc Flash Studies	Buildings	Carollo to conduct comprehensive, plant wide ARC Flash Studies as part of Master Planning Efforts.	Under Carollo's Master Plan Consultant.	TBD	TBD	**H**
		MCC's					**H**
		Main Switchgear					**H**
		Co-Generation					**H**
		16KV Switchgear					**H**
		North Area Electrical					**H**
		Headworks Electrical					**H**
1.2	Roof Rehabilitation	Buildings	Rehabilitate and refurbish building roofs, flashings, and roof penetrations to eliminate leaks.				
		Main Switchgear			$20,300	$28,420	H
		Co-Generation			$59,000	$82,600	H
		16KV Switchgear			$38,800	$54,320	H
		North Area Electrical			$38,800	$54,320	H
		Plant Control Center			$33,700	$47,180	H
		Administration			$59,000	$82,600	M
		Subtotal 1.2			**$249,600**	**$349,440**	
1.3	Electrical Vault Repairs	Plant Wide	Repair corroded concrete surfaces, install protective coatings; and replace corroded conduit and wires with new conduits, wires, and Junction boxes.	$26,240	TBD	TBD	H
1.4	Eyewash / Shower Stations	Plant Wide	Exercise all Stations and refurbish/repair as needed.		OWTP Staff		H
1.5	Chemical Storage Tanks Sight Glasses	Plant Wide Chemical Bulk Storage	Install protective "cages" on all sight glasses.		$24,000	$33,600	H
1.6	BioFilter Removal Pre-design Investigations	Biofilters	Undertake a comprehensive pre-design effort to decommission and ultimately remove the biotowers from service.				H
			Predesign Elements to Include:				
			1. Enhanced primary treatment chemical addition "bench scale" and pilot scale testing with polymer and ferric chloride to evaluated impacts on TSS and TBOD5 removal efficiency and subsequent loads on the activated sludge system.	$11,160	TBD	TBD	H
			2. Development of contingency plan to decommission the biotowers and for operation of the activated sludge system should the biofilters fail or need to be taken out of service prior to completion of capital improvements to the activated sludge system.	$104,188	TBD	TBD	H
		Subtotal 1.6		**$115,348**			
1.7	Primary Clarifier Access Walkways	Primary Clarifiers	1. Replace the catwalks.		$268,300	$375,620	H
			2. Install walkways with handrails and hose stations in a 4-quadrant interior layout for cleaning of launders		$552,100	$772,940	H
		Subtotal 1.7			**$820,400**	**$1,148,560**	
1.8	Fall & Slip Prevention		1. Refurbish BFP Building roof and skylights to eliminate leaks.		$70,800	$99,120	H
			2. Install non-skid epoxy floor coating on BFP Building ground floor and belt filter press floor.		$105,000	$147,000	H

Table 1
Priority 1 - Immediate Needs (Safety)

			3. Install permanent access stairs and platforms on DAF area and BFP area polymer mixing tanks.		$5,500	$7,700	H
			4. Install containment structure around DAF area bulk polymer storage tank.		$42,000	$58,800	M
			5. Install access walkways and maintenance platforms for gravity thickeners roof mounted air handling units.		$53,600	$75,040	H
			6. Install headwork's blower building and electrical building roof access caution signs and fall prevention cables.		$5,300	$7,420	H
			7. Expandable base fall arrest system for sewage lift stations, collection system manholes, vortex structures, and junction structures, and BILCO fall prevtion grating at LS 29		$73,100	$102,340	H
			8. Install access ladders for AST's.		$47,900	$67,060	H
			9. Install acces ladder at AWPF Supply Fans		$16,100	$22,540	H
		Subtotal 1.8			**$419,300**	**$587,020**	
1.9	"Below" Cover Structures Rehabilitation	Plant wide					
			1. Influent sewer vortex structures. Repair deteriorated concrete surfaces and install new protective coatings on all "below cover" surfaces.		$366,000	$512,400	H
			2. Influent junction structure. Repair coatings on all vertical walls to depth of 2 feet below cover and 1 foot above cover, all surfaces of below cover beams with 6 inch overlap on top surfaces and all surfaces of above cover curbs.		$83,700	$117,180	M
			3. Influent screen channels. Repair coatings on surfaces identified in 1.9.1.		$139,400	$195,160	M
			4. Grit Chamber and bypass Channels. Repair Coatings on surface identified in item 1.9.1.		$148,600	$208,040	M
			5. Influent Pump Station Wet Well. Repair Coatings on surface identified in item 1.9.1.		$185,400	$259,560	M
			6. RAS / WAS Wet well.		$142,100	$198,940	H
			7. Lift Station 29.		$179,800	$251,720	M
		Subtotal 1.9			**$1,245,000**	**$1,743,000**	
1.10	HVAC Replacements	Buildings	Replace HVAC and air handling units.				
		Gravity Thickeners			$107,900	$151,060	M
		Main Switchgear			$49,000	$68,600	H
		Co-generation			$352,300	$493,220	H
		16KV Switchgear			$40,500	$56,700	H
		North Area Electrical			$59,100	$82,740	M
		Plant Control Center			$190,800	$267,120	M
		Administration			$190,800	$267,120	M
		Laboratory			$95,400	$133,560	H
		Collection / Main			$102,900	$144,060	M
		Primary / DAF			$97,900	$137,060	L
		Maintenance			$212,400	$297,360	M
		Vacuum Filter			$38,800	$54,320	L
		BFP Building Personnel Areas			$59,100	$82,740	M
		Digester Control Building			$54,000	$75,600	M
		Subtotal 1.10			**$1,650,900**	**$2,311,260**	
1.11	BFP Building Air Quality Investigation	BFP Building	Conduct pre-design assessment of air quailty in building during operation	$16,056	TBD	TBD	H

Table 2
Priority 2 - Immediate Needs (Avoidance of Public Nuisance)

Priority Number	Project Title	Impact Areas	Description	Estimated Predesign Budget	Estimated Construction Costs	Total Capital Costs	Risk Value
2.1	Collection System Magnesium Hydroxide Addition Predesign Investigations	Collection System (Redwood Trunk, Central Trunk, Eastern Trunk)	1. Conduct additional magnesium hydroxide pilot addition study for the Eastern Trunk Sewer.	$12,763	TBD	TBD	**H**
			2. Conduct site visit to the CSDLAC to obtain full scale information on dosages, points of chemical adddition, mixing, design sizing and storage criteria, P-trap manhole, and / or curtain wall design criteria for selected manholes.	$3,883			**H**
			3. Conduct site visits to potential chemical storage sites for each of the three trunk sewers.	$3,530			**H**
			4. Prepare "turn-key" installtion definitions and skectches for installation of interim chemical addition systems by City staff.	$21,976	TBD	TBD	**H**
			5. Prepare a TM with conceptual skectches and equipment lists prior to detailed design of permenant systems	$21,900	TBD	TBD	**H**
		Subtotal 2.1		**$64,052**	**TBD**	**TBD**	
2.2	SST OSHA " Sea Gull" Netting	SSTS	Complete the installation of netting on the secondary sedmintation tanks for elimination of sea gulls congregation.		$51,500	$72,100	**H**
2.3	Primary Effluent Emergnecy Storage Predesign Investigations	Interstage PS and CCT primary effluent bypass.	Condcut a predesign investigation to evaluate emergency storage options for primary effluent, including continuation of storage in one primary clarifier , storage in the CCT, storage in the bio-filter lower structure, and pumping equipment and power supply redundancy at the interstage PS.	$30,244	TBD	TBD	**H**
2.4	HW Odor Control Optimization Predesign Investigations	Headworks	1. Conduct odor control ventiallation " air flow" check balancing measurements on the ventillation system.	$2,670			**M**
			2. Confirm the installation of odor control ductwork, including balancing dampers in accordance with the original contract documents for the Headworks area improvements project.	$2,407			**M**
			3. Identify additional improvements such as the installation of strategy pressure monitoring gauges to enhance operation and control of the odor control system.	$1,923			**M**
			4. Prepare an assessment TM with conceptual sketches and equipment lists prior to detailed design.	$10,900			
		Subtotal 2.4		**$17,900**			
2.5	Influent Screens Odor Control Predesign Investigations	Headworks	1. Conduct an alternative analysis for reduction of fecal matter capture on the influent screens and acummaltion of fecal matter on the screenings conveyor.	$6,220			**M**
			2. Conduit alternatives analysis for enclosing the influent screening conveyor belt and ventilation of the contained atompshpere to the Headworks odor control scrubbers.	$5,480			**M**
			3. Prepare an assessment TM with conceptual sketches and equipment lists prior to detailed design.	$11,546			**M**
		Subtotal 2.5		**$23,246**			

Table 3
Priority 3 - Immediate Needs (Operability and Maintenance Enhancements)

Priority Number	Project Title	Impact Areas	Description	Estimated Predesign Budget	Estimated Construction Costs	Total Capital Costs	Risk Value
3.1	3WHP Improvements	3WHP Pump Station	1. Replace manually cleaned basket strainers with automatic " self cleaning" basket strainers.		$206,000	$288,400	**L**
			2. Replace the 3WHP pumps and drives.		$377,600	$528,640	**M**
3.2	RAS & WAS Flow Meters	RAS and WAS flow metering	Refurbish and replace meters as necessary.		$215,100	$301,100	**M**
3.3	Gravity Thickener Improvements	Gravity Thickener	1. Permanently repair or replace leaking section(s) of the feed sludge manifold.		$52,800	$73,920	**M**
			2. Replace GT 1 and GT 2 "top mounted" air handling units. This immediate need will be coordinated with Priority 1 Immediate need 1.8.5.		$118,800	$166,320	**M**
			3. Replace GT 1 collector mechanism, launders, and repair concrete surfaces. Place GT1 back in service before you remove GT2 out of service.		$1,048,400	$1,467,760	**M**
			4. Replace GT 2 collector mechanism, launders, and repair concrete surfaces. Place GT2 back in service.		$1,048,400	$1,467,760	**M**
3.4	Effluent Conveyance Improvements	CCT & Effluent Pump Station	1. Conduct a "low flow" inspection of the gravity pipeline check valve to determine repair needs.	$2,034			**M**
			2. Schedule "low flow" repair of the check valve.		TBD	TBD	M
			3. Coordinate an inspection / assessment of the Big Red effluent pump station by the pump manufacturer to determine repair / replacement needs to eliminate vibration concerns.	$1,554			L
			4. Implement manufacturer recommendations for repair / replacement improvements to Big Red.	TBD	TBD	TBD	L
			5. Revist the Effluent Pump Station Wet Well Study.	$2,035			L
			6. Power supply redundancy / reliability Predesign Investigations	$21,476	TBD	TBD	L
3.5	AST Walkway Lights	AST	Replace the handrail mounted walkway lights with corrosion resistant LED lights.	$4,040	TBD	TBD	M
3.6	Cell Phone Coverage	Plant Wide	1. Coordinate a site visit with the OWTP cell phone service provider for recommendations for expanded and reliable coverage throughout the plant.	$1,221	TBD	TBD	H
			2. Implement recommendations of cell phone service provider for "booster" antennas.	TBD	TBD	TBD	
3.7	DAF Polymer System and Air Compressors	DAF Thickeners	1. Upsize and replace DAF system air compressors.		$145,400	$203,560	L
			2. Upgrade the DAF polymer solution to re-establish the contiguous batching system.		$26,800	$37,520	L
3.8	Digester Improvement	Digesters	1. Digester No. 2				H
			1.1 Clean digester. NOT NECESSARY; DIGESTER RECENTLY CLEANED		$0	$0	
			1.2 Replace cover with cover identical to Digester No. 1		$1,596,800	$2,235,520	
			1.3 Repair interior concrete coatings and install coating on underside of new cover.		$393,200	$550,480	
			1.4 Refurbish and recoat draft tube assembly.		$55,100	$77,140	
			1.5 Replace heat exchangers and gas piping		$258,100	$361,340	
			2. Digester No. 1				M
			2.1 Clean digester.		$392,800	$549,920	
			2.2 Repair interior coatings		$441,800	$618,520	
			2.3 Refurbish and recoat draft tube assembly.		$55,100	$77,140	
			2.4 Replace heat exchangers and gas piping		$258,100	$361,340	
			3. Digester No. 3				M
			3.1 Clean digester.		$480,100	$672,140	
			3.2 Repair interior coatings		$541,800	$758,520	
			3.3 Refurbish and recoat draft tube assembly.		$66,000	$92,400	

Table 3
Priority 3 - Immediate Needs (Operability and Maintenance Enhancements)

			3.4 Replace heat exchangers.		$258,100	$361,340	
		Subtotal 3.8			**$4,797,000**	**$6,715,800**	
3.9	Sludge Dewatering Improvements	Sludge Dewatering	1. Update the MPI 2007 Centrifuge Study Report including consideration of the alternatives presented in the PS/MKA 2014 Unit Process Evaluation and Optimization Study.	$14,080	TBD	TBD	M
			2. Pre-desing investigations with manufacturer to define requirements to refurbish 2 BFP's on an interim basis until the BFP's are replaced with an alternative technology.	$12,120	TBD	TBD	H
			3. Upgrade BFP Polymer solution make up system to re-establish the continuous batching system.		$26,100	$36,540	M
			4. Replace " wet sprinkler" piping in the BFP Building.		$82,600	$115,640	H
		Subtotal 3.9			**$108,700**	**$152,180**	
3.10	Primary Clarifier Improvements	Primary Clarifier	1. Replace scum / sludge collectors and scum beach.		$4,267,500	$5,974,500	M
			2. Replace Launders with FRP Launders and supports.		$634,800	$888,720	M
			3. Concrete repairs and coatings.		$327,900	$459,060	M
			4. Replace or refurbish the primary sludge pumps.		$252,900	$354,060	M
			5. Replace or refurbish the scum ejectors.		$252,900	$354,060	M
			6. Predesign investigations for the primary clarifier covers and odor control.	$77,248	TBD	TBD	
3.11	Co-Gen Cooling Water System at CCT	Co-Gen Cooling Water	1. Install new automatic strainer on 3WHP cooling water loop at CCT		$188,800	$264,320	
			2. Modify cooling water loop with loop extension into CCT	$12,472	TBD	TBD	

This document is released for the purpose of information exchange review and planning only under the authority of Tracy Anne Clinton, September 2017, State of California, PE No. 48199 and Elizabeth Abigail Charbonnet, September 2017, State of California, PE No. 84612

City of Oxnard

Public Works Integrated Master Plan

WASTEWATER

PROJECT MEMORANDUM 3.7.2 ALTERNATIVE OXNARD WASTEWATER TREATMENT PLANT ASSESSMENT – PARTIAL RELOCATION OF OXNARD WASTEWATER TREATMENT PLANT

REVISED FINAL DRAFT
September 2017

carollo
Engineers...Working Wonders With Water™

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PREFACE

The analysis and evaluations contained in these Project Memorandum (PM) are based on data and information available at the time of the original date of publication, December 2015. After development of the December 2015 Final Draft PMs, the City continued to move forward on two concurrent aspects: 1) advancing the facilities planning for the water, wastewater, recycled water, and stormwater facilities; and 2) developing Updated Cost of Service (COS) Studies (Carollo, 2017) for the wastewater/collection system and the water/distribution system. The updated 2017 COS studies contain the most recent near-term Capital Improvement Projects (CIP). The complete updated CIP based on the near-term and long-term projects is contained in the Brief History and Overview of the City of Oxnard Public Works Department's Integrated Planning Efforts: May 2014 – August 2017 section.

At the time of this Revised PWIMP, minor edits were also incorporated into the PMs. Minor edits included items such as table title changes and updating reports that were completed after the December 2015 original publication date.

City of Oxnard

Public Works Integrated Master Plan

WASTEWATER

PROJECT MEMORANDUM 3.7.2
ALTERNATIVE OXNARD WASTEWATER TREATMENT PLANT ASSESSMENT - RELOCATE OXNARD WASTEWATER TREATMENT PLANT

TABLE OF CONTENTS

Page No.

LIST OF TABLES

ALTERNATIVE OXNARD WASTEWATER TREATMENT PLANT ASSESSMENT - RELOCATE OXNARD WASTEWATER TREATMENT PLANT

1.0 INTRODUCTION

The City of Oxnard (City) is considering purchasing the land to the North and East of the Advanced Water Purification Facility (AWPF) for a variety of uses. This land, located along Hueneme Road at Perkins Road, is currently owned by the Navy. The City and Navy are in discussions regarding the lands ownership and use. The City is considering using a portion of this land for a 'Gateway Park' and another portion of this land for AWPF finished water storage. However, there would still be space available for other City uses. One possible other use for this land is the relocation of a portion of the Oxnard Wastewater Treatment Plant (OWTP) processes. While there is still considerable work that would be needed to assess the feasibility of moving portions of the OWTP, at this time there are no fatal flaws to this option and thus it is considered in this PM, by request of the City.

There are a variety of considerations that make moving the OWTP a viable option. First, much of the existing infrastructure at the OWTP is nearing the end of its useful life and needs to be repaired or replaced within the next 15 years. Since a large portion of the OWTP facilities are recommended for replacement in this Public Works Integrated Master Plan (PWIMP), it is worth considering the optimal location for these replacement facilities. Additionally, the OWTP is located very near the coast. FEMA predicts that in the future there is the possibility that portions of the OWTP will experience significant flooding within the next fifty years due to its low elevation. Thus precautions should be planned to prevent such flooding. One such option for flooding protection is the construction of a floodwall to protect the OWTP at its existing location. This option is currently planned for in Scenario 2, and outlined in Project Memorandum (PM) 3.7.1. Another option to consider is to move many of the OWTP facilities to a location of higher elevation, while leaving some facilities in place. This preliminary option is discussed in the sections below.

1.1 PMs Used for Reference

The recommendations outlined in this PM include recommendations from the following other PMs:

- PM 3.2 - Wastewater System - Flow and Load Projections.
- PM 3.4 - Wastewater System - Treatment Plant Performance and Capacity.
- PM 3.5 - Wastewater System - Condition Assessment.
- PM 3.6 - Wastewater System - Seismic Assessment.

- PM 3.8 - Wastewater System - Arc Flash Assessment.
- PM 3.9 - Wastewater System - Cathodic Protection Assessment.
- PM 3.10 - Wastewater System - SCADA Assessment.
- PM 3.11 - Wastewater System - Flow Monitoring.

1.2 Other Reports Used for Reference

In addition to the information referenced in PM 3.7.1, this PM also draws on information from the following reports:

- *Gateway Park / Ormond Beach Opportunities Analysis*, August 2011, (Kestrel Consulting, 2011).
- *DRAFT Direct Potable Reuse Case Study for WRRRF,* May 2013, (Carollo, 2013).

2.0 IMMEDIATE NEEDS

In order to move some of the OWTP processes to a new location, the City would need to consider the regulatory, timing, and financial feasibility of the move. A detailed facilities feasibility study (including location/sizing of facilities and costs) and environmental assessment would need to be conducted. The City would also need to obtain the proper permits for converting the land to its intended uses. It is estimated that this upfront work could take approximately five to ten years to complete. Given this timeframe and the existing condition of many of the OWTP facilities, there are a number of critical improvement projects at the OWTP that will need to move forward regardless of whether some of the OWTP processes will be relocated in the future.

Table 1 outlines the projects critical to keeping the plant safe and operational for the next five to ten years. During this time, the City can study and determine whether the preference is to keep the OWTP at its existing location or better define moving some of or all of the wastewater facilities. The projects identified as critical are based on those identified in PM 3.7.1 and also several small group workshops held with City management and staff and other consultants currently working directly with the wastewater plant. Table 1 lists the critically needed projects, a brief description, project timing, and a planning level cost estimate for each project. Two estimates are given. The higher estimate would provide more complete repairs and be more likely to sustain the plant for ten years. It also includes a 10 percent contingency for emergency needs that might arise. The lower estimate would likely cover the bare-bone essential repairs needed to keep the plant operational for five to six years. The total estimated cost of these immediate needs ranges from $21 to $39 Million (M). Moving forward, an average repair cost of $30 M was used.

Table 1 Recommended Projects, Cost Estimates, and Phasing for Immediate Needs at the OWTP to Keep the Plant Operational[2]
Public Works Integrated Master Plan
City of Oxnard

		Low-End Estimate		High-End Estimate	
Start Year	**Years to Implement**	**Project Name**	**Un-escalated Project Cost Estimate**	**Project Name**	**Un-escalated Project Cost Estimate**
2016	3	Headworks Odor Control with Screen Walls, Concrete Repair, and RPF Cover Replacement	$3,000,000	Headworks Odor Control with Screen Walls, Concrete Repair, and RPF Cover Replacement	$4,640,000
2016	4	Headworks Below Cover Coating Repairs	$500,000	Headworks Below Cover Coating Repairs	$1,310,000
2016	2	Replace Primary Clarifier Equipment and secure launders	$3,000,000	Replace Primary Clarifier Equipment	$5,000,000
2016	1	Demolish Biotowers	$800,000	Demolish Biotowers	$800,000
2016	1	Add Baffle Walls in ASTs	$380,000	Add Baffle Walls in ASTs	$380,000
2016	2	Replace/Refurbish Interstage and Effluent Pump Station Pumps	$1,500,000	Replace Interstage and Effluent Pump Station Pumps	$4,000,000
2016	2	Clean Digesters #1 and #3, add Dystor Cover to #2	$3,000,000	Clean Digesters #1 and #3, add Dystor Cover to #2	$3,000,000
2016	1	Rebuild/Rehab the Gravity Thickeners	$750,000	Rebuild/Rehab the Gravity Thickeners	$1,000,000
2016	1	Refurbish the Belt Filter Presses	$2,000,000	Replace the Belt Filter Presses	$4,000,000
2016	2	Refurbish 2 of 3 Cogen Units	$800,000	Rebuild Cogen Units	$500,000
2016	3	Replace Standby Generators	$2,500,000	Replace Standby Generators	$2,500,000
2016	5	Replace Some Plant MCCs	$1,500,000	Replace Plant MCCs	$5,430,000
2016	2	Plant-Wide Utilities	$1,000,000	Plant-wide Cathodic Protection	$1,430,000
2016	1	SCADA System Upgrades	$500,000	SCADA System Replacement	$1,000,000
2016	4	Water Quality Early Warning System	$330,000	Water Quality Early Warning System	$330,000
	Subtotal		$21,230,000		$35,320,000
	Contingency				$3,680,000
	Total		**$21,560,000**[1]		**$39,000,000**[1]

Notes:
(1) $30,000,000 was chosen as a budgetary estimate of immediate CIP project needs.
(2) Project costs, schedules, and phasing are based on data and information available at the time of the original date of preparation – December 2015. The updated CIP is contained in the Brief History section of the PMs, the Summary Report, and the Executive Summary.

3.0 PRELIMINARY SITE LAYOUT FOR MOVING THE OWTP

If the City moves forward with relocating all or part of the OWTP, a phased approach to relocation is suggested. If relocation is the preferred option, the City should consider moving all primary treatment, solids handling, and support facilities to the new site in the first phase of plant relocation. During Phase 2, secondary treatment, disinfection, and effluent pumping should also be relocated. Phase 2 facilities were broken out because they are generally on higher ground than Phase 1 facilities and are not as impacted by potential flooding associated with sea level rise. Additionally these Phase 2 facilities are generally in better shape and have a longer remaining useful life. However, when these Phase 2 facilities reach the end of their remaining useful life they too should be relocated as sea level rise will eventually impact them as well. Assuming permitting and the environmental process takes five to ten years, moving the Phase 1 facilities should start around 2023 and Phase 2 should start around 2035.

Phase 1 should not only include the relocation of primary treatment, solids handling, and support facilities, but it should also include rehabilitation of the facilities that will stay in their existing location until Phase 2, namely secondary treatment, disinfection, and effluent pumping facilities. Additionally, Phase 1 should include the demolition of the biotowers and gravity thickeners as well as headworks rehabilitation.

At this time it's assumed that the new plant location will not be as space limited, therefore conventional activated sludge treatment and chlorine disinfection could be installed for secondary treatment instead of MBR and UV facilities, to reduce costs. However, all other new facilities recommended in PM 3.7.1 - *Wastewater System - Traditional OWTP Alternatives - Upgrade in Place,* like a FOG receiving station and Chemically Enhanced Primary Treatment (CEPT), are still recommended with this partially relocated plant option.

Given the OWTP's existing footprint, and the additional facilities needed through 2040, it is estimated that approximately 1,230,000 square feet (sqft) (around 28 acres) will be needed for this relocation. This footprint accounts for the additional DAFTs needed for co-thickening, larger digesters, a non-hazardous liquid receiving station, a FOG receiving station, sludge silos, and additional aeration basins if nitrification/denitrification is needed in secondary treatment. This footprint does not include a new headworks, as it is assumed that will remain in place and in operation and will not be relocated.

While more study is needed to determine the optimal site layout, it is recommended that all liquid treatment facilities be located together. It is also recommended that solids treatment facilities be located further from the roads to provide an added buffer from neighboring communities due to possible odors. Additionally, to provide a welcoming entrance and easy access, the administration and operations buildings should be located near the plant entrance. If located near the AWPF, these facilities could be similar in style to the AWPF for continuity and architectural interest. The equalization basins (approximately 90,000 square feet) could either be re-built near their existing location, or moved to the new site as well. The phasing of facility transition should be explored further and will depend on the age and condition of existing facilities, the ability of the plant to operate during the transition, regulatory considerations, and constructability.

3.1 Other Site Considerations

The land east of the AWPF is not only being considered for OWTP relocation, but other facilities as well. The City is also considering using this land for a proposed 'Gateway Park', DPR and agricultural storage, parking, and a regional project to support groundwater basin management. Land requirements for these other projects are shown in Table 2. If the OWTP is relocated to the proposed site north and east of the AWPF, the remaining available land is expected to be around 397,000 sqft. This available land area is less than the minimum land needed for other uses. However, it is possible that the EQ basins could remain at their existing location freeing up an additional 90,000 sqft, and some of the existing OWTP facilities/buildings could be consolidated when they are relocated. Additionally, the City could look into purchasing additional land nearby or reducing the footprint of other proposed facilities.

Table 2 Other Possible Land Uses Considered for the Land Near the AWPF
Public Works Integrated Master Plan
City of Oxnard

Purpose	Area Needed (sqft)
Gateway Park(1)	353,000 - 666,000
DPR Storage(2)	60,000
Agricultural Storage(3)	45,000
Parking(4)	76,000 - 120,000
Regional Project to Support Groundwater Basin Management(5)	100,000
Total	**634,000 - 991,000**

Notes:
(1) Based on the ranges given in *Gateway Park / Ormond Beach Opportunities Analysis*, Kestrel Consulting 2011. Includes a visitor center and adjacent amenities, community recreation area, trails and access, and general landscaping and signage.
(2) Assumes 3 tanks each with 3.125 MG storage capacity. This is based on the 2013 *Direct Potable Reuse Case Study for WRF*.
(3) Assumes peak irrigation flow of 7 mgd for 8 hours would need to be stored in an 8 ft deep basin. This is based on the 2013 *Direct Potable Reuse Case Study for WRF*.
(4) Based on the ranges given in *Gateway Park / Ormond Beach Opportunities Analysis,* Kestrel Consulting 2011.
(5) Based on the land used for the existing Port Hueneme Water Agency Desalter.

4.0 PRELIMINARY COST FOR RELOCATING THE OWTP

A preliminary master-planning-level cost estimate was developed for relocating the OWTP to a new location; however, this estimate should be refined as the project develops further. Table 3 shows the projects involved in this option and their associated costs. In addition to these projects, funds should also be reserved for land acquisition, permitting, demolition and reclamation of the existing OWTP site, and additional civil/site work/inter-process piping needed with a new plant. For example, the site may need to be raised to a higher elevation and consider future sea-level rise. Table 4 adds these costs to the new plant option and compares the total cost of a new plant to the cost of rehabilitating the existing plant. This table also incorporates the additional operations and maintenance costs likely to be realized with an aging plant if the existing plant is kept in operation. As this table shows, based on class five cost estimates, there is not a significant difference between these two options.

The costs and timing presented in this PM represent Carollo's best professional judgment of the capital expenditure needs of the City and of the timing needed to maintain a reliable and compliant system that can meet current and future wastewater generation needs. Timing was set to align with the seven master plan drivers, namely: R&R, regulatory requirements, economic benefit, performance benefit, growth, resource sustainability, and policy decisions. Timing is also based on input from City staff and the condition assessments performed.

While the costs developed in this PM match the costs analyzed as part of the Cost of Service Study, the timing presented may differ. The Cost of Service Study will balance not only the CIP projects identified but also the rates and rate payer affordability based on a yearly balance and also the integrated costs for the different City funds and enterprises.

Table 3 Recommended Projects, Cost Estimates, and Phasing for Relocating the OWTP to a New Site
Public Works Integrated Master Plan
City of Oxnard

Project	Driver	Start Year	Years to Implement	Un-escalated Project Cost ($)
Phase 1 Projects				
New Primary Clarifiers	R&R	2023	5	$24,500,000(1)
CEPT	Performance	2023	2	$1,500,000(2)
New Digesters	R&R	2023	5	$78,800,000(1)
New DAFTs	Performance	2023	3	$15,800,000(1)
New Chemical Handling Facilities	R&R	2023	2	$19,300,000(1)
New Primary Sedimentation Building	R&R	2023	5	$3,100,000(2)
New Chemical Handling Building	R&R	2023	3	$3,400,000(2)
New Non Hazardous Liquid Receiving Station	Performance	2023	2	$2,800,000(2)
New FOG Receiving Station	Resource Sustainability	2023	2	$3,700,000(2)
New Digester Control Building	R&R	2023	5	$1,700,000(2)
New Polymer Building	R&R	2023	3	$800,000(2)
New Solids Processing Facility	Performance	2023	3	$27,800,000(2)
New Sludge Silos	Performance	2023	3	$6,900,000(2)
New Cogeneration Facility	R&R	2023	A	$16,100,000(2)
New Operations Center and Lab Building	R&R	2023	4	$18,500,000(2)
New Collection System Maintenance Building	R&R	2023	2	$7,100,000(2)
New Storage/Warehouse	R&R	2023	2	$7,100,000(2)
New Effluent Electrical Building	R&R	2023	3	$1,300,000(2)
New North Area Electrical Building	R&R	2023	3	$2,000,000(2)
New Main Electrical Building	R&R	2023	3	$1,000,000(2)
Solar Facilities	Resource Sustainability	2023	10	$1,700,000(2)
SCADA System Upgrade	R&R	2023	5	$11,800,000(2)
AST Blower and Diffuser Replacement	R&R	2016	3	$6,200,000(2)

Table 3 Recommended Projects, Cost Estimates, and Phasing for Relocating the OWTP to a New Site[3]
Public Works Integrated Master Plan
City of Oxnard

Project	Driver	Start Year	Years to Implement	Un-escalated Project Cost ($)
Secondary Small Equipment Replacement	Small Equipment Replacement	2016	3	$700,000[2]
Secondary Sedimentation Tanks Replace Skimmers, Collectors, Drives and RAS Pumps	R&R	2016	3	$12,000,000[2]
EQ Basin Small Equipment Replacement	Small Equipment Replacement	2019	3	$ 600,000[2]
AST Concrete Rehabilitation	R&R	2016	11	$8,800,000[2]
SST Concrete Rehabilitation	R&R	2016	11	$6,200,000[2]
EQ Concrete Rehabilitation	R&R	2016	3	$2,800,000[2]
Chlorine Contact Tanks Rehabilitation	Small Equipment Replacement	2023	3	$400,000[2]
Chlorine Contact Tanks Coating	R&R	2025	2	$1,500,000[2]
Effluent Pump Station Rehabilitation	R&R	2016	3	$16,800,000[2]
CMMS	R&R	2016	3	$300,000[2]
Phase 2 Projects				
New Activated Sludge Tanks	R&R	2035	5	$33,300,000[1]
New Secondary Sedimentation Tanks	R&R	2035	5	$31,500,000[1]
New EQ Basin	R&R	2035	5	$8,800,000[1]
New Chlorine Contact Tanks	R&R	2035	5	$3,500,000[1]
New Effluent Pump Station	R&R	2035	5	$8,800,000[1]
Headworks Rehabilitation	R&R	2035	5	$11,600,000[2]
			Total:	**$410,500,000**

Notes:
(1) EALC is 75% of construction cost for those projects based on cost curves.
(2) EALC is 35% of construction cost for those projects originally estimated for the existing site, but now moved to new site with this scenario, due to new site uncertainties.
(3) Project costs, schedules, and phasing are based on data and information available at the time of the original date of preparation – December 2015. The updated CIP is contained in the Brief History section of the PMs, the Summary Report, and the Executive Summary.

Table 4	Cost Comparison Between Keeping the Existing Plant and Constructing a New Plant Public Works Integrated Master Plan City of Oxnard	
Components	**Existing Plant ($ M)[1]**	**New Plant ($ M)[2][3]**
Total Construction Cost	$331	$258
Total Project Cost	**$410**	**$411**
Constructability and Protection of electrical and major equipment from SLR	$50	--
Additional O&M for Old Plant (15% of Construction Cost)	$77	--
Immediate Needs	--	$30
Additional civil/site work/inter-process piping needed with new plant (15% of Construction Cost)	--	$39[4]
Demolish and Reclaim old site	--	$10
Land Acquisition	--	$22
CEQA/Permitting (2% of Construction Cost)	--	$5
Total[5]	**$540**	**$520**

Notes:
(1) EALC is 24% of construction cost, consistent with other recommended projects in this PWIMP.
(2) EALC is 35% of construction cost for those projects originally estimated for the existing site, but now moved to new site with this scenario, due to new site uncertainties.
(3) EALC is 75% of construction cost for those projects based on cost curves.
(4) Spread over all the projects implemented at the new site.
(5) Totals are rounded up to the nearest 5 Million.

This document is released for the purpose of information exchange review and planning only under the authority of Tracy Anne Clinton, September 2017, State of California, PE No. 48199 and Christopher Alan Carvalho, September 2017, State of California, PE No. E20740

City of Oxnard

Public Works Integrated Master Plan

WASTEWATER

PROJECT MEMORANDUM 3.8
ARC FLASH ASSESSMENT

REVISED FINAL DRAFT
September 2017

Engineers...Working Wonders With Water™

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PREFACE

The analysis and evaluations contained in these Project Memorandum (PM) are based on data and information available at the time of the original date of publication, December 2015. After development of the December 2015 Final Draft PMs, the City continued to move forward on two concurrent aspects: 1) advancing the facilities planning for the water, wastewater, recycled water, and stormwater facilities; and 2) developing Updated Cost of Service (COS) Studies (Carollo, 2017) for the wastewater/collection system and the water/distribution system. The updated 2017 COS studies contain the most recent near-term Capital Improvement Projects (CIP). **The complete updated CIP based on the near-term and long-term projects is contained in the Brief History and Overview of the City of Oxnard Public Works Department's Integrated Planning Efforts: May 2014 – August 2017 section.**

At the time of this Revised PWIMP, minor edits were also incorporated into the PMs. Minor edits included items such as table title changes and updating reports that were completed after the December 2015 original publication date.

City of Oxnard

Public Works Integrated Master Plan

WASTEWATER

PROJECT MEMORANDUM 3.8
ARC FLASH ASSESSMENT

TABLE OF CONTENTS

Page No.

LIST OF TABLES

LIST OF FIGURES

ARC FLASH ASSESSMENT

1.0 INTRODUCTION

The short circuit, coordination, and arc flash hazard studies contained in this report provide information necessary for the safe and reliable operation and maintenance of the City of Oxnard (City) wastewater treatment facilities' electrical distribution system, and to help them meet the safety requirements of NFPA 70E and OSHA 1910.132(d). The facilities with dedicated utilities power that were included in this electrical study are:

- Main Electrical Building.
- Headworks Facilities.
- Gym.
- Sampling Station/Eastern Trunk Pump Station.

The studies in this report were performed using ETAP power system analysis software. The data required to build the electrical system model was obtained from a combination of field investigation and as-built project documentation.

1.1 Project Memorandums (PMs) Used for Reference

The recommendations outlined in this PM include background from the following other PMs:

- PM 2.6 - Water System - Arc Flash Assessment.
- PM 3.1 - Wastewater System - Background Summary.
- PM 4.4 - Recycled Water System - Arc Flash Assessment.

1.2 Other Reports Used for Reference

The following codes and standards are referenced in this PM:

- NFPA 70 National Electric Code (NEC).
- NFPA 70E Standard for Electrical Safety in the Workplace.
- IEEE Standard 242 (IEEE Buff Book) - Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
- IEEE 1584 - Guide for Performing Arc Flash Hazard Calculations.

1.3 Short Circuit Study

The objective of the Short Circuit Study is to verify that the electrical distribution equipment in the plant is rated to withstand and interrupt the short circuit currents that could result from a fault in the electrical distribution system.

Section 2.0 identifies equipment that is not properly rated for the available short circuit current.

1.4 Protective Device Coordination Study

The Protective Device Coordination Study has been performed to achieve four objectives – sensitivity, security, selectivity, and safety. Sensitivity refers to the degree of certainty that a device will operate correctly under a fault. Security is the degree of certainty that a device will not operate when there is no fault condition. Selectivity means that the protective device closest to a fault trips before any upstream devices to clear the fault, isolating the resulting outage to the smallest amount of equipment possible. Safety primarily applies to the arc flash hazard and requires that protective devices operate as quickly as possible to reduce incident energy.

The results of the study show that certain protective devices are not properly coordinated and require adjustment**.** Section 3.0 identifies the protective devices, which are not properly coordinated.

1.5 Arc Flash Study

The objective of the Arc Flash Study is to provide information that allows plant staff to take appropriate precautions when working on energized electrical equipment to reduce the potential risk of injury from an arc flash event. The results of the Short Circuit and the Protective Device Coordination Studies are used to calculate the incident energy and hazard boundaries based upon NFPA 70E 2015 Edition and IEEE 1584 for equipment in the electrical distribution system. OSHA regulations require that employers perform an assessment of the workplace to identify arc flash hazards.

Specifically, "The employer shall assess the workplace to determine if hazards are present, or are likely to be present, which necessitate the use of personal protective equipment (PPE). If such hazards are present, or likely to be present, the employer shall: Select, and have each affected employee use, the types of PPE that will protect the affected employee from the hazards identified in the hazard assessment; communicate selection decisions to each affected employee; and select PPE that properly fits each affected employee." [OSHA 1910.132(d)(1)].

The arc-flash labels provided with this study will help the plant to comply with these regulations by identifying the PPE level and arc flash boundary at each piece of equipment.

2.0 SHORT CIRCUIT STUDY

The objective of the Short Circuit Study is to verify that the electrical distribution equipment in the facility is rated to withstand and interrupt the available short circuit currents that could result from a fault in the electrical distribution system in accordance with NFPA 70 National Electric Code (NEC), Article 110 Paragraph's 110.9 and 110.10. The study results show that the existing electrical distribution equipment is sufficiently rated for the worst-case short circuit current with the exceptions of the following below:

- Main Electrical Building:
  - The main breaker for PNL DP4 is not properly rated for the available fault current.
  - The main bus for PNL DP4 is not properly rated for the available fault current.
  - The fuse for B20100.00 for Blower No. 1 is not properly rated for the available fault current.
  - The fuse for B20200.00 for Blower No. 2 is not properly rated for the available fault current.
  - The fuse for B20400.00 for Blower No. 4 is not properly rated for the available fault current.
- Headworks Facility:
  - The feeder Breaker for ATS-L BUS A is not properly rated for the available fault current.
  - The feeder Breaker for ATS-L BUS B is not properly rated for the available fault current.

2.1 Source Data

The results of the Short Circuit Study are completely dependent on the information in the electrical system model. As such, every effort has been made to obtain the most up-to-date information available for all equipment covered under the scope of the study. In the future, when changes are made to the electrical distribution system, the system model must be updated and a new short circuit study performed based on the updated model.

2.1.1 Utility Contribution

The following values are the available fault current at the utility service entrance, as provided by the utility in March 2015. Both the maximum and minimum fault current levels are incorporated into the electrical system model in order to capture the worst case arc flash event. It is important to note that utility fault current levels can change due to numerous variables in the utility distribution and transmission system. This is why it is undesirable to have equipment's short circuit rating too close to the calculated short circuit values.

Main Electrical Building Bus A (Filter):

- Available 3-Phase Fault Current: 3,700A, X/R Ratio: 334.22.
- Available Single Line-Ground Fault: 4,000A, X/R Ratio: 145.30.
- Nominal Voltage: 16340V.

Main Electrical Building Bus B (Sludge):

- Available 3-Phase Fault Current: 3,700A, X/R Ratio: 182.34.
- Available Single Line-Ground Fault: 4,000A, X/R Ratio: 79.20.
- Nominal Voltage: 16340V.

Headworks facility Bus A:

- Available 3-Phase Fault Current: 24,900A, X/R Ratio: 5.05.
- Available Single Line-Ground Fault: 27,400A, X/R Ratio: 5.64.
- Nominal Voltage: 480V.

Headworks facility Bus B:

- Available 3-Phase Fault Current: 24,900A, X/R Ratio: 5.03.
- Available Single Line-Ground Fault: 27,400A, X/R Ratio: 5.63.
- Nominal Voltage: 480V.

Gym Switchgear Bus A:

- Available 3-Phase Fault Current: 17,600A, X/R Ratio: 6.54.
- Available Single Line-Ground Fault: 18,600A, X/R Ratio: 6.63.
- Nominal Voltage: 480V.

Gym Switchgear Bus B:

- Available 3-Phase Fault Current: 17,600A, X/R Ratio: 6.61.
- Available Single Line-Ground Fault: 18,600A, X/R Ratio: 6.68.
- Nominal Voltage: 480V.

Gym Switchgear Bus A:

- Available 3-Phase Fault Current: 17,600A, X/R Ratio: 6.54.
- Available Single Line-Ground Fault: 18,600A, X/R Ratio: 6.63.
- Nominal Voltage: 480V.

Sampling Station/Eastern Trunk Pump Station:

- Available 3-Phase Fault Current: 10,300A, X/R Ratio: 2.12.
- Available Single Line-Ground Fault: 10,000A, X/R Ratio: 2.19.
- Nominal Voltage: 480V.

2.2 Assumptions

The following assumptions were used in performing the study:

- All motors and other continuous or intermittent loads (actuators, heaters, etc.) are running.
- Purely electronic loads do not contribute to a fault. This includes variable frequency drives without bypass capability, uninterruptible power supplies, UV ballasts, and other rectified loads.
- Loads 240V and below were not included in the arc flash calculations for systems fed from a 112.5 kilovolt-ampere (kVA) transformer or smaller, in accordance with IEEE 1584.
- Multipliers are applied to the reactance values of rotating machinery based on the recommendations in IEEE 141 (Red Book), as identified in Table 1.

Table 1 Motor and Generator Reactance Multipliers
Public Works Integrated Master Plan
City of Oxnard

Machine Type	First Cycle Network	Interrupting Network
Turbine generators; all hydrogenerators with amortissuer windings; all condensers	1.0 Xd"	1.0 Xd"
Synchronous Motors	1.0 Xd"	1.5 Xd"
Induction Motors > 1,000 hp at ≤ 1,800 RPM	1.0 Xd"	1.5 Xd"
Induction Motors > 250 hp at 3,600 RPM	1.0 Xd"	1.5 Xd"
Induction Motors ≥ 50 hp not covered above	1.2 Xd"	3.0 Xd"
Induction Motors < 50 hp	1.67 Xd"	Neglect

Notes:
Xd = direct axis sub-transient reactance.

The direct axis sub-transient reactance value is inversely proportional to and has a significant impact on the sub-transient fault current magnitude, and, therefore affects the short circuit contribution from rotating machines operating in the system.

2.3 One-line Diagrams

One-line diagrams of the plant's electrical distribution system are shown in Appendix A. These diagrams are generated by ETAP as part of the model construction. Each element (breaker, cable, fuse, etc.) is uniquely named. Medium voltage breakers, loads, busses, and transformers are named in accordance with the record drawings. Cables, fuses, equipment terminals are named after their associated equipment. (For example, F-TRF-T2 is the fuse that protects the transformer TRF-T2.) Low voltage breakers in panelboards and switchboards are named according to their location. Similarly, low voltage breakers in MCCs are named as shown in Figure 1:

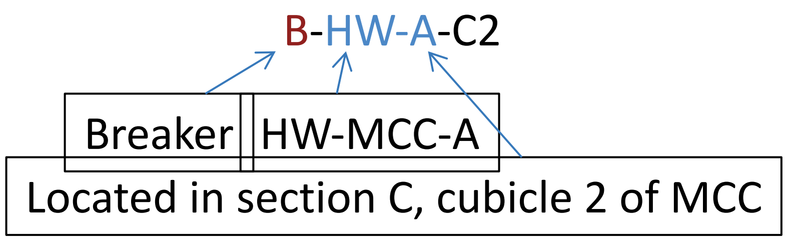


Figure 1 Naming Low Voltage Breakers in MCCs

Figure 2 is an example one-line diagram that identifies the locations in this report where information corresponding to the equipment is located.

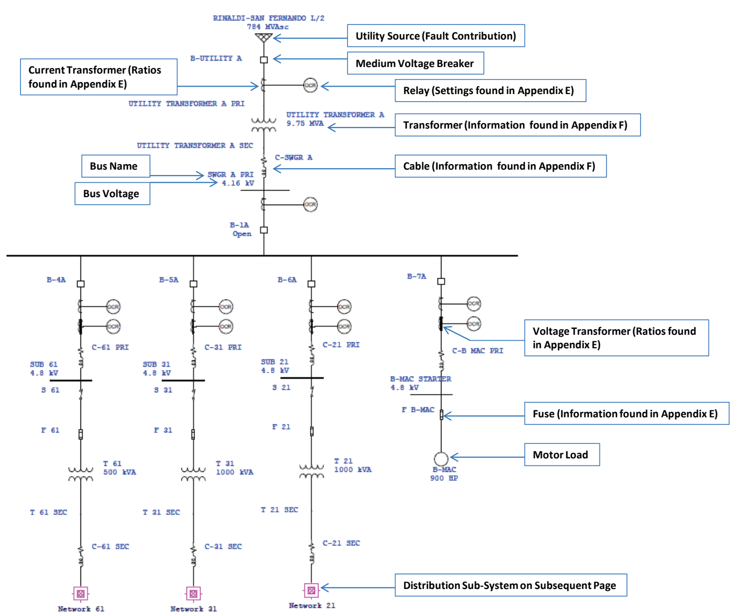


Figure 2 Example One-Line Diagrams

2.4 Short Circuit Reports

Appendix B presents a set of three reports used to verify that the ratings of the overcurrent protective devices, in the electrical distribution system, are sufficient to interrupt the available fault current. Three-phase bolted, line-to-ground, line-to-line-to-ground, and line-to-line faults are calculated and tabulated in the attached reports. Three-phase bolted faults are usually the highest magnitude type of fault. Line-to-ground faults can be larger than three-phase bolted fault values if they occur near generators. Line-to-line fault current magnitudes are important for medium voltage circuit breakers and low voltage power circuit breakers (30-cycle rated breakers) because they can also be worst-case after the first cycle. Line-line-ground fault data is provided only for completeness. Short circuit results are provided as symmetrical current.

2.4.1 Momentary Duty Summary Report – Appendix B1

The momentary duty summary report evaluates the short circuit bracing of each bus by comparing it to the calculated 1/2-cycle (momentary) current:

- Low-voltage bus bracing is evaluated based on its rating in symmetrical root mean square (rms) fault current.
- Medium-voltage bus bracing is evaluated based on its rating in asymmetrical rms fault current and asymmetrical crest (peak) fault current.

The calculated values shown in the report are based on the worst-case scenario with the highest available fault current. Any inadequately rated busses are flagged by an asterisk and are colored red. The report shows that all the busses in the facilities are adequately rated for the available fault current.

2.4.2 Interrupting Duty Summary Report – Appendix B2

The interrupting duty summary report evaluates whether each circuit breaker or fuse can safely interrupt the available fault current by comparing its interrupting capabilities to the calculated fault current. The calculated fault current is determined as follows:

- Low-voltage molded case or insulated case circuit breakers:
  - The 1/2 cycle (momentary) symmetrical rms current is used in accordance with UL 489 – Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
  - Where the calculated X/R ratio at the breaker location exceeds the test X/R ratio specified in the standard, the program adjusts the required interrupting current proportionally.

- Low-voltage power circuit breakers (30-cycle rated breakers):
  - The 1/2 cycle (momentary) symmetrical rms current is used in accordance with ANSI C37.13 – Standard for Low-Voltage Power Circuit Breakers Used in Enclosures.
  - Where the calculated X/R ratio at the breaker location exceeds the test X/R ratio specified in the standard, the program adjusts the required interrupting current proportionally.
- Low-voltage fuses:
  - The procedures for calculating the low-voltage fuse interrupting short circuit current is the same as those for the low-voltage molded case or insulated case circuit breaker interrupting duty calculation.
- Medium-voltage circuit breakers:
  - The 1/2-4 cycle current is used to calculate the interrupting current in accordance with ANSI C37.010 – Application Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
- Medium-voltage fuses:
  - The 1/2 cycle (momentary) symmetrical and asymmetrical rms current are used in accordance with ANSI C37.41 – Standard Design Tests for High-Voltage Fuses.

The calculated values shown in the report are based on the worst-case scenario with the highest available fault current. Any inadequately rated protective devices are flagged with an asterisk and colored red. The report shows that all of the protective devices at the plant are adequately rated to interrupt the worst-case fault current.

2.4.3 1/2 Cycle Short-Circuit Current Summary Report– Appendix B3

The 1/2 Cycle Short-Circuit Current Summary Report shows the current at each bus during the first 1/2 cycle after a fault. These values are used to evaluate the bus bracing and interrupting ratings of equipment in the facilities as indicated above, and to evaluate the closing and latching (momentary) ratings of medium voltage circuit breakers in accordance with IEEE C37.010.

The report includes calculations for both three phase and unbalanced faults (line-to-ground, line-to-line, and line-to-line-to-ground). The calculated current for each type of fault is different because fault current passes through a different set of impedances depending on the fault type.

2.4.4 1/2-4 Cycle Short-Circuit Summary Report – Appendix B4

The 1/2-4 Cycle Short-Circuit Summary Report shows the current at each bus from 1/2 to 4 cycles after a fault. These values are used to evaluate the interrupting ratings of medium voltage circuit breakers in accordance with IEEE C37.010.

The report includes calculations for both three phase and unbalanced faults (line-to-ground, line-to-line, and line-to-line-to-ground). The calculated current for each type of fault is different because fault current passes through a different set of impedances depending on the fault type.

2.4.5 30 Cycle Short-Circuit Summary Report – Appendix B5

The 30 Cycle Short-Circuit Summary Report shows the current at each bus during the first 30 cycles after a fault. These values are used for setting back-up time delay relays for medium-voltage breakers.

The report includes calculations for both three phase and unbalanced faults (line-to-ground, line-to-line, and line-to-line-to-ground). The calculated current for each type of fault is different because fault current passes through a different set of impedances depending on the fault type.

3.0 PROTECTIVE DEVICE COORDINATION STUDY

The protective device coordination study has four objectives – sensitivity, security, selectivity, and safety. Coordination between different types of protective devices is shown by plotting their individual time-current characteristics. A set of time-current curves (TCCs) showing the coordination between various protective devices in the City of Oxnard Wastewater Treatment Plant has been produced as part of this report.

The coordination study has been performed using the guidelines in IEEE Standard 242 (IEEE Buff Book) - Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.

3.1 Source Data

3.1.1 Utility Protective Devices

The model did not include protective device setting from the utility.

3.2 Time-Current Curves

Time-current curves are provided for the entire electrical distribution system, from the main breakers in switchgear/switchboards through the largest feeder breaker of each 480V motor control center (MCC), switchboard, or panelboard. Time-current curves are a visual representation representing coordination of protective devices. Current (in Amperes based upon a reference Voltage) is plotted on the X axis and tripping time (in seconds) is plotted on the Y axis, both on a logarithmic scale. Protective devices each have their own time-current tripping characteristics, which are identified by colored bands on the plot. When analyzing the curves the devices are expected to trip at the top-most edge of their band for a given current.

To determine the tripping time of a given device the protective device curves are used by identifying a short circuit current and finding the curve (for a protective device through which the short circuit is travelling) with the lowest time to trip. If a protective device operates during this short circuit, the protective devices have adequate sensitivity. If the first protective device that operates is the one closest to the fault, the system is said to have selectivity. Identifying a normal operating current (with a given duration) on a TCC plot and showing that no protective device operates is security. Safety primarily applies to the arc flash hazard and requires that protective devices operate as quickly as possible to reduce incident energy.

To ensure proper selectivity, the TCC for the protective devices closest to the fault should be located to the left of the TCC for the upstream protective devices as displayed on the TCC plot. This orientation is referred to as proper coordination. When portions of the TCC for the protective device closest to the fault overlap the TCC for the upstream devices, coordination is not achieved. From a coordination perspective, there are instances when the breaker closest to the fault does not need to clear the fault before the upstream protective device. Some of these possible scenarios occur when two devices are in series and no other branch circuits exist between the two devices, i.e. the same equipment will be affected by an outage no matter which series protective device trips first. Note that coordination cannot always be achieved between protective devices due to inherent limitations of each protective device, but it is important to coordinate as much as possible to deliver the highest level of security and selectivity for the electrical system. Additionally instantaneous regions of the TCCs cannot be coordinated due to inherent limitations of the protective devices.

The TCCs for the facilities not only include the protective device settings needed for coordination, but also equipment characteristics such as:

- Transformer damage curves – used to verify proper transformer protection. Curves are shifted to the conservative “frequent fault” curves per ANSI C57.

  Motor starting curves – used to ensure protective devices will not experience nuisance trips on motor inrush currents. Motors on full voltage starters are assumed to have 6 per-unit current for 5 seconds and motors on reduced voltage starters started in 10 seconds.

- Generator decrement curves-used to analyze short circuit contribution from the generator.

- Generator thermal damage curves-used to verify proper generator protection. Generator thermal capability curve $I^{2*}t$ is calculated based on the negative sequence current, where the negative sequence current is expressed in multiples of machine rated stator current or FLA. For synchronous generators with a rotor type defined as round rotor, this factor is typically equal to 30, whereas for salient pole, this factor is typically equal to 40. For the engine-driven generators at the facilities an $I^{2*}t$ value of 40 was used as recommended by ETAP.

3.3 Coordination Results

Refer to Appendix C for the results of the Protective Device Coordination Study for the "As-found" condition. The results of the Protective Device Coordination Study are described in the following bullets:

- ATS 8 TCC – Coordination is achieved from SWGR breaker through largest feeder breaker of panel EDP1.

- EFF Pump No. 2 VFD Tie TCC – Coordination is achieved from EFF PS SWGR down through the largest feeder breakers (feeder and tie breaker) down to Pump No. 2 VFD. Note that there is some overlap between the feeder breaker and TIE breaker. This is not a concern, as these devices are in series and the opening of either device will clear a fault at EFF PS SWGR.

- EFF Pump No. 2 VFD Tie TCCG – Ground fault coordination is achieved from EFF PS SWGR main breaker and feeder breaker as well as the tie breaker.

- EFF Pump No. 4 VFD Tie TCC – Coordination is achieved from EFF PS SWGR down through the largest feeder breakers (feeder and tie breaker) down to Pump No. 4 VFD. Note that there is some overlap between the feeder breaker and TIE breaker. This is not a concern, as these devices are in series and the opening of either device will clear a fault at EFF PS SWGR.

- EFF Pump No. 4 VFD Tie TCCG – Ground fault coordination is achieved from EFF PS SWGR main breaker and feeder breaker as well as the tie breaker.

- EFF Pump No. 2 VFD TCC – Coordination is achieved from EFF PS SWGR down through the largest feeder breaker down to Pump No. 2 VFD.

- EFF Pump No. 2 VFD Tie TCCG – Ground fault coordination is achieved from EFF PS SWGR main breaker and feeder breaker.

- EFF Pump No. 4 VFD TCC – Coordination is achieved from EFF PS SWGR down through the largest feeder breaker down to Pump No. 4 VFD.

- EFF Pump No. 4 VFD Tie TCCG – Ground fault coordination is achieved from EFF PS SWGR main breaker and feeder breaker.

- MAIN SWGR A1 FILTER TCC – Coordination is achieved from MAIN SWGR down through the largest feeder breaker of MCC-NA.

- MAIN SWGR A1 FILTER TCCG – Ground fault coordination is achieved from MAIN SWGR main breaker and feeder breaker.

- MAIN SWGR B1 SLUDGE TCC – Coordination is achieved from MAIN SWGR down through the largest feeder breaker of MCC-NA.

- MAIN SWGR B1 SLUDGE TCCG – Ground fault coordination is not achieved from MAIN SWGR main breaker and feeder breaker.

- MCC-DP2B TCC – Coordination is achieved from MCC-DP2B down through the largest feeder breaker.

- MCC-DP3D TCC – Coordination is achieved from MCC-DP3D down through the largest feeder breaker.

- MCC-GB TCC – Coordination is not achieved from MCC-GB down through the largest motor.

- MCC-GB TCCG – Ground fault coordination is achieved from MAIN SWGR main breaker and feeder breaker MCC-GB.

- MCC-GC TCC – Coordination is not achieved from MCC-GC down through the largest motor.

- MCC-GD TCC – Coordination is not achieved from MCC-GD down through the largest feeder breaker.

- MCC-GE TCC – Coordination is not achieved from MCC-GE down through the largest motor.

- MCC-GF TCC – Coordination is achieved from MCC-GF down through the largest motor.

- MCC-GF TCC – Coordination is achieved from MCC-GF down through the largest motor.

- MCC-HW BUS A TCC – Coordination is achieved from MCC-HW BUS A down through the largest motor.

- MCC-HW BUS A TCCG – Ground fault coordination is achieved from MS-HW main breaker and feeder breaker MCC-HW BUS A.
- MCC-HW BUS B TCC – Coordination is achieved from MCC-HW BUS B down through the largest motor.
- MCC-HW BUS B TCCG – Ground fault coordination is achieved from MS-HW main breaker and feeder breaker MCC-HW BUS B.
- MCC-NA BUS A TCC – Coordination is achieved from MCC-NA BUS A down through the largest motor.
- MCC-NA BUS B TCC – Coordination is achieved from MCC-NA BUS B down through the largest motor.
- MCC-NC TCC – Coordination is achieved from MCC-NC down through the largest motor.
- MCC-ND TCC – Coordination is achieved from MCC-ND down through the largest motor.
- MCC-NE TCC – Coordination is not achieved from MCC-NE down through the largest feeder breaker.
- MCC-NF TCC – Coordination is not achieved from MCC-NF down through the largest feeder breaker.
- MCC-NG BUS A TCC – Coordination is not achieved from MCC-NG BUS A down through the largest feeder breaker.
- MCC-NG BUS B TCC – Coordination is achieved from MCC-NG BUS B down through the largest feeder breaker.
- MCC-PD3B TCC – Coordination is not achieved from MCC- PD3B down through the largest feeder breaker.
- MCC-SH BUS A TCC – Coordination is not achieved from MCC- SH BUS A down through the largest feeder breaker.
- MCC-SH BUS B TCC – Coordination is not achieved from MCC- SH BUS B down through the largest feeder breaker.
- MS-HW BUS A TIE TCC – Coordination is achieved from MS-HW main BUS A down through the largest feeder breaker (MS-HW BUS TIE).

- MS-HW BUS A TIE TCCG – Ground fault coordination is achieved from MS-HW main breaker and feeder breaker MS-HW BUS TIE.
- MS-HW BUS A GEN TCC – Coordination is achieved from MS-HW main Bus A down through the generator breaker.
- MS-HW BUS A GEN TCCG – Ground fault coordination is achieved from MS-HW main breaker and generator breaker.
- MS-HW BUS A PUMP TCC – Coordination is not achieved from MS-HW main Bus A down through pump feeder breaker.
- MS-HW BUS A PUMP TCCG – Ground fault coordination is achieved from MS-HW main A breaker and pump feeder breaker.
- MS-HW BUS B TIE TCC – Coordination is achieved from MS-HW main bus B down through the largest feeder breaker (MS-HW BUS TIE).
- MS-HW BUS B TIE TCCG – Ground fault coordination is achieved from MS-HW main BUS B breaker and feeder breaker MS-HW BUS TIE.
- MS-HW BUS B GEN TCC – Coordination is achieved from MS-HW main BUS B down through the generator breaker.
- MS-HW BUS B GEN TCCG – Ground fault coordination is achieved from MS-HW main breaker and generator breaker.
- MS-HW BUS B PUMP TCC – Coordination is achieved from MS-HW main Bus B down through pump feeder breaker.
- MS-HW BUS B PUMP TCCG – Ground fault coordination is achieved from MS-HW main B breaker and pump feeder breaker.
- Panel DB TCC – Coordination is achieved from Panel DB down through the largest feeder breaker.
- Panel DB GEN TCC – Coordination is not achieved from Panel DB upstream through generator breaker.
- PNL DP1 TCC – Coordination is not achieved from PNL DP1 upstream through Main SWGR feeder breaker.
- PNL DP2 TCC – Coordination is achieved from PNL DP2 upstream through Main SWGR feeder breaker.

- PNL DP3 TCC – Coordination is not achieved from PNL DP3 upstream through Main SWGR feeder breaker.
- PNL DP3 TCCG – Ground fault coordination is achieved from Main SWGR breaker through the main breaker PNL DP3.
- PNL DP4 TCC – Coordination is not achieved from PNL DP4 upstream through Main SWGR feeder breaker.
- PNL DP4 TCCG – Ground fault coordination is not achieved from Main SWGR breaker through the main breaker PNL DP4.
- PNL DPMB TCC – Coordination is achieved from PNL DP3 down through the largest feeder breaker.
- PNL DPP8 TCC – Coordination is not achieved from PNL DPP8 upstream through PNL DP3 feeder breaker.
- SWBD GDP TCC – Coordination is achieved from SWBD GDP upstream through Main SWGR breaker.
- SWBD GDP TCCG – Ground fault coordination is not achieved from Main SWGR breaker through the main breaker SWBD GDP.
- SWBD-NB BUS A TCC – Coordination is achieved from SWBD-NB BUS A down through the largest feeder breaker.
- SWBD-NB BUS A TCCG – Ground fault coordination is achieved from SWBD-NB breaker and feeder breaker MCC-NC.
- SWBD-NB BUS B TCC – Coordination is achieved from SWBD-NB BUS A down through the largest feeder breaker.
- SWBD-NB BUS B TCCG – Ground fault coordination is achieved from SWBD-NB breaker and feeder breaker MCC-ND.

4.0 ARC FLASH STUDY

The Arc Flash Study builds upon the results of the Short Circuit and Protective Device Coordination Studies to calculate the incident energy, PPE Level, and arc flash boundary for each piece of equipment in the electrical distribution system. Results of this study are printed on labels and attached to electrical equipment to inform plant staff of shock hazards and arc flash hazards associated with working on energized equipment. These calculations have been performed in accordance with IEEE 1584 - Guide for Performing Arc Flash Hazard Calculations.

The incident energy varies with changes in the arcing fault current and the resulting protective device clearing time that occur during different operational conditions within the facility. In order to determine the worst-case incident energy, a number of different operational scenarios have been evaluated. The operational scenarios evaluated for this report are identified in Table 2:

Table 2 Operational Scenarios
Public Works Integrated Master Plan
City of Oxnard

Scenario	Configuration	Description
Utility Power	Utility	Normal Running Condition With Cogen in Operation
Standby	Standby	Running on Generator Power With All Generators in Operation

The incident energy calculations allow electrical equipment to be flagged with a PPE level A through D. The personal protective equipment (PPE) recommended by NFPA 70E for each of the categories is shown in Table 3. Where the calculations determine that the incident energy is above a Category 4, the equipment is identified as “DANGEROUS.” There is no PPE available that is suitable for use when working on energized equipment identified as “DANGEROUS.” “DANGEROUS” labels are printed with a red border.

Table 3 Personal Protective Equipment (PPE)
Public Works Integrated Master Plan
City of Oxnard

Level	Clothing Description	Required Minimum Arc Rating of PPE (cal/cm^2)
A	Non-melting, non-flammable materials (i.e., untreated cotton, wool, rayon, or silk, or blends of these materials), safety glasses or safety goggles, hearing protection, leather gloves, hard hat, face shield (as needed), hearing protection, leather work shoes.	<1.2
B	Arc-rated (AR) clothing system appropriately rated for the incident energy, arc rated or nonmelting untreated fibers for underlayers, face shield or arc flash suit hood, arc-rated jacket (as needed), hard hat, arc-rated hard hat liner, safety glasses or goggles, hearing protection, leather gloves, leather work shoes.	≥1.2 and <12

Table 3	Personal Protective Equipment (PPE) Public Works Integrated Master Plan City of Oxnard	
Level	**Clothing Description**	**Required Minimum Arc Rating of PPE (cal/cm^2)**
C	Arc-rated (AR) clothing system appropriately rated for the incident energy, arc rated or nonmelting untreated fibers for underlayers, arc-rated arc flash suit hood, arc-rated jacket (as needed), hard hat, arc-rated hard hat liner, safety glasses or goggles, hearing protection, leather gloves, leather work shoes.	≥12 and ≤40
D	PPE Not Available.	≥40
Note: Based on Annex H Table H.3(b) of NFPA 70E - 2015 Edition.		

Note that wearing the recommended PPE does not guarantee safety - it is intended to reduce risk to personnel and limit burns to second degree. Whenever possible, equipment should be de-energized before work is performed.

4.1 Source Data

The Arc Flash Study builds upon the results of the Short Circuit Study and the Protective Device Coordination Study in order to calculate the incident energy. Consequently, the Arc Flash Study is completely dependent on the results of these two studies. When the Short Circuit Study or Protective Device Coordination Study is updated due to changes in the electrical distribution system, a revised Arc Flash Study must be performed to ensure that the incident energy, PPE level, and arc flash boundary at each piece of equipment are correctly calculated. The standard IEEE arcing current variation of 15% was incorporated to these scenarios representing utility fault current variation as well as other factors that affect arcing fault current. Reduced fault current levels result in long clearing times for protective devices. The arc flash incident energy is the result of both fault current and clearing time; therefore, reduced fault current can result in higher incident energy.

Note that the Arc Flash Study was performed without any information from the utility on the upstream overcurrent protective devices. Obtaining the primary overcurrent protective device information protecting the service transformer and conductor data from the protective device to the service transformer is also critical when performing an Arc Flash Hazard Analysis. The reason for obtaining this additional Utility information is to analyze the effects of the primary service transformer protection on the calculated arc flash incident energy at the service equipment. At low voltages, this incident energy normally exceeds 40 cal/cm2 – rendering this panel unable to be maintained while energized. However, there exists a possibility of reducing this incident energy to a manageable level when including the effects of the primary protection.

4.2 Arc Flash Summary

The Arc Flash Summary Table, found in Appendix D, uses the Arc Flash Evaluation Module of ETAP. Appendix D contains the worst-case results from all of the operating scenarios as defined in Table 2. This summary shows both the inputs to and results of the incident energy calculations. The results found in Appendix D are based on the protective device settings and parameters of the electrical system. Refer to Appendix E for all the protective device settings and parameters for the “As-found” condition. Equipment data for transformers and cables used in modeling the electrical system can be found in Appendix F. Columns in the arc flash summary are as follows:

Bus - The location of the arcing fault.

kV - Bus voltage in kV.

Configuration - The name of the scenario which resulted in the worst case incident energy results.

Energy (cal/cm^2) - The energy produced by the arcing fault experienced at the working distance of 18 inches.

Arc Flash Boundary (ft) - The distance from the arcing fault that results in an incident energy of 1.2 cal/cm^2.

Hazard Category - The category of personal protective equipment (PPE) required based on the calculated incident energy.

Final FCT (sec) - The amount of time it takes for a breaker to open once the trip has been initiated. Note that protective devices with an opening time of zero are those devices whose opening time is included in their characteristic curves on the TCC (e.g., thermal-magnetic molded-case circuit breakers).

Ia at FCT (kA) - Total symmetrical arcing fault current at the fault location for an arcing fault.

Source Protective Device Name - The name of the first protective device to clear the arcing fault.

% Ia Variation - Whether or not the worst case was caused when 15% IEEE 1584 current variation was used.

4.3 Arc Flash Hazard Mitigation Techniques

There is a variety of methods available to reduce arc flash hazards at specific pieces of equipment. Some potential mitigation methods are outlined below.

4.3.1 Zone Selective Interlocking

Zone Selective Interlocking (ZSI) is a coordination and protection strategy typically employed in low voltage switchgear. The goal of a well-coordinated electrical system is for the breaker closest to the fault, to clear the fault, minimizing interruption to other parts of the facility. In a ZSI system, the circuit breaker closest to a fault restrains or inhibits upstream breakers for a preset time delay before the upstream breaker is allowed to trip clearing the fault.

The goal of using ZSI is to allow for closer coordination between switchgear feeder, tie, and main circuit breakers. Reductions in the LSG settings of switchgear main and tie breaker minimize equipment damage due to electrical faults. Use of ZSI also allows for activation of the instantaneous settings on the main breakers, which may reduce arc flash hazards in the switchgear itself.

4.3.2 Maintenance Mode

Some breakers and relays have the ability to store multiple settings for the same breaker. This functionality can be used for implementing a “maintenance mode” that can enable instantaneous and altering other settings to allow breakers to trip faster, reducing incident energy levels in equipment for personnel. Use of this “maintenance mode” may help to reduce Arc Flash hazards by up to 75 percent in some cases.

4.3.3 Differential Relay

A differential relay is a protection device used to monitor for fault scenarios within a defined zone of protection, often a switchgear bus or a transformer. The relay uses current transformers to monitor the current entering the zone of protection and exiting the zone of protection. When the amount of current entering and exiting the zone of protection is not equal, the relay will then trip the associated circuit interrupter to clear the fault. This relay provides the ability to detect and clear a fault extremely quickly and reduces the incident energy level.

4.3.4 Arc Flash Rated Equipment

Arc flash rated equipment provides a more robust enclosure that is designed to withstand the forces of an arc flash event and divert the pressure and gasses of the explosion out the top of the equipment using ducts. While the equipment does provide protection in the normal operating state of the equipment, it does not provide this additional protection when circuit breaker covers are open or removed.

4.3.5 Arc Flash Detection Relays

A relatively new technology is available for retrofitting or equipping on new equipment that utilizes light and current sensors to detect an arc flash event. When the event is detected, the upstream protective device is actuated to interrupt and limit the incident energy at the associated equipment.

4.3.6 Arc Vault

Another relatively new technology available for retrofitting or equipping new equipment is the Arc Vault. When a current spike is detected (indicating the fault or arc flash event), the upstream protective device is called to trip while intentionally and simultaneously creating a separate arc flash event inside a containment dome (the vault). The arc flash event in the dome takes all the energy from the unintentional fault until the upstream protective device is able to clear the fault. Because almost all the energy is diverted and maintained within the vault, the equipment should only sustain minor, but repairable damage.

4.4 Arc Flash Hazard Labels

A sample arc flash label for review is shown in Figure 3. A complete set of labels suitable for direct application to equipment is provided as part of the final study for installation on the appropriate electrical equipment.

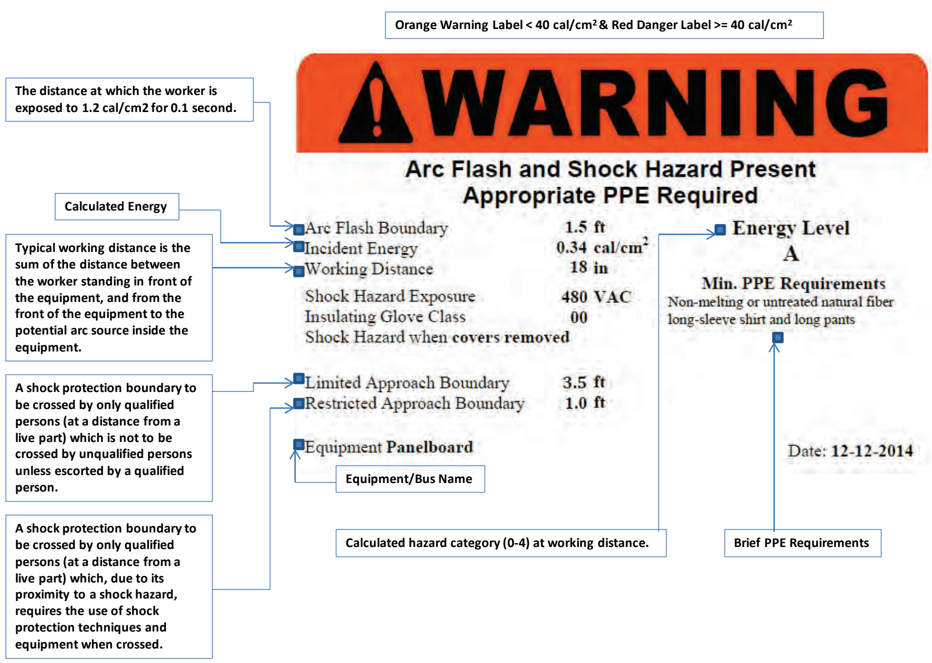


Figure 3 Sample Arc Flash Label

5.0 MISCELLANEOUS FIELD INVESTIGATION FINDINGS

During the field investigation, most equipment in the electrical distribution system was opened for data collection. Appendix G contains a summary of the electrical equipment condition assessment based on field investigation, for equipment rated 480V, and above. In addition to the protective devices identified in Section 2.0 of the report, the following concerns and code violations are listed as follows.

5.1 General

The majority of electrical equipment in the OWTP was found to be old, obsolete, dirty, and rusty. Much of the electrical equipment is located in unconditioned spaces, and the physical condition is deteriorated. Equipment was found throughout the facility from a variety of installation years and manufacturers: 1978 (Federal Pacific Electric/FPE), 1989 (Westinghouse), 1997 (Cutler-Hammer Westinghouse), 1999 (Cutler-Hammer), 2007 (Allen-Bradley and Siemens), and 2011 (Allen-Bradley) with the majority of the equipment being from 1978 and 1989.

The equipment from 1978 is obsolete and replacement parts are often difficult to obtain. The condition ranges from dirty with cobwebs to very dirty and rusted. Recommend replacing all equipment from 1978.

The equipment from 1989 is obsolete, though replacement parts can generally be obtained from Eaton Cutler-Hammer. However, replacement parts are costly and may take time to procure. Equipment from this time that is located in the North Area Electrical Room and the Solids Processing Building is in conditioned spaces and in adequate physical condition. The condition ranges from somewhat dirty to scratched, dirty, and rusty with cobwebs. Recommend replacing all other equipment from 1989.

The equipment from 1997 is in a conditioned space and in adequate physical condition.

The equipment from 1999 is scratched and somewhat rusty. Recommend painting to prevent further degradation.

The equipment from 2007 is located in the Headworks Electrical Building. It is in a conditioned space and in good physical condition.

The equipment from 2011 is in excellent condition, however it is in the Eastern Trunk Pump Station/Sampling Station, which is an unconditioned space and the electrical equipment may degrade over time. Other electrical equipment in this building is in very poor condition.

HVAC is non-existent or inadequate for most of the electrical equipment, which shortens the useful life of the equipment. Adequate HVAC should be provided for all spaces containing electrical equipment to maintain the equipment in better condition, and to avoid shortening the equipment life.

Many motor control centers, switchboards, and switchgear have burned out or broken bulbs. Recommend replacing bulbs and lenses as necessary.

5.2 Administration Building

Access to MCC-EDP1E is partially blocked due to stacked items in front of the equipment. Recommend ensuring that the NEC required working space is maintained about electrical equipment.

5.3 DAF Building

- MCC-EDP1A has open openings in the equipment. The openings should be covered for safety.

5.4 Digester Control Building

- The circuit breaker for the Sludge Circ Pump Digester 1 in MCC-GF was found to have wires on the line side which are undersized and cracked. Recommend replacing the wires in accordance with the NEC.

- The cubicle for Sludge Gas Circ Blower 2 in MCC-GH: wires going between the circuit breaker and the capacitors are undersized. Recommend replacing the wires in accordance with the NEC.

- MCC-EDP1C has uncovered openings in the equipment. The openings should be covered for safety.

5.5 Headworks Building

- MCC-HW is located below what appear to be drainage pipes from the roof of the building. Drip protection is required by code. Recommend installing protection to avoid damage to the MCC from condensation, leaks, or breaks in the drainage pipes in accordance with the NEC.

- A Lockout Tagout Station in located behind SWGR MS-HW in the NEC required working space. Recommend re-locating the Lockout Tagout Station in order to maintain the REC required working space.

5.6 Main Electrical Building

- The Main Electrical Building has had issues with water leaking in when it rains. Recommend replacing the roofing.

- The circuit breaker in MCC-GD for Biofilter Pump (Circ) 4 was observed to jump from the OFF position to the TRIPPED Position. Recommend investigating the operation of this circuit breaker.

- Main SWGR circuit breaker to DP1 will not charge electrically anymore and must be manually recharged in order to close. Recommend investigating the charging motor.

- Main SWGR Tie breaker cannot be manually recharged due to a broken charging handle. Recommend replacing the charging handle.

- MCC-DP4B and MCC-GD have broken lights. Recommend replacing bulbs and lenses as necessary.

5.7 North Area Electrical Building

- Netting on the floor next to the MCCs is a tripping hazard. Recommend removing the netting from the room.

5.8 Old Blower Building

- MCC-DP2B has exposed bus within the motor control center. Recommend covering openings in accordance with the NEC.

5.9 Old Effluent Building

- MCC-EDP1B has uncovered openings and exposed bus within the motor control center. Recommend covering openings in accordance with the NEC.

5.10 PCC Building

- MCC-DP2D has uncovered openings in the equipment. The openings should be covered for safety.

5.11 Primary Building

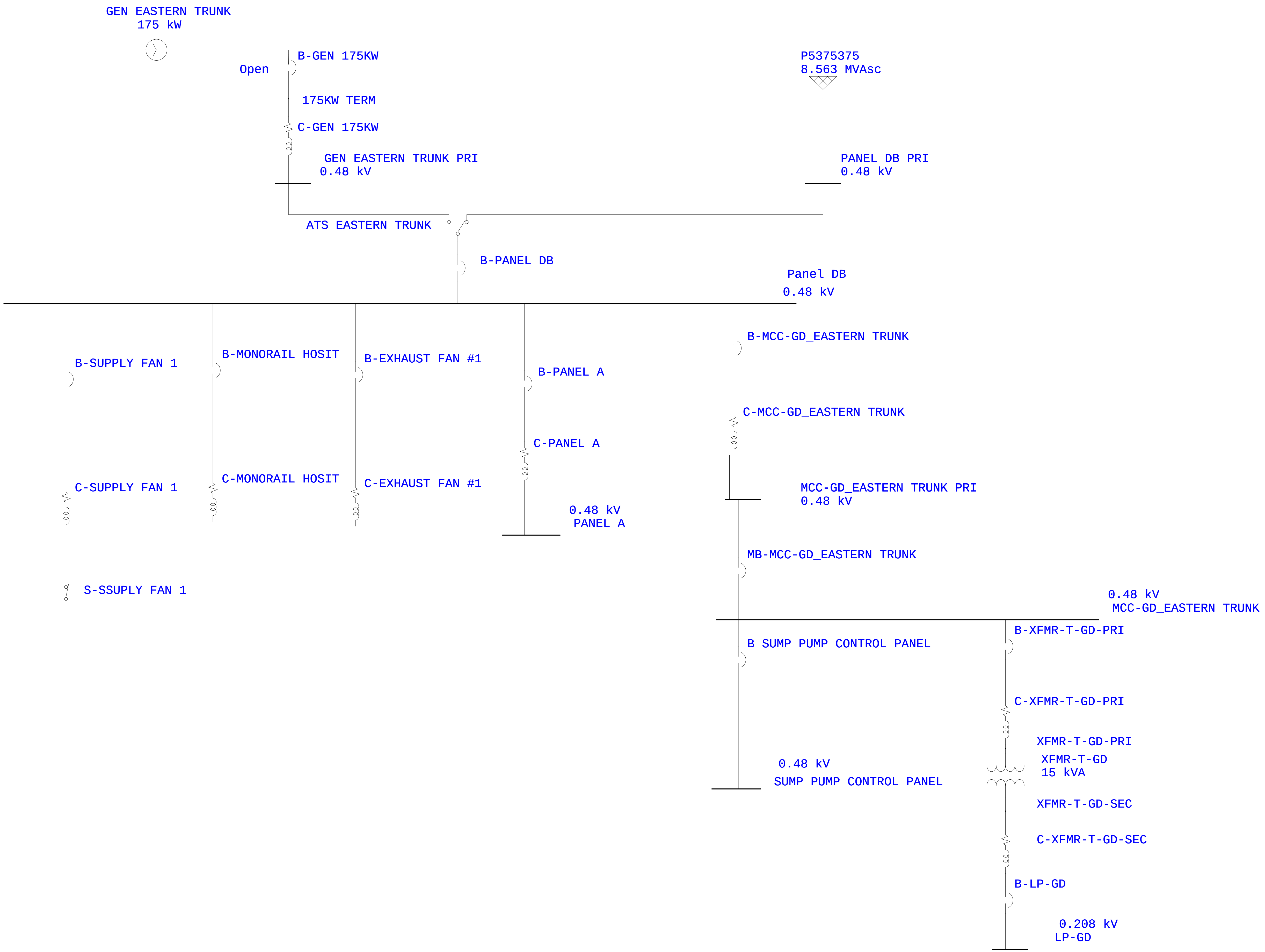
- MCC-DP1B has uncovered openings in the equipment. The openings should be covered for safety.

5.12 Solid Processing Building - Electrical Room

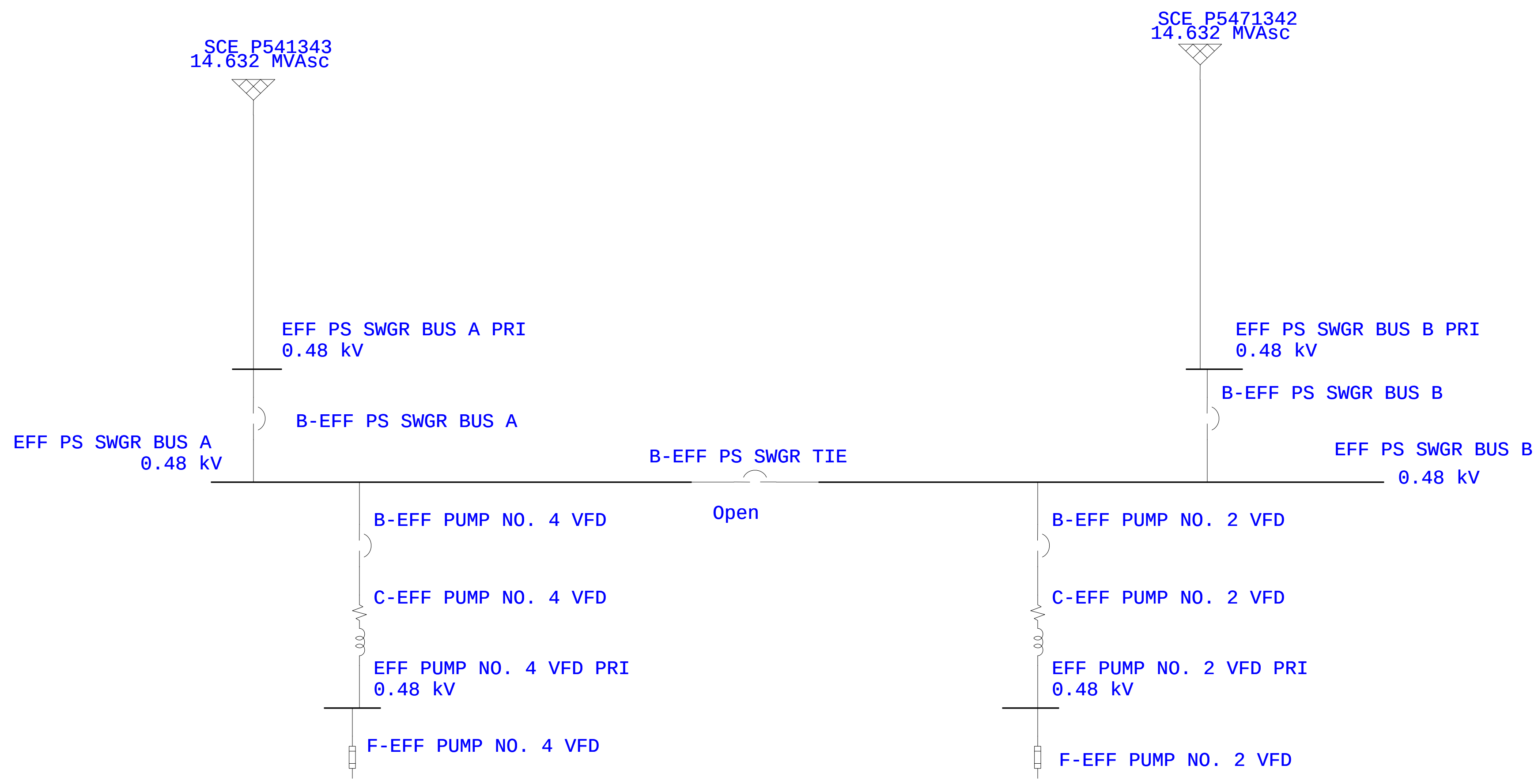
- Air compressor is located in front of MCC-SH within 3'-6", which is within the NEC working space. Recommend to re-locate the air compressor away from the MCC-SH.

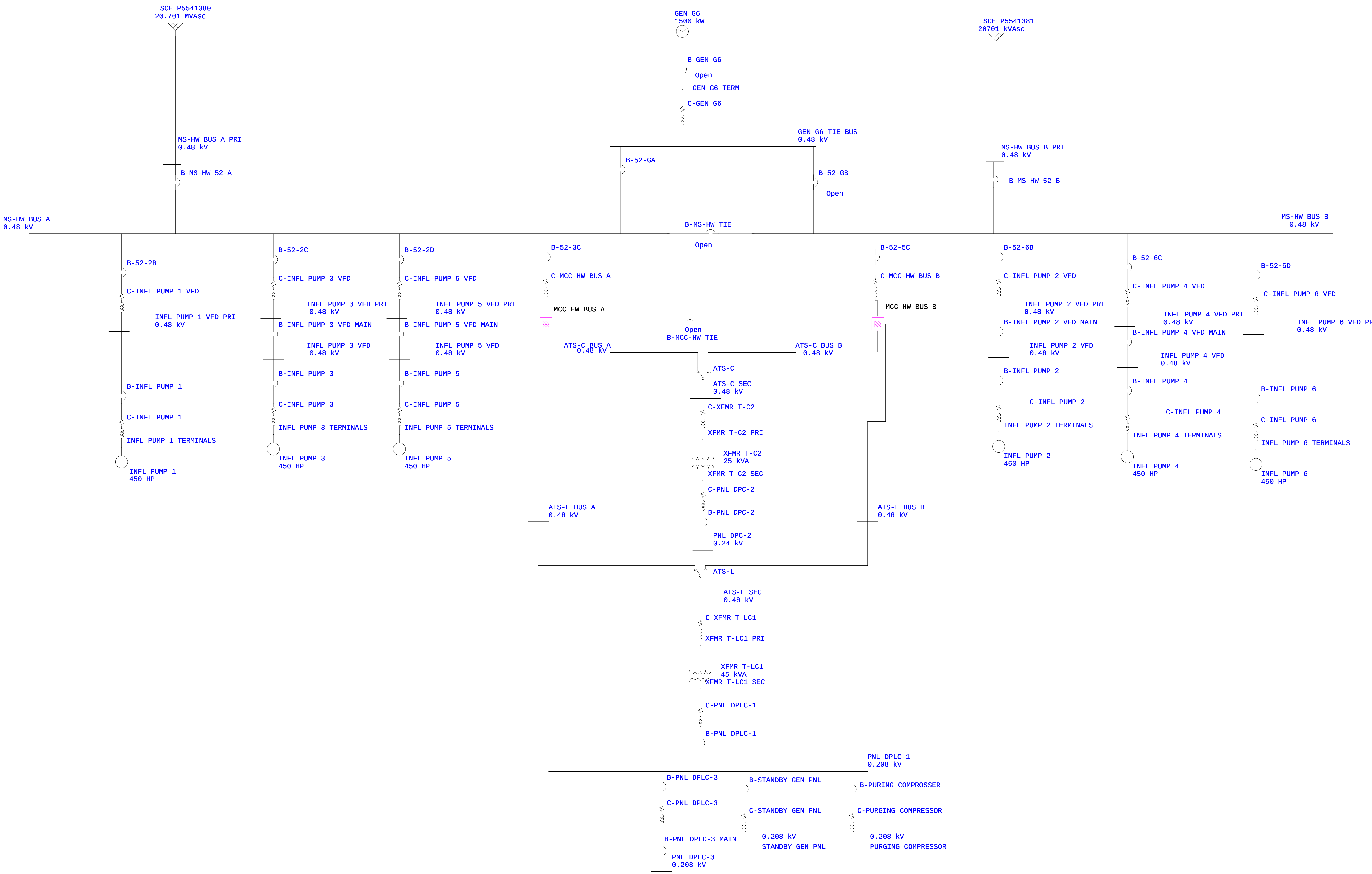
APPENDIX A – ONE-LINES

One-Line Diagram - OLV1 (Edit Mode)

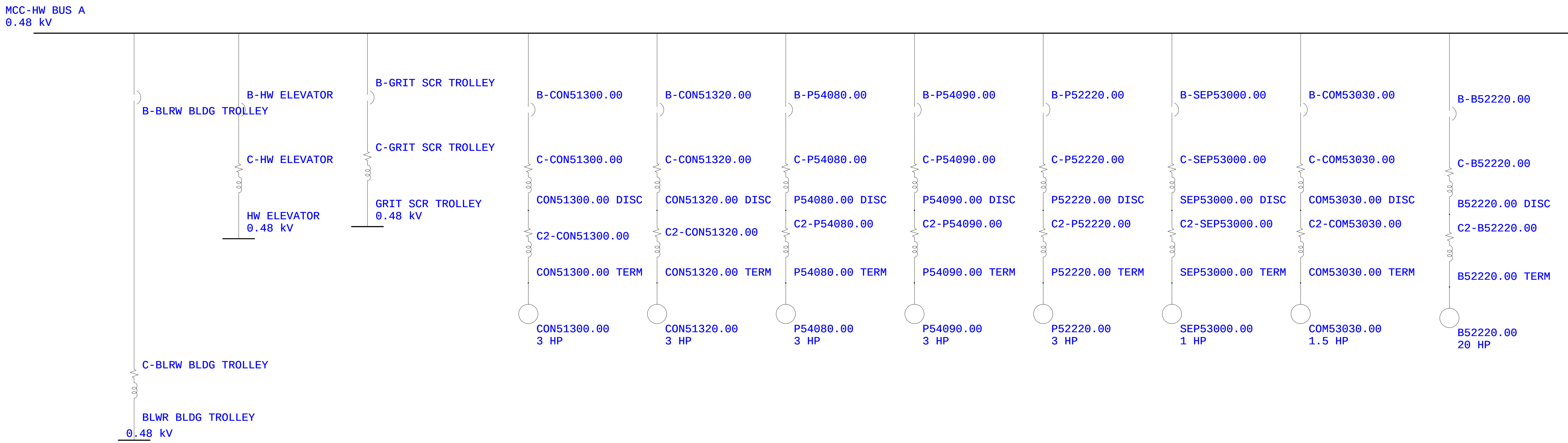


One-Line Diagram - OLV1 (Edit Mode)

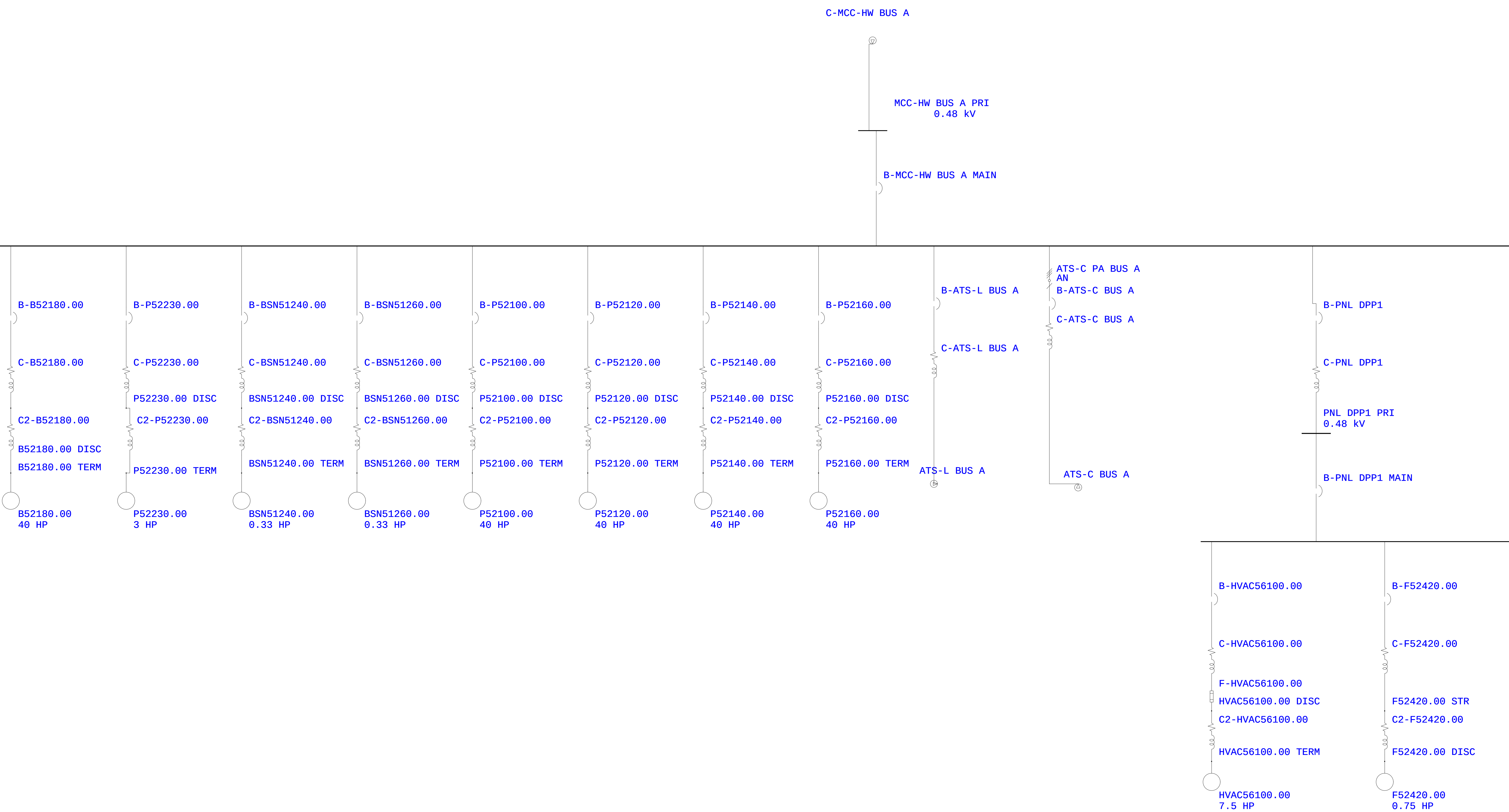



SCE P5541380
20.701 MVAsc
GEN G6
1500 kW
SCE P5541381
20701 kVAsc
B-GEN G6
Open
GEN G6 TERM
C-GEN G6
GEN G6 TIE BUS
0.48 kV
MS-HW BUS A PRI
0.48 kV
MS-HW BUS B PRI
0.48 kV
B-52-GA
B-52-GB
Open
B-MS-HW 52-A
B-MS-HW 52-B
MS-HW BUS A
0.48 kV
B-MS-HW TIE
Open
MS-HW BUS B
0.48 kV
B-52-2B
B-52-2C
B-52-2D
B-52-3C
B-52-5C
B-52-6B
B-52-6C
B-52-6D
C-INFL PUMP 1 VFD
C-INFL PUMP 3 VFD
C-INFL PUMP 5 VFD
C-MCC-HW BUS A
C-MCC-HW BUS B
C-INFL PUMP 2 VFD
C-INFL PUMP 4 VFD
C-INFL PUMP 6 VFD
INFL PUMP 1 VFD PRI
0.48 kV
INFL PUMP 3 VFD PRI
0.48 kV
INFL PUMP 5 VFD PRI
0.48 kV
MCC HW BUS A
MCC HW BUS B
INFL PUMP 2 VFD PRI
0.48 kV
INFL PUMP 4 VFD PRI
0.48 kV
INFL PUMP 6 VFD PRI
0.48 kV
B-INFL PUMP 3 VFD MAIN
B-INFL PUMP 5 VFD MAIN
Open
B-MCC-HW TIE
B-INFL PUMP 2 VFD MAIN
B-INFL PUMP 4 VFD MAIN
INFL PUMP 3 VFD
0.48 kV
INFL PUMP 5 VFD
0.48 kV
ATS-C BUS A
0.48 kV
ATS-C BUS B
0.48 kV
INFL PUMP 2 VFD
0.48 kV
INFL PUMP 4 VFD
0.48 kV
ATS-C
B-INFL PUMP 3
B-INFL PUMP 5
B-INFL PUMP 2
B-INFL PUMP 4
B-INFL PUMP 1
B-INFL PUMP 6
ATS-C SEC
0.48 kV
C-XFMR T-C2
C-INFL PUMP 3
C-INFL PUMP 5
C-INFL PUMP 2
C-INFL PUMP 4
C-INFL PUMP 1
C-INFL PUMP 6
INFL PUMP 3 TERMINALS
INFL PUMP 5 TERMINALS
INFL PUMP 2 TERMINALS
INFL PUMP 4 TERMINALS
INFL PUMP 1 TERMINALS
INFL PUMP 6 TERMINALS
XFMR T-C2 PRI
XFMR T-C2
25 kVA
XFMR T-C2 SEC
INFL PUMP 3
450 HP
INFL PUMP 5
450 HP
INFL PUMP 2
450 HP
INFL PUMP 4
450 HP
INFL PUMP 1
450 HP
INFL PUMP 6
450 HP
C-PNL DPC-2
ATS-L BUS A
0.48 kV
B-PNL DPC-2
ATS-L BUS B
0.48 kV
PNL DPC-2
0.24 kV
ATS-L
ATS-L SEC
0.48 kV
C-XFMR T-LC1
XFMR T-LC1 PRI
XFMR T-LC1
45 kVA
XFMR T-LC1 SEC
C-PNL DPLC-1
B-PNL DPLC-1
PNL DPLC-1
0.208 kV
B-PNL DPLC-3
B-STANDBY GEN PNL
B-PURING COMPROSSER
C-PNL DPLC-3
C-STANDBY GEN PNL
C-PURGING COMPRESSOR
B-PNL DPLC-3 MAIN
0.208 kV
STANDBY GEN PNL
0.208 kV
PURGING COMPRESSOR
PNL DPLC-3
0.208 kV

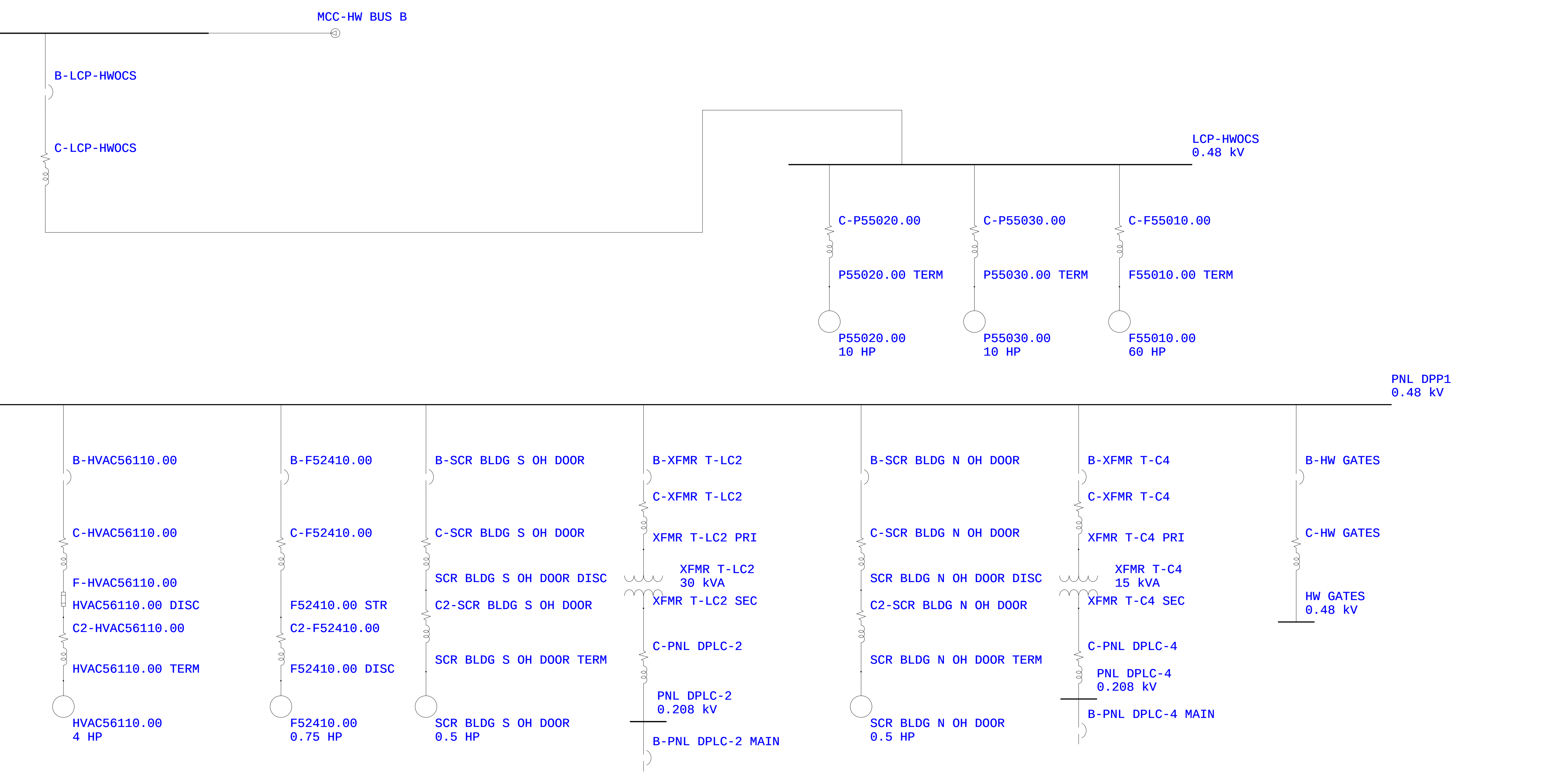
One-Line Diagram - OLV1=>MCC HW BUS A (Edit Mode)



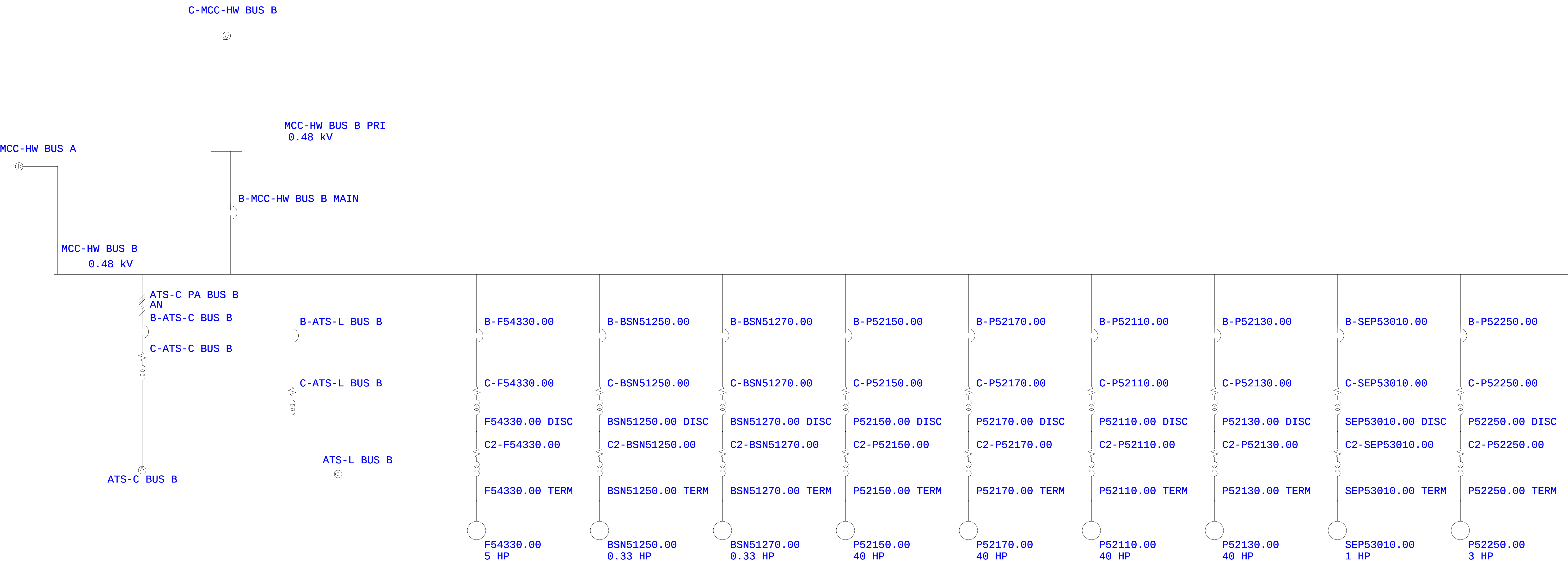
One-Line Diagram - OLV1=>MCC HW BUS A (Edit Mode)



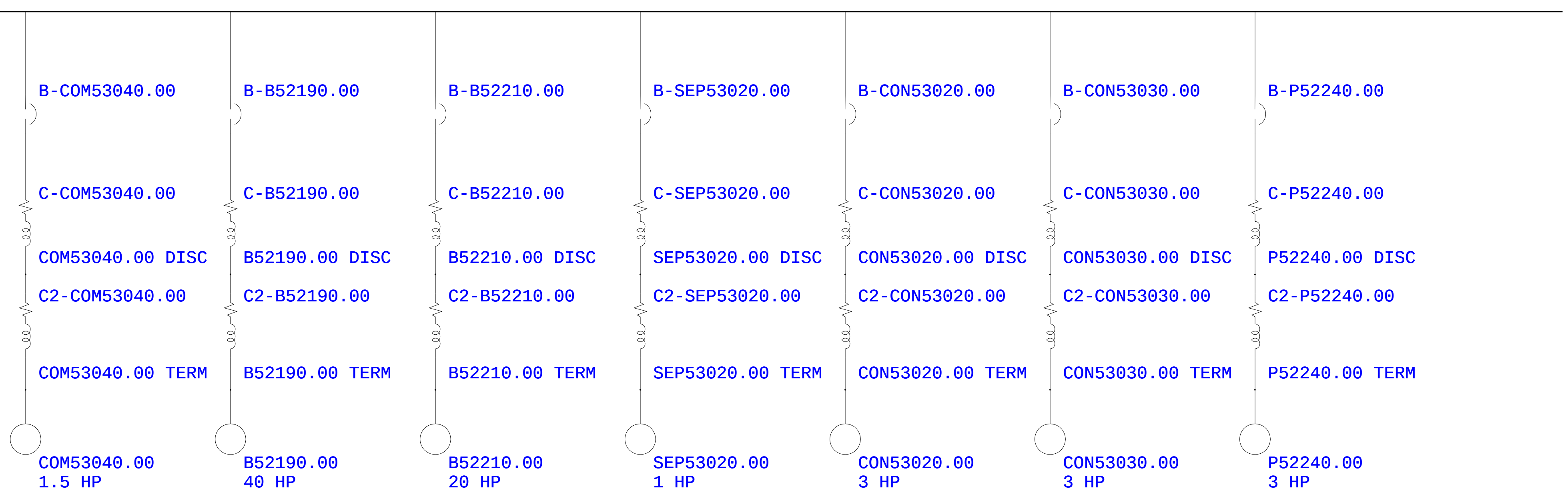
One-Line Diagram - OLV1=>MCC HW BUS A (Edit Mode)



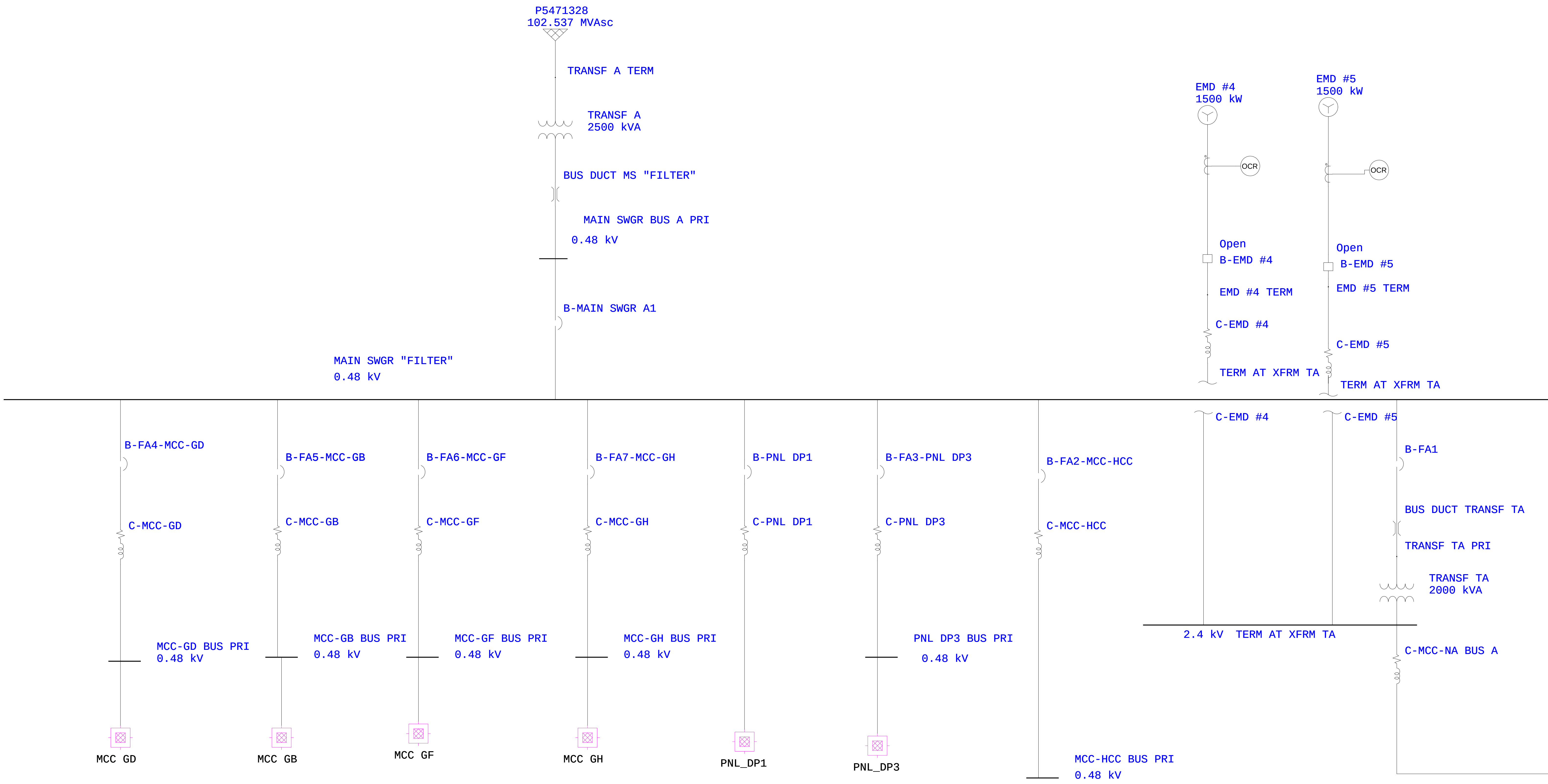
One-Line Diagram - OLV1=>MCC HW BUS B (Edit Mode)

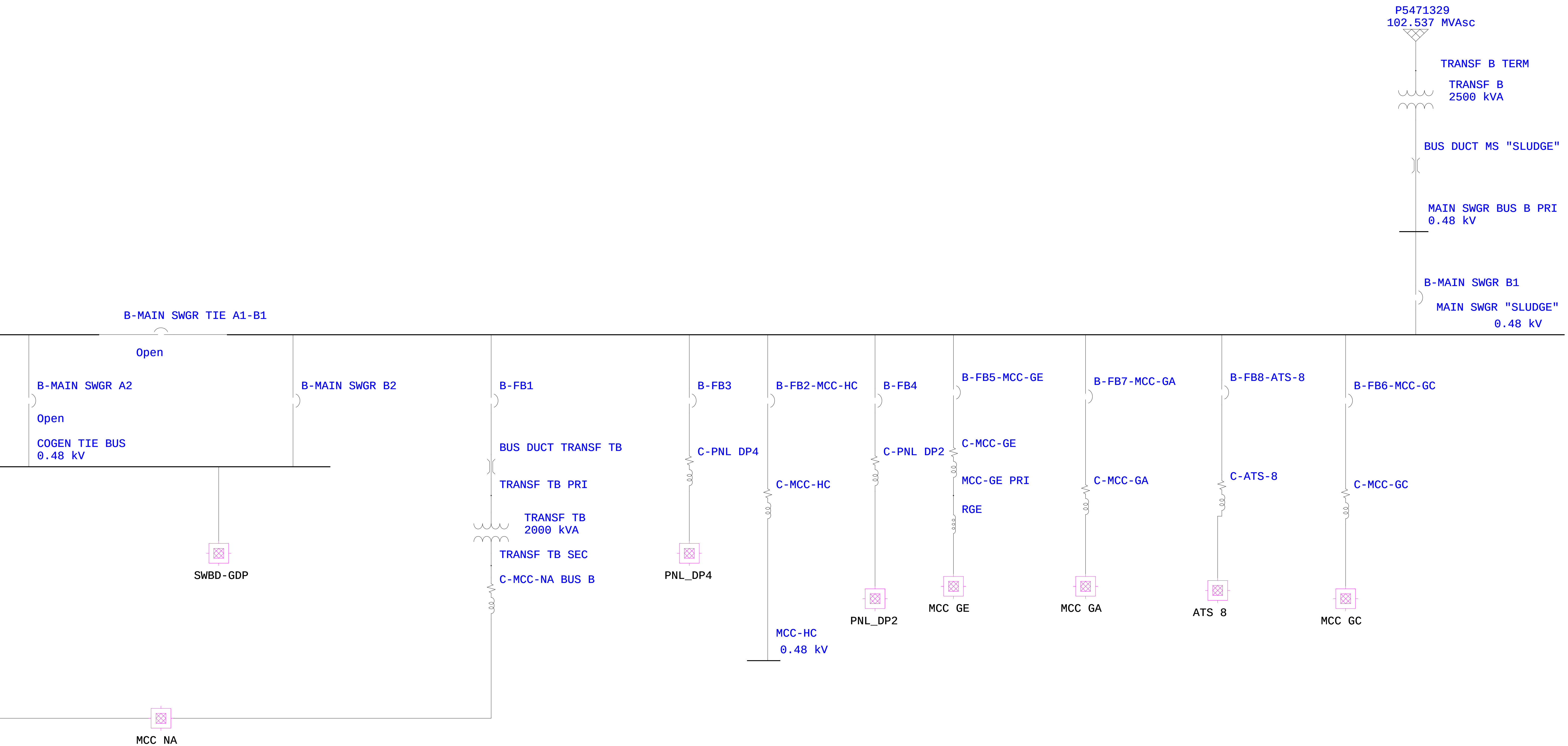


One-Line Diagram - OLV1=>MCC HW BUS B (Edit Mode)



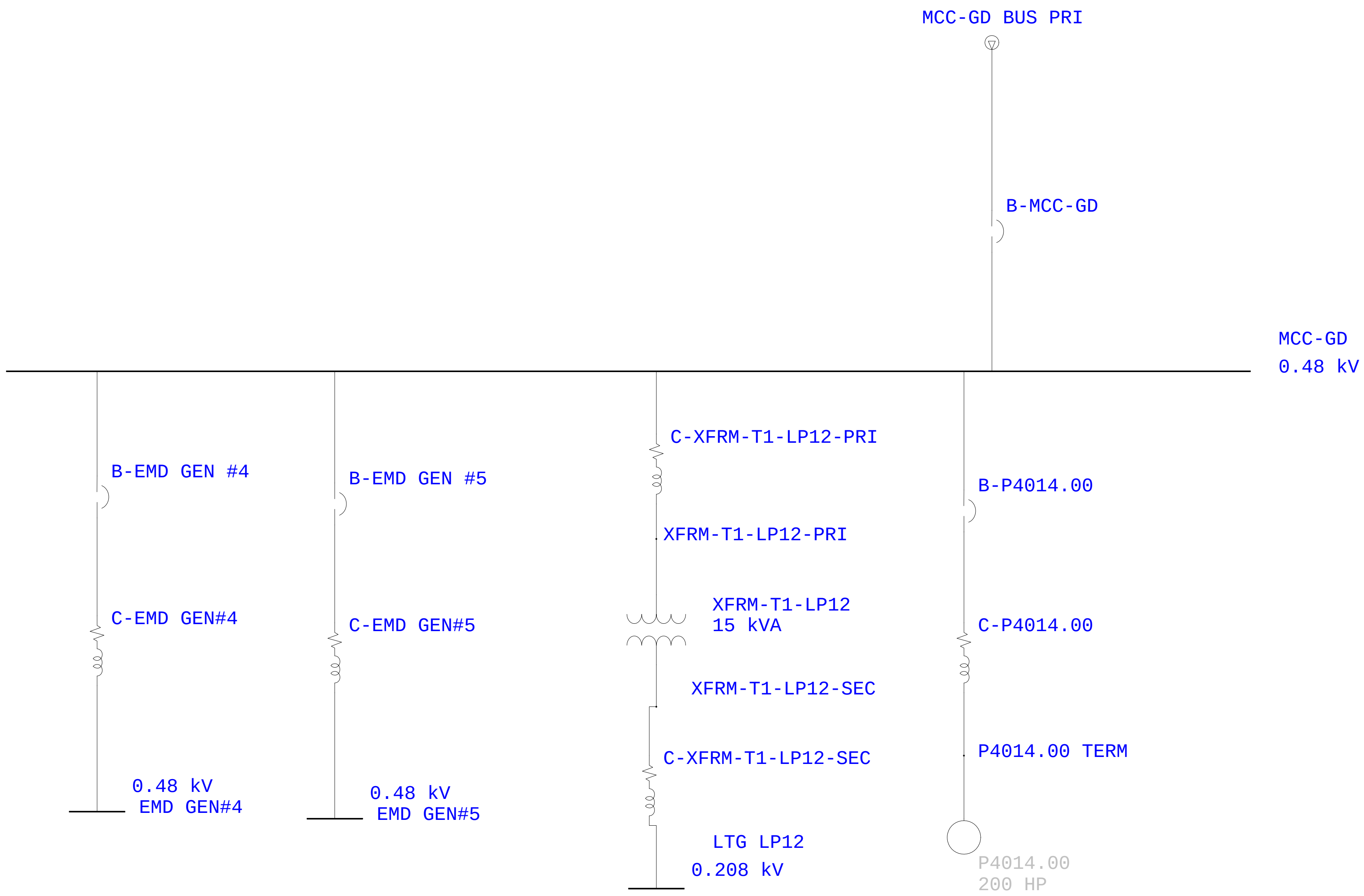
One-Line Diagram - OLV1 (Edit Mode)



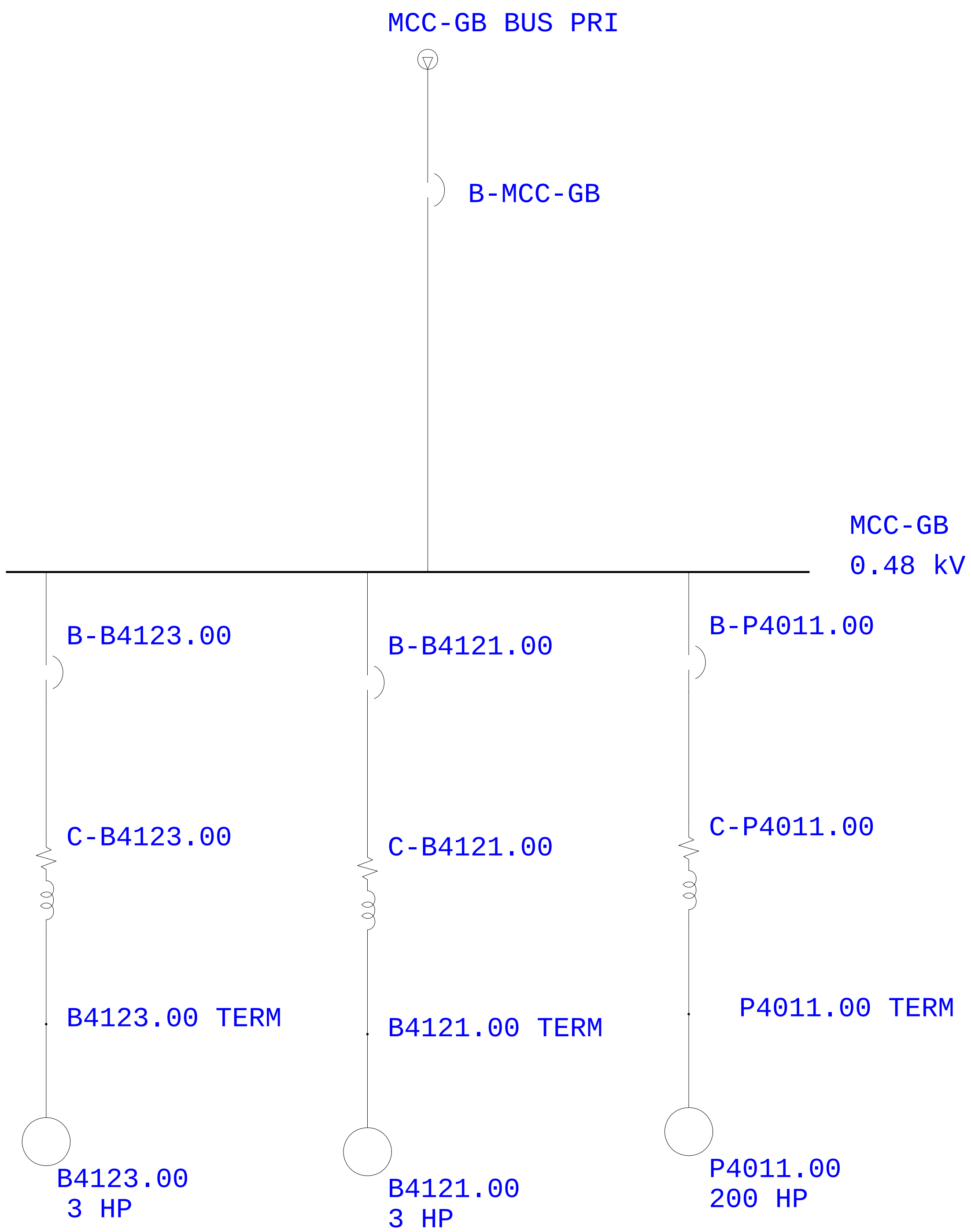


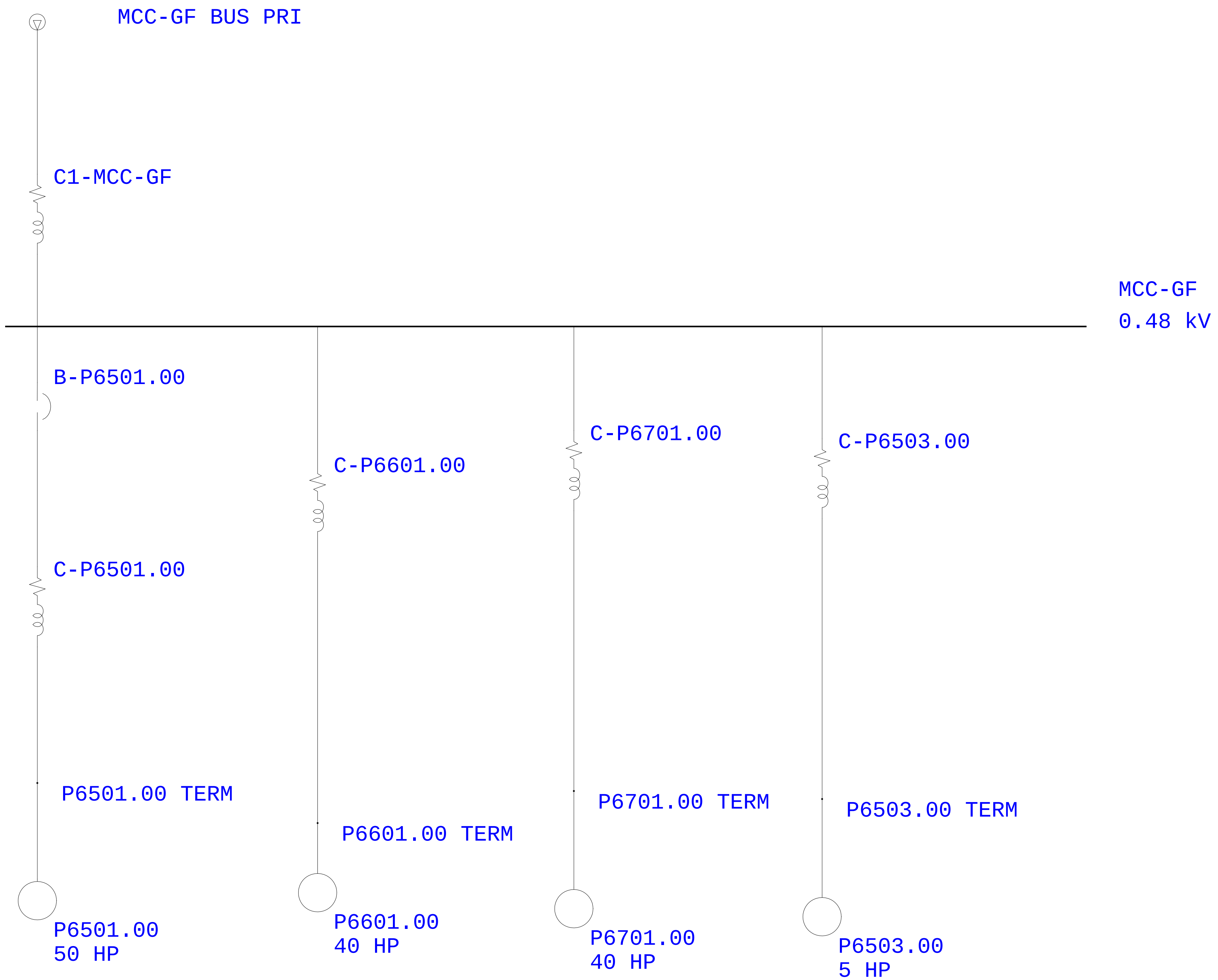
P5471329
102.537 MVAsc
TRANSF B TERM
TRANSF B
2500 kVA
BUS DUCT MS "SLUDGE"
MAIN SWGR BUS B PRI
0.48 kV
B-MAIN SWGR B1
MAIN SWGR "SLUDGE"
0.48 kV
B-MAIN SWGR TIE A1-B1
Open
B-MAIN SWGR A2
Open
COGEN TIE BUS
0.48 kV
B-MAIN SWGR B2
SWBD-GDP
B-FB1
BUS DUCT TRANSF TB
TRANSF TB PRI
TRANSF TB
2000 kVA
TRANSF TB SEC
C-MCC-NA BUS B
MCC NA
B-FB3
C-PNL DP4
PNL_DP4
B-FB2-MCC-HC
C-MCC-HC
MCC-HC
0.48 kV
B-FB4
C-PNL DP2
PNL_DP2
B-FB5-MCC-GE
C-MCC-GE
MCC-GE PRI
RGE
MCC GE
B-FB7-MCC-GA
C-MCC-GA
MCC GA
B-FB8-ATS-8
C-ATS-8
ATS 8
B-FB6-MCC-GC
C-MCC-GC
MCC GC

One-Line Diagram - OLV1=>MCC GD (Edit Mode)

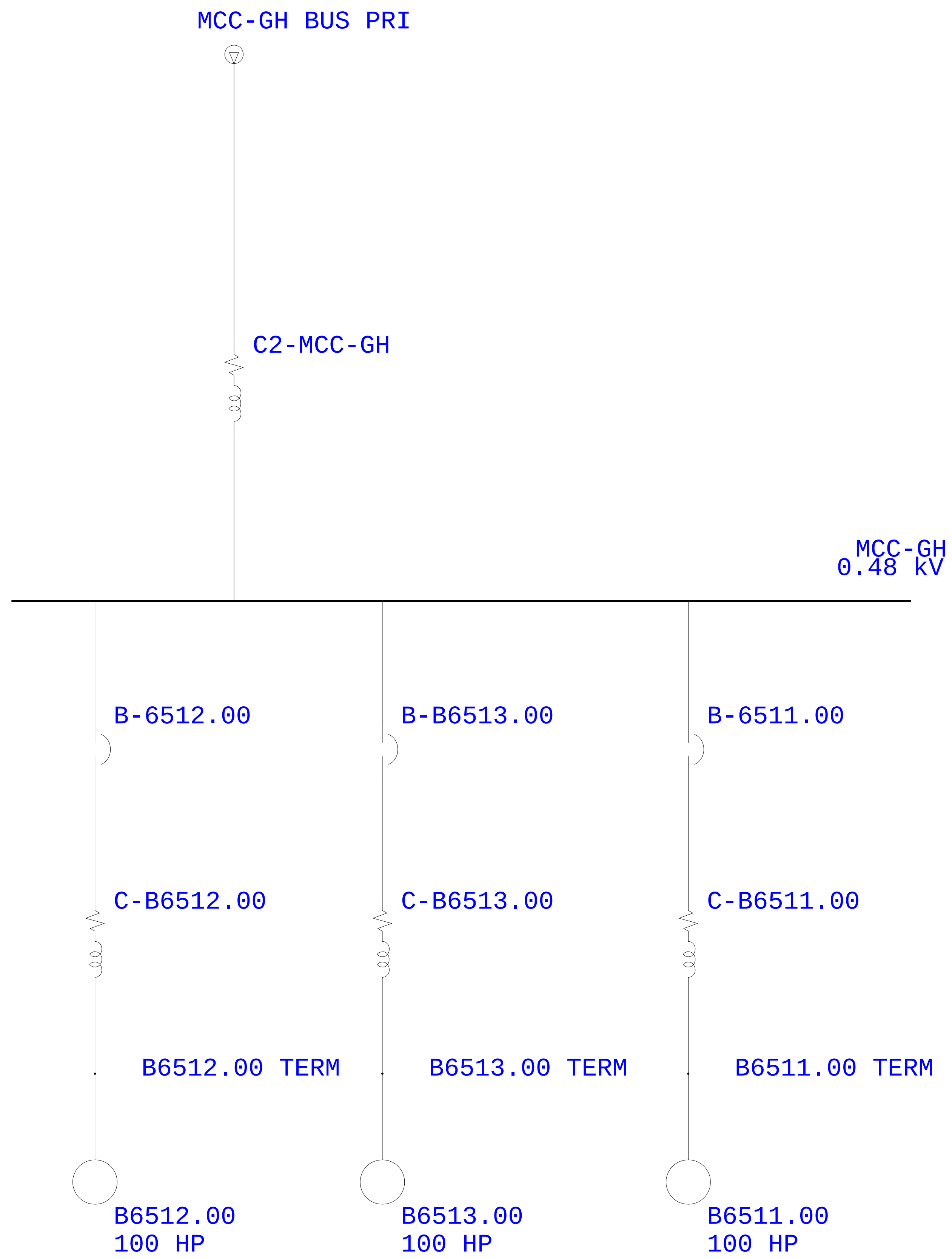


One-Line Diagram - OLV1=>MCC GB (Edit Mode)

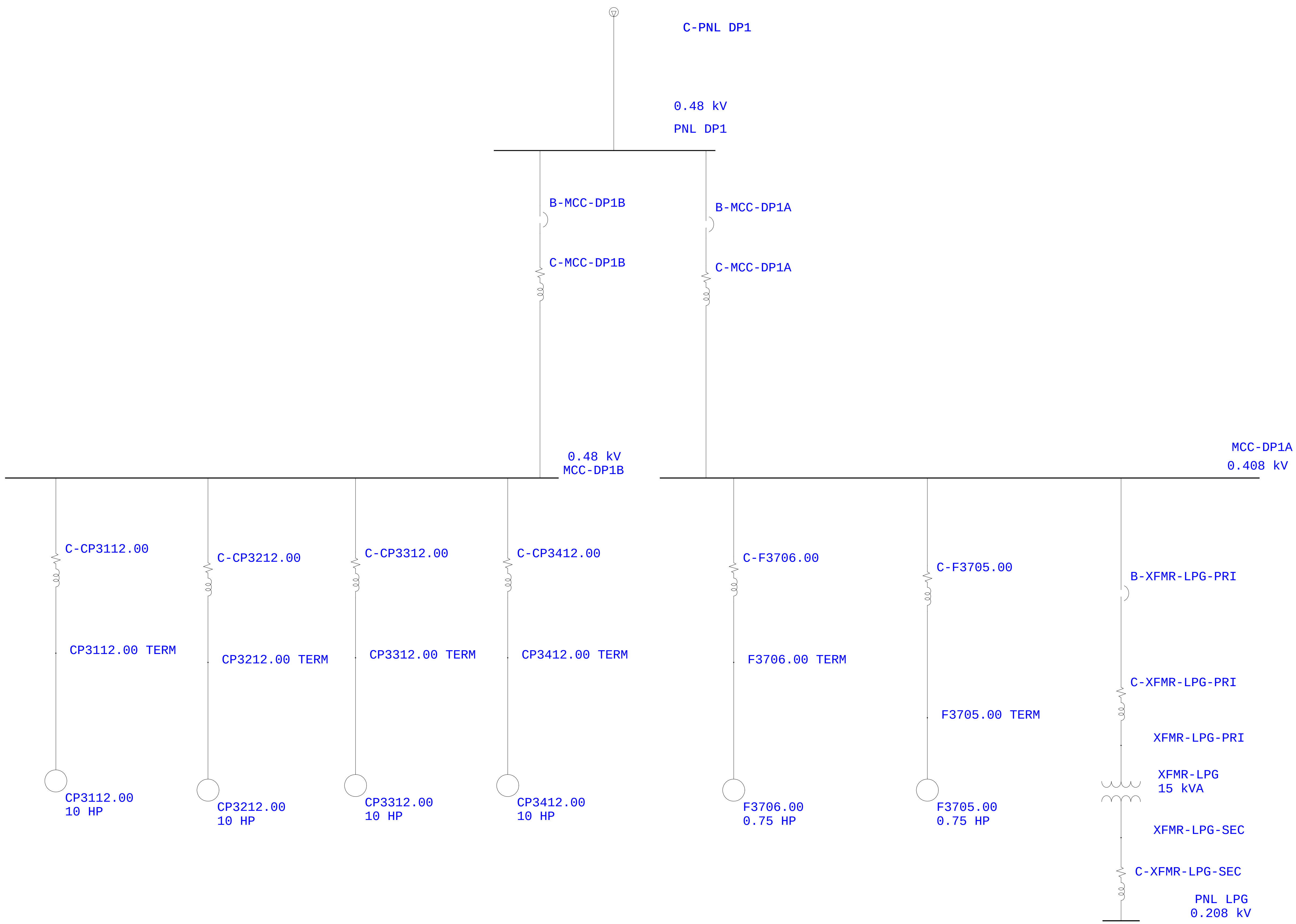



MCC-GF BUS PRI
C1-MCC-GF
MCC-GF
0.48 kV
B-P6501.00
C-P6601.00
C-P6701.00
C-P6503.00
C-P6501.00
P6501.00 TERM
P6601.00 TERM
P6701.00 TERM
P6503.00 TERM
P6501.00
50 HP
P6601.00
40 HP
P6701.00
40 HP
P6503.00
5 HP

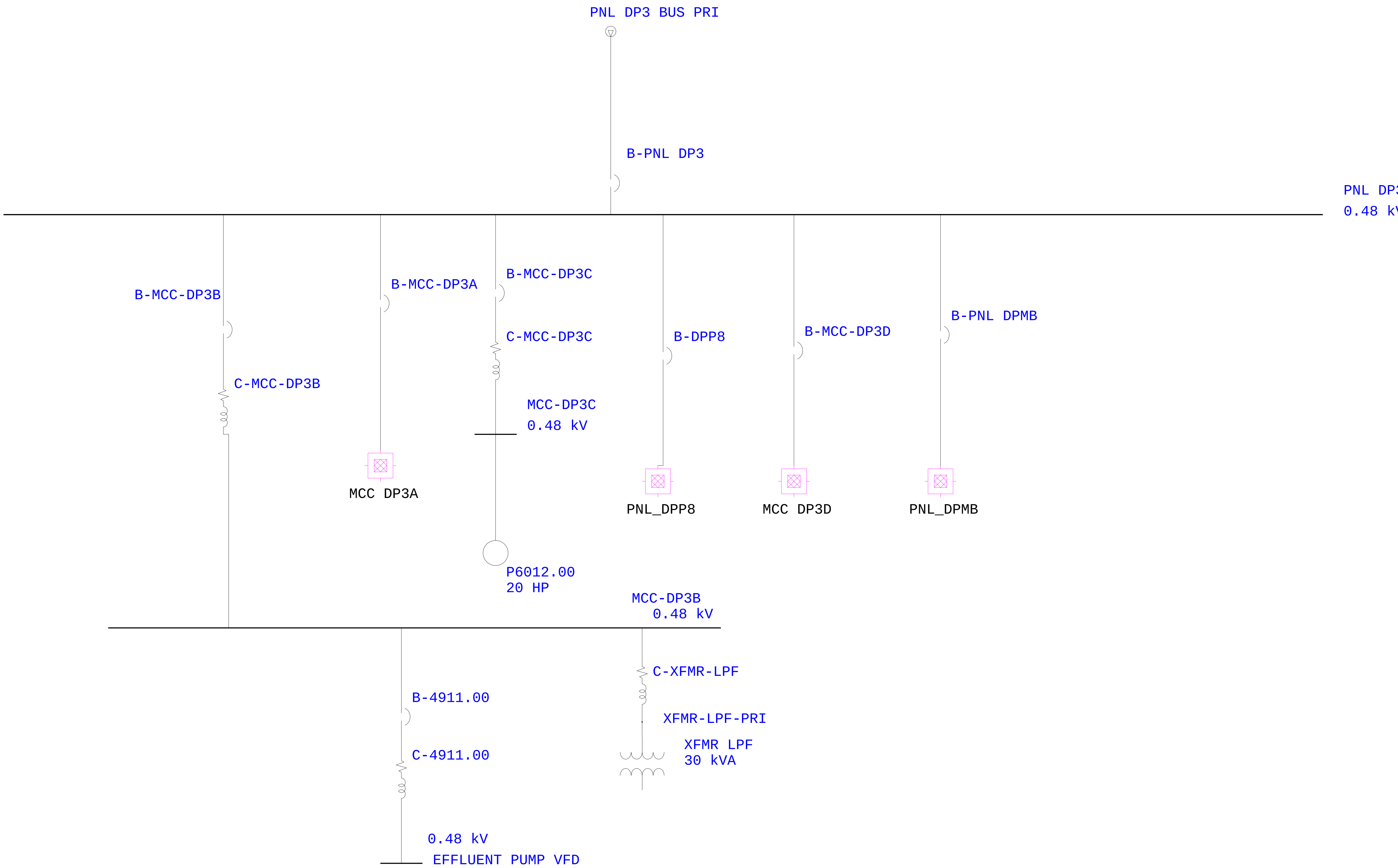
One-Line Diagram - OLV1=>MCC GH (Edit Mode)

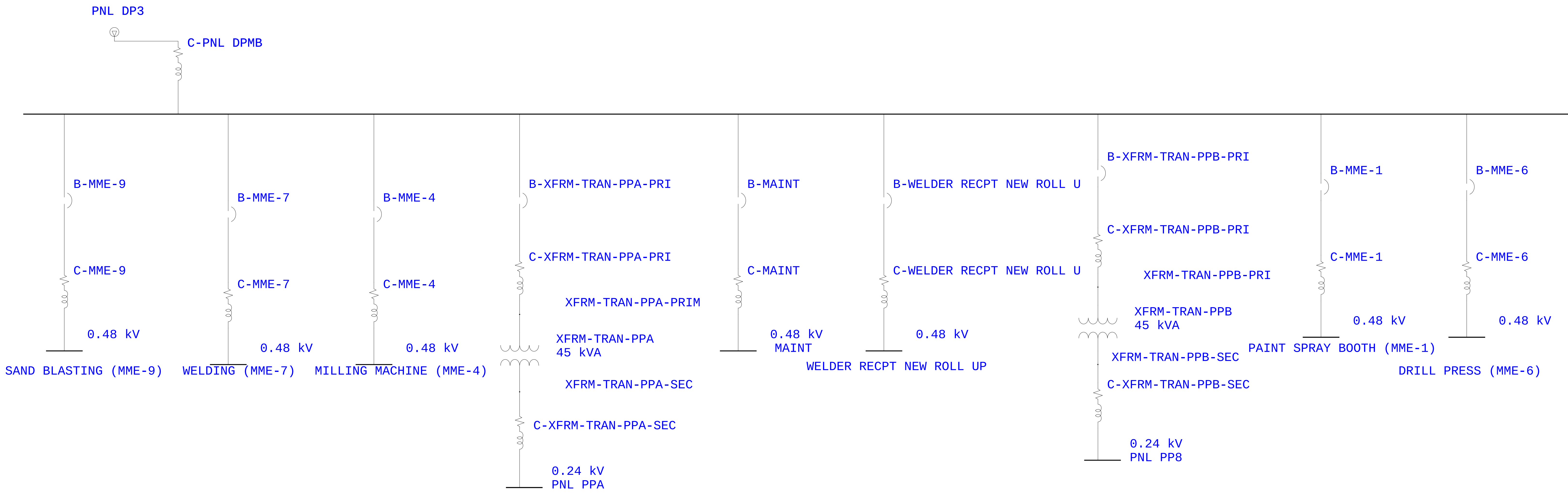


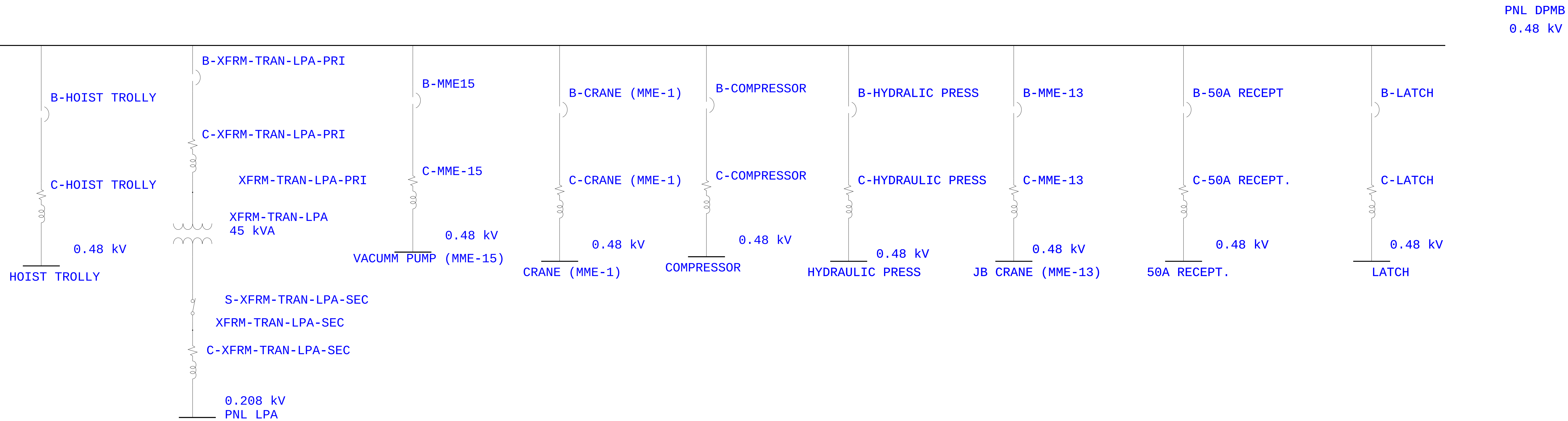
One-Line Diagram - OLV1=>PNL_DP1 (Edit Mode)

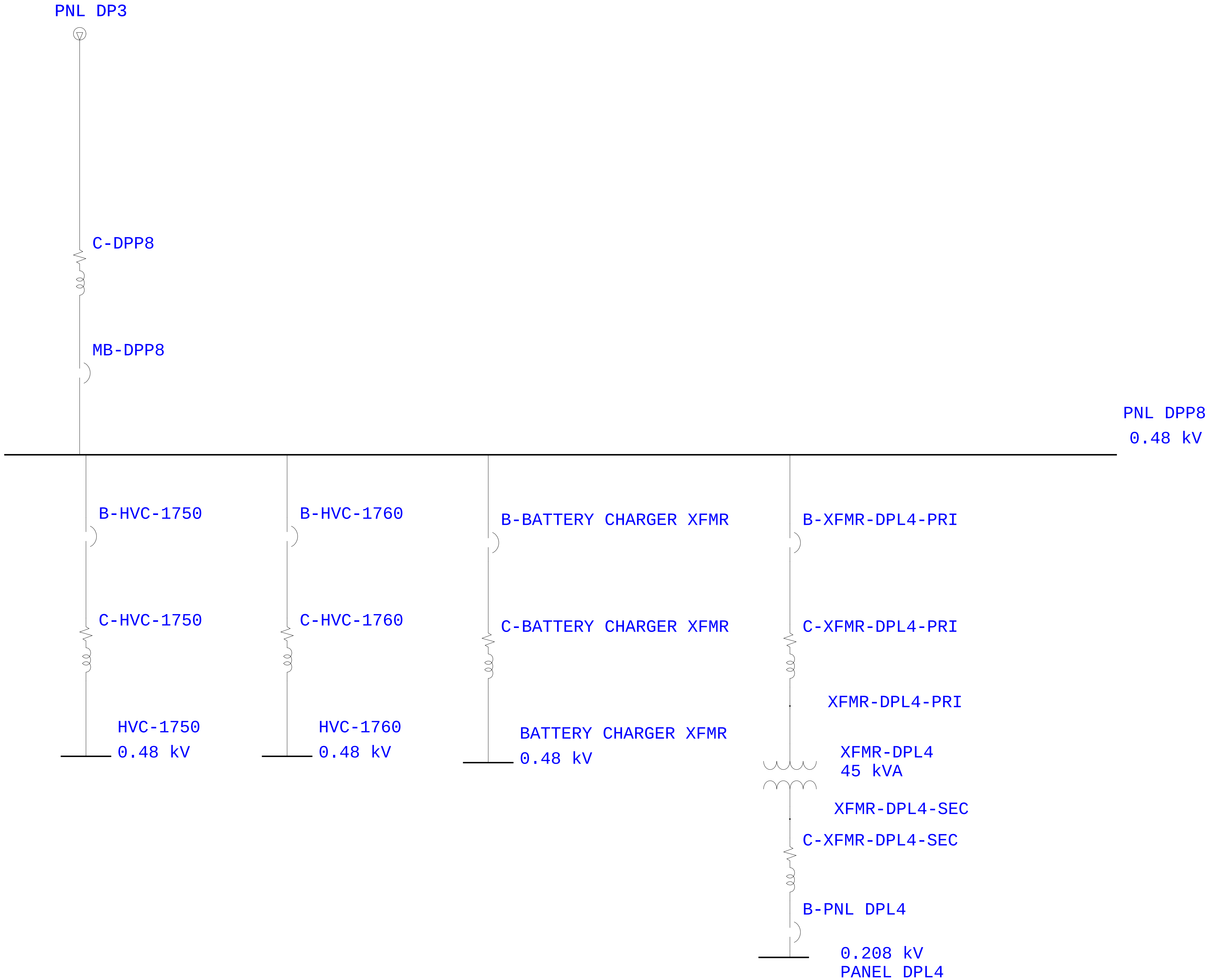


One-Line Diagram - OLV1=>PNL_DP3 (Edit Mode)

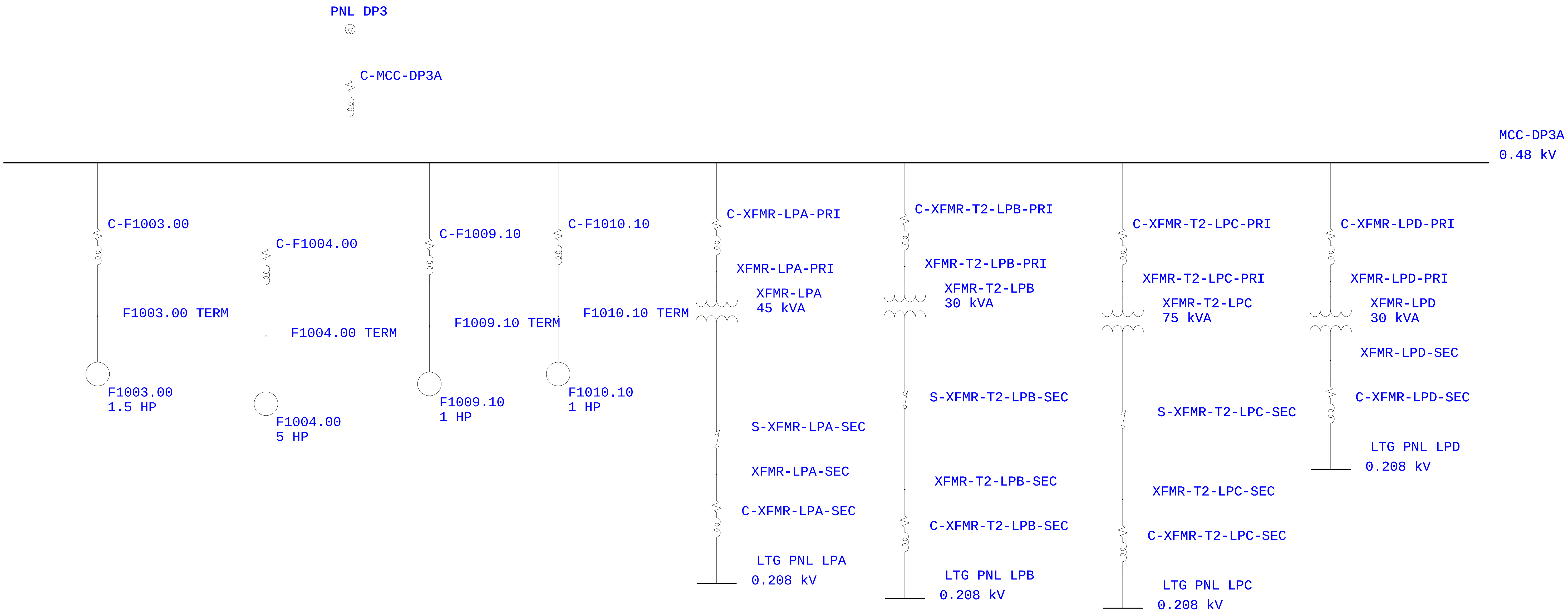



PNL DP3
C-PNL DPMB
B-MME-9
C-MME-9
0.48 kV
SAND BLASTING (MME-9)
B-MME-7
C-MME-7
0.48 kV
WELDING (MME-7)
B-MME-4
C-MME-4
0.48 kV
MILLING MACHINE (MME-4)
B-XFRM-TRAN-PPA-PRI
C-XFRM-TRAN-PPA-PRI
XFRM-TRAN-PPA-PRIM
XFRM-TRAN-PPA
45 kVA
XFRM-TRAN-PPA-SEC
C-XFRM-TRAN-PPA-SEC
0.24 kV
PNL PPA
B-MAINT
C-MAINT
0.48 kV
MAINT
B-WELDER RECPT NEW ROLL U
C-WELDER RECPT NEW ROLL U
0.48 kV
WELDER RECPT NEW ROLL UP
B-XFRM-TRAN-PPB-PRI
C-XFRM-TRAN-PPB-PRI
XFRM-TRAN-PPB-PRI
XFRM-TRAN-PPB
45 kVA
XFRM-TRAN-PPB-SEC
C-XFRM-TRAN-PPB-SEC
0.24 kV
PNL PP8
B-MME-1
C-MME-1
0.48 kV
PAINT SPRAY BOOTH (MME-1)
B-MME-6
C-MME-6
0.48 kV
DRILL PRESS (MME-6)

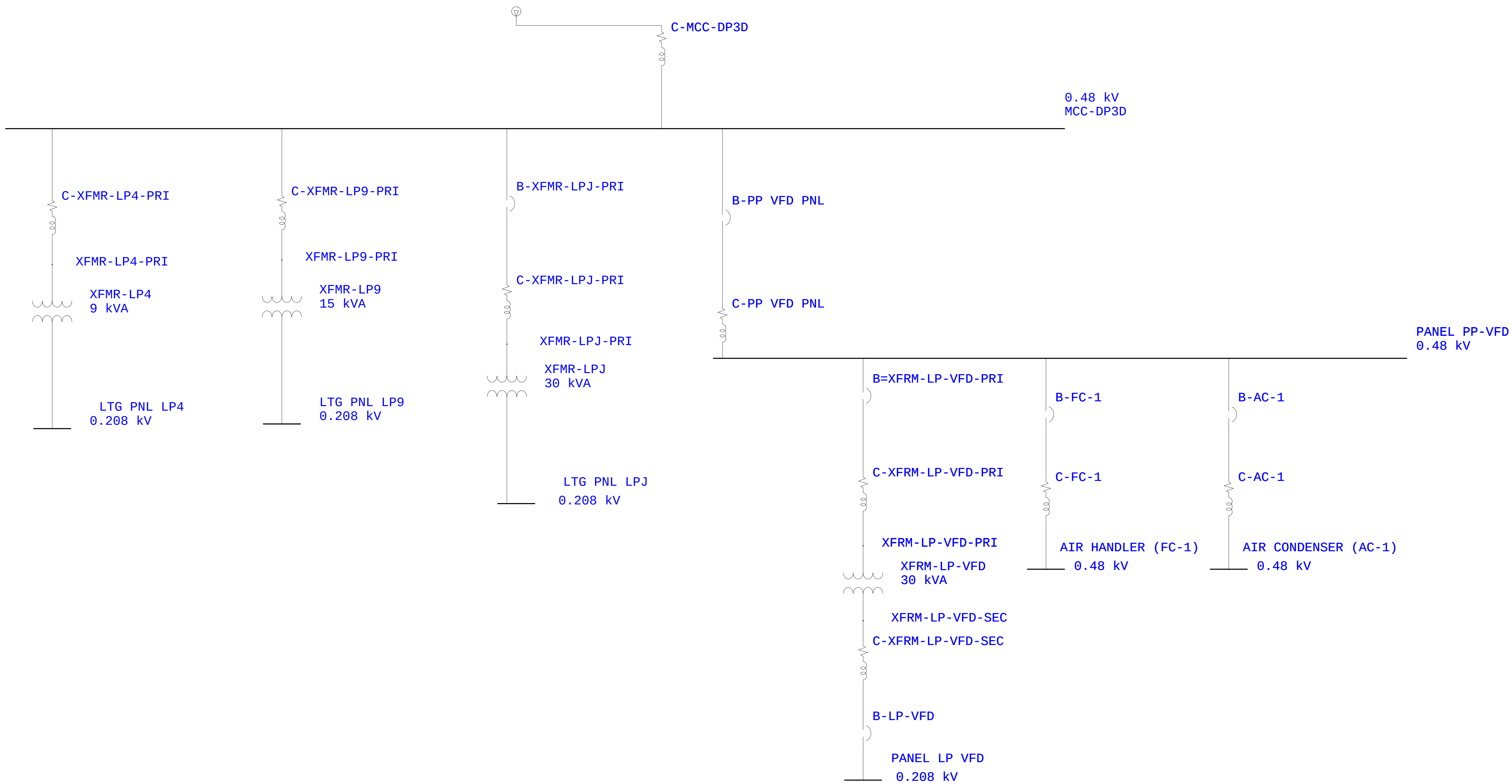

PNL DPMB
0.48 kV
B-HOIST TROLLY
C-HOIST TROLLY
0.48 kV
HOIST TROLLY
B-XFRM-TRAN-LPA-PRI
C-XFRM-TRAN-LPA-PRI
XFRM-TRAN-LPA-PRI
XFRM-TRAN-LPA
45 kVA
S-XFRM-TRAN-LPA-SEC
XFRM-TRAN-LPA-SEC
C-XFRM-TRAN-LPA-SEC
0.208 kV
PNL LPA
B-MME15
C-MME-15
0.48 kV
VACUMM PUMP (MME-15)
B-CRANE (MME-1)
C-CRANE (MME-1)
0.48 kV
CRANE (MME-1)
B-COMPRESSOR
C-COMPRESSOR
0.48 kV
COMPRESSOR
B-HYDRALIC PRESS
C-HYDRAULIC PRESS
0.48 kV
HYDRAULIC PRESS
B-MME-13
C-MME-13
0.48 kV
JB CRANE (MME-13)
B-50A RECEPT
C-50A RECEPT.
0.48 kV
50A RECEPT.
B-LATCH
C-LATCH
0.48 kV
LATCH


PNL DP3
C-DPP8
MB-DPP8
PNL DPP8
0.48 kV
B-HVC-1750
C-HVC-1750
HVC-1750
0.48 kV
B-HVC-1760
C-HVC-1760
HVC-1760
0.48 kV
B-BATTERY CHARGER XFMR
C-BATTERY CHARGER XFMR
BATTERY CHARGER XFMR
0.48 kV
B-XFMR-DPL4-PRI
C-XFMR-DPL4-PRI
XFMR-DPL4-PRI
XFMR-DPL4
45 kVA
XFMR-DPL4-SEC
C-XFMR-DPL4-SEC
B-PNL DPL4
0.208 kV
PANEL DPL4

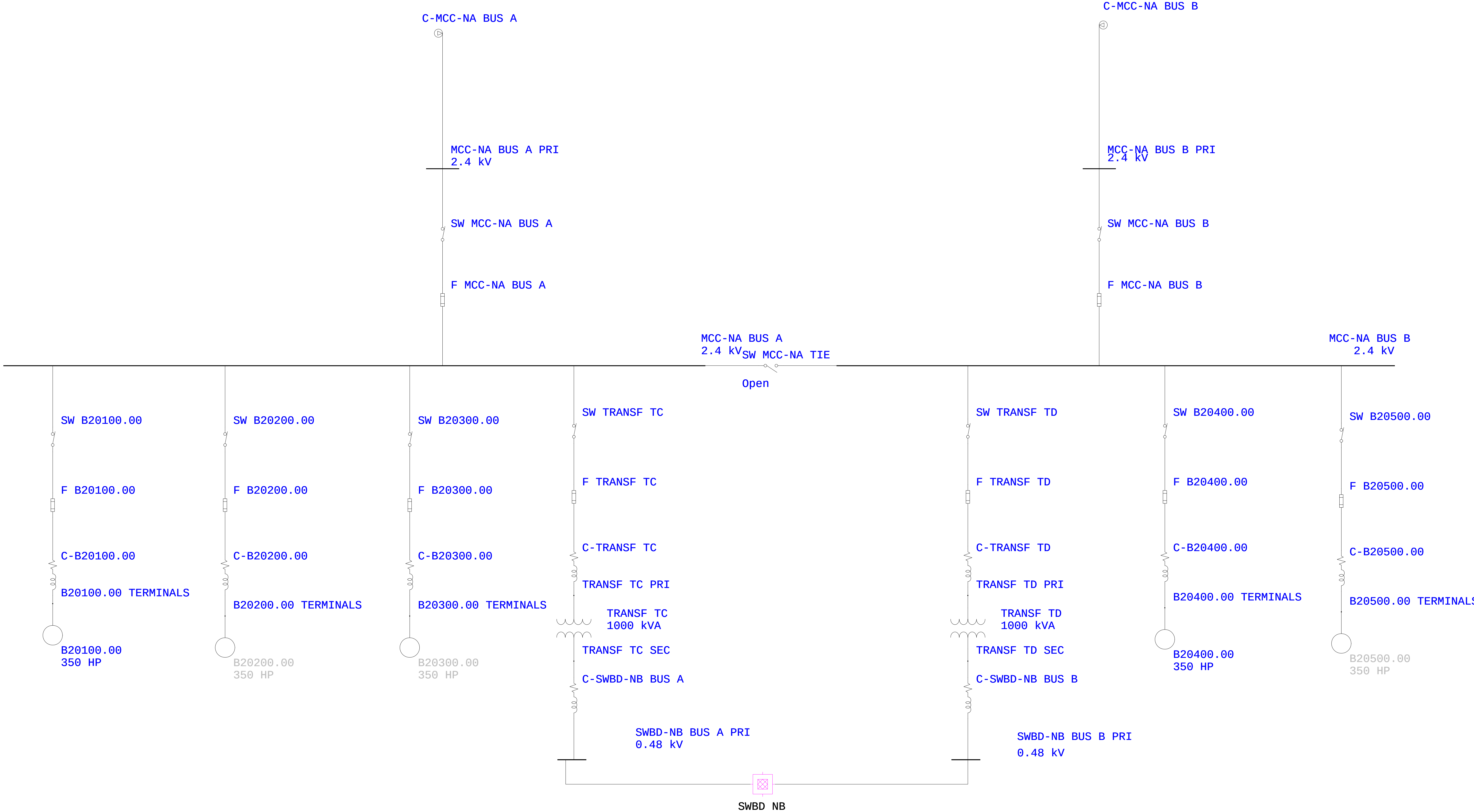
One-Line Diagram - OLV1=>...=>MCC DP3A (Edit Mode)



One-Line Diagram - OLV1=>...=>MCC DP3D (Edit Mode)

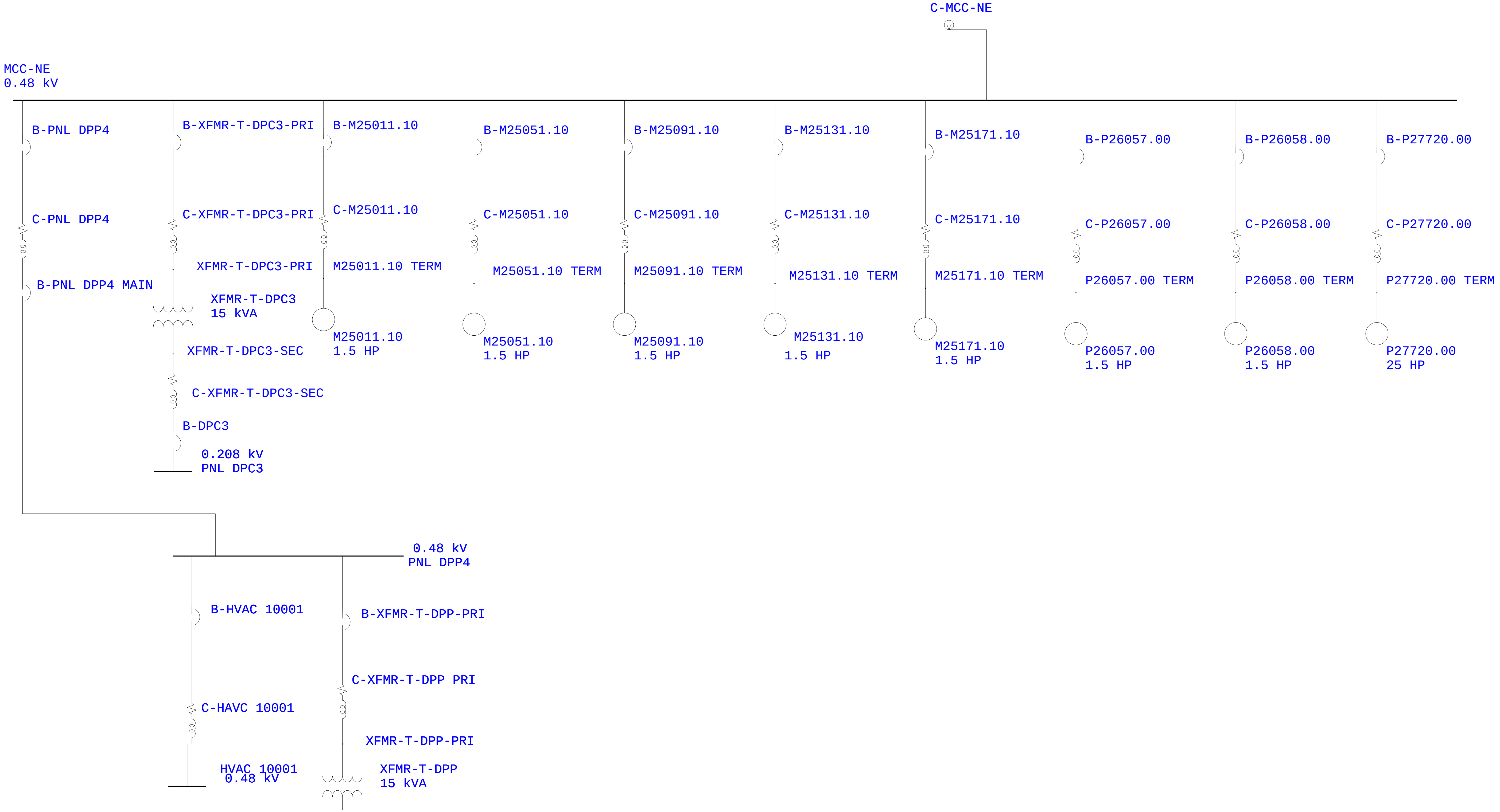


One-Line Diagram - OLV1=>MCC NA (Edit Mode)

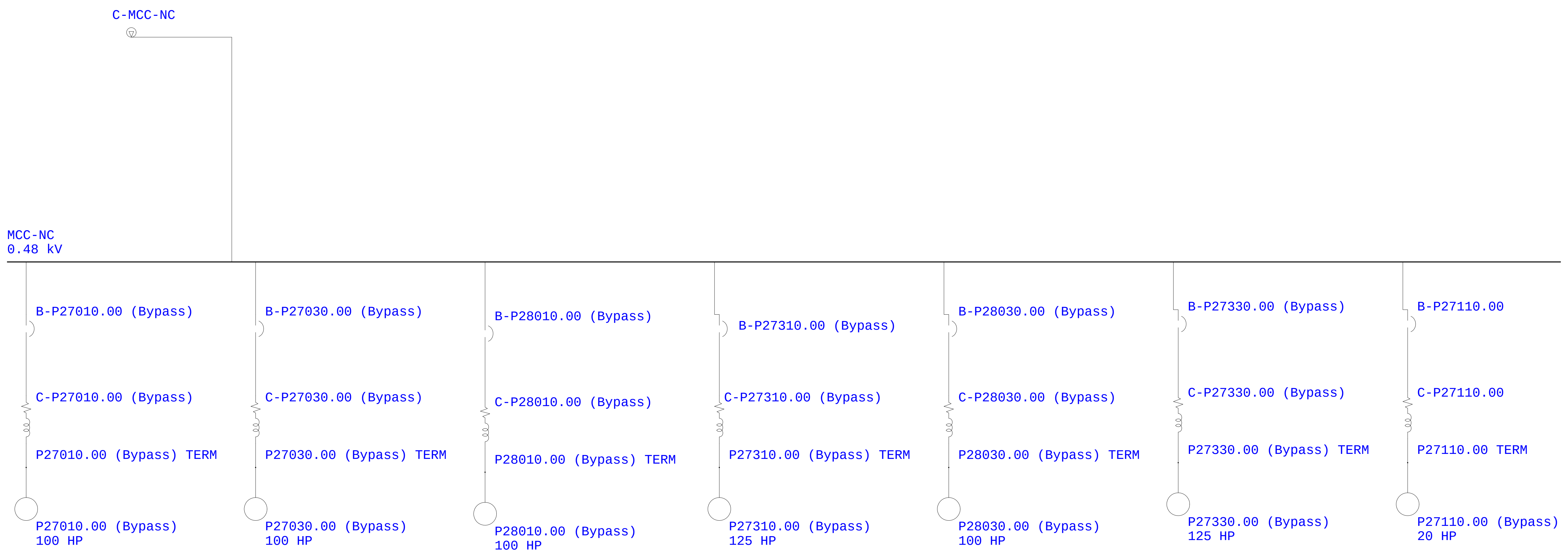


One-Line Diagram - OLV1=>...=>SWBD NB (Edit Mode)

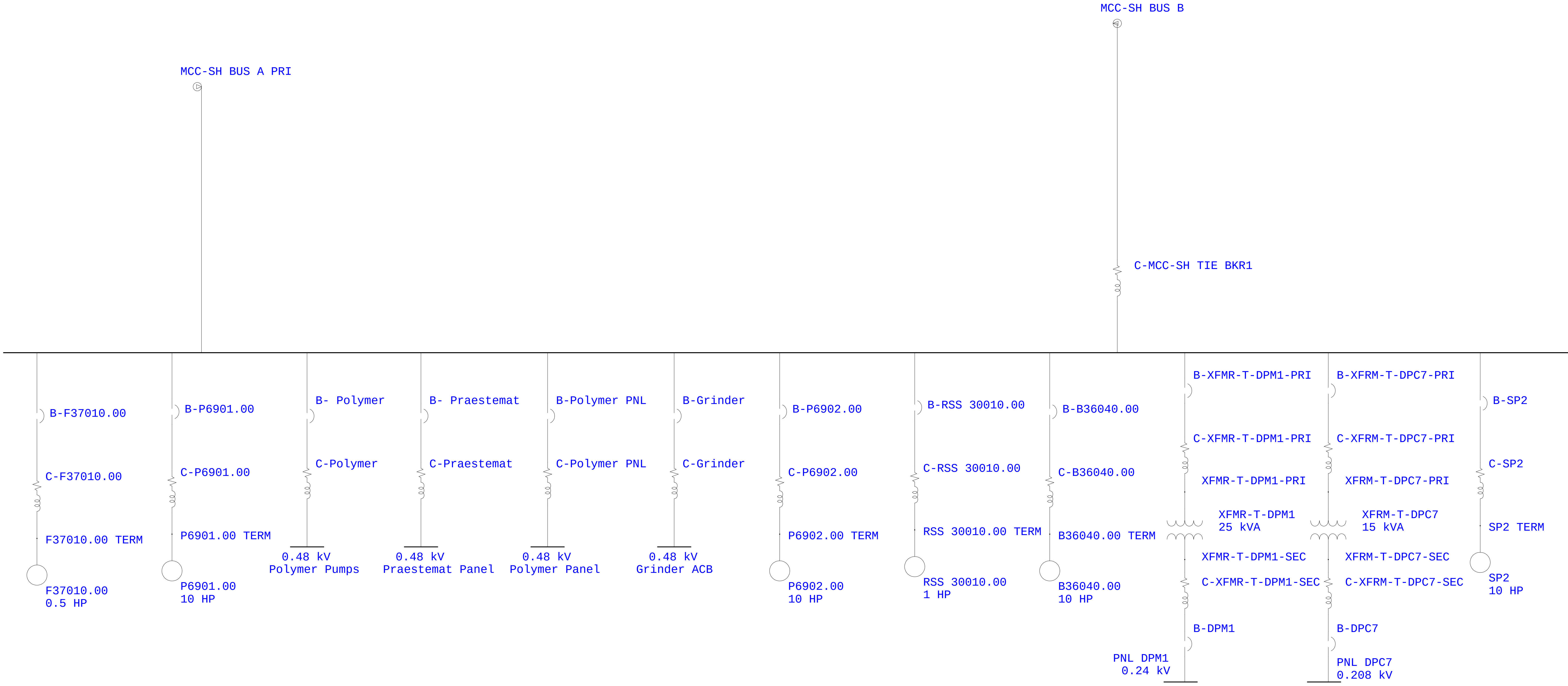
One-Line Diagram - OLV1=>...=>MCC NE (Edit Mode)



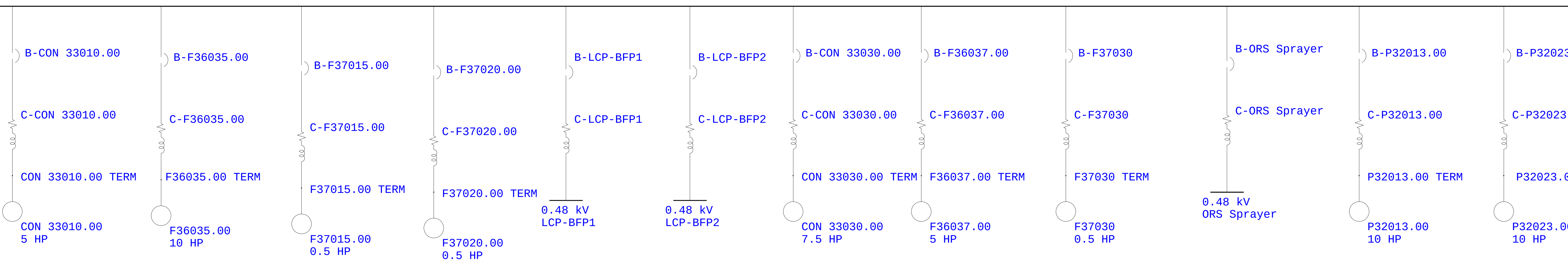
One-Line Diagram - OLV1=>...=>MCC NC (Edit Mode)

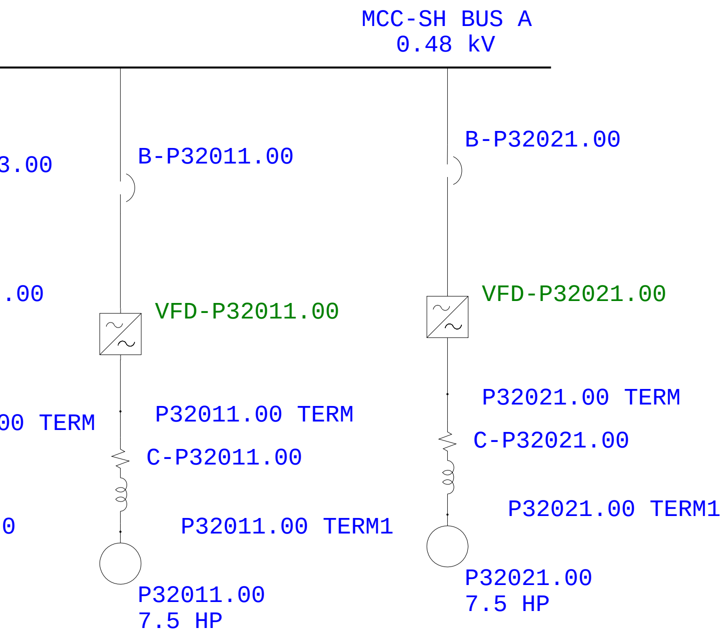


One-Line Diagram - OLV1=>...=>MCC SH BUS A (Edit Mode)

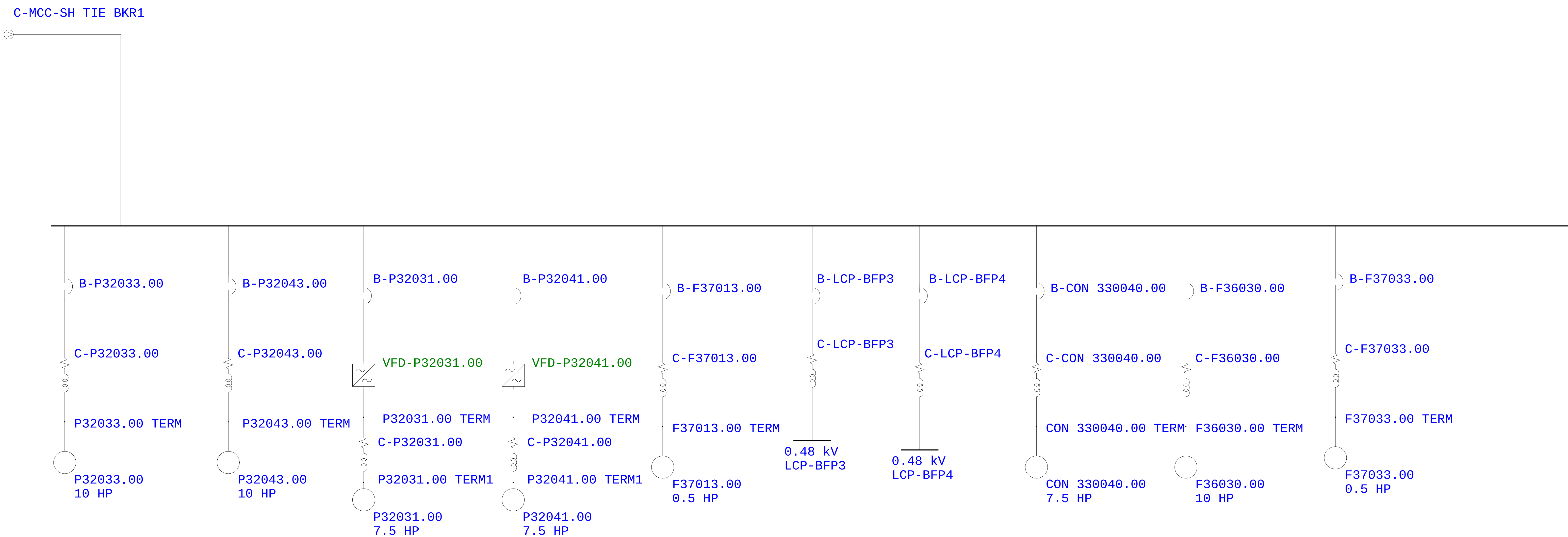


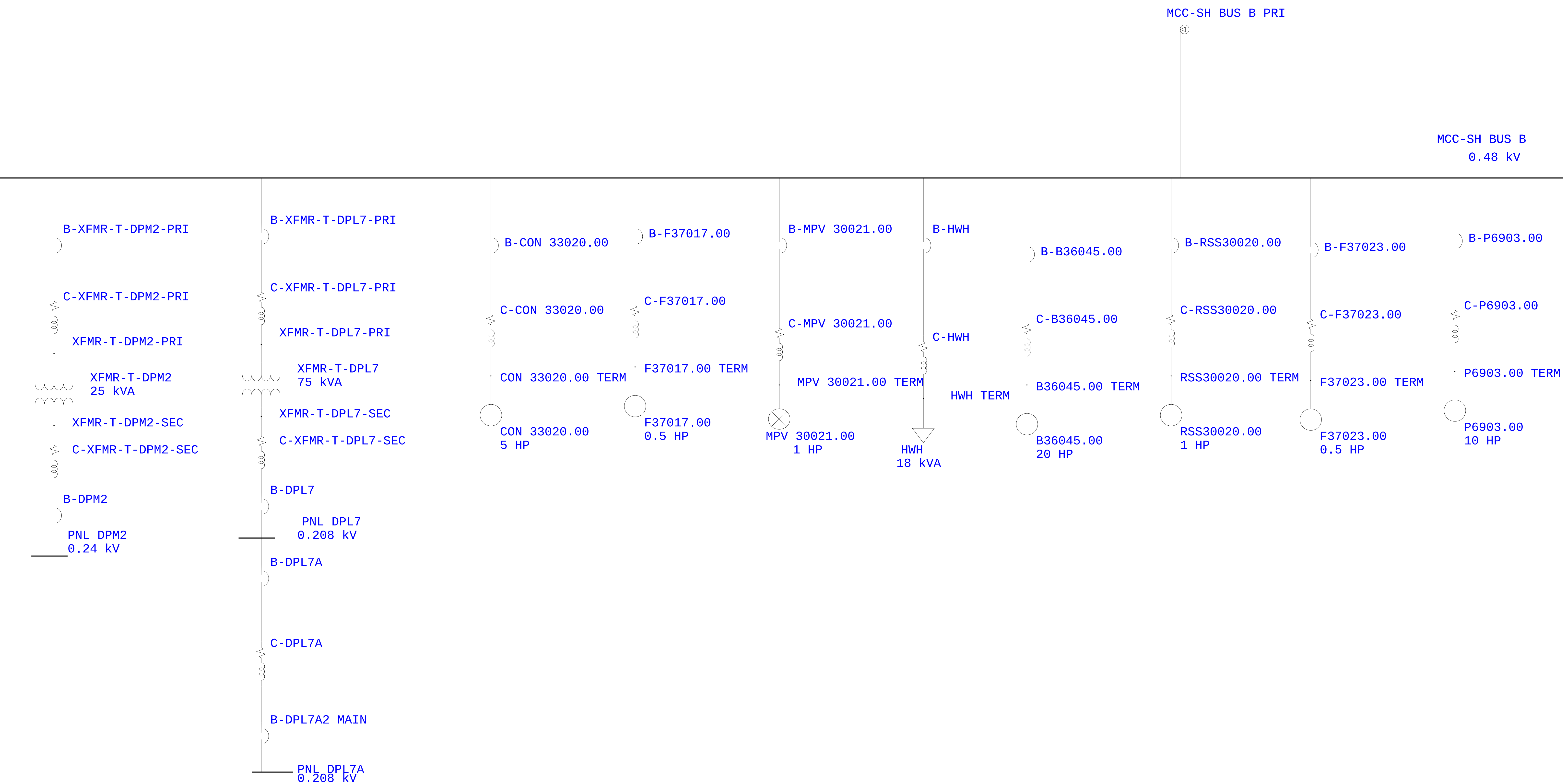
One-Line Diagram - OLV1=>...=>MCC SH BUS A (Edit Mode)



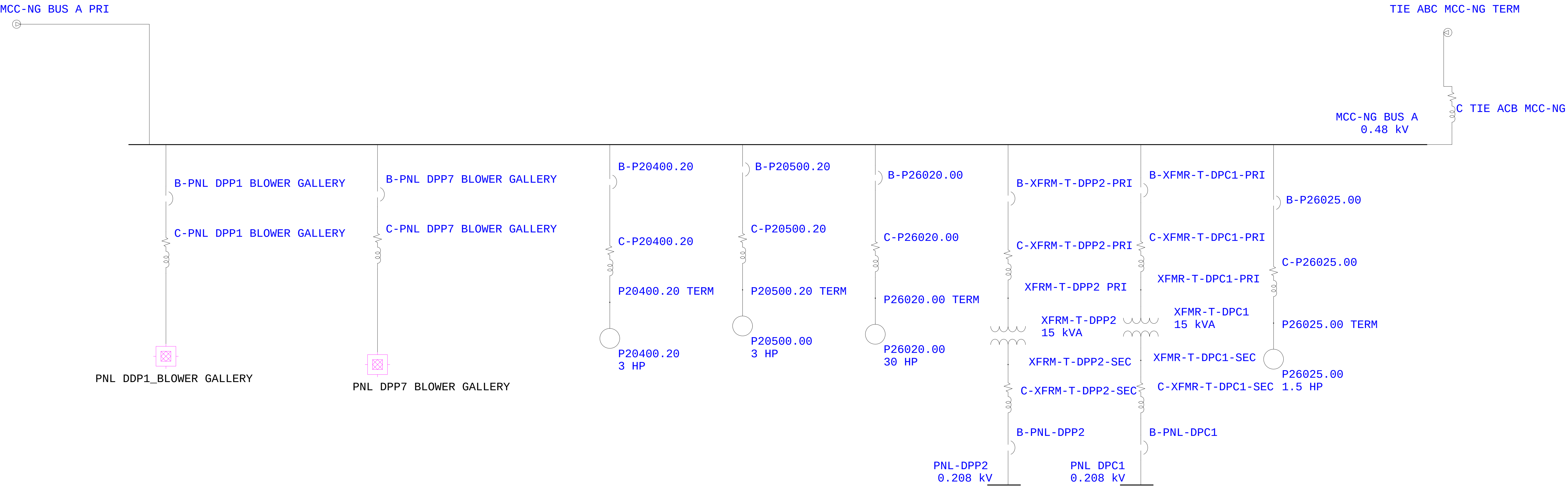

MCC-SH BUS A
0.48 kV
3.00
B-P32011.00
B-P32021.00
.00
VFD-P32011.00
VFD-P32021.00
00 TERM
P32011.00 TERM
P32021.00 TERM
C-P32011.00
C-P32021.00
0
P32011.00 TERM1
P32021.00 TERM1
P32011.00
7.5 HP
P32021.00
7.5 HP

One-Line Diagram - OLV1=>...=>MCC SH BUS B (Edit Mode)

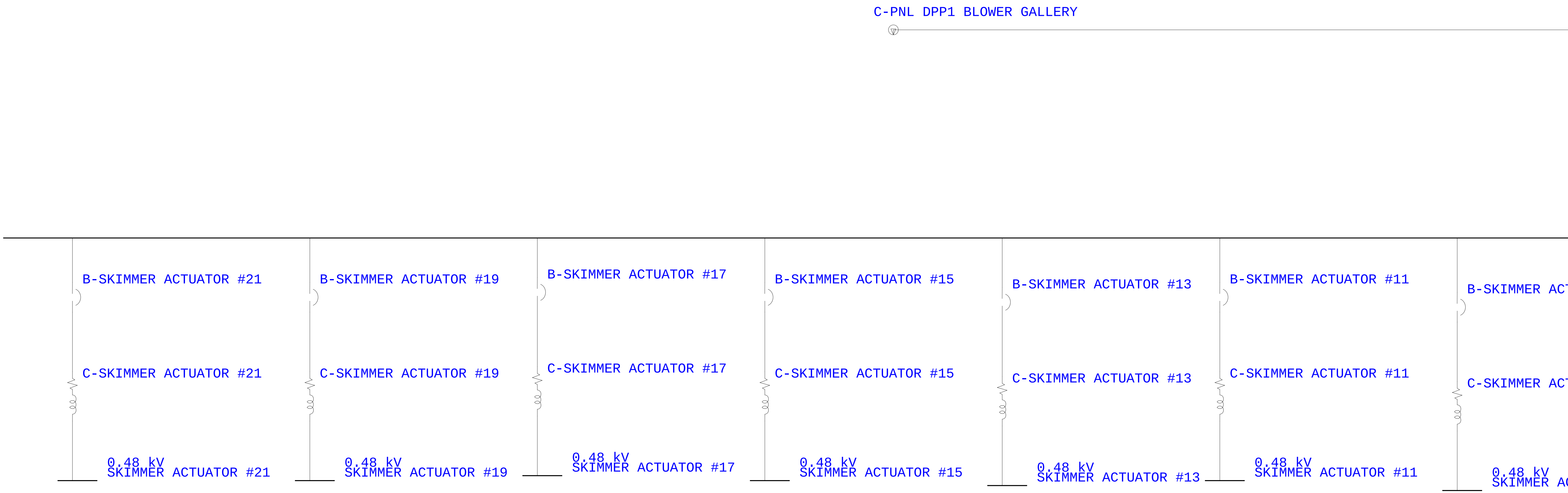


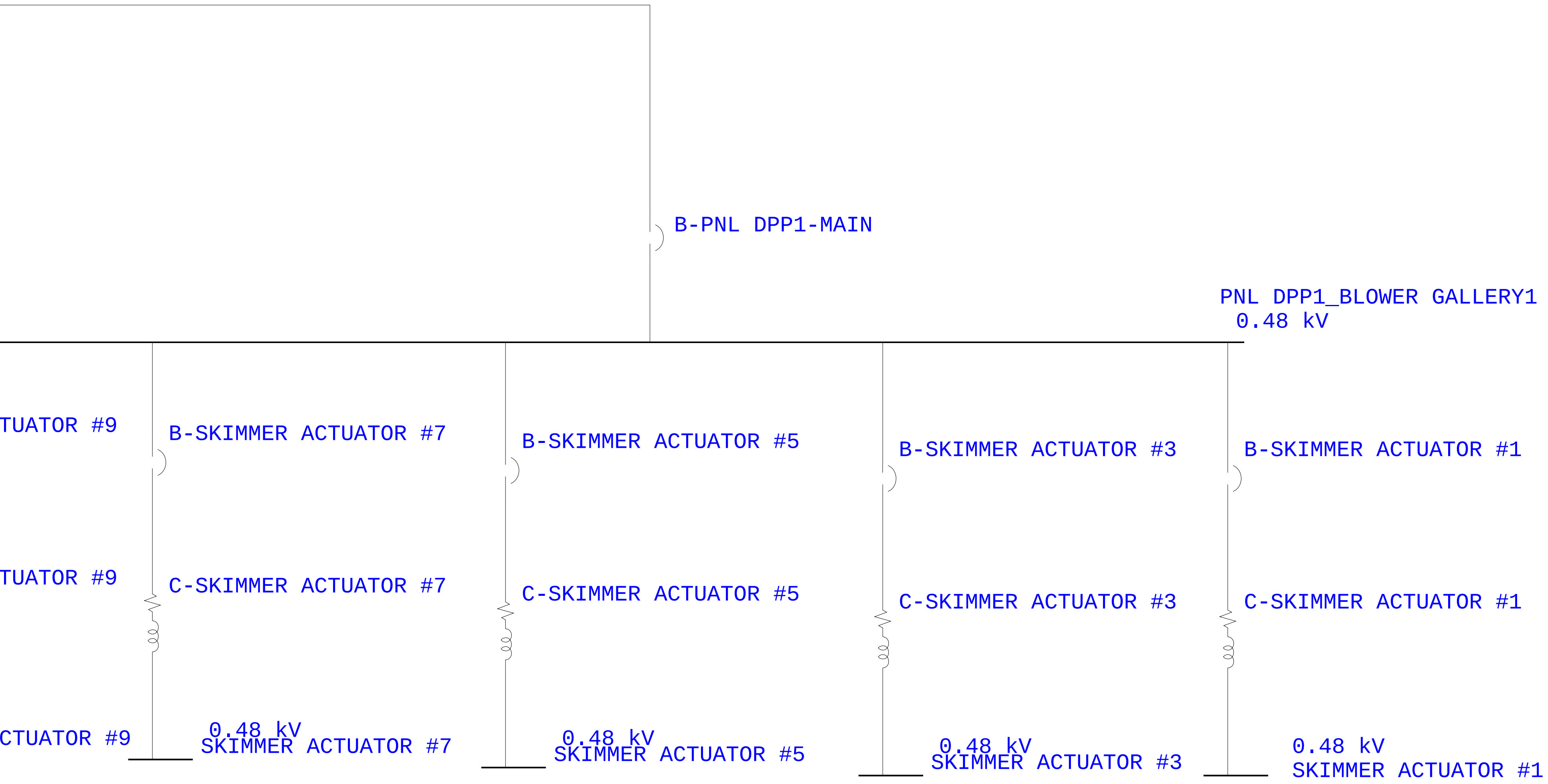

MCC-SH BUS B PRI
MCC-SH BUS B
0.48 kV
B-XFMR-T-DPM2-PRI
C-XFMR-T-DPM2-PRI
XFMR-T-DPM2-PRI
XFMR-T-DPM2
25 kVA
XFMR-T-DPM2-SEC
C-XFMR-T-DPM2-SEC
B-DPM2
PNL DPM2
0.24 kV
B-XFMR-T-DPL7-PRI
C-XFMR-T-DPL7-PRI
XFMR-T-DPL7-PRI
XFMR-T-DPL7
75 kVA
XFMR-T-DPL7-SEC
C-XFMR-T-DPL7-SEC
B-DPL7
PNL DPL7
0.208 kV
B-DPL7A
C-DPL7A
B-DPL7A2 MAIN
PNL DPL7A
0.208 kV
B-CON 33020.00
C-CON 33020.00
CON 33020.00 TERM
CON 33020.00
5 HP
B-F37017.00
C-F37017.00
F37017.00 TERM
F37017.00
0.5 HP
B-MPV 30021.00
C-MPV 30021.00
MPV 30021.00 TERM
MPV 30021.00
1 HP
B-HWH
C-HWH
HWH TERM
HWH
18 kVA
B-B36045.00
C-B36045.00
B36045.00 TERM
B36045.00
20 HP
B-RSS30020.00
C-RSS30020.00
RSS30020.00 TERM
RSS30020.00
1 HP
B-F37023.00
C-F37023.00
F37023.00 TERM
F37023.00
0.5 HP
B-P6903.00
C-P6903.00
P6903.00 TERM
P6903.00
10 HP

One-Line Diagram - OLV1=>...=>MCC NG BUS A (Edit Mode)

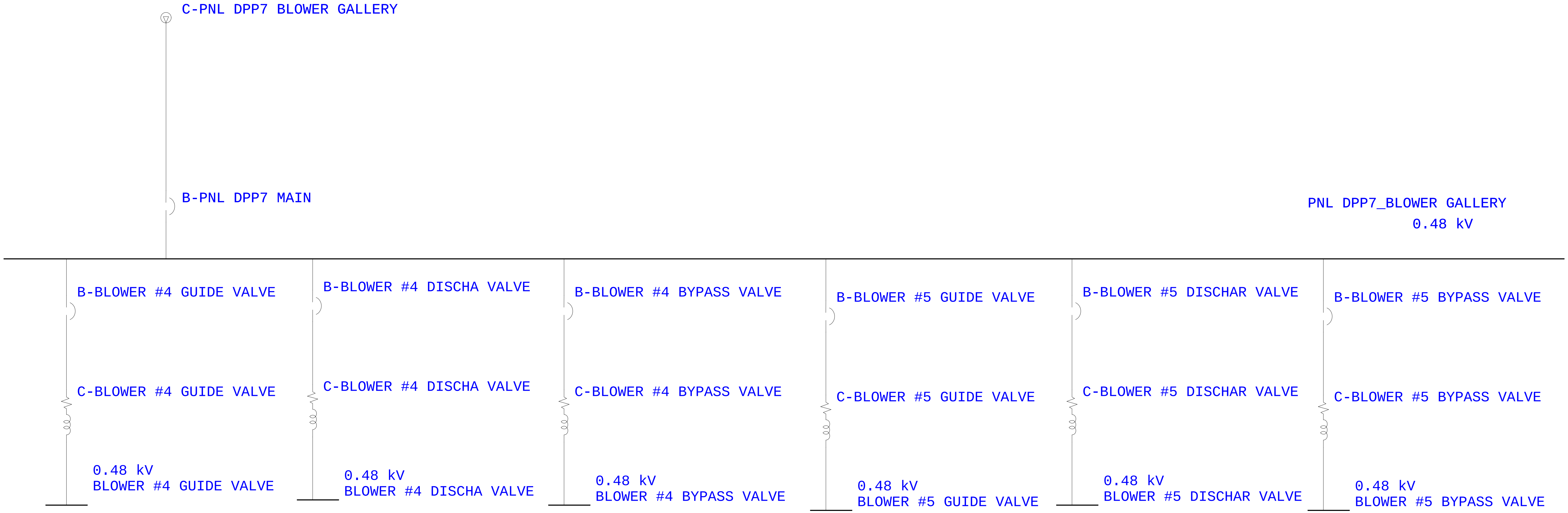


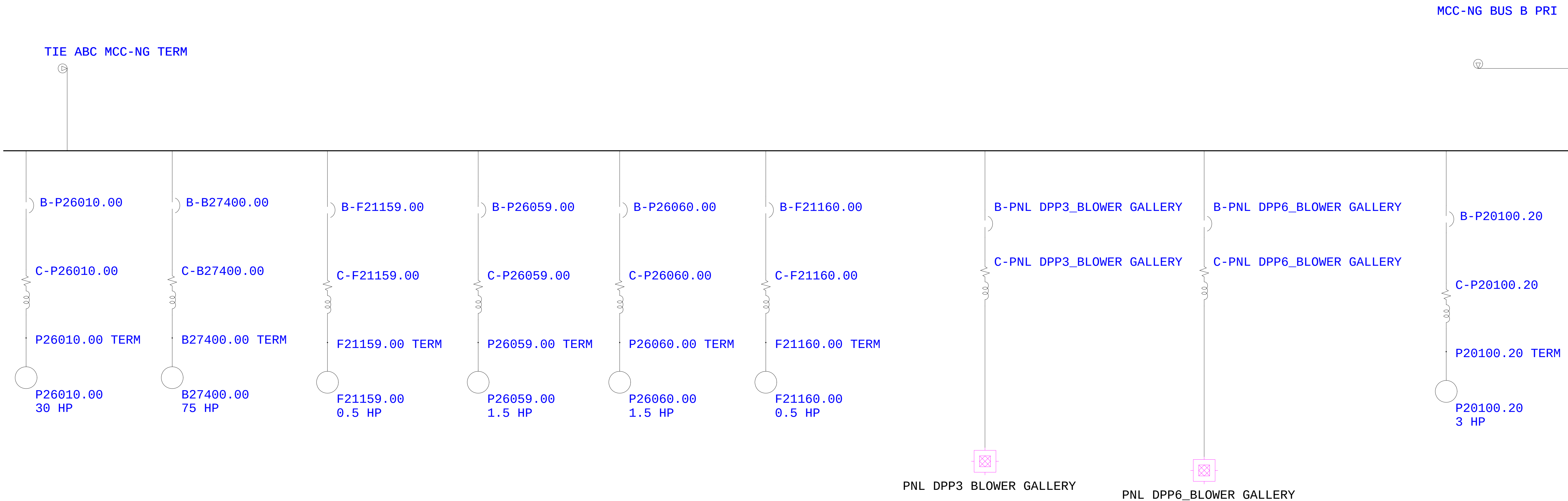
One-Line Diagram - OLV1=>...=>PNL DDP1_BLOWER GALLERY (Edit Mode)

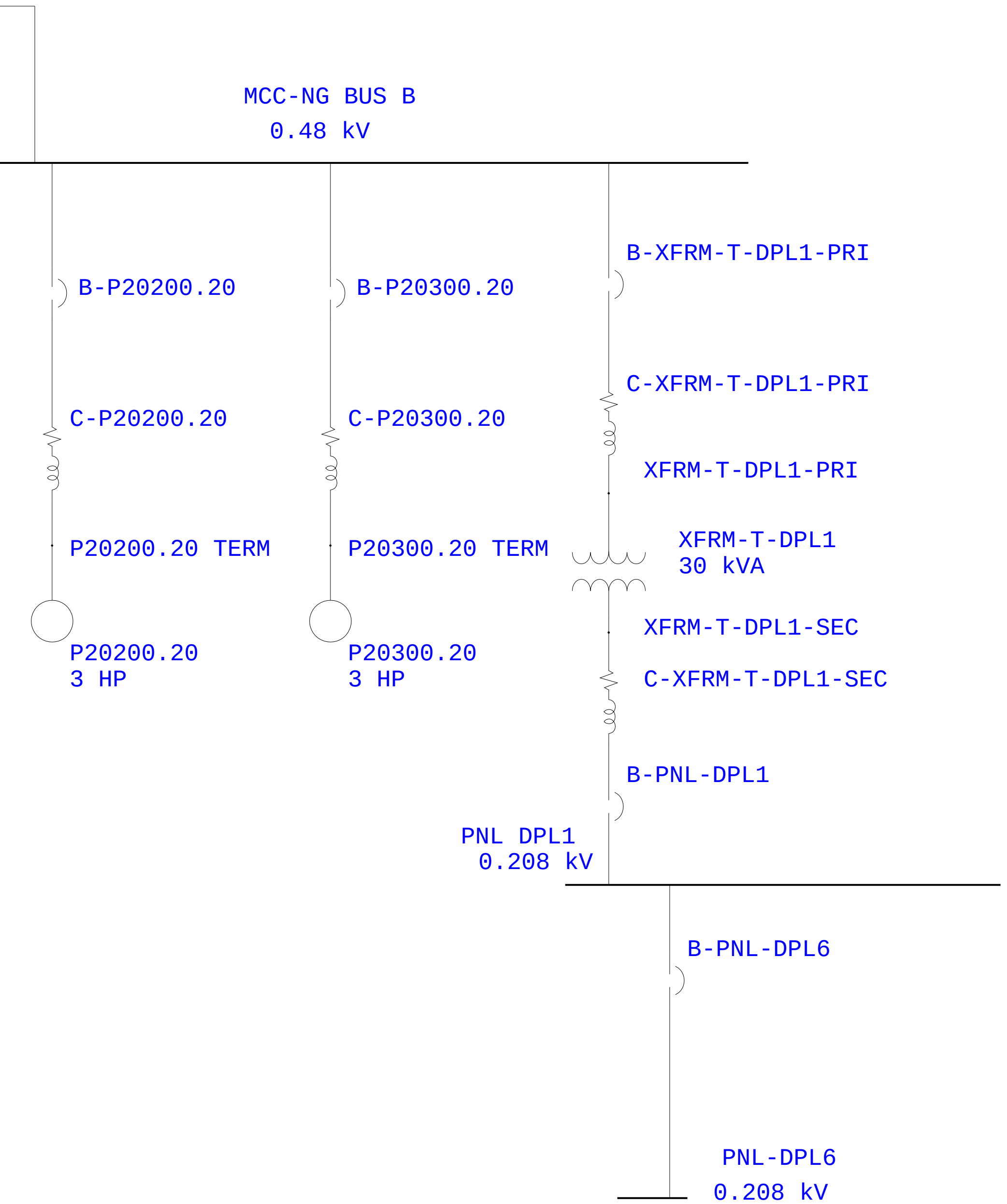


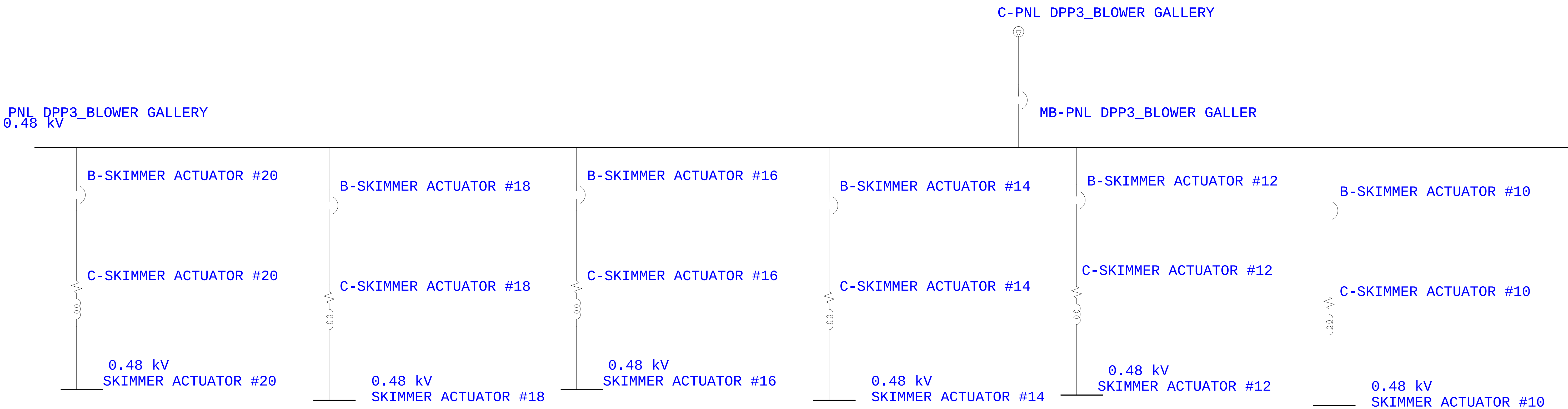

B-PNL DPP1-MAIN
PNL DPP1_BLOWER GALLERY1
0.48 kV
TUATOR #9
B-SKIMMER ACTUATOR #7
B-SKIMMER ACTUATOR #5
B-SKIMMER ACTUATOR #3
B-SKIMMER ACTUATOR #1
TUATOR #9
C-SKIMMER ACTUATOR #7
C-SKIMMER ACTUATOR #5
C-SKIMMER ACTUATOR #3
C-SKIMMER ACTUATOR #1
CTUATOR #9
0.48 kV
SKIMMER ACTUATOR #7
0.48 kV
SKIMMER ACTUATOR #5
0.48 kV
SKIMMER ACTUATOR #3
0.48 kV
SKIMMER ACTUATOR #1

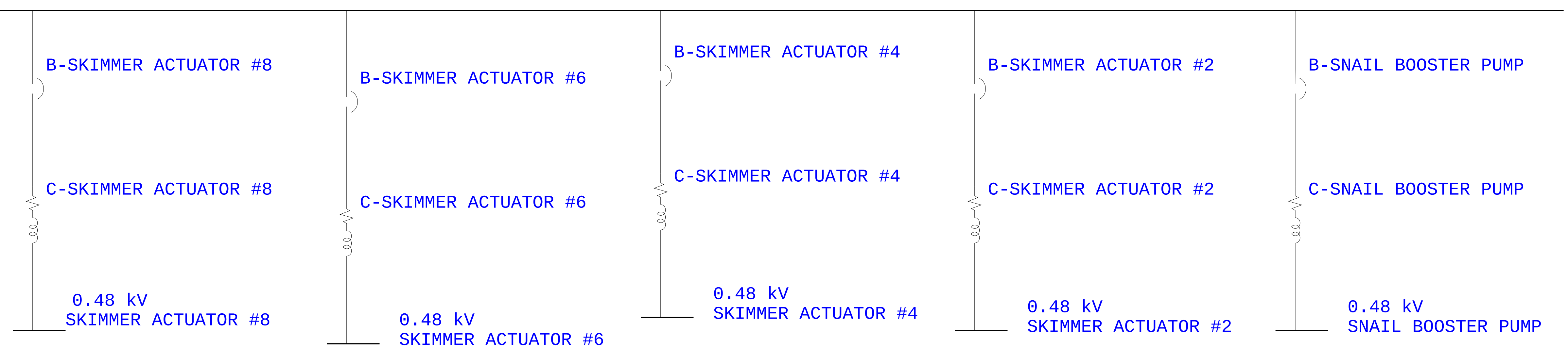
One-Line Diagram - OLV1=>...=>PNL DPP7 BLOWER GALLERY (Edit Mode)



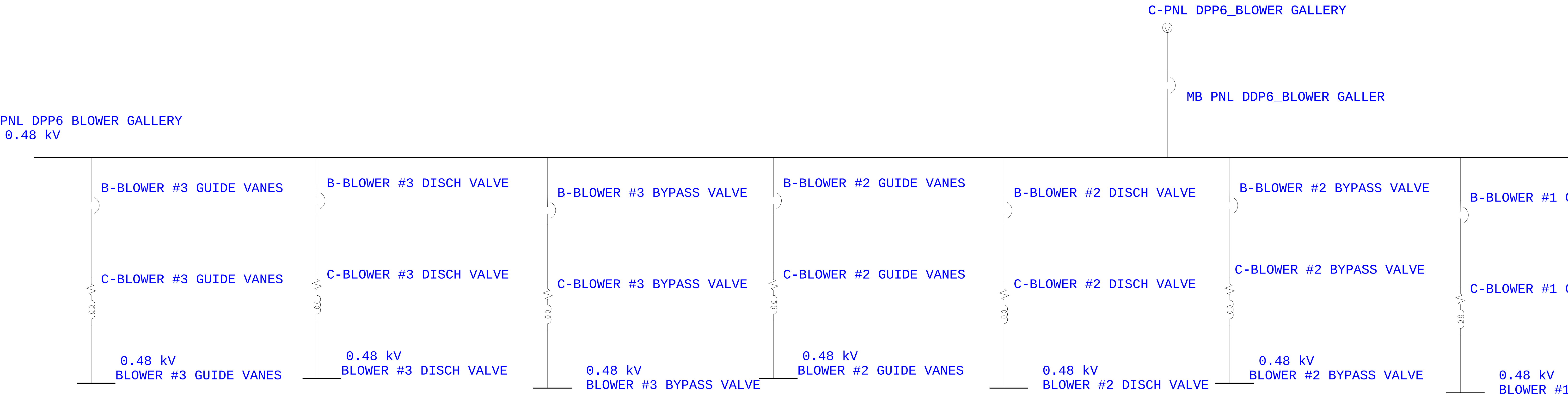

MCC-NG BUS B PRI
TIE ABC MCC-NG TERM
B-P26010.00
C-P26010.00
P26010.00 TERM
P26010.00
30 HP
B-B27400.00
C-B27400.00
B27400.00 TERM
B27400.00
75 HP
B-F21159.00
C-F21159.00
F21159.00 TERM
F21159.00
0.5 HP
B-P26059.00
C-P26059.00
P26059.00 TERM
P26059.00
1.5 HP
B-P26060.00
C-P26060.00
P26060.00 TERM
P26060.00
1.5 HP
B-F21160.00
C-F21160.00
F21160.00 TERM
F21160.00
0.5 HP
B-PNL DPP3_BLOWER GALLERY
C-PNL DPP3_BLOWER GALLERY
PNL DPP3 BLOWER GALLERY
B-PNL DPP6_BLOWER GALLERY
C-PNL DPP6_BLOWER GALLERY
PNL DPP6_BLOWER GALLERY
B-P20100.20
C-P20100.20
P20100.20 TERM
P20100.20
3 HP

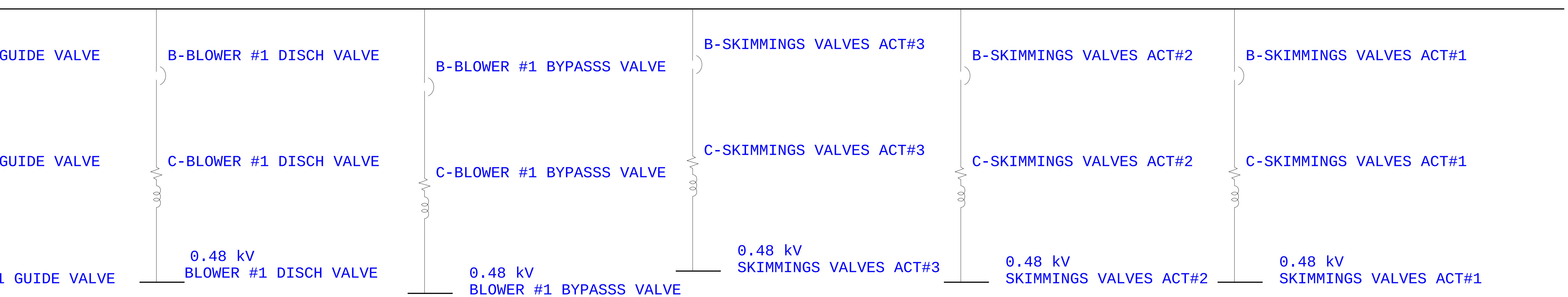

MCC-NG BUS B
0.48 kV
B-P20200.20
B-P20300.20
B-XFRM-T-DPL1-PRI
C-XFRM-T-DPL1-PRI
C-P20200.20
C-P20300.20
XFRM-T-DPL1-PRI
P20200.20 TERM
P20300.20 TERM
XFRM-T-DPL1
30 kVA
P20200.20
3 HP
P20300.20
3 HP
XFRM-T-DPL1-SEC
C-XFRM-T-DPL1-SEC
B-PNL-DPL1
PNL DPL1
0.208 kV
B-PNL-DPL6
PNL-DPL6
0.208 kV

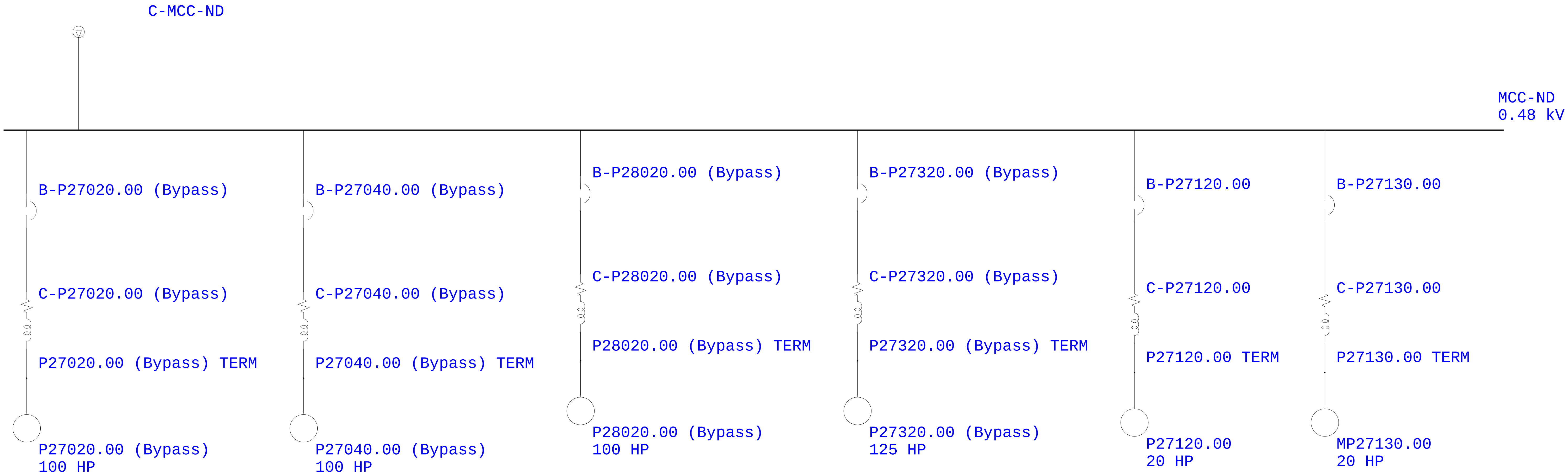

C-PNL DPP3_BLOWER GALLERY
MB-PNL DPP3_BLOWER GALLER
PNL DPP3_BLOWER GALLERY
0.48 kV
B-SKIMMER ACTUATOR #20
C-SKIMMER ACTUATOR #20
0.48 kV
SKIMMER ACTUATOR #20
B-SKIMMER ACTUATOR #18
C-SKIMMER ACTUATOR #18
0.48 kV
SKIMMER ACTUATOR #18
B-SKIMMER ACTUATOR #16
C-SKIMMER ACTUATOR #16
0.48 kV
SKIMMER ACTUATOR #16
B-SKIMMER ACTUATOR #14
C-SKIMMER ACTUATOR #14
0.48 kV
SKIMMER ACTUATOR #14
B-SKIMMER ACTUATOR #12
C-SKIMMER ACTUATOR #12
0.48 kV
SKIMMER ACTUATOR #12
B-SKIMMER ACTUATOR #10
C-SKIMMER ACTUATOR #10
0.48 kV
SKIMMER ACTUATOR #10


B-SKIMMER ACTUATOR #8
C-SKIMMER ACTUATOR #8
0.48 kV
SKIMMER ACTUATOR #8
B-SKIMMER ACTUATOR #6
C-SKIMMER ACTUATOR #6
0.48 kV
SKIMMER ACTUATOR #6
B-SKIMMER ACTUATOR #4
C-SKIMMER ACTUATOR #4
0.48 kV
SKIMMER ACTUATOR #4
B-SKIMMER ACTUATOR #2
C-SKIMMER ACTUATOR #2
0.48 kV
SKIMMER ACTUATOR #2
B-SNAIL BOOSTER PUMP
C-SNAIL BOOSTER PUMP
0.48 kV
SNAIL BOOSTER PUMP

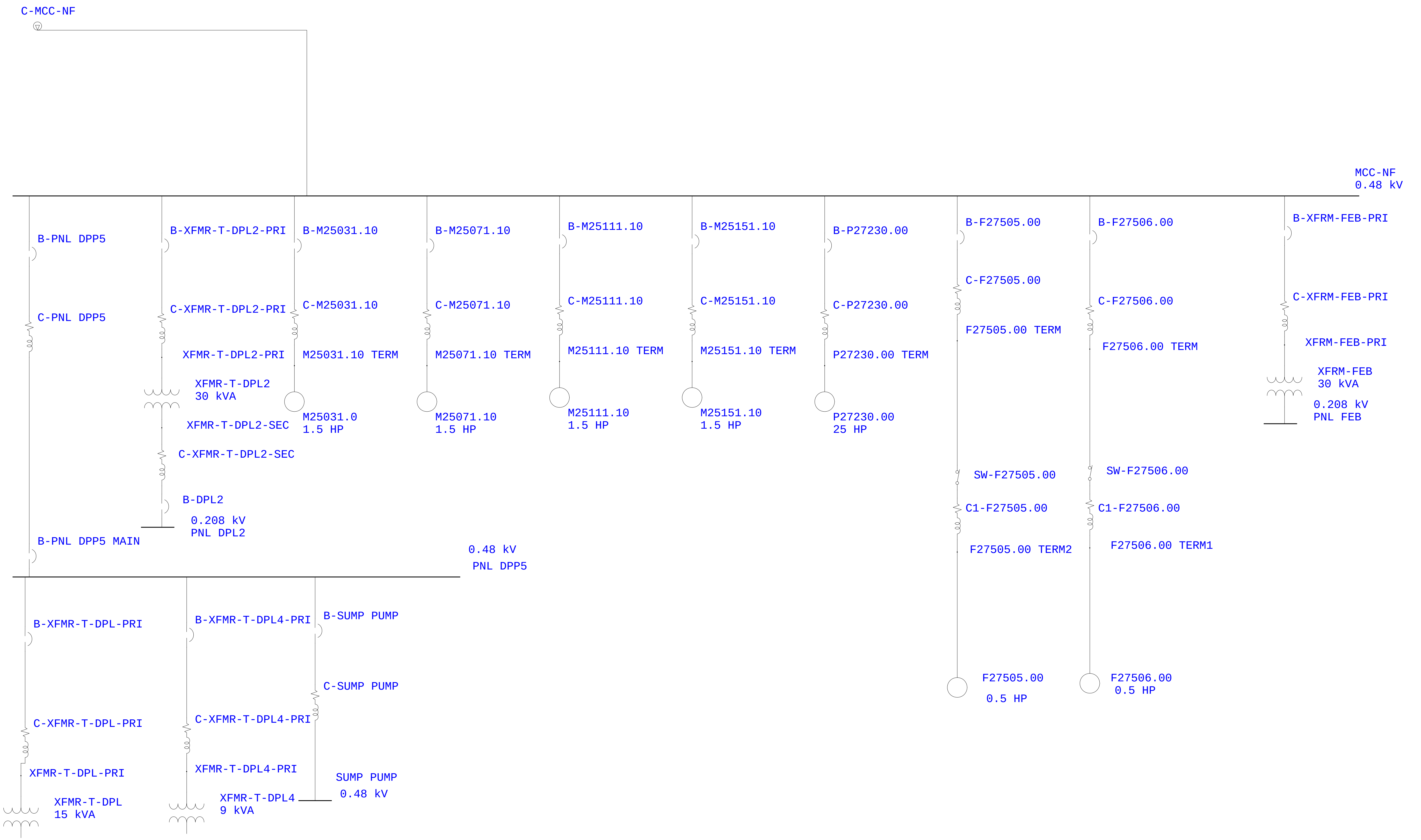
One-Line Diagram - OLV1=>...=>PNL DPP6_BLOWER GALLERY (Edit Mode)

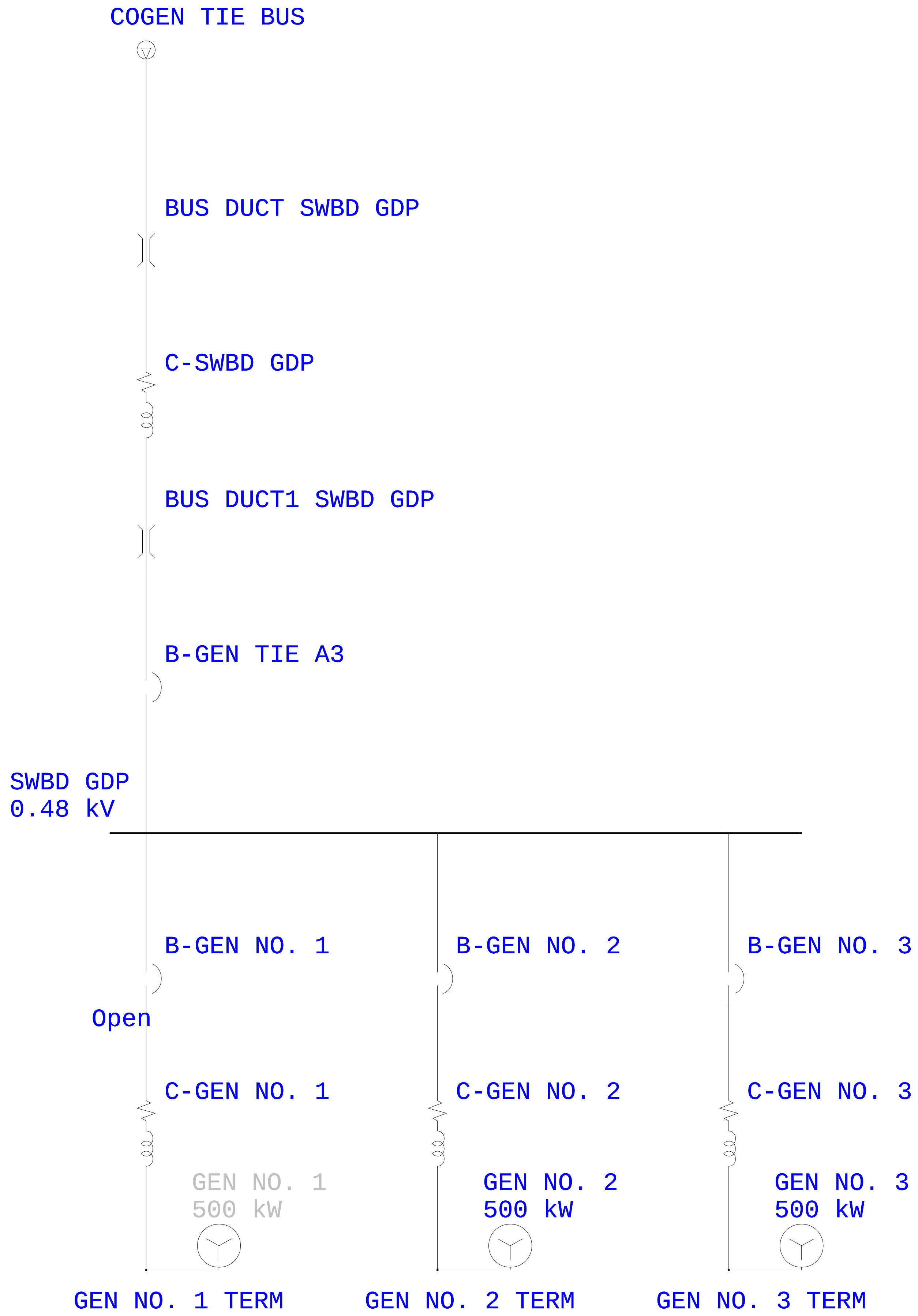



GUIDE VALVE
GUIDE VALVE
l GUIDE VALVE
B-BLOWER #1 DISCH VALVE
C-BLOWER #1 DISCH VALVE
0.48 kV
BLOWER #1 DISCH VALVE
B-BLOWER #1 BYPASSS VALVE
C-BLOWER #1 BYPASSS VALVE
0.48 kV
BLOWER #1 BYPASSS VALVE
B-SKIMMINGS VALVES ACT#3
C-SKIMMINGS VALVES ACT#3
0.48 kV
SKIMMINGS VALVES ACT#3
B-SKIMMINGS VALVES ACT#2
C-SKIMMINGS VALVES ACT#2
0.48 kV
SKIMMINGS VALVES ACT#2
B-SKIMMINGS VALVES ACT#1
C-SKIMMINGS VALVES ACT#1
0.48 kV
SKIMMINGS VALVES ACT#1

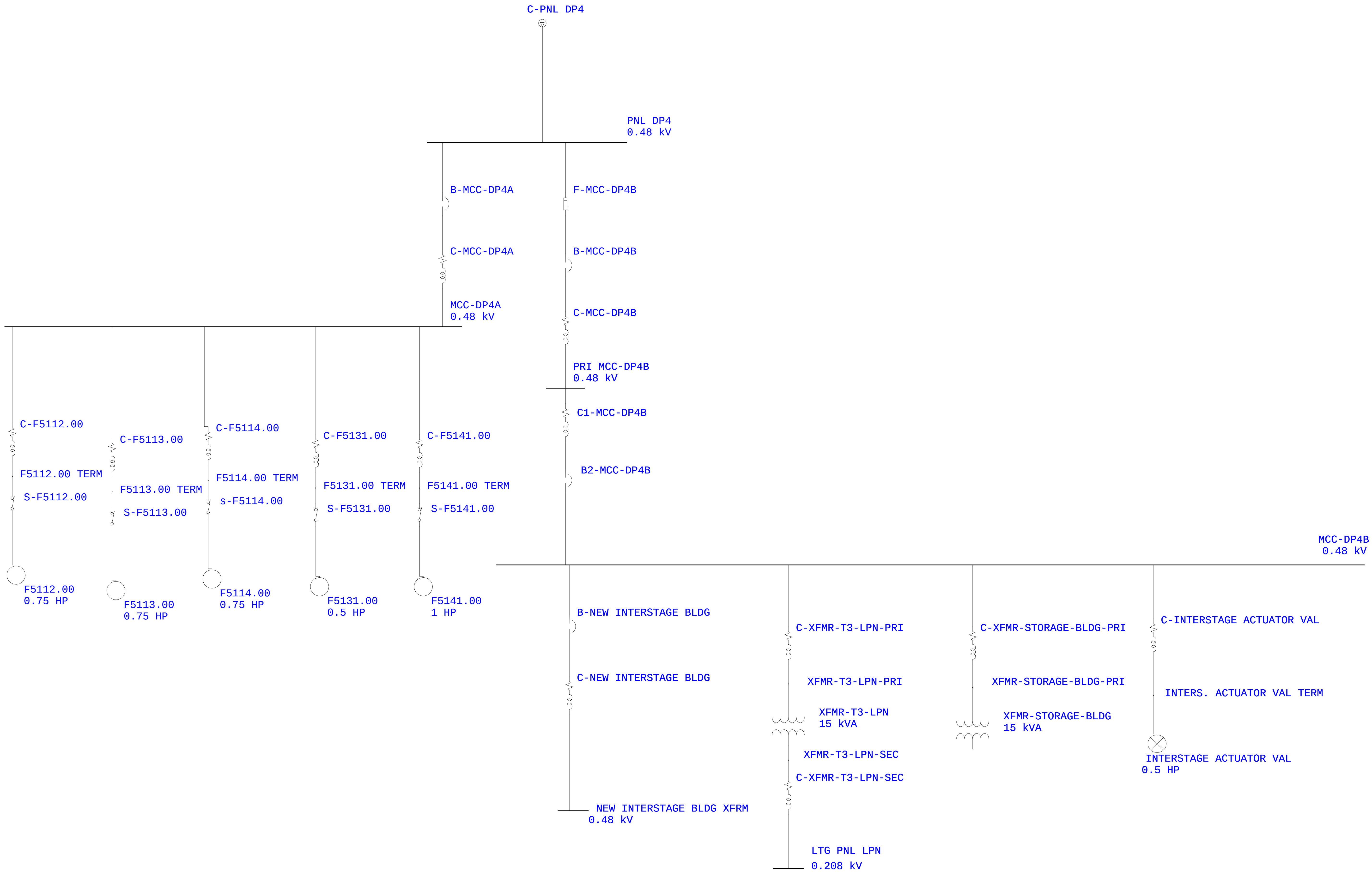

C-MCC-ND
MCC-ND
0.48 kV
B-P27020.00 (Bypass)
C-P27020.00 (Bypass)
P27020.00 (Bypass) TERM
P27020.00 (Bypass)
100 HP
B-P27040.00 (Bypass)
C-P27040.00 (Bypass)
P27040.00 (Bypass) TERM
P27040.00 (Bypass)
100 HP
B-P28020.00 (Bypass)
C-P28020.00 (Bypass)
P28020.00 (Bypass) TERM
P28020.00 (Bypass)
100 HP
B-P27320.00 (Bypass)
C-P27320.00 (Bypass)
P27320.00 (Bypass) TERM
P27320.00 (Bypass)
125 HP
B-P27120.00
C-P27120.00
P27120.00 TERM
P27120.00
20 HP
B-P27130.00
C-P27130.00
P27130.00 TERM
MP27130.00
20 HP

One-Line Diagram - OLV1=>...=>MCC NF (Edit Mode)

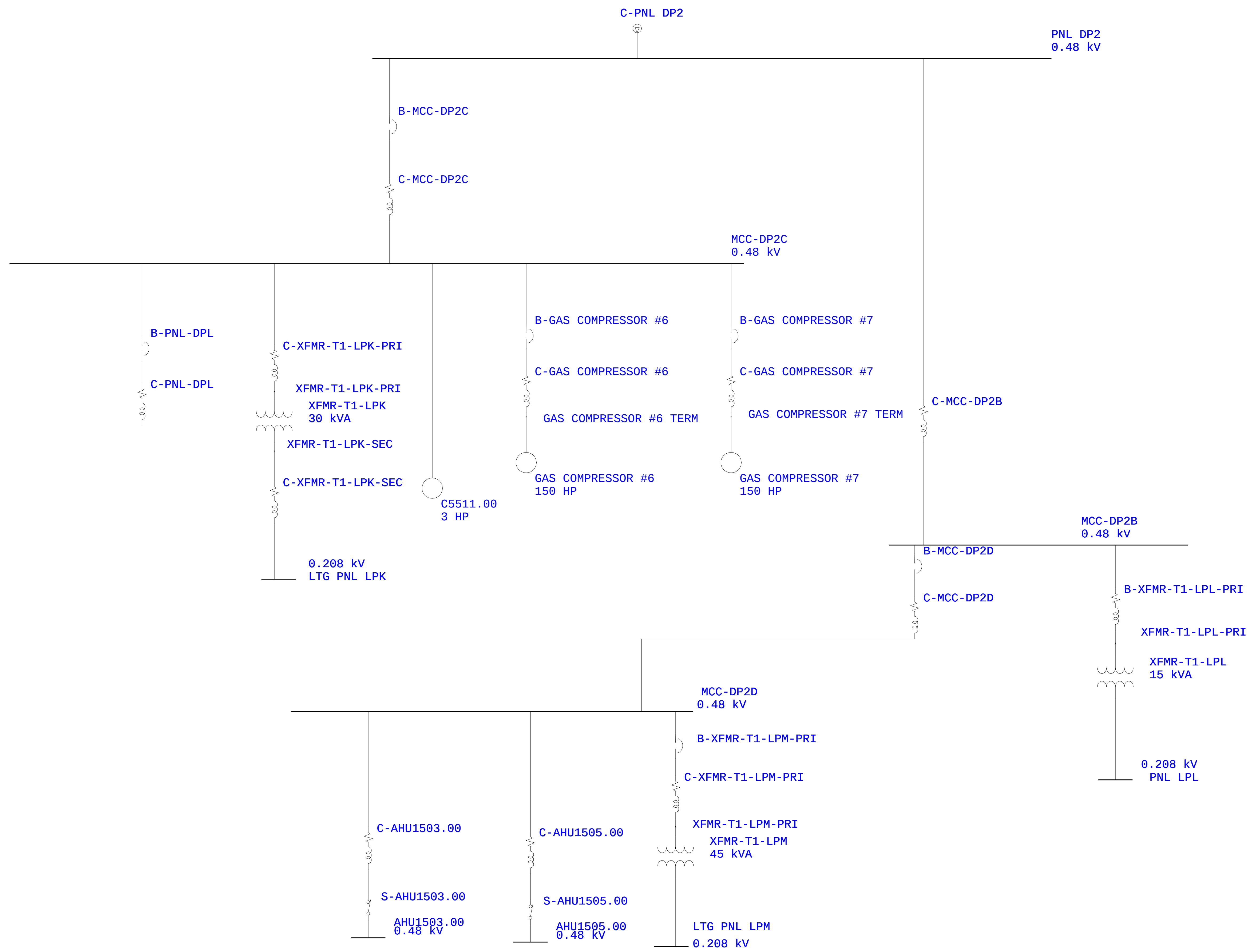



COGEN TIE BUS
BUS DUCT SWBD GDP
C-SWBD GDP
BUS DUCT1 SWBD GDP
B-GEN TIE A3
SWBD GDP
0.48 kV
B-GEN NO. 1
B-GEN NO. 2
B-GEN NO. 3
Open
C-GEN NO. 1
C-GEN NO. 2
C-GEN NO. 3
GEN NO. 1
500 kW
GEN NO. 2
500 kW
GEN NO. 3
500 kW
GEN NO. 1 TERM
GEN NO. 2 TERM
GEN NO. 3 TERM

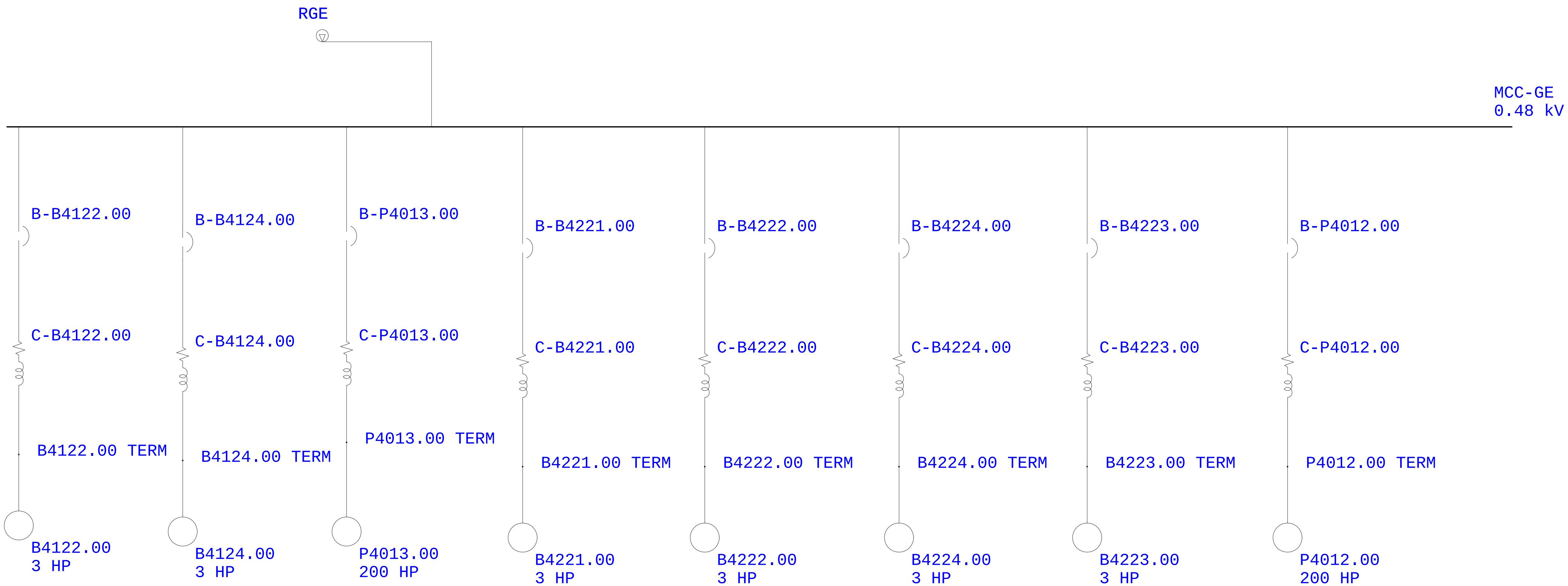
One-Line Diagram - OLV1=>PNL_DP4 (Edit Mode)

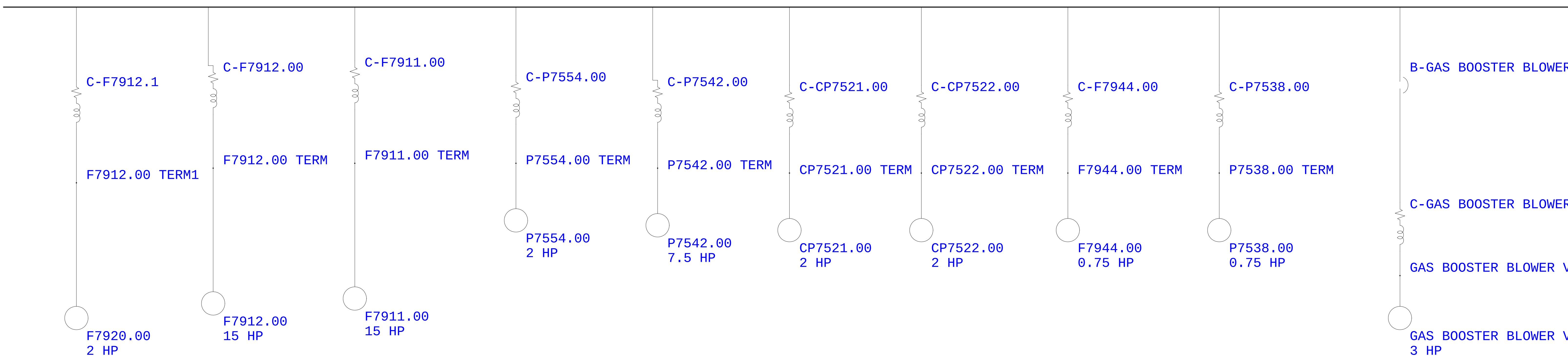


One-Line Diagram - OLV1=>PNL_DP2 (Edit Mode)

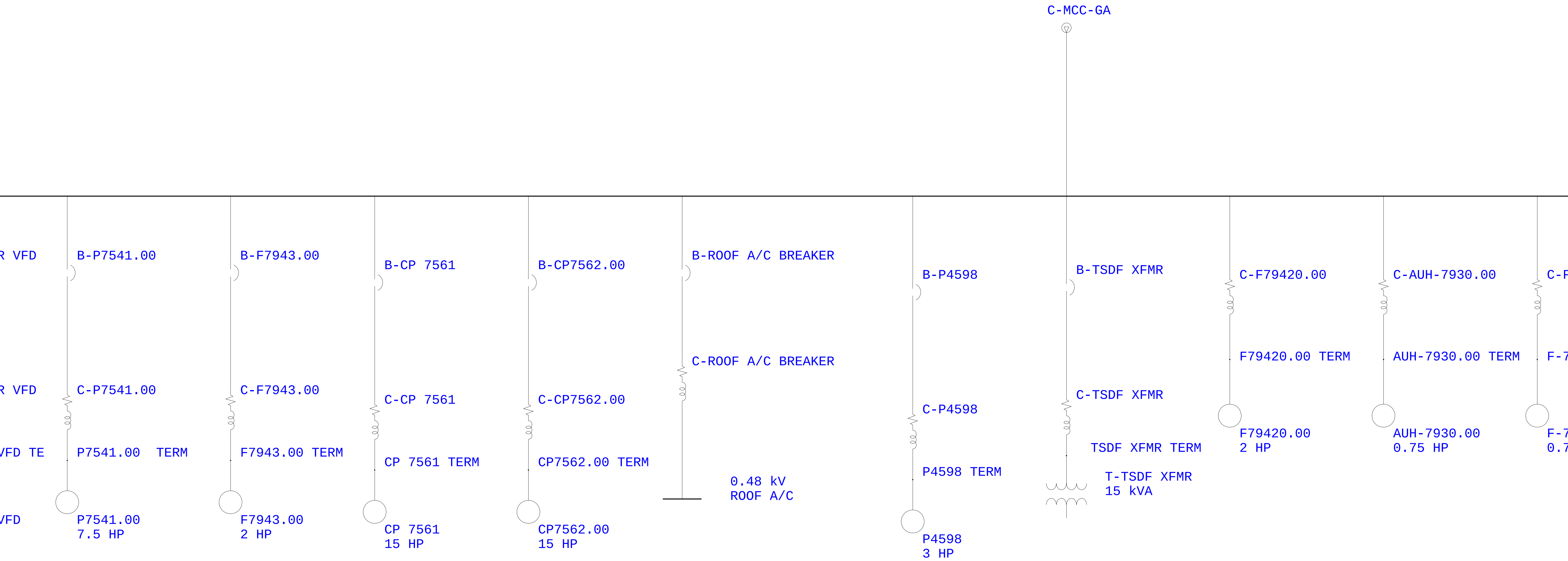


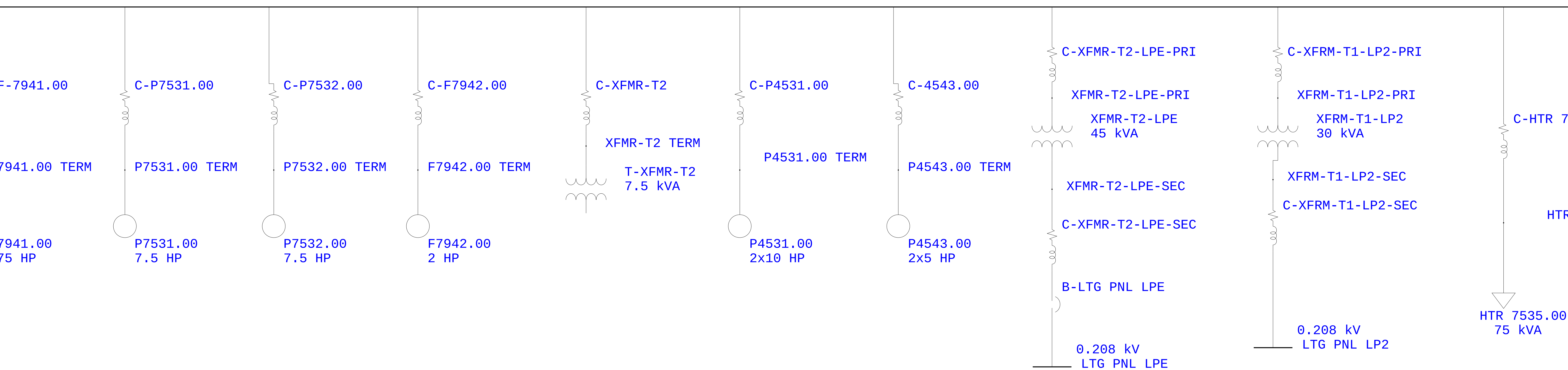
One-Line Diagram - OLV1=>MCC GE (Edit Mode)

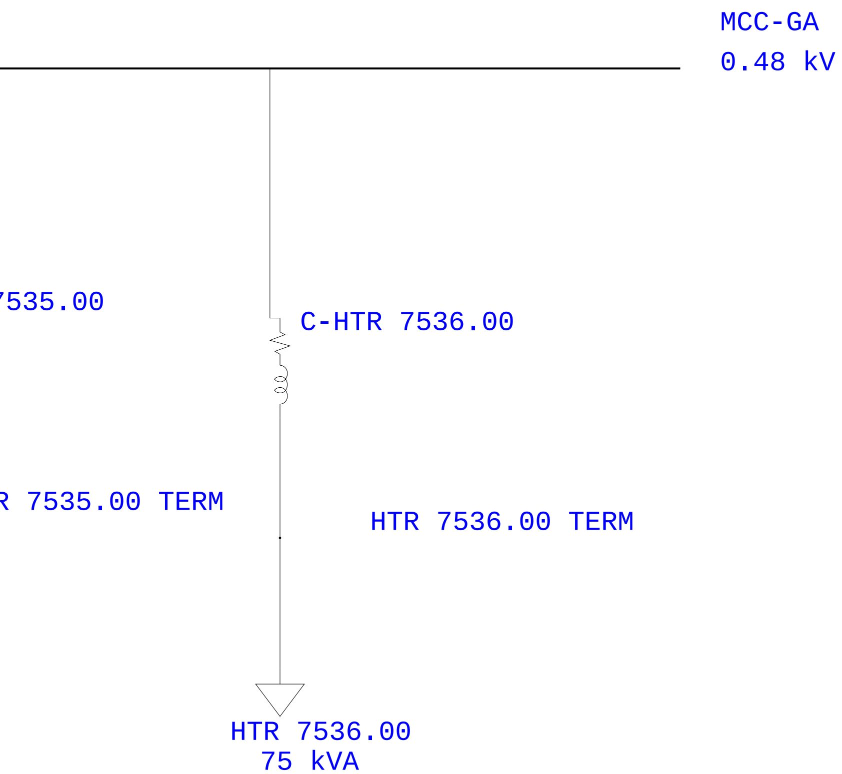


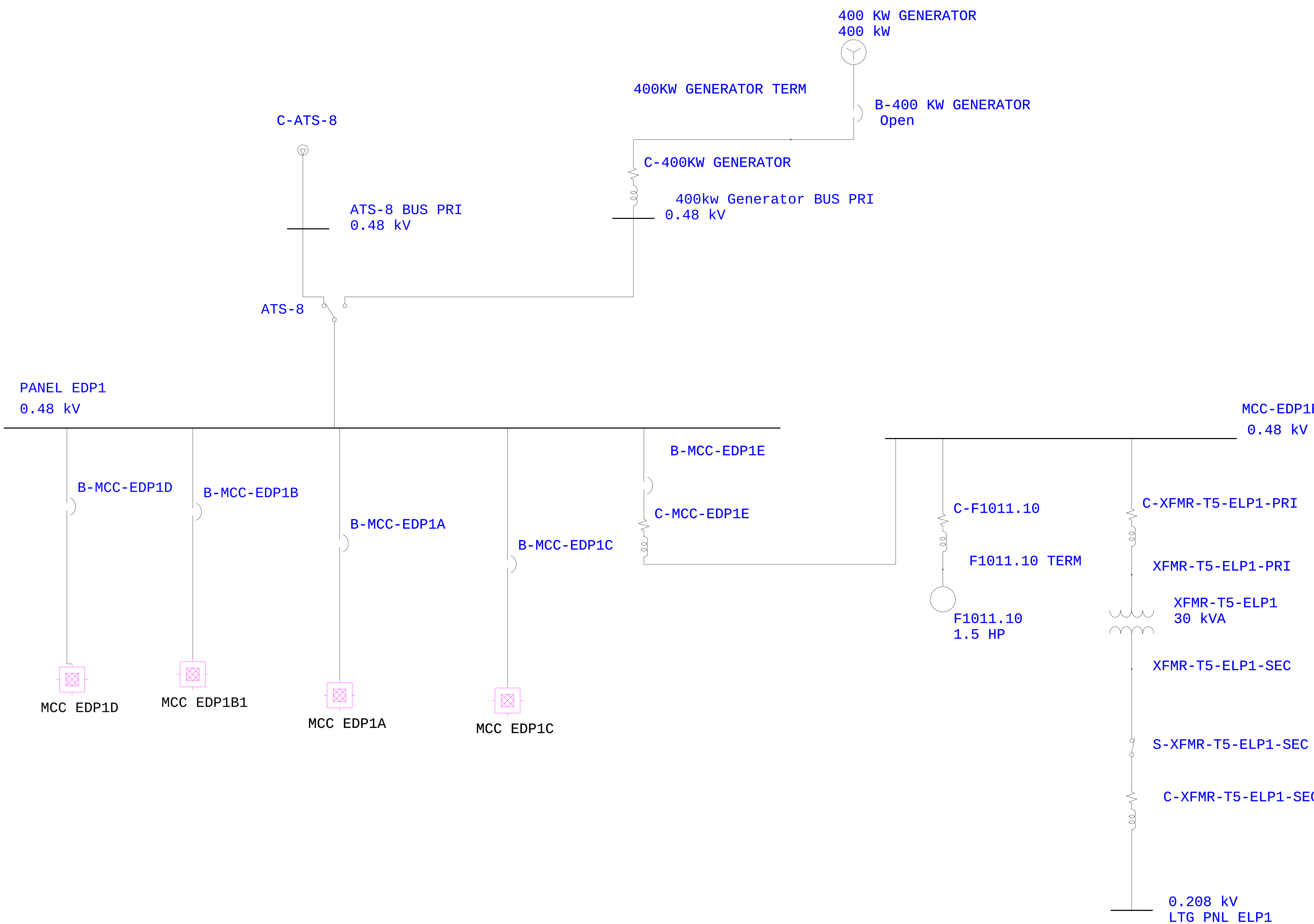

C-F7912.1
F7912.00 TERM1
F7920.00
2 HP
C-F7912.00
F7912.00 TERM
F7912.00
15 HP
C-F7911.00
F7911.00 TERM
F7911.00
15 HP
C-P7554.00
P7554.00 TERM
P7554.00
2 HP
C-P7542.00
P7542.00 TERM
P7542.00
7.5 HP
C-CP7521.00
CP7521.00 TERM
CP7521.00
2 HP
C-CP7522.00
CP7522.00 TERM
CP7522.00
2 HP
C-F7944.00
F7944.00 TERM
F7944.00
0.75 HP
C-P7538.00
P7538.00 TERM
P7538.00
0.75 HP
B-GAS BOOSTER BLOWER
C-GAS BOOSTER BLOWER
GAS BOOSTER BLOWER V
GAS BOOSTER BLOWER V
3 HP

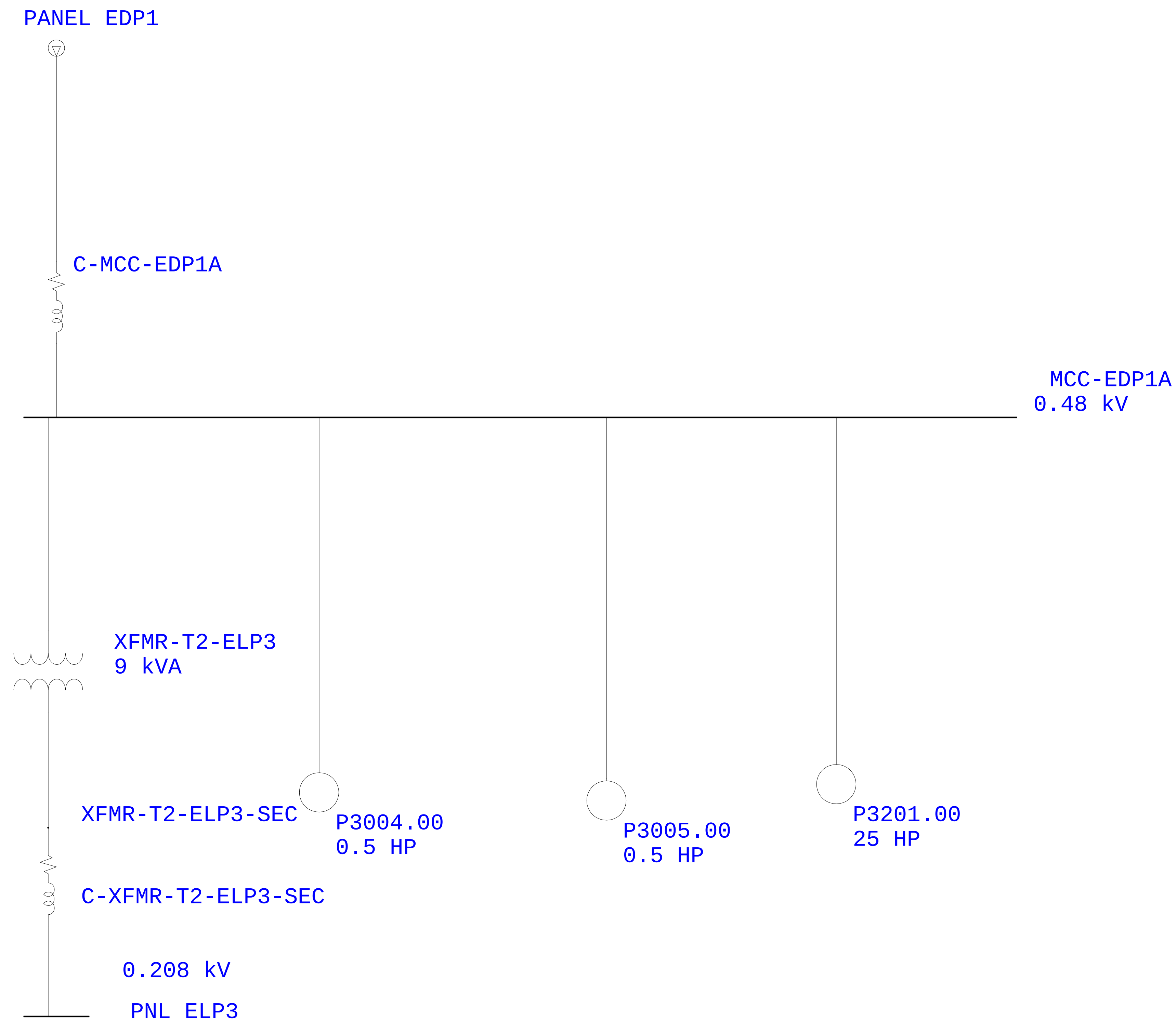
One-Line Diagram - OLV1=>MCC GA (Edit Mode)



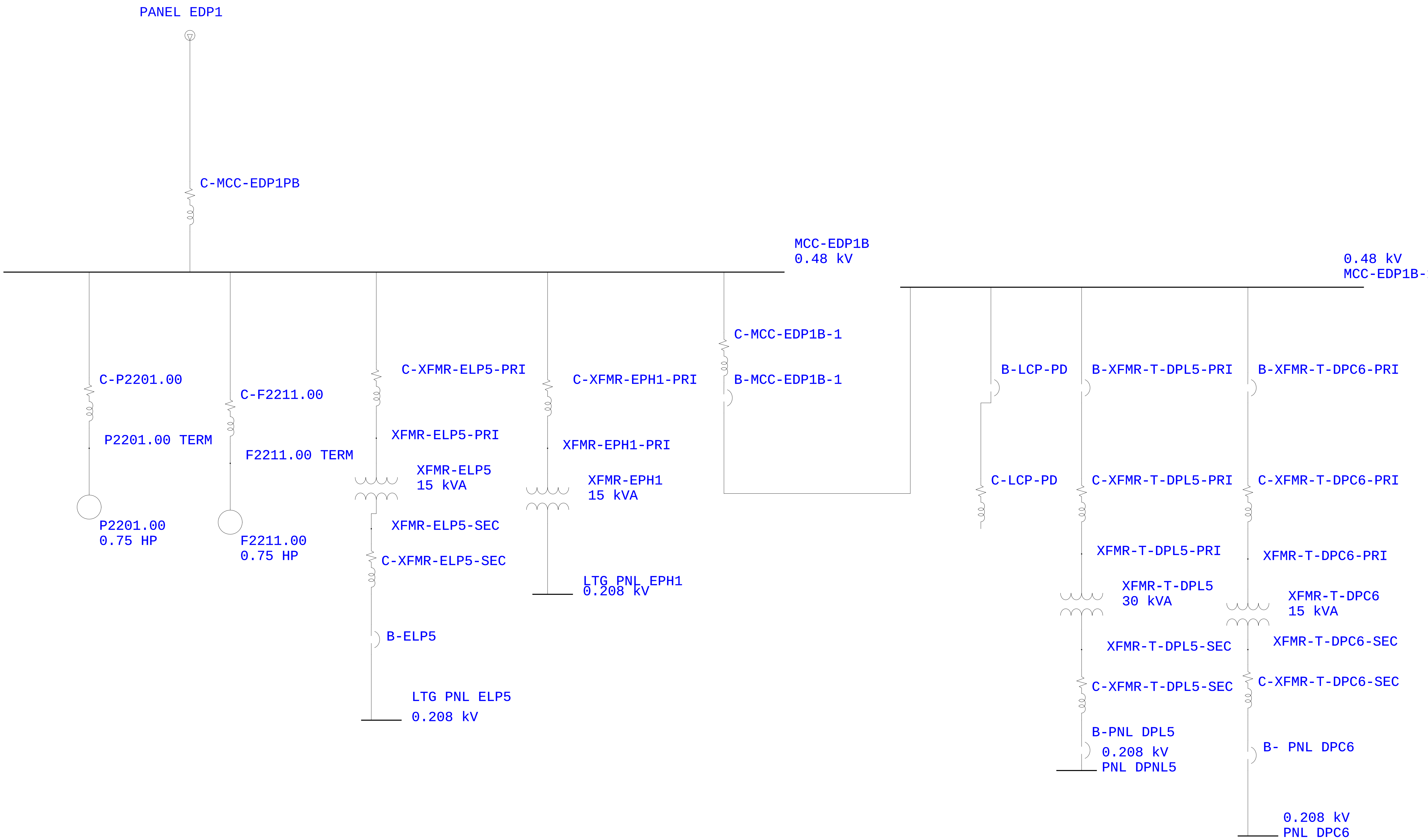

F-7941.00
7941.00 TERM
7941.00
75 HP
C-P7531.00
P7531.00 TERM
P7531.00
7.5 HP
C-P7532.00
P7532.00 TERM
P7532.00
7.5 HP
C-F7942.00
F7942.00 TERM
F7942.00
2 HP
C-XFMR-T2
XFMR-T2 TERM
T-XFMR-T2
7.5 kVA
C-P4531.00
P4531.00 TERM
P4531.00
2x10 HP
C-4543.00
P4543.00 TERM
P4543.00
2x5 HP
C-XFMR-T2-LPE-PRI
XFMR-T2-LPE-PRI
XFMR-T2-LPE
45 kVA
XFMR-T2-LPE-SEC
C-XFMR-T2-LPE-SEC
B-LTG PNL LPE
0.208 kV
LTG PNL LPE
C-XFRM-T1-LP2-PRI
XFRM-T1-LP2-PRI
XFRM-T1-LP2
30 kVA
XFRM-T1-LP2-SEC
C-XFRM-T1-LP2-SEC
0.208 kV
LTG PNL LP2
C-HTR 7
HTR
HTR 7535.00
75 kVA


MCC-GA
0.48 kV
7535.00
C-HTR 7536.00
R 7535.00 TERM
HTR 7536.00 TERM
HTR 7536.00
75 kVA

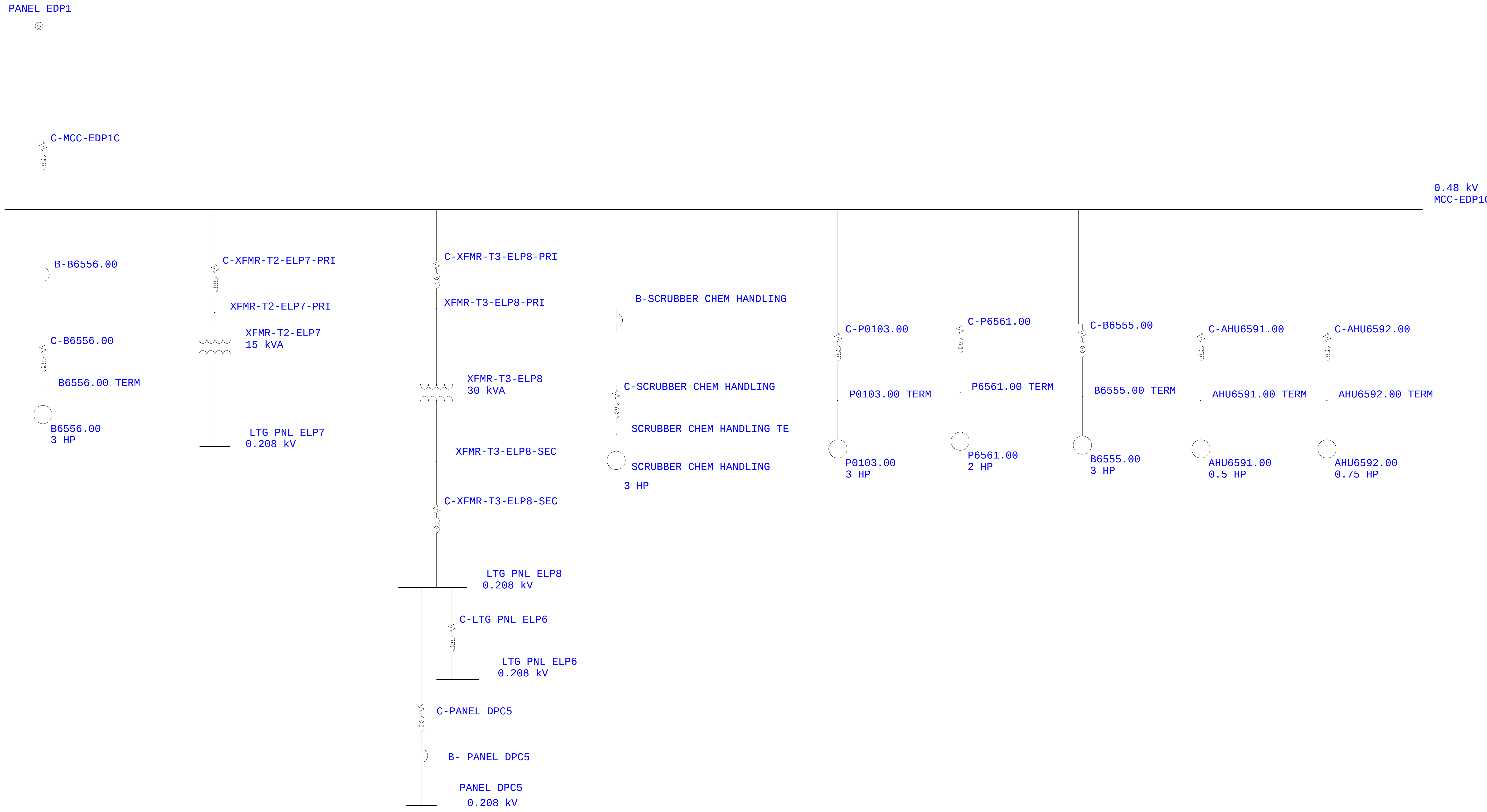

400 KW GENERATOR
400 kW
400KW GENERATOR TERM
B-400 KW GENERATOR
Open
C-ATS-8
C-400KW GENERATOR
400kw Generator BUS PRI
0.48 kV
ATS-8 BUS PRI
0.48 kV
ATS-8
PANEL EDP1
0.48 kV
MCC-EDP1E
0.48 kV
B-MCC-EDP1E
B-MCC-EDP1D
B-MCC-EDP1B
B-MCC-EDP1A
B-MCC-EDP1C
C-MCC-EDP1E
C-F1011.10
F1011.10 TERM
F1011.10
1.5 HP
C-XFMR-T5-ELP1-PRI
XFMR-T5-ELP1-PRI
XFMR-T5-ELP1
30 kVA
XFMR-T5-ELP1-SEC
S-XFMR-T5-ELP1-SEC
C-XFMR-T5-ELP1-SEC
0.208 kV
LTG PNL ELP1
MCC EDP1D
MCC EDP1B1
MCC EDP1A
MCC EDP1C

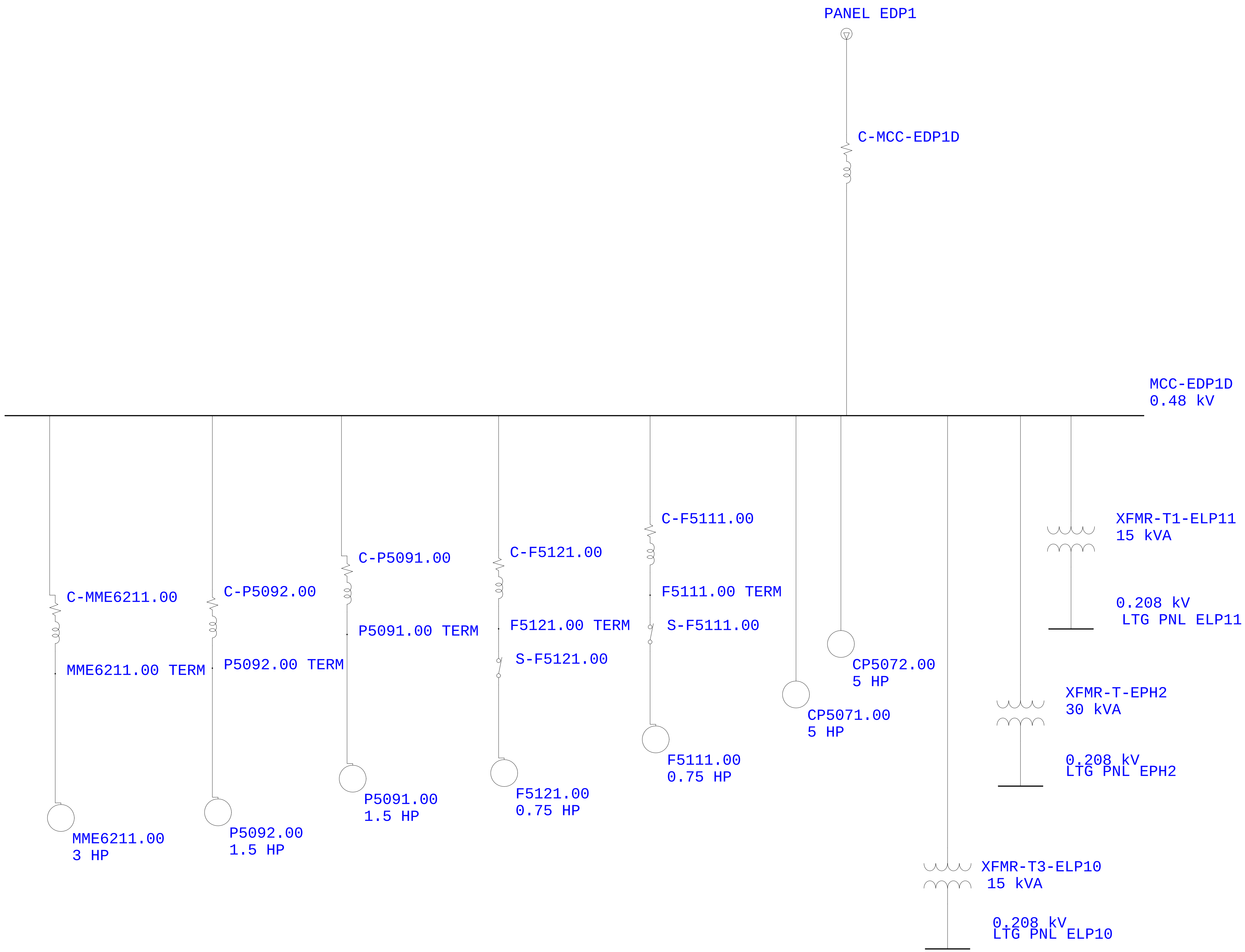

PANEL EDP1
C-MCC-EDP1A
MCC-EDP1A
0.48 kV
XFMR-T2-ELP3
9 kVA
XFMR-T2-ELP3-SEC
C-XFMR-T2-ELP3-SEC
0.208 kV
PNL ELP3
P3004.00
0.5 HP
P3005.00
0.5 HP
P3201.00
25 HP

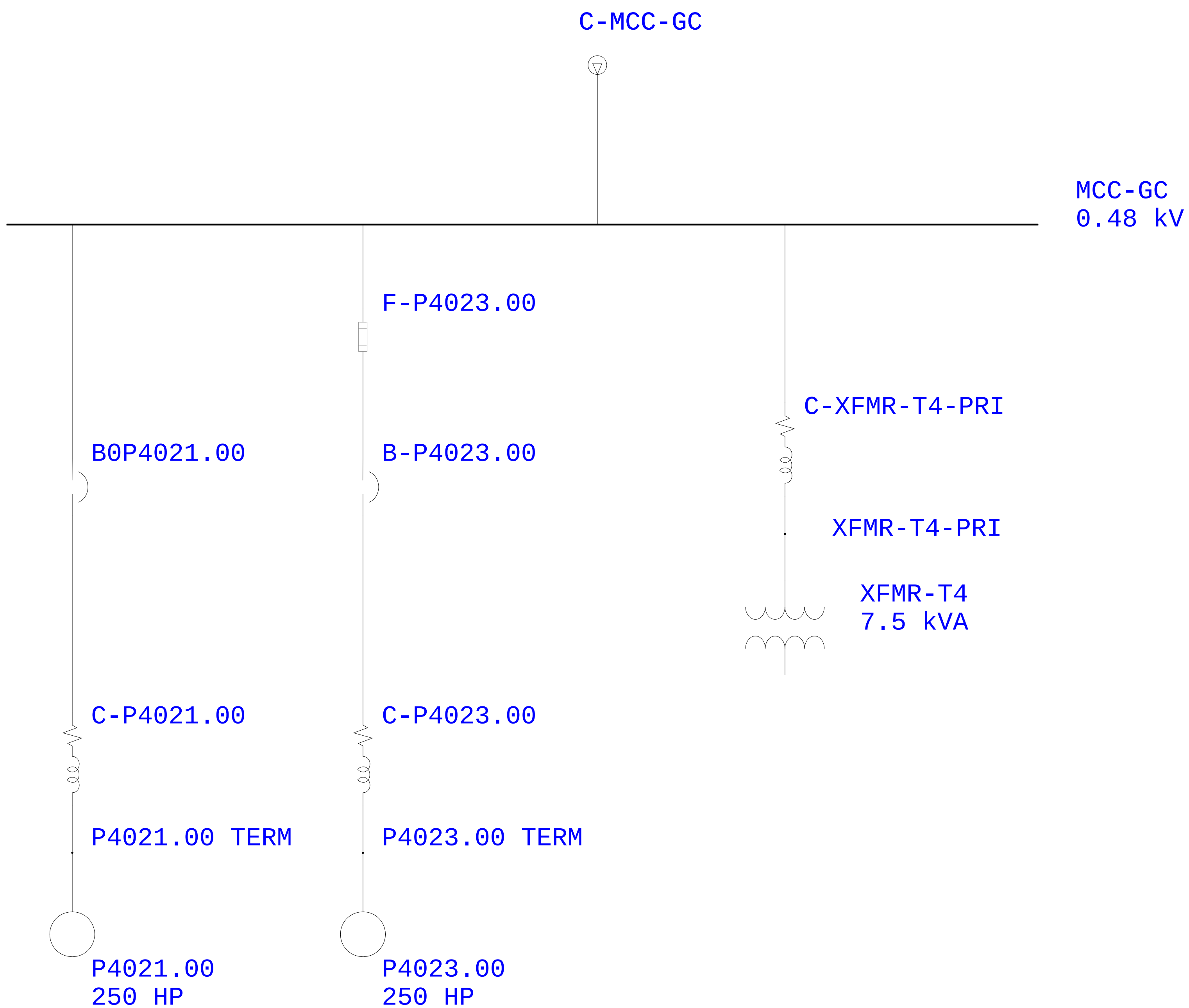
One-Line Diagram - OLV1=>...=>MCC EDP1B1 (Edit Mode)



One-Line Diagram - OLV1=>...=>MCC EDP1C (Edit Mode)




PANEL EDP1
C-MCC-EDP1D
MCC-EDP1D
0.48 kV
C-MME6211.00
MME6211.00 TERM
MME6211.00
3 HP
C-P5092.00
P5092.00 TERM
P5092.00
1.5 HP
C-P5091.00
P5091.00 TERM
P5091.00
1.5 HP
C-F5121.00
F5121.00 TERM
S-F5121.00
F5121.00
0.75 HP
C-F5111.00
F5111.00 TERM
S-F5111.00
F5111.00
0.75 HP
CP5071.00
5 HP
CP5072.00
5 HP
XFMR-T1-ELP11
15 kVA
0.208 kV
LTG PNL ELP11
XFMR-T-EPH2
30 kVA
0.208 kV
LTG PNL EPH2
XFMR-T3-ELP10
15 kVA
0.208 kV
LTG PNL ELP10


C-MCC-GC
MCC-GC
0.48 kV
F-P4023.00
C-XFMR-T4-PRI
B0P4021.00
B-P4023.00
XFMR-T4-PRI
XFMR-T4
7.5 kVA
C-P4021.00
C-P4023.00
P4021.00 TERM
P4023.00 TERM
P4021.00
250 HP
P4023.00
250 HP

APPENDIX B1 – SHORT CIRCUIT STUDY (MOMENTARY DUTY SUMMARY REPORT)

Momentary Duty Summary Report

3-Phase Fault Currents: (Prefault Voltage = 100 % of the Bus Nominal Voltage)

Bus		Device		Momentary Duty					Device Capability		
ID	kV	ID	Type	Symm. kA rms	X/R Ratio	M.F.	Asymm. kA rms	Asymm. kA Peak	Symm. kA rms	Asymm. kA rms	Asymm. kA Peak
ATS-L BUS A	0.480	ATS-L BUS A	MCC	30.392	3.4	1.149	34.916	60.169	65.000	81.100	
ATS-L BUS B	0.480	ATS-L BUS B	MCC	26.452	2.0	1.039	27.491	44.894	65.000	81.100	
ATS-L SEC	0.480	ATS-L SEC	MCC	30.392	3.4	1.149	34.916	60.169	65.000	81.100	
B20100.00 TERMINALS	2.400	B20100.00 TERMINALS	MCC	4.779	6.1	1.310	6.260	10.802		81.100	0.000 *
B20200.00 TERMINALS	2.400	B20200.00 TERMINALS	MCC	4.723	5.5	1.278	6.037	10.439		81.100	0.000 *
B20400.00 TERMINALS	2.400	B20400.00 TERMINALS	MCC	4.811	5.8	1.297	6.240	10.778		81.100	0.000 *
B52180.00 DISC	0.480	B52180.00 DISC	Bus	5.714	0.5	1.000	5.714	8.101			
B52180.00 TERM	0.480	B52180.00 TERM	Bus	5.544	0.5	1.000	5.544	7.858			
B52190.00 DISC	0.480	B52190.00 DISC	Bus	4.218	0.4	1.000	4.218	5.966			
B52190.00 TERM	0.480	B52190.00 TERM	Bus	4.123	0.4	1.000	4.123	5.832			
B52210.00 DISC	0.480	B52210.00 DISC	Bus	1.587	0.2	1.000	1.587	2.244			
B52210.00 TERM	0.480	B52210.00 TERM	Bus	1.553	0.2	1.000	1.553	2.197			
B52220.00 DISC	0.480	B52220.00 DISC	Bus	1.491	0.2	1.000	1.491	2.109			
B52220.00 TERM	0.480	B52220.00 TERM	Bus	1.462	0.2	1.000	1.462	2.068			
BLWR BLDG TROLLEY	0.480	BLWR BLDG TROLLEY	MCC	4.420	0.3	1.000	4.420	6.251	65.000	81.100	
BSN51240.00 DISC	0.480	BSN51240.00 DISC	Bus	0.765	0.1	1.000	0.765	1.082			
BSN51240.00 TERM	0.480	BSN51240.00 TERM	Bus	0.752	0.1	1.000	0.752	1.064			
BSN51250.00 DISC	0.480	BSN51250.00 DISC	Bus	0.765	0.1	1.000	0.765	1.081			
BSN51250.00 TERM	0.480	BSN51250.00 TERM	Bus	0.752	0.1	1.000	0.752	1.064			
BSN51260.00 DISC	0.480	BSN51260.00 DISC	Bus	0.765	0.1	1.000	0.765	1.082			
BSN51260.00 TERM	0.480	BSN51260.00 TERM	Bus	0.752	0.1	1.000	0.752	1.064			
BSN51270.00 DISC	0.480	BSN51270.00 DISC	Bus	0.765	0.1	1.000	0.765	1.081			
BSN51270.00 TERM	0.480	BSN51270.00 TERM	Bus	0.752	0.1	1.000	0.752	1.064			
COGEN TIE BUS	0.480	COGEN TIE BUS	Switchgear	57.915	13.6	1.504	87.095	146.954	100.000	133.000	
COM53030.00 DISC	0.480	COM53030.00 DISC	Bus	0.795	0.1	1.000	0.795	1.125			
COM53030.00 TERM	0.480	COM53030.00 TERM	Bus	0.782	0.1	1.000	0.782	1.106			
COM53040.00 DISC	0.480	COM53040.00 DISC	Bus	0.869	0.1	1.000	0.869	1.229			
COM53040.00 TERM	0.480	COM53040.00 TERM	Bus	0.853	0.1	1.000	0.853	1.207			
CON51300.00 DISC	0.480	CON51300.00 DISC	Bus	0.798	0.1	1.000	0.798	1.129			
CON51300.00 TERM	0.480	CON51300.00 TERM	Bus	0.785	0.1	1.000	0.785	1.110			
CON51320.00 DISC	0.480	CON51320.00 DISC	Bus	0.798	0.1	1.000	0.798	1.129			
CON51320.00 TERM	0.480	CON51320.00 TERM	Bus	0.785	0.1	1.000	0.785	1.110			
CON53020.00 DISC	0.480	CON53020.00 DISC	Bus	0.748	0.1	1.000	0.748	1.057			
CON53020.00 TERM	0.480	CON53020.00 TERM	Bus	0.736	0.1	1.000	0.736	1.041			

3-Phase Fault Currents: (Prefault Voltage = 100 % of the Bus Nominal Voltage)

Bus		Device		Momentary Duty					Device Capability		
ID	kV	ID	Type	Symm. kA rms	X/R Ratio	M.F.	Asymm. kA rms	Asymm. kA Peak	Symm. kA rms	Asymm. kA rms	Asymm. kA Peak
CON53030.00 DISC	0.480	CON53030.00 DISC	Bus	0.748	0.1	1.000	0.748	1.057			
CON53030.00 TERM	0.480	CON53030.00 TERM	Bus	0.736	0.1	1.000	0.736	1.041			
EFF PS SWGR BUS A	0.480	EFF PS SWGR BUS A	Switchgear	19.810	5.8	1.294	25.632	44.281	65.000	86.500	
EFF PS SWGR BUS A PRI	0.480	EFF PS SWGR BUS A PRI	Bus	19.810	5.8	1.294	25.632	44.281			
EFF PS SWGR BUS B	0.480	EFF PS SWGR BUS B	Switchgear	19.809	5.8	1.297	25.687	44.368	65.000	86.500	
EFF PS SWGR BUS B PRI	0.480	EFF PS SWGR BUS B PRI	Bus	19.809	5.8	1.297	25.687	44.368			
EFF PUMP NO. 2 VFD PRI	0.480	EFF PUMP NO. 2 VFD PRI	Bus	19.060	5.0	1.252	23.864	41.314			
EFF PUMP NO. 4 VFD PRI	0.480	EFF PUMP NO. 4 VFD PRI	Bus	19.061	4.9	1.250	23.819	41.240			
F52410.00 DISC	0.480	F52410.00 DISC	Bus	0.627	0.1	1.000	0.627	0.887			
F52410.00 STR	0.480	F52410.00 STR	Bus	0.673	0.1	1.000	0.673	0.951			
F52420.00 DISC	0.480	F52420.00 DISC	Bus	0.503	0.1	1.000	0.503	0.712			
F52420.00 STR	0.480	F52420.00 STR	Bus	0.532	0.1	1.000	0.532	0.752			
F54330.00 DISC	0.480	F54330.00 DISC	Bus	2.516	0.1	1.000	2.516	3.558			
F54330.00 TERM	0.480	F54330.00 TERM	Bus	2.388	0.1	1.000	2.388	3.377			
F55010.00 TERM	0.480	F55010.00 TERM	Bus	4.157	0.4	1.000	4.157	5.881			
GEN NO. 2 TERM	0.480	GEN NO. 2 TERM	Bus	22.464	9.3	1.421	31.923	54.450			
GEN NO. 3 TERM	0.480	GEN NO. 3 TERM	Bus	22.780	9.6	1.429	32.544	55.457			
GRIT SCR TROLLEY	0.480	GRIT SCR TROLLEY	MCC	0.739	0.1	1.000	0.739	1.046	65.000	81.100	
HVAC56100.00 DISC	0.480	HVAC56100.00 DISC	Bus	6.021	0.3	1.000	6.021	8.516			
HVAC56100.00 TERM	0.480	HVAC56100.00 TERM	Bus	5.563	0.3	1.000	5.563	7.867			
HVAC56110.00 DISC	0.480	HVAC56110.00 DISC	Bus	2.531	0.2	1.000	2.531	3.579			
HVAC56110.00 TERM	0.480	HVAC56110.00 TERM	Bus	2.401	0.2	1.000	2.401	3.395			
HW ELEVATOR	0.480	HW ELEVATOR	MCC	8.455	0.5	1.000	8.455	11.973	65.000	81.100	
HW GATES	0.480	HW GATES	MCC	0.418	0.1	1.000	0.418	0.591	65.000	81.100	
INFL PUMP 1 TERMINALS	0.480	INFL PUMP 1 TERMINALS	Bus	24.231	4.7	1.236	29.944	51.860			
INFL PUMP 1 VFD PRI	0.480	INFL PUMP 1 VFD PRI	Bus	31.573	5.7	1.288	40.655	70.262			
INFL PUMP 2 TERMINALS	0.480	INFL PUMP 2 TERMINALS	Bus	21.921	3.7	1.170	25.657	44.333			
INFL PUMP 2 VFD	0.480	INFL PUMP 2 VFD	Bus	30.017	5.3	1.267	38.025	65.793			
INFL PUMP 2 VFD PRI	0.480	INFL PUMP 2 VFD PRI	Bus	30.017	5.3	1.267	38.025	65.793			
INFL PUMP 3 TERMINALS	0.480	INFL PUMP 3 TERMINALS	Bus	22.707	3.7	1.167	26.499	45.772			
INFL PUMP 3 VFD	0.480	INFL PUMP 3 VFD	Bus	31.575	5.6	1.283	40.525	70.056			
INFL PUMP 3 VFD PRI	0.480	INFL PUMP 3 VFD PRI	Bus	31.575	5.6	1.283	40.525	70.056			
INFL PUMP 4 TERMINALS	0.480	INFL PUMP 4 TERMINALS	Bus	22.114	3.7	1.170	25.872	44.702			
INFL PUMP 4 VFD	0.480	INFL PUMP 4 VFD	Bus	30.385	5.3	1.272	38.649	66.856			
INFL PUMP 4 VFD PRI	0.480	INFL PUMP 4 VFD PRI	Bus	30.385	5.3	1.272	38.649	66.856			
INFL PUMP 5 TERMINALS	0.480	INFL PUMP 5 TERMINALS	Bus	22.707	3.7	1.167	26.499	45.772			

3-Phase Fault Currents: (Prefault Voltage = 100 % of the Bus Nominal Voltage)

Bus		Device		Momentary Duty					Device Capability		
ID	kV	ID	Type	Symm. kA rms	X/R Ratio	M.F.	Asymm. kA rms	Asymm. kA Peak	Symm. kA rms	Asymm. kA rms	Asymm. kA Peak
INFL PUMP 5 VFD	0.480	INFL PUMP 5 VFD	Bus	31.575	5.6	1.283	40.525	70.056			
INFL PUMP 5 VFD PRI	0.480	INFL PUMP 5 VFD PRI	Bus	31.575	5.6	1.283	40.525	70.056			
INFL PUMP 6 TERMINALS	0.480	INFL PUMP 6 TERMINALS	Bus	23.125	4.7	1.233	28.520	49.396			
INFL PUMP 6 VFD PRI	0.480	INFL PUMP 6 VFD PRI	Bus	29.655	5.3	1.269	37.623	65.092			
LCP-HWOCS	0.480	LCP-HWOCS	MCC	4.308	0.4	1.000	4.308	6.095	65.000	81.100	
MAIN SWGR "FILTER"	0.480	MAIN SWGR "FILTER"	Switchgear	49.949	14.1	1.510	75.420	127.147	100.000	133.000	
MAIN SWGR "SLUDGE"	0.480	MAIN SWGR "SLUDGE"	Switchgear	57.915	13.6	1.504	87.095	146.954	100.000	133.000	
MAIN SWGR BUS A PRI	0.480	MAIN SWGR BUS A PRI	Bus	49.949	14.1	1.510	75.420	127.147			
MAIN SWGR BUS B PRI	0.480	MAIN SWGR BUS B PRI	Bus	57.915	13.6	1.504	87.095	146.954			
MCC-DP2C	0.480	MCC-DP2C	MCC	16.279	2.7	1.095	17.833	30.304	25.000	31.200	
MCC-DP4A	0.480	MCC-DP4A	MCC	1.724	0.2	1.000	1.724	2.437	25.000	31.200	
MCC-DP4B	0.480	MCC-DP4B	MCC	48.572	6.1	1.311	63.699	109.902	65.000	81.100	
MCC-GE	0.480	MCC-GE	MCC	15.296	9.2	1.417	21.676	36.990	35.000	43.600	
MCC-GE PRI	0.480	MCC-GE PRI	MCC	42.998	4.4	1.213	52.170	90.352	65.000	81.100	
MCC-HW BUS A	0.480	MCC-HW BUS A	MCC	31.811	5.3	1.270	40.387	69.871	65.000	81.100	
MCC-HW BUS A PRI	0.480	MCC-HW BUS A PRI	Bus	31.811	5.3	1.270	40.387	69.871			
MCC-HW BUS B	0.480	MCC-HW BUS B	MCC	31.318	5.3	1.269	39.736	68.746	65.000	81.100	
MCC-HW BUS B PRI	0.480	MCC-HW BUS B PRI	Bus	31.318	5.3	1.269	39.736	68.746			
MCC-NA BUS A	2.400	MCC-NA BUS A	MCC	5.016	7.3	1.360	6.821	11.716		50.000	84.375
MCC-NA BUS A PRI	2.400	MCC-NA BUS A PRI	MCC	5.016	7.3	1.360	6.821	11.716		81.100	25.000
MCC-NA BUS B	2.400	MCC-NA BUS B	MCC	5.091	7.1	1.352	6.883	11.833		50.000	84.375
MCC-NA BUS B PRI	2.400	MCC-NA BUS B PRI	MCC	5.091	7.1	1.352	6.883	11.833		81.100	25.000
MCC-NC	0.480	MCC-NC	MCC	15.294	6.0	1.306	19.980	34.485	65.000	81.100	
MCC-ND	0.480	MCC-ND	MCC	14.124	5.9	1.300	18.366	31.713	65.000	81.100	
MCC-NE	0.480	MCC-NE	MCC	14.305	4.9	1.247	17.838	30.887	65.000	81.100	
MCC-NF	0.480	MCC-NF	MCC	13.303	4.9	1.249	16.613	28.764	65.000	81.100	
MCC-NG BUS A	0.480	MCC-NG BUS A	MCC	8.191	2.3	1.066	8.733	14.613	65.000	81.100	
MCC-NG BUS A PRI	0.480	MCC-NG BUS A PRI	Bus	8.191	2.3	1.066	8.733	14.613			
MCC-NG BUS B	0.480	MCC-NG BUS B	MCC	8.233	2.6	1.089	8.963	15.187	65.000	81.100	
MCC-NG BUS B PRI	0.480	MCC-NG BUS B PRI	Bus	8.233	2.6	1.089	8.963	15.187			
MCC-SH BUS A	0.480	MCC-SH BUS A	MCC	8.185	2.3	1.061	8.686	14.481	65.000	81.100	
MCC-SH BUS A PRI	0.480	MCC-SH BUS A PRI	Bus	8.185	2.3	1.061	8.686	14.481			
MCC-SH BUS B	0.480	MCC-SH BUS B	MCC	8.118	2.3	1.060	8.607	14.340	65.000	81.100	
MCC-SH BUS B PRI	0.480	MCC-SH BUS B PRI	Bus	7.425	2.3	1.063	7.891	13.171			
MS-HW BUS A	0.480	MS-HW BUS A	Switchgear	33.733	6.3	1.320	44.511	76.746	100.000	133.000	
MS-HW BUS A PRI	0.480	MS-HW BUS A PRI	Bus	33.733	6.3	1.320	44.511	76.746			

3-Phase Fault Currents: (Prefault Voltage = 100 % of the Bus Nominal Voltage)

Bus		Device		Momentary Duty					Device Capability		
ID	kV	ID	Type	Symm. kA rms	X/R Ratio	M.F.	Asymm. kA rms	Asymm. kA Peak	Symm. kA rms	Asymm. kA rms	Asymm. kA Peak
MS-HW BUS B	0.480	MS-HW BUS B	Switchgear	33.241	6.3	1.318	43.828	75.574	100.000	133.000	
MS-HW BUS B PRI	0.480	MS-HW BUS B PRI	Bus	33.241	6.3	1.318	43.828	75.574			
P52100.00 DISC	0.480	P52100.00 DISC	Bus	3.998	0.5	1.000	3.998	5.663			
P52100.00 TERM	0.480	P52100.00 TERM	Bus	3.942	0.5	1.000	3.942	5.583			
P52110.00 DISC	0.480	P52110.00 DISC	Bus	2.808	0.4	1.000	2.808	3.972			
P52110.00 TERM	0.480	P52110.00 TERM	Bus	2.766	0.4	1.000	2.766	3.913			
P52120.00 DISC	0.480	P52120.00 DISC	Bus	4.240	0.5	1.000	4.240	6.006			
P52120.00 TERM	0.480	P52120.00 TERM	Bus	4.177	0.5	1.000	4.177	5.916			
P52130.00 DISC	0.480	P52130.00 DISC	Bus	2.989	0.4	1.000	2.989	4.227			
P52130.00 TERM	0.480	P52130.00 TERM	Bus	2.941	0.4	1.000	2.941	4.160			
P52140.00 DISC	0.480	P52140.00 DISC	Bus	4.998	0.5	1.000	4.998	7.082			
P52140.00 TERM	0.480	P52140.00 TERM	Bus	4.910	0.5	1.000	4.910	6.957			
P52150.00 DISC	0.480	P52150.00 DISC	Bus	3.564	0.4	1.000	3.564	5.042			
P52150.00 TERM	0.480	P52150.00 TERM	Bus	3.497	0.4	1.000	3.497	4.946			
P52160.00 DISC	0.480	P52160.00 DISC	Bus	3.710	0.4	1.000	3.710	5.248			
P52160.00 TERM	0.480	P52160.00 TERM	Bus	3.637	0.4	1.000	3.637	5.144			
P52170.00 DISC	0.480	P52170.00 DISC	Bus	3.946	0.4	1.000	3.946	5.582			
P52170.00 TERM	0.480	P52170.00 TERM	Bus	3.863	0.4	1.000	3.863	5.465			
P52220.00 DISC	0.480	P52220.00 DISC	Bus	0.693	0.1	1.000	0.693	0.980			
P52220.00 TERM	0.480	P52220.00 TERM	Bus	0.683	0.1	1.000	0.683	0.966			
P52230.00 DISC	0.480	P52230.00 DISC	Bus	0.693	0.1	1.000	0.693	0.980			
P52230.00 TERM	0.480	P52230.00 TERM	Bus	0.683	0.1	1.000	0.683	0.966			
P52240.00 DISC	0.480	P52240.00 DISC	Bus	0.872	0.1	1.000	0.872	1.233			
P52240.00 TERM	0.480	P52240.00 TERM	Bus	0.856	0.1	1.000	0.856	1.211			
P52250.00 DISC	0.480	P52250.00 DISC	Bus	0.872	0.1	1.000	0.872	1.233			
P52250.00 TERM	0.480	P52250.00 TERM	Bus	0.856	0.1	1.000	0.856	1.211			
P54080.00 DISC	0.480	P54080.00 DISC	Bus	1.432	0.1	1.000	1.432	2.025			
P54080.00 TERM	0.480	P54080.00 TERM	Bus	1.389	0.1	1.000	1.389	1.965			
P54090.00 DISC	0.480	P54090.00 DISC	Bus	1.432	0.1	1.000	1.432	2.025			
P54090.00 TERM	0.480	P54090.00 TERM	Bus	1.389	0.1	1.000	1.389	1.965			
P55020.00 TERM	0.480	P55020.00 TERM	MCC	3.398	0.3	1.000	3.398	4.805	65.000	81.100	
P55030.00 TERM	0.480	P55030.00 TERM	Bus	3.398	0.3	1.000	3.398	4.805			
PNL DP2	0.480	PNL DP2	Switchboard	19.957	2.8	1.098	21.906	37.256	22.000	27.400	
PNL DP4	0.480	PNL DP4	Switchboard	53.398	8.0	1.382	73.820	126.487	14.000 *	17.500 *	
PNL DPLC-1	0.208	PNL DPLC-1	Panelboard	1.963	1.5	1.017	1.996	3.141	10.000	12.500	
PNL DPLC-2	0.208	PNL DPLC-2	Panelboard	1.560	1.2	1.005	1.568	2.362	10.000	12.500	

3-Phase Fault Currents: (Prefault Voltage = 100 % of the Bus Nominal Voltage)

Bus		Device		Momentary Duty					Device Capability		
ID	kV	ID	Type	Symm. kA rms	X/R Ratio	M.F.	Asymm. kA rms	Asymm. kA Peak	Symm. kA rms	Asymm. kA rms	Asymm. kA Peak
PNL DPLC-3	0.208	PNL DPLC-3	Panelboard	1.862	1.4	1.010	1.881	2.898	10.000	12.500	
PNL DPLC-4	0.208	PNL DPLC-4	Panelboard	0.881	1.0	1.002	0.883	1.305	10.000	12.500	
PNL DPP1	0.480	PNL DPP1	Panelboard	16.073	0.9	1.001	16.091	23.497	160.000	200.000	
PNL DPP1 PRI	0.480	PNL DPP1 PRI	MCC	16.073	0.9	1.001	16.091	23.497	65.000	81.100	
SCR BLDG N OH DOOR DISC	0.480	SCR BLDG N OH DOOR DISC	Bus	1.240	0.1	1.000	1.240	1.753			
SCR BLDG N OH DOOR TERM	0.480	SCR BLDG N OH DOOR TERM	Bus	1.207	0.1	1.000	1.207	1.707			
SCR BLDG S OH DOOR DISC	0.480	SCR BLDG S OH DOOR DISC	Bus	1.348	0.1	1.000	1.348	1.906			
SCR BLDG S OH DOOR TERM	0.480	SCR BLDG S OH DOOR TERM	Bus	1.310	0.1	1.000	1.310	1.852			
SEP53000.00 DISC	0.480	SEP53000.00 DISC	Bus	0.742	0.1	1.000	0.742	1.050			
SEP53000.00 TERM	0.480	SEP53000.00 TERM	Bus	0.731	0.1	1.000	0.731	1.033			
SEP53010.00 DISC	0.480	SEP53010.00 DISC	Bus	0.742	0.1	1.000	0.742	1.050			
SEP53010.00 TERM	0.480	SEP53010.00 TERM	Bus	0.731	0.1	1.000	0.731	1.033			
SEP53020.00 DISC	0.480	SEP53020.00 DISC	Bus	0.719	0.1	1.000	0.719	1.017			
SEP53020.00 TERM	0.480	SEP53020.00 TERM	Bus	0.708	0.1	1.000	0.708	1.002			
SR-DAF	0.480	SR-DAF	Cable Bus	9.941	2.9	1.109	11.026	18.828			
SR-DAF PRI	0.480	SR-DAF PRI	Bus	9.941	2.9	1.109	11.026	18.828			
SWBD GDP	0.480	SWBD GDP	Switchboard	24.385	11.9	1.476	35.980	60.942	100.000	125.000	
SWBD-NB BUS A	0.480	SWBD-NB BUS A	Switchboard	15.403	6.1	1.310	20.180	34.821	50.000	62.300	
SWBD-NB BUS A PRI	0.480	SWBD-NB BUS A PRI	Switchboard	15.403	6.1	1.310	20.180	34.821	50.000	62.300	
SWBD-NB BUS B	0.480	SWBD-NB BUS B	Switchboard	14.246	6.0	1.307	18.617	32.132	50.000	62.300	
SWBD-NB BUS B PRI	0.480	SWBD-NB BUS B PRI	Switchboard	14.246	6.0	1.307	18.617	32.132	50.000	62.300	
TRANSF TA PRI	0.480	TRANSF TA PRI	Bus	49.949	14.1	1.510	75.420	127.147			
TRANSF TB PRI	0.480	TRANSF TB PRI	Bus	57.915	13.6	1.504	87.095	146.954			
TRANSF TB SEC	2.400	TRANSF TB SEC	Bus	5.694	8.9	1.411	8.033	13.719			
TRANSF TC PRI	2.400	TRANSF TC PRI	Bus	4.986	7.1	1.353	6.744	11.592			
TRANSF TC SEC	0.480	TRANSF TC SEC	Bus	15.560	6.3	1.318	20.511	35.369			
TRANSF TD PRI	2.400	TRANSF TD PRI	Bus	5.056	6.9	1.344	6.797	11.693			
TRANSF TD SEC	0.480	TRANSF TD SEC	Bus	14.441	6.3	1.317	19.015	32.794			
XFMR T-C4 PRI	0.480	XFMR T-C4 PRI	MCC	8.349	0.4	1.000	8.349	11.813	65.000	81.100	
XFMR T-C4 SEC	0.208	XFMR T-C4 SEC	MCC	0.906	1.1	1.003	0.909	1.352	65.000	81.100	
XFMR T-LC1 PRI	0.480	XFMR T-LC1 PRI	MCC	11.990	0.6	1.000	11.991	17.057	65.000	81.100	
XFMR T-LC1 SEC	0.208	XFMR T-LC1 SEC	MCC	1.982	1.6	1.018	2.018	3.181	65.000	81.100	
XFMR T-LC2 PRI	0.480	XFMR T-LC2 PRI	MCC	2.958	0.2	1.000	2.958	4.183	65.000	81.100	
XFMR T-LC2 SEC	0.208	XFMR T-LC2 SEC	MCC	1.565	1.2	1.005	1.573	2.370	65.000	81.100	

Method: IEEE - X/R is calculated from separate R & X networks.

Protective device duty is calculated based on total fault current.

The multiplication factors for high voltage circuit-breaker and high voltage bus momentary duty (asymmetrical and crest values) are calculated based on system X/R.

* Indicates a device with momentary duty exceeding the device capability

APPENDIX B2 – SHORT CIRCUIT STUDY (INTERRUPTING DUTY SUMMARY REPORT)

Interrupting Duty Summary Report

3-Phase Fault Currents: (Prefault Voltage = 100 % of the Bus Nominal Voltage)

Bus		Device			Interrupting Duty				Device Capability			
ID	kV	ID	Type	CPT (Cy)	Symm. kA rms	X/R Ratio	M.F.	Adj. Sym. kA rms	kV	Test PF	Rated Int.	Adjusted Int.
ATS-L BUS A	0.480				30.392	3.4						
ATS-L BUS B	0.480				26.452	2.0						
ATS-L SEC	0.480				30.392	3.4						
B20100.00 TERMINALS	2.400				3.982	6.1						
B20200.00 TERMINALS	2.400				3.959	5.8						
B20400.00 TERMINALS	2.400				4.102	5.7						
B52180.00 DISC	0.480				5.714	0.5						
B52180.00 TERM	0.480				5.544	0.5						
B52190.00 DISC	0.480				4.218	0.4						
B52190.00 TERM	0.480				4.123	0.4						
B52210.00 DISC	0.480				1.587	0.2						
B52210.00 TERM	0.480				1.553	0.2						
B52220.00 DISC	0.480				1.491	0.2						
B52220.00 TERM	0.480				1.462	0.2						
BLWR BLDG TROLLEY	0.480				4.420	0.3						
BSN51240.00 DISC	0.480				0.765	0.1						
BSN51240.00 TERM	0.480				0.752	0.1						
BSN51250.00 DISC	0.480				0.765	0.1						
BSN51250.00 TERM	0.480				0.752	0.1						
BSN51260.00 DISC	0.480				0.765	0.1						
BSN51260.00 TERM	0.480				0.752	0.1						
BSN51270.00 DISC	0.480				0.765	0.1						
BSN51270.00 TERM	0.480				0.752	0.1						
COGEN TIE BUS	0.480	B-MAIN SWGR B2	InsulUnfuse		57.915	13.6	1.130	65.447	0.480	15.00	100.000	100.000
COM53030.00 DISC	0.480				0.795	0.1						
COM53030.00 TERM	0.480				0.782	0.1						
COM53040.00 DISC	0.480				0.869	0.1						
COM53040.00 TERM	0.480				0.853	0.1						
CON51300.00 DISC	0.480				0.798	0.1						
CON51300.00 TERM	0.480				0.785	0.1						
CON51320.00 DISC	0.480				0.798	0.1						
CON51320.00 TERM	0.480				0.785	0.1						

3-Phase Fault Currents: (Prefault Voltage = 100 % of the Bus Nominal Voltage)

Bus		Device			Interrupting Duty				Device Capability			
ID	kV	ID	Type	CPT (Cy)	Symm. kA rms	X/R Ratio	M.F.	Adj. Sym. kA rms	kV	Test PF	Rated Int.	Adjusted Int.
CON53020.00 DISC	0.480				0.748	0.1						
CON53020.00 TERM	0.480				0.736	0.1						
CON53030.00 DISC	0.480				0.748	0.1						
CON53030.00 TERM	0.480				0.736	0.1						
EFF PS SWGR BUS A	0.480	B-EFF PS SWGR BUS A	PowerUnfuse		19.810	5.8	1.000	19.810	0.480	15.00	65.000	65.000
		B-EFF PUMP NO. 4 VFD	PowerUnfuse		19.810	5.8	1.000	19.810	0.480	15.00	65.000	65.000
EFF PS SWGR BUS A PRI	0.480	B-EFF PS SWGR BUS A	PowerUnfuse		19.810	5.8	1.000	19.810	0.480	15.00	65.000	65.000
EFF PS SWGR BUS B	0.480	B-EFF PS SWGR BUS B	PowerUnfuse		19.809	5.8	1.000	19.809	0.480	15.00	65.000	65.000
		B-EFF PUMP NO. 2 VFD	PowerUnfuse		19.809	5.8	1.000	19.809	0.480	15.00	65.000	65.000
EFF PS SWGR BUS B PRI	0.480	B-EFF PS SWGR BUS B	PowerUnfuse		19.809	5.8	1.000	19.809	0.480	15.00	65.000	65.000
EFF PUMP NO. 2 VFD PRI	0.480	F-EFF PUMP NO. 2 VFD	Fuse		19.060	5.0	1.004	19.139	0.600	20.00	300.000	300.000
EFF PUMP NO. 4 VFD PRI	0.480	F-EFF PUMP NO. 4 VFD	Fuse		19.061	4.9	1.002	19.103	0.600	20.00	300.000	300.000
F52410.00 DISC	0.480				0.627	0.1						
F52410.00 STR	0.480				0.673	0.1						
F52420.00 DISC	0.480				0.503	0.1						
F52420.00 STR	0.480				0.532	0.1						
F54330.00 DISC	0.480				2.516	0.1						
F54330.00 TERM	0.480				2.388	0.1						
F55010.00 TERM	0.480				4.157	0.4						
GEN NO. 2 TERM	0.480				22.464	9.3						
GEN NO. 3 TERM	0.480				22.780	9.6						
GRIT SCR TROLLEY	0.480				0.739	0.1						
HVAC56100.00 DISC	0.480	F-HVAC56100.00	Fuse		6.021	0.3	1.000	6.021	0.480	6.65	14.000	14.000
HVAC56100.00 TERM	0.480				5.563	0.3						
HVAC56110.00 DISC	0.480	F-HVAC56110.00	Fuse		2.531	0.2	1.000	2.531	0.480	6.65	14.000	14.000
HVAC56110.00 TERM	0.480				2.401	0.2						
HW ELEVATOR	0.480				8.455	0.5						
HW GATES	0.480				0.418	0.1						
INFL PUMP 1 TERMINALS	0.480				24.231	4.7						
INFL PUMP 1 VFD PRI	0.480	B-INFL PUMP 1	Molded Case		31.573	5.7	1.033	32.606	0.480	20.00	65.000	65.000
INFL PUMP 2 TERMINALS	0.480				21.921	3.7						
INFL PUMP 2 VFD	0.480	B-INFL PUMP 2 VFD MAIN	Molded Case		30.017	5.3	1.016	30.497	0.480	20.00	65.000	65.000
		B-INFL PUMP 2	Molded Case		30.017	5.3	1.016	30.497	0.480	20.00	50.000	50.000
INFL PUMP 2 VFD PRI	0.480	B-INFL PUMP 2 VFD MAIN	Molded Case		30.017	5.3	1.016	30.497	0.480	20.00	65.000	65.000

3-Phase Fault Currents: (Prefault Voltage = 100 % of the Bus Nominal Voltage)

Bus		Device			Interrupting Duty				Device Capability			
ID	kV	ID	Type	CPT (Cy)	Symm. kA rms	X/R Ratio	M.F.	Adj. Sym. kA rms	kV	Test PF	Rated Int.	Adjusted Int.
INFL PUMP 3 TERMINALS	0.480				22.707	3.7						
INFL PUMP 3 VFD	0.480	B-INFL PUMP 3 VFD MAIN	Molded Case		31.575	5.6	1.029	32.502	0.480	20.00	65.000	65.000
		B-INFL PUMP 3	Molded Case		31.575	5.6	1.029	32.502	0.480	20.00	50.000	50.000
INFL PUMP 3 VFD PRI	0.480	B-INFL PUMP 3 VFD MAIN	Molded Case		31.575	5.6	1.029	32.502	0.480	20.00	65.000	65.000
INFL PUMP 4 TERMINALS	0.480				22.114	3.7						
INFL PUMP 4 VFD	0.480	B-INFL PUMP 4 VFD MAIN	Molded Case		30.385	5.3	1.020	30.997	0.480	20.00	65.000	65.000
		B-INFL PUMP 4	Molded Case		30.385	5.3	1.020	30.997	0.480	20.00	50.000	50.000
INFL PUMP 4 VFD PRI	0.480	B-INFL PUMP 4 VFD MAIN	Molded Case		30.385	5.3	1.020	30.997	0.480	20.00	65.000	65.000
INFL PUMP 5 TERMINALS	0.480				22.707	3.7						
INFL PUMP 5 VFD	0.480	B-INFL PUMP 5 VFD MAIN	Molded Case		31.575	5.6	1.029	32.502	0.480	20.00	65.000	65.000
		B-INFL PUMP 5	Molded Case		31.575	5.6	1.029	32.502	0.480	20.00	50.000	50.000
INFL PUMP 5 VFD PRI	0.480	B-INFL PUMP 5 VFD MAIN	Molded Case		31.575	5.6	1.029	32.502	0.480	20.00	65.000	65.000
INFL PUMP 6 TERMINALS	0.480				23.125	4.7						
INFL PUMP 6 VFD PRI	0.480	B-INFL PUMP 6	Molded Case		29.655	5.3	1.018	30.174	0.480	20.00	65.000	65.000
LCP-HWOCS	0.480				4.308	0.4						
MAIN SWGR "FILTER"	0.480	B-FA5-MCC-GB	InsulUnfuse		49.949	14.1	1.135	56.673	0.480	15.00	100.000	100.000
		B-FA7-MCC-GH	InsulUnfuse		49.949	14.1	1.135	56.673	0.480	15.00	100.000	100.000
		B-FA6-MCC-GF	InsulUnfuse		49.949	14.1	1.135	56.673	0.480	15.00	100.000	100.000
		B-PNL DP1	InsulUnfuse		49.949	14.1	1.135	56.673	0.480	15.00	100.000	100.000
		B-FA2-MCC-HCC	InsulUnfuse		49.949	14.1	1.135	56.673	0.480	15.00	100.000	100.000
		B-FA1	InsulUnfuse		49.949	14.1	1.135	56.673	0.480	15.00	100.000	100.000
		B-FA3-PNL DP3	InsulUnfuse		49.949	14.1	1.135	56.673	0.480	15.00	100.000	100.000
		B-FA4-MCC-GD	InsulUnfuse		49.949	14.1	1.135	56.673	0.480	15.00	100.000	100.000
		B-MAIN SWGR A1	InsulUnfuse		49.949	14.1	1.135	56.673	0.480	15.00	100.000	100.000
MAIN SWGR "SLUDGE"	0.480	B-MAIN SWGR B2	InsulUnfuse		57.915	13.6	1.130	65.447	0.480	15.00	100.000	100.000
		B-FB1	InsulUnfuse		57.915	13.6	1.130	65.447	0.480	15.00	100.000	100.000
		B-FB3	InsulUnfuse		57.915	13.6	1.130	65.447	0.480	15.00	100.000	100.000
		B-FB4	InsulUnfuse		57.915	13.6	1.130	65.447	0.480	15.00	100.000	100.000
		B-FB5-MCC-GE	InsulUnfuse		57.915	13.6	1.130	65.447	0.480	15.00	100.000	100.000
		B-FB8-ATS-8	InsulUnfuse		57.915	13.6	1.130	65.447	0.480	15.00	100.000	100.000
		B-FB7-MCC-GA	InsulUnfuse		57.915	13.6	1.130	65.447	0.480	15.00	100.000	100.000
		B-FB6-MCC-GC	InsulUnfuse		57.915	13.6	1.130	65.447	0.480	15.00	100.000	100.000
		B-FB2-MCC-HC	InsulUnfuse		57.915	13.6	1.130	65.447	0.480	15.00	100.000	100.000
		B-MAIN SWGR B1	InsulUnfuse		57.915	13.6	1.130	65.447	0.480	15.00	100.000	100.000

3-Phase Fault Currents: (Prefault Voltage = 100 % of the Bus Nominal Voltage)

Bus		Device			Interrupting Duty				Device Capability				
ID	kV	ID	Type	CPT (Cy)	Symm. kA rms	X/R Ratio	M.F.	Adj. Sym. kA rms	kV	Test PF	Rated Int.	Adjusted Int.	
MAIN SWGR BUS A PRI	0.480	B-MAIN SWGR A1	InsulUnfuse		49.949	14.1	1.135	56.673	0.480	15.00	100.000	100.000	
MAIN SWGR BUS B PRI	0.480	B-MAIN SWGR B1	InsulUnfuse		57.915	13.6	1.130	65.447	0.480	15.00	100.000	100.000	
MCC-DP2C	0.480	B-GAS COMPRESSOR #6	Molded Case		16.279	2.7	1.000	16.279	0.480	20.00	35.000	35.000	
		B-GAS COMPRESSOR #7	Molded Case		16.279	2.7	1.000	16.279	0.480	20.00	35.000	35.000	
MCC-DP4A	0.480				1.724	0.2							
MCC-DP4B	0.480	B-NEW INTERSTAGE BLDG	Molded Case		48.572	6.1	1.052	51.088	0.480	20.00	65.000	65.000	
		B2-MCC-DP4B	Molded Case		48.572	6.1	1.052	51.088	0.480	20.00	200.000	200.000	
MCC-GE	0.480	B-P4013.00	Molded Case		15.296	9.2	1.137	17.384	0.480	20.00	100.000	100.000	
		B-P4012.00	Molded Case		15.296	9.2	1.137	17.384	0.600	20.00	200.000	200.000	
MCC-GE PRI	0.480				42.998	4.4							
MCC-HW BUS A	0.480	B-MCC-HW BUS A MAIN	Molded Case		31.811	5.3	1.018	32.391	0.480	20.00	65.000	65.000	
		B-P52160.00	Molded Case		31.811	5.3	1.018	32.391	0.480	20.00	100.000	100.000	
		B-P52140.00	Molded Case		31.811	5.3	1.018	32.391	0.480	20.00	100.000	100.000	
		B-P52120.00	Molded Case		31.811	5.3	1.018	32.391	0.480	20.00	100.000	100.000	
		B-P52100.00	Molded Case		31.811	5.3	1.018	32.391	0.480	20.00	100.000	100.000	
		B-BSN51260.00	Molded Case		31.811	5.3	1.018	32.391	0.480	20.00	100.000	100.000	
		B-BSN51240.00	Molded Case		31.811	5.3	1.018	32.391	0.480	20.00	100.000	100.000	
		B-P52230.00	Molded Case		31.811	5.3	1.018	32.391	0.480	20.00	100.000	100.000	
		B-B52180.00	Molded Case		31.811	5.3	1.018	32.391	0.480	20.00	100.000	100.000	
		B-B52220.00	Molded Case		31.811	5.3	1.018	32.391	0.480	20.00	100.000	100.000	
		B-COM53030.00	Molded Case		31.811	5.3	1.018	32.391	0.480	20.00	100.000	100.000	
		B-SEP53000.00	Molded Case		31.811	5.3	1.018	32.391	0.480	20.00	100.000	100.000	
		B-P52220.00	Molded Case		31.811	5.3	1.018	32.391	0.480	20.00	100.000	100.000	
		B-P54090.00	Molded Case		31.811	5.3	1.018	32.391	0.480	20.00	100.000	100.000	
		B-P54080.00	Molded Case		31.811	5.3	1.018	32.391	0.480	20.00	100.000	100.000	
		B-CON51320.00	Molded Case		31.811	5.3	1.018	32.391	0.480	20.00	100.000	100.000	
		B-CON51300.00	Molded Case		31.811	5.3	1.018	32.391	0.480	20.00	100.000	100.000	
		B-HW ELEVATOR	Molded Case		31.811	5.3	1.018	32.391	0.480	20.00	65.000	65.000	
		B-ATS-L BUS A	Molded Case		31.811	5.3	1.123	35.736	0.480	30.00	14.000	14.000	*
		B-GRIT SCR TROLLEY	Molded Case		31.811	5.3	1.018	32.391	0.480	20.00	65.000	65.000	
		B-BLRW BLDG TROLLEY	Molded Case		31.811	5.3	1.018	32.391	0.480	20.00	65.000	65.000	
		B-PNL DPP1	Molded Case		31.811	5.3	1.018	32.391	0.480	20.00	65.000	65.000	
		B-LCP-HWOCS	Molded Case		31.811	5.3	1.018	32.391	0.480	20.00	65.000	65.000	
MCC-HW BUS A PRI	0.480	B-MCC-HW BUS A MAIN	Molded Case		31.811	5.3	1.018	32.391	0.480	20.00	65.000	65.000	

3-Phase Fault Currents: (Prefault Voltage = 100 % of the Bus Nominal Voltage)

Bus		Device			Interrupting Duty				Device Capability				
ID	kV	ID	Type	CPT (Cy)	Symm. kA rms	X/R Ratio	M.F.	Adj. Sym. kA rms	kV	Test PF	Rated Int.	Adjusted Int.	
MCC-HW BUS B	0.480	B-MCC-HW BUS B MAIN	Molded Case		31.318	5.3	1.018	31.869	0.480	20.00	65.000	65.000	
		B-F54330.00	Molded Case		31.318	5.3	1.018	31.869	0.480	20.00	100.000	100.000	
		B-BSN51250.00	Molded Case		31.318	5.3	1.018	31.869	0.480	20.00	100.000	100.000	
		B-BSN51270.00	Molded Case		31.318	5.3	1.018	31.869	0.480	20.00	100.000	100.000	
		B-P52150.00	Molded Case		31.318	5.3	1.018	31.869	0.480	20.00	100.000	100.000	
		B-P52170.00	Molded Case		31.318	5.3	1.018	31.869	0.480	20.00	100.000	100.000	
		B-P52110.00	Molded Case		31.318	5.3	1.018	31.869	0.480	20.00	100.000	100.000	
		B-P52130.00	Molded Case		31.318	5.3	1.018	31.869	0.480	20.00	100.000	100.000	
		B-SEP53010.00	Molded Case		31.318	5.3	1.018	31.869	0.480	20.00	100.000	100.000	
		B-P52250.00	Molded Case		31.318	5.3	1.018	31.869	0.480	20.00	100.000	100.000	
		B-COM53040.00	Molded Case		31.318	5.3	1.018	31.869	0.480	20.00	100.000	100.000	
		B-B52190.00	Molded Case		31.318	5.3	1.018	31.869	0.480	20.00	100.000	100.000	
		B-B52210.00	Molded Case		31.318	5.3	1.018	31.869	0.480	20.00	100.000	100.000	
		B-SEP53020.00	Molded Case		31.318	5.3	1.018	31.869	0.480	20.00	100.000	100.000	
		B-CON53020.00	Molded Case		31.318	5.3	1.018	31.869	0.480	20.00	100.000	100.000	
		B-CON53030.00	Molded Case		31.318	5.3	1.018	31.869	0.480	20.00	100.000	100.000	
		B-P52240.00	Molded Case		31.318	5.3	1.018	31.869	0.480	20.00	100.000	100.000	
		B-ATS-L BUS B	Molded Case		31.318	5.3	1.123	35.159	0.480	30.00	18.000	18.000	*
MCC-HW BUS B PRI	0.480	B-MCC-HW BUS B MAIN	Molded Case		31.318	5.3	1.018	31.869	0.480	20.00	65.000	65.000	
MCC-NA BUS A	2.400	F MCC-NA BUS A	Fuse		5.016	7.3	1.000	5.016	5.500	6.65	25.000	25.000	
		F TRANSF TC	Fuse		5.016	7.3	1.000	5.016	5.500	6.65	25.000	25.000	
		F B20100.00	Fuse		5.016	7.3	1.000	5.016	5.080	3.95	50.000	50.000	
		F B20200.00	Fuse		5.016	7.3	1.000	5.016	5.080	3.95	50.000	50.000	
		F B20300.00	Fuse		5.016	7.3	1.000	5.016	5.080	3.95	50.000	50.000	
MCC-NA BUS A PRI	2.400	F MCC-NA BUS A	Fuse		5.016	7.3	1.000	5.016	5.500	6.65	25.000	25.000	
MCC-NA BUS B	2.400	F MCC-NA BUS B	Fuse		5.091	7.1	1.000	5.091	5.500	6.65	25.000	25.000	
		F TRANSF TD	Fuse		5.091	7.1	1.000	5.091	5.500	6.65	25.000	25.000	
		F B20400.00	Fuse		5.091	7.1	1.000	5.091	5.080	3.95	50.000	50.000	
		F B20500.00	Fuse		5.091	7.1	1.000	5.091	5.080	3.95	50.000	50.000	
MCC-NA BUS B PRI	2.400	F MCC-NA BUS B	Fuse		5.091	7.1	1.000	5.091	5.500	6.65	25.000	25.000	
MCC-NC	0.480	B-P27010.00 (Bypass)	Molded Case		15.294	6.0	1.048	16.024	0.480	20.00	100.000	100.000	
		B-P27030.00 (Bypass)	Molded Case		15.294	6.0	1.048	16.024	0.480	20.00	100.000	100.000	
		B-P28010.00 (Bypass)	Molded Case		15.294	6.0	1.048	16.024	0.480	20.00	100.000	100.000	
		B-P27310.00 (Bypass)	Molded Case		15.294	6.0	1.048	16.024	0.480	20.00	100.000	100.000	

3-Phase Fault Currents: (Prefault Voltage = 100 % of the Bus Nominal Voltage)

Bus		Device			Interrupting Duty				Device Capability			
ID	kV	ID	Type	CPT (Cy)	Symm. kA rms	X/R Ratio	M.F.	Adj. Sym. kA rms	kV	Test PF	Rated Int.	Adjusted Int.
MCC-NC		B-P28030.00 (Bypass)	Molded Case		15.294	6.0	1.048	16.024	0.480	20.00	100.000	100.000
		B-P27330.00 (Bypass)	Molded Case		15.294	6.0	1.048	16.024	0.480	20.00	100.000	100.000
		B-P27110.00	Molded Case		15.294	6.0	1.048	16.024	0.480	20.00	100.000	100.000
MCC-ND	0.480	B-P27020.00 (Bypass)	Molded Case		14.124	5.9	1.043	14.729	0.480	20.00	100.000	100.000
		B-P27040.00 (Bypass)	Molded Case		14.124	5.9	1.043	14.729	0.480	20.00	100.000	100.000
		B-P28020.00 (Bypass)	Molded Case		14.124	5.9	1.043	14.729	0.480	20.00	100.000	100.000
		B-P27320.00 (Bypass)	Molded Case		14.124	5.9	1.043	14.729	0.480	20.00	100.000	100.000
		B-P27120.00	Molded Case		14.124	5.9	1.043	14.729	0.480	20.00	100.000	100.000
		B-P27130.00	Molded Case		14.124	5.9	1.043	14.729	0.480	20.00	100.000	100.000
MCC-NE	0.480	B-PNL DPP4	Molded Case		14.305	4.9	1.000	14.307	0.480	20.00	65.000	65.000
		B-XFMR-T-DPC3-PRI	Molded Case		14.305	4.9	1.000	14.307	0.480	20.00	65.000	65.000
		B-M25011.10	Molded Case		14.305	4.9	1.000	14.307	0.480	20.00	100.000	100.000
		B-M25051.10	Molded Case		14.305	4.9	1.000	14.307	0.480	20.00	100.000	100.000
		B-M25131.10	Molded Case		14.305	4.9	1.000	14.307	0.480	20.00	100.000	100.000
		B-M25091.10	Molded Case		14.305	4.9	1.000	14.307	0.480	20.00	100.000	100.000
		B-M25171.10	Molded Case		14.305	4.9	1.000	14.307	0.480	20.00	100.000	100.000
		B-P26057.00	Molded Case		14.305	4.9	1.000	14.307	0.480	20.00	100.000	100.000
		B-P26058.00	Molded Case		14.305	4.9	1.000	14.307	0.480	20.00	100.000	100.000
		B-P27720.00	Molded Case		14.305	4.9	1.000	14.307	0.480	20.00	100.000	100.000
MCC-NF	0.480	B-PNL DPP5	Molded Case		13.303	4.9	1.002	13.324	0.480	20.00	65.000	65.000
		B-XFMR-T-DPL2-PRI	Molded Case		13.303	4.9	1.002	13.324	0.480	20.00	65.000	65.000
		B-M25031.10	Molded Case		13.303	4.9	1.002	13.324	0.480	20.00	100.000	100.000
		B-M25071.10	Molded Case		13.303	4.9	1.002	13.324	0.480	20.00	100.000	100.000
		B-M25111.10	Molded Case		13.303	4.9	1.002	13.324	0.480	20.00	100.000	100.000
		B-M25151.10	Molded Case		13.303	4.9	1.002	13.324	0.480	20.00	100.000	100.000
		B-P27230.00	Molded Case		13.303	4.9	1.002	13.324	0.480	20.00	100.000	100.000
		B-F27505.00	Molded Case		13.303	4.9	1.002	13.324	0.480	20.00	100.000	100.000
		B-F27506.00	Molded Case		13.303	4.9	1.002	13.324	0.480	20.00	100.000	100.000
		B-XFRM-FEB-PRI	Molded Case		13.303	4.9	1.002	13.324	0.480	20.00	65.000	65.000
MCC-NG BUS A	0.480	B-PNL DPP7 BLOWER GALLERY	Molded Case		8.191	2.3	1.000	8.191	0.480	20.00	65.000	65.000
		B-P20400.20	Molded Case		8.191	2.3	1.000	8.191	0.480	20.00	100.000	100.000
		B-P20500.20	Molded Case		8.191	2.3	1.000	8.191	0.480	20.00	100.000	100.000
		B-P26020.00	Molded Case		8.191	2.3	1.000	8.191	0.480	20.00	100.000	100.000
		B-XFRM-T-DPP2-PRI	Molded Case		8.191	2.3	1.000	8.191	0.480	20.00	65.000	65.000

3-Phase Fault Currents: (Prefault Voltage = 100 % of the Bus Nominal Voltage)

Bus		Device			Interrupting Duty				Device Capability			
ID	kV	ID	Type	CPT (Cy)	Symm. kA rms	X/R Ratio	M.F.	Adj. Sym. kA rms	kV	Test PF	Rated Int.	Adjusted Int.
MCC-NG BUS A		B-XFMR-T-DPC1-PRI	Molded Case		8.191	2.3	1.000	8.191	0.480	20.00	65.000	65.000
		B-P26025.00	Molded Case		8.191	2.3	1.000	8.191	0.480	20.00	100.000	100.000
		B-PNL DPP1 BLOWER GALLERY	Molded Case		8.191	2.3	1.000	8.191	0.480	20.00	65.000	65.000
		B-BUS A MCC-NG	Molded Case		8.191	2.3	1.000	8.191	0.480	20.00	65.000	65.000
MCC-NG BUS A PRI	0.480	B-BUS A MCC-NG	Molded Case		8.191	2.3	1.000	8.191	0.480	20.00	65.000	65.000
MCC-NG BUS B	0.480	B-P26010.00	Molded Case		8.233	2.6	1.000	8.233	0.480	20.00	100.000	100.000
		B-B27400.00	Molded Case		8.233	2.6	1.000	8.233	0.480	20.00	100.000	100.000
		B-F21159.00	Molded Case		8.233	2.6	1.000	8.233	0.480	20.00	100.000	100.000
		B-P26059.00	Molded Case		8.233	2.6	1.000	8.233	0.480	20.00	100.000	100.000
		B-P26060.00	Molded Case		8.233	2.6	1.000	8.233	0.480	20.00	100.000	100.000
		B-F21160.00	Molded Case		8.233	2.6	1.000	8.233	0.480	20.00	100.000	100.000
		B-PNL DPP3_BLOWER GALLERY	Molded Case		8.233	2.6	1.000	8.233	0.480	20.00	65.000	65.000
		B-PNL DPP6_BLOWER GALLERY	Molded Case		8.233	2.6	1.000	8.233	0.480	20.00	65.000	65.000
		B-P20100.20	Molded Case		8.233	2.6	1.000	8.233	0.480	20.00	100.000	100.000
		B-P20200.20	Molded Case		8.233	2.6	1.000	8.233	0.480	20.00	100.000	100.000
		B-P20300.20	Molded Case		8.233	2.6	1.000	8.233	0.480	20.00	100.000	100.000
		B-XFRM-T-DPL1-PRI	Molded Case		8.233	2.6	1.000	8.233	0.480	20.00	65.000	65.000
		B-BUS-B MCC-NG	Molded Case		8.233	2.6	1.000	8.233	0.480	20.00	65.000	65.000
MCC-NG BUS B PRI	0.480	B-BUS-B MCC-NG	Molded Case		8.233	2.6	1.000	8.233	0.480	20.00	65.000	65.000
MCC-SH BUS A	0.480	B-P6901.00	Molded Case		8.185	2.3	1.000	8.185	0.480	20.00	100.000	100.000
		B-F37010.00	Molded Case		8.185	2.3	1.000	8.185	0.480	20.00	100.000	100.000
		B- Polymer	Molded Case		8.185	2.3	1.000	8.185	0.480	20.00	65.000	65.000
		B- Praestemat	Molded Case		8.185	2.3	1.000	8.185	0.480	20.00	65.000	65.000
		B-Polymer PNL	Molded Case		8.185	2.3	1.000	8.185	0.480	20.00	65.000	65.000
		B-Grinder	Molded Case		8.185	2.3	1.000	8.185	0.480	20.00	65.000	65.000
		B-P6902.00	Molded Case		8.185	2.3	1.000	8.185	0.480	20.00	100.000	100.000
		B-RSS 30010.00	Molded Case		8.185	2.3	1.000	8.185	0.480	20.00	100.000	100.000
		B-B36040.00	Molded Case		8.185	2.3	1.000	8.185	0.480	20.00	100.000	100.000
		B-XFMR-T-DPM1-PRI	Molded Case		8.185	2.3	1.000	8.185	0.480	20.00	65.000	65.000
		B-XFMR-T-DPC7-PRI	Molded Case		8.185	2.3	1.000	8.185	0.480	20.00	65.000	65.000
		B-SP2	Molded Case		8.185	2.3	1.000	8.185	0.480	20.00	100.000	100.000
		B-CON 33010.00	Molded Case		8.185	2.3	1.000	8.185	0.480	20.00	100.000	100.000
		B-F36035.00	Molded Case		8.185	2.3	1.000	8.185	0.480	20.00	100.000	100.000

3-Phase Fault Currents: (Prefault Voltage = 100 % of the Bus Nominal Voltage)

Bus		Device			Interrupting Duty				Device Capability			
ID	kV	ID	Type	CPT (Cy)	Symm. kA rms	X/R Ratio	M.F.	Adj. Sym. kA rms	kV	Test PF	Rated Int.	Adjusted Int.
MCC-SH BUS A		B-F37015.00	Molded Case		8.185	2.3	1.000	8.185	0.480	20.00	100.000	100.000
		B-F37020.00	Molded Case		8.185	2.3	1.000	8.185	0.480	20.00	100.000	100.000
		B-LCP-BFP2	Molded Case		8.185	2.3	1.000	8.185	0.480	20.00	65.000	65.000
		B-LCP-BFP1	Molded Case		8.185	2.3	1.000	8.185	0.480	20.00	65.000	65.000
		B-CON 33030.00	Molded Case		8.185	2.3	1.000	8.185	0.480	20.00	100.000	100.000
		B-F36037.00	Molded Case		8.185	2.3	1.000	8.185	0.480	20.00	100.000	100.000
		B-F37030	Molded Case		8.185	2.3	1.000	8.185	0.480	20.00	100.000	100.000
		B-ORS Sprayer	Molded Case		8.185	2.3	1.000	8.185	0.480	20.00	35.000	35.000
		B-P32013.00	Molded Case		8.185	2.3	1.000	8.185	0.480	20.00	100.000	100.000
		B-P32023.00	Molded Case		8.185	2.3	1.000	8.185	0.480	20.00	100.000	100.000
		B-P32011.00	Molded Case		8.185	2.3	1.000	8.185	0.480	20.00	100.000	100.000
		B-P32021.00	Molded Case		8.185	2.3	1.000	8.185	0.480	20.00	100.000	100.000
		B-MCC-SH BUS A MAIN	Molded Case		8.185	2.3	1.000	8.185	0.480	20.00	30.000	30.000
MCC-SH BUS A PRI	0.480	B-MCC-SH BUS A MAIN	Molded Case		8.185	2.3	1.000	8.185	0.480	20.00	30.000	30.000
MCC-SH BUS B	0.480	B-P32033.00	Molded Case		8.118	2.3	1.000	8.118	0.480	20.00	100.000	100.000
		B-P32043.00	Molded Case		8.118	2.3	1.000	8.118	0.480	20.00	100.000	100.000
		B-P32031.00	Molded Case		8.118	2.3	1.000	8.118	0.480	20.00	100.000	100.000
		B-P32041.00	Molded Case		8.118	2.3	1.000	8.118	0.480	20.00	100.000	100.000
		B-F37013.00	Molded Case		8.118	2.3	1.000	8.118	0.480	20.00	100.000	100.000
		B-LCP-BFP3	Molded Case		8.118	2.3	1.000	8.118	0.480	20.00	65.000	65.000
		B-LCP-BFP4	Molded Case		8.118	2.3	1.000	8.118	0.480	20.00	65.000	65.000
		B-CON 330040.00	Molded Case		8.118	2.3	1.000	8.118	0.480	20.00	100.000	100.000
		B-F36030.00	Molded Case		8.118	2.3	1.000	8.118	0.480	20.00	100.000	100.000
		B-F37033.00	Molded Case		8.118	2.3	1.000	8.118	0.480	20.00	100.000	100.000
		B-XFMR-T-DPM2-PRI	Molded Case		8.118	2.3	1.000	8.118	0.480	20.00	65.000	65.000
		B-XFMR-T-DPL7-PRI	Molded Case		8.118	2.3	1.000	8.118	0.480	20.00	65.000	65.000
		B-CON 33020.00	Molded Case		8.118	2.3	1.000	8.118	0.480	20.00	100.000	100.000
		B-F37017.00	Molded Case		8.118	2.3	1.000	8.118	0.480	20.00	100.000	100.000
		B-MPV 30021.00	InsulUnfuse		8.118	2.3	1.000	8.118	0.480	15.00	50.000	50.000
		B-HWH	Molded Case		8.118	2.3	1.000	8.118	0.480	20.00	100.000	100.000
		B-B36045.00	Molded Case		8.118	2.3	1.000	8.118	0.480	20.00	100.000	100.000
		B-RSS30020.00	Molded Case		8.118	2.3	1.000	8.118	0.480	20.00	100.000	100.000
		B-F37023.00	Molded Case		8.118	2.3	1.000	8.118	0.480	20.00	100.000	100.000
		B-P6903.00	Molded Case		8.118	2.3	1.000	8.118	0.480	20.00	100.000	100.000

3-Phase Fault Currents: (Prefault Voltage = 100 % of the Bus Nominal Voltage)

Bus		Device			Interrupting Duty				Device Capability			
ID	kV	ID	Type	CPT (Cy)	Symm. kA rms	X/R Ratio	M.F.	Adj. Sym. kA rms	kV	Test PF	Rated Int.	Adjusted Int.
MCC-SH BUS B		B-MCC-SH TIE	Molded Case		8.118	2.3	1.000	8.118	0.480	20.00	30.000	30.000
MCC-SH BUS B PRI	0.480				7.425	2.3						
MS-HW BUS A	0.480	B-MS-HW 52-A	PowerUnfuse		33.733	6.3	1.000	33.733	0.508	15.00	100.000	100.000
		B-52-2B	PowerUnfuse		33.733	6.3	1.000	33.733	0.508	15.00	100.000	100.000
		B-52-2C	PowerUnfuse		33.733	6.3	1.000	33.733	0.508	15.00	100.000	100.000
		B-52-2D	PowerUnfuse		33.733	6.3	1.000	33.733	0.508	15.00	100.000	100.000
		B-52-3C	PowerUnfuse		33.733	6.3	1.000	33.733	0.508	15.00	100.000	100.000
MS-HW BUS A PRI	0.480	B-MS-HW 52-A	PowerUnfuse		33.733	6.3	1.000	33.733	0.508	15.00	100.000	100.000
MS-HW BUS B	0.480	B-52-5C	PowerUnfuse		33.241	6.3	1.000	33.241	0.508	15.00	100.000	100.000
		B-MS-HW 52-B	PowerUnfuse		33.241	6.3	1.000	33.241	0.508	15.00	100.000	100.000
		B-52-6B	PowerUnfuse		33.241	6.3	1.000	33.241	0.508	15.00	100.000	100.000
		B-52-6C	PowerUnfuse		33.241	6.3	1.000	33.241	0.508	15.00	100.000	100.000
		B-52-6D	PowerUnfuse		33.241	6.3	1.000	33.241	0.508	15.00	100.000	100.000
MS-HW BUS B PRI	0.480	B-MS-HW 52-B	PowerUnfuse		33.241	6.3	1.000	33.241	0.508	15.00	100.000	100.000
P52100.00 DISC	0.480				3.998	0.5						
P52100.00 TERM	0.480				3.942	0.5						
P52110.00 DISC	0.480				2.808	0.4						
P52110.00 TERM	0.480				2.766	0.4						
P52120.00 DISC	0.480				4.240	0.5						
P52120.00 TERM	0.480				4.177	0.5						
P52130.00 DISC	0.480				2.989	0.4						
P52130.00 TERM	0.480				2.941	0.4						
P52140.00 DISC	0.480				4.998	0.5						
P52140.00 TERM	0.480				4.910	0.5						
P52150.00 DISC	0.480				3.564	0.4						
P52150.00 TERM	0.480				3.497	0.4						
P52160.00 DISC	0.480				3.710	0.4						
P52160.00 TERM	0.480				3.637	0.4						
P52170.00 DISC	0.480				3.946	0.4						
P52170.00 TERM	0.480				3.863	0.4						
P52220.00 DISC	0.480				0.693	0.1						
P52220.00 TERM	0.480				0.683	0.1						
P52230.00 DISC	0.480				0.693	0.1						
P52230.00 TERM	0.480				0.683	0.1						

3-Phase Fault Currents: (Prefault Voltage = 100 % of the Bus Nominal Voltage)

Bus		Device			Interrupting Duty				Device Capability				
ID	kV	ID	Type	CPT (Cy)	Symm. kA rms	X/R Ratio	M.F.	Adj. Sym. kA rms	kV	Test PF	Rated Int.	Adjusted Int.	
P52240.00 DISC	0.480				0.872	0.1							
P52240.00 TERM	0.480				0.856	0.1							
P52250.00 DISC	0.480				0.872	0.1							
P52250.00 TERM	0.480				0.856	0.1							
P54080.00 DISC	0.480				1.432	0.1							
P54080.00 TERM	0.480				1.389	0.1							
P54090.00 DISC	0.480				1.432	0.1							
P54090.00 TERM	0.480				1.389	0.1							
P55020.00 TERM	0.480				3.398	0.3							
P55030.00 TERM	0.480				3.398	0.3							
PNL DP2	0.480	B-MCC-DP2C	Molded Case		19.957	2.8	1.000	19.957	0.480	20.00	30.000	30.000	
PNL DP4	0.480	B-MCC-DP4A	Molded Case		53.398	8.0	1.223	65.318	0.600	30.00	14.000	14.000	*
		F-MCC-DP4B	Fuse		53.398	8.0	1.109	59.204	0.600	20.00	200.000	200.000	
		B-MCC-DP4B	Molded Case		53.398	8.0	1.109	59.204	0.600	20.00	200.000	200.000	
PNL DPLC-1	0.208	B-PNL DPLC-3	Molded Case		1.963	1.5	1.000	1.963	0.240	50.00	10.000	10.000	
		B-STANDBY GEN PNL	Molded Case		1.963	1.5	1.000	1.963	0.240	50.00	10.000	10.000	
		B-PURGING COMPROSSER	Molded Case		1.963	1.5	1.000	1.963	0.240	50.00	10.000	10.000	
		B-PNL DPLC-1	Molded Case		1.963	1.5	1.000	1.963	0.240	20.00	65.000	65.000	
PNL DPLC-2	0.208	B-PNL DPLC-2 MAIN	Molded Case		1.560	1.2	1.000	1.560	0.240	20.00	65.000	65.000	
PNL DPLC-3	0.208	B-PNL DPLC-3 MAIN	Molded Case		1.862	1.4	1.000	1.862	0.240	50.00	10.000	10.000	
PNL DPLC-4	0.208	B-PNL DPLC-4 MAIN	Molded Case		0.881	1.0	1.000	0.881	0.240	50.00	10.000	10.000	
PNL DPP1	0.480	B-XFMR T-C4	MoldedFused		16.073	0.9	1.000	16.073	0.480	30.00	18.000	18.000	
		B-HVAC56100.00	MoldedFused		16.073	0.9	1.000	16.073	0.480	30.00	18.000	18.000	
		B-HVAC56110.00	MoldedFused		16.073	0.9	1.000	16.073	0.480	30.00	18.000	18.000	
		B-F52420.00	MoldedFused		16.073	0.9	1.000	16.073	0.480	30.00	18.000	18.000	
		B-F52410.00	MoldedFused		16.073	0.9	1.000	16.073	0.480	30.00	18.000	18.000	
		B-SCR BLDG S OH DOOR	MoldedFused		16.073	0.9	1.000	16.073	0.480	30.00	18.000	18.000	
		B-XFMR T-LC2	MoldedFused		16.073	0.9	1.000	16.073	0.480	30.00	18.000	18.000	
		B-SCR BLDG N OH DOOR	MoldedFused		16.073	0.9	1.000	16.073	0.480	30.00	18.000	18.000	
		B-HW GATES	MoldedFused		16.073	0.9	1.000	16.073	0.480	30.00	18.000	18.000	
		B-PNL DPP1 MAIN	MoldedFused		16.073	0.9	1.000	16.073	0.480	20.00	42.000	42.000	
PNL DPP1 PRI	0.480	B-PNL DPP1 MAIN	MoldedFused		16.073	0.9	1.000	16.073	0.480	20.00	42.000	42.000	
SCR BLDG N OH DOOR DISC	0.480				1.240	0.1							

3-Phase Fault Currents: (Prefault Voltage = 100 % of the Bus Nominal Voltage)

Bus		Device			Interrupting Duty				Device Capability			
ID	kV	ID	Type	CPT (Cy)	Symm. kA rms	X/R Ratio	M.F.	Adj. Sym. kA rms	kV	Test PF	Rated Int.	Adjusted Int.
SCR BLDG N OH DOOR TERM	0.480				1.207	0.1						
SCR BLDG S OH DOOR DISC	0.480				1.348	0.1						
SCR BLDG S OH DOOR TERM	0.480				1.310	0.1						
SEP53000.00 DISC	0.480				0.742	0.1						
SEP53000.00 TERM	0.480				0.731	0.1						
SEP53010.00 DISC	0.480				0.742	0.1						
SEP53010.00 TERM	0.480				0.731	0.1						
SEP53020.00 DISC	0.480				0.719	0.1						
SEP53020.00 TERM	0.480				0.708	0.1						
SR-DAF	0.480				9.941	2.9						
SR-DAF PRI	0.480				9.941	2.9						
SWBD GDP	0.480	B-GEN NO. 2	PowerUnfuse		24.385	11.9	1.090	26.586	0.480	15.00	50.000	50.000
		B-GEN NO. 3	PowerUnfuse		24.385	11.9	1.090	26.586	0.480	15.00	50.000	50.000
		B-GEN TIE A3	InsulUnfuse		24.385	11.9	1.109	27.037	0.480	15.00	100.000	100.000
SWBD-NB BUS A	0.480	B-SWBD-NB BUS A MAIN	InsulUnfuse		15.403	6.1	1.000	15.403	0.480	15.00	65.000	65.000
		B-MCC-NG BUS A	InsulUnfuse		15.403	6.1	1.000	15.403	0.480	15.00	50.000	50.000
		B-MCC-SH BUS A	InsulUnfuse		15.403	6.1	1.000	15.403	0.480	15.00	50.000	50.000
		B-MCC-NC	InsulUnfuse		15.403	6.1	1.000	15.403	0.480	15.00	65.000	65.000
		B-MCC-NE	InsulUnfuse		15.403	6.1	1.000	15.403	0.480	15.00	50.000	50.000
		B-SR-DAF	InsulUnfuse		15.403	6.1	1.000	15.403	0.480	15.00	50.000	50.000
SWBD-NB BUS A PRI	0.480	B-SWBD-NB BUS A MAIN	InsulUnfuse		15.403	6.1	1.000	15.403	0.480	15.00	65.000	65.000
SWBD-NB BUS B	0.480	B-MCC-NG BUS B	InsulUnfuse		14.246	6.0	1.000	14.246	0.480	15.00	50.000	50.000
		B-MCC-SH BUS B	InsulUnfuse		14.246	6.0	1.000	14.246	0.480	15.00	50.000	50.000
		B-SWBD-NB BUS B MAIN	InsulUnfuse		14.246	6.0	1.000	14.246	0.480	15.00	65.000	65.000
		B-MCC-NF	InsulUnfuse		14.246	6.0	1.000	14.246	0.480	15.00	50.000	50.000
		B-MCC-ND	InsulUnfuse		14.246	6.0	1.000	14.246	0.480	15.00	65.000	65.000
SWBD-NB BUS B PRI	0.480	B-SWBD-NB BUS B MAIN	InsulUnfuse		14.246	6.0	1.000	14.246	0.480	15.00	65.000	65.000
TRANSF TA PRI	0.480	B-FA1	InsulUnfuse		49.949	14.1	1.135	56.673	0.480	15.00	100.000	100.000
TRANSF TB PRI	0.480	B-FB1	InsulUnfuse		57.915	13.6	1.130	65.447	0.480	15.00	100.000	100.000
TRANSF TB SEC	2.400				4.909	9.4						
TRANSF TC PRI	2.400				4.133	7.2						
TRANSF TC SEC	0.480				15.560	6.3						
TRANSF TD PRI	2.400				4.294	6.9						

3-Phase Fault Currents: (Prefault Voltage = 100 % of the Bus Nominal Voltage)

Bus		Device			Interrupting Duty				Device Capability			
ID	kV	ID	Type	CPT (Cy)	Symm. kA rms	X/R Ratio	M.F.	Adj. Sym. kA rms	kV	Test PF	Rated Int.	Adjusted Int.
TRANSF TD SEC	0.480				14.441	6.3						
XFMR T-C4 PRI	0.480				8.349	0.4						
XFMR T-C4 SEC	0.208				0.906	1.1						
XFMR T-LC1 PRI	0.480				11.990	0.6						
XFMR T-LC1 SEC	0.208				1.982	1.6						
XFMR T-LC2 PRI	0.480				2.958	0.2						
XFMR T-LC2 SEC	0.208				1.565	1.2						

Method: IEEE - X/R is calculated from separate R & X networks.
HV CB interrupting capability is adjusted based on bus nominal voltage
Short-circuit multiplying factor for LV Molded Case and Insulated Case Circuit Breakers is calculated based on asymmetrical current.
Generator protective device duty is calculated based on maximum through fault current. Other protective device duty is calculated based on total fault current.

* Indicates a device with interrupting duty exceeding the device capability
** Indicates that the circuit breaker has been flagged as a generator circuit breaker. However, ETAP could not detect a single path, without a transformer, to the specified generator. Therefore, this circuit breaker is treated as a regular circuit breaker in short-circuit calculations.
+ The prefault voltage exceeds the rated maximum kV limit of the circuit breaker - The rated interrupting kA must be derated.

APPENDIX B3 – SHORT CIRCUIT STUDY (1/2 CYCLE SHORT-CIRCUIT SUMMARY REPORT)

Short-Circuit Summary Report

1/2 Cycle - 3-Phase, LG, LL, & LLG Fault Currents

Prefault Voltage = 100 % of the Bus Nominal Voltage

Bus		3-Phase Fault			Line-to-Ground Fault			Line-to-Line Fault			*Line-to-Line-to-Ground		
ID	kV	Real	Imag.	Mag.	Real	Imag.	Mag.	Real	Imag.	Mag.	Real	Imag.	Mag.
ATS-L BUS A	0.48	8.990	-29.032	30.392	10.625	-26.498	28.549	25.142	7.785	26.320	-30.997	4.251	31.287
ATS-L BUS B	0.48	12.342	-23.396	26.452	13.709	-18.132	22.731	20.262	10.689	22.908	-27.061	-3.636	27.304
ATS-L SEC	0.48	8.990	-29.032	30.392	10.625	-26.498	28.549	25.142	7.785	26.320	-30.997	4.251	31.287
B20100.00 TERMINALS	2.40	0.874	-4.698	4.779	1.291	-3.882	4.091	4.069	0.757	4.139	-4.793	0.854	4.868
B20200.00 TERMINALS	2.40	0.910	-4.634	4.723	1.300	-3.834	4.048	4.013	0.788	4.090	-4.736	0.807	4.804
B20400.00 TERMINALS	2.40	0.908	-4.724	4.811	1.313	-3.843	4.061	4.092	0.790	4.168	-4.813	0.789	4.877
B52180.00 DISC	0.48	5.122	-2.533	5.714	3.260	-1.193	3.471	2.194	4.436	4.949	-3.379	-4.064	5.285
B52180.00 TERM	0.48	4.986	-2.425	5.544	3.162	-1.138	3.361	2.100	4.318	4.801	-3.248	-3.964	5.125
B52190.00 DISC	0.48	3.964	-1.442	4.218	2.423	-0.631	2.504	1.249	3.433	3.653	-2.116	-3.243	3.873
B52190.00 TERM	0.48	3.877	-1.402	4.123	2.368	-0.613	2.446	1.214	3.358	3.571	-2.062	-3.174	3.785
B52210.00 DISC	0.48	1.561	-0.286	1.587	0.912	-0.110	0.918	0.248	1.352	1.374	-0.569	-1.321	1.438
B52210.00 TERM	0.48	1.528	-0.280	1.553	0.892	-0.107	0.899	0.242	1.323	1.345	-0.557	-1.293	1.408
B52220.00 DISC	0.48	1.467	-0.268	1.491	0.856	-0.102	0.862	0.232	1.271	1.292	-0.534	-1.242	1.352
B52220.00 TERM	0.48	1.438	-0.263	1.462	0.839	-0.100	0.845	0.228	1.245	1.266	-0.523	-1.218	1.325
BLWR BLDG TROLLEY	0.48	4.270	-1.143	4.420	2.592	-0.508	2.642	0.990	3.698	3.828	-1.917	-3.544	4.029
BSN51240.00 DISC	0.48	0.763	-0.058	0.765	0.446	-0.027	0.446	0.051	0.660	0.662	-0.208	-0.652	0.684
BSN51240.00 TERM	0.48	0.750	-0.057	0.752	0.438	-0.026	0.439	0.050	0.650	0.652	-0.204	-0.642	0.673
BSN51250.00 DISC	0.48	0.762	-0.059	0.765	0.446	-0.027	0.446	0.051	0.660	0.662	-0.208	-0.652	0.684
BSN51250.00 TERM	0.48	0.750	-0.057	0.752	0.438	-0.026	0.439	0.050	0.650	0.652	-0.205	-0.641	0.673
BSN51260.00 DISC	0.48	0.763	-0.058	0.765	0.446	-0.027	0.446	0.051	0.660	0.662	-0.208	-0.652	0.684
BSN51260.00 TERM	0.48	0.750	-0.057	0.752	0.438	-0.026	0.439	0.050	0.650	0.652	-0.204	-0.642	0.673
BSN51270.00 DISC	0.48	0.762	-0.059	0.765	0.446	-0.027	0.446	0.051	0.660	0.662	-0.208	-0.652	0.684
BSN51270.00 TERM	0.48	0.750	-0.057	0.752	0.438	-0.026	0.439	0.050	0.650	0.652	-0.205	-0.641	0.673
COGEN TIE BUS	0.48	4.920	-57.705	57.915	5.767	-61.084	61.356	50.056	4.382	50.248	-53.253	27.990	60.161
COM53030.00 DISC	0.48	0.793	-0.065	0.795	0.462	-0.029	0.463	0.056	0.686	0.689	-0.219	-0.678	0.712
COM53030.00 TERM	0.48	0.779	-0.064	0.782	0.454	-0.028	0.455	0.055	0.675	0.677	-0.215	-0.666	0.700
COM53040.00 DISC	0.48	0.866	-0.073	0.869	0.505	-0.032	0.506	0.063	0.750	0.753	-0.241	-0.740	0.779
COM53040.00 TERM	0.48	0.850	-0.071	0.853	0.496	-0.031	0.497	0.062	0.736	0.739	-0.237	-0.727	0.764
CON51300.00 DISC	0.48	0.795	-0.070	0.798	0.462	-0.030	0.463	0.061	0.689	0.691	-0.224	-0.680	0.716
CON51300.00 TERM	0.48	0.782	-0.069	0.785	0.455	-0.029	0.456	0.060	0.677	0.680	-0.220	-0.668	0.704
CON51320.00 DISC	0.48	0.795	-0.070	0.798	0.462	-0.030	0.463	0.061	0.689	0.691	-0.224	-0.680	0.716

1/2 Cycle - 3-Phase, LG, LL, & LLG Fault Currents

Prefault Voltage = 100 % of the Bus Nominal Voltage

Bus		3-Phase Fault			Line-to-Ground Fault			Line-to-Line Fault			*Line-to-Line-to-Ground		
ID	kV	Real	Imag.	Mag.	Real	Imag.	Mag.	Real	Imag.	Mag.	Real	Imag.	Mag.
CON51320.00 TERM	0.48	0.782	-0.069	0.785	0.455	-0.029	0.456	0.060	0.677	0.680	-0.220	-0.668	0.704
CON53020.00 DISC	0.48	0.745	-0.066	0.748	0.433	-0.028	0.434	0.057	0.645	0.647	-0.209	-0.637	0.670
CON53020.00 TERM	0.48	0.733	-0.065	0.736	0.426	-0.027	0.427	0.056	0.635	0.637	-0.206	-0.627	0.660
CON53030.00 DISC	0.48	0.745	-0.066	0.748	0.433	-0.028	0.434	0.057	0.645	0.647	-0.209	-0.637	0.670
CON53030.00 TERM	0.48	0.733	-0.065	0.736	0.426	-0.027	0.427	0.056	0.635	0.637	-0.206	-0.627	0.660
EFF PS SWGR BUS A	0.48	4.127	-19.376	19.810	3.635	-19.734	20.066	16.669	3.333	16.999	14.870	13.605	20.155
EFF PS SWGR BUS A PRI	0.48	4.127	-19.376	19.810	3.635	-19.734	20.066	16.669	3.333	16.999	14.870	13.605	20.155
EFF PS SWGR BUS B	0.48	4.100	-19.380	19.809	3.609	-19.738	20.065	16.673	3.309	16.998	14.886	13.583	20.152
EFF PS SWGR BUS B PRI	0.48	4.100	-19.380	19.809	3.609	-19.738	20.065	16.673	3.309	16.998	14.886	13.583	20.152
EFF PUMP NO. 2 VFD PRI	0.48	4.409	-18.543	19.060	4.204	-18.202	18.681	15.947	3.573	16.342	-18.259	5.406	19.043
EFF PUMP NO. 4 VFD PRI	0.48	4.434	-18.538	19.061	4.226	-18.197	18.681	15.942	3.595	16.342	-18.265	5.382	19.041
F52410.00 DISC	0.48	0.626	-0.039	0.627	0.365	-0.017	0.365	0.033	0.542	0.543	-0.162	-0.537	0.561
F52410.00 STR	0.48	0.671	-0.043	0.673	0.391	-0.019	0.392	0.037	0.581	0.583	-0.175	-0.576	0.602
F52420.00 DISC	0.48	0.502	-0.029	0.503	0.292	-0.013	0.293	0.025	0.435	0.436	-0.128	-0.431	0.450
F52420.00 STR	0.48	0.531	-0.031	0.532	0.309	-0.014	0.309	0.027	0.460	0.461	-0.136	-0.456	0.475
F54330.00 DISC	0.48	2.493	-0.343	2.516	1.469	-0.139	1.476	0.297	2.159	2.179	-0.817	-2.119	2.271
F54330.00 TERM	0.48	2.366	-0.317	2.388	1.393	-0.129	1.399	0.275	2.049	2.068	-0.768	-2.012	2.154
F55010.00 TERM	0.48	3.906	-1.421	4.157	2.350	-0.541	2.411	1.231	3.383	3.600	-2.063	-3.235	3.837
GEN NO. 2 TERM	0.48	2.839	-22.284	22.464	4.116	-24.096	24.445	19.429	2.656	19.610	-21.985	10.320	24.287
GEN NO. 3 TERM	0.48	2.751	-22.613	22.780	4.027	-24.546	24.874	19.716	2.581	19.885	-22.230	10.697	24.670
GRIT SCR TROLLEY	0.48	0.737	-0.055	0.739	0.431	-0.025	0.432	0.048	0.639	0.640	-0.200	-0.631	0.662
HVAC56100.00 DISC	0.48	5.719	-1.882	6.021	3.537	-0.826	3.632	1.630	4.953	5.214	-2.903	-4.707	5.530
HVAC56100.00 TERM	0.48	5.314	-1.646	5.563	3.264	-0.720	3.342	1.425	4.602	4.818	-2.598	-4.387	5.098
HVAC56110.00 DISC	0.48	2.499	-0.397	2.531	1.476	-0.169	1.486	0.344	2.165	2.192	-0.867	-2.114	2.285
HVAC56110.00 TERM	0.48	2.373	-0.365	2.401	1.400	-0.155	1.409	0.316	2.055	2.079	-0.812	-2.009	2.166
HW ELEVATOR	0.48	7.654	-3.594	8.455	4.989	-1.676	5.263	3.112	6.628	7.323	-4.944	-6.116	7.865
HW GATES	0.48	0.417	-0.021	0.418	0.243	-0.010	0.244	0.018	0.361	0.362	-0.104	-0.358	0.373
INFL PUMP 1 TERMINALS	0.48	6.511	-23.340	24.231	6.987	-18.995	20.239	20.213	5.639	20.985	-23.661	2.298	23.773
INFL PUMP 1 VFD PRI	0.48	6.263	-30.945	31.573	6.724	-29.682	30.434	26.800	5.424	27.343	-30.350	8.821	31.606
INFL PUMP 2 TERMINALS	0.48	8.389	-20.252	21.921	8.917	-14.803	17.282	17.539	7.265	18.984	-21.737	-1.604	21.796
INFL PUMP 2 VFD	0.48	6.280	-29.353	30.017	6.902	-27.570	28.420	25.420	5.439	25.996	-29.097	7.529	30.056
INFL PUMP 2 VFD PRI	0.48	6.280	-29.353	30.017	6.902	-27.570	28.420	25.420	5.439	25.996	-29.097	7.529	30.056
INFL PUMP 3 TERMINALS	0.48	8.720	-20.966	22.707	9.310	-15.430	18.021	18.157	7.552	19.665	-22.561	-1.629	22.620
INFL PUMP 3 VFD	0.48	6.270	-30.946	31.575	6.729	-29.682	30.435	26.800	5.430	27.345	-30.351	8.815	31.605

1/2 Cycle - 3-Phase, LG, LL, & LLG Fault Currents

Prefault Voltage = 100 % of the Bus Nominal Voltage

Bus		3-Phase Fault			Line-to-Ground Fault			Line-to-Line Fault			*Line-to-Line-to-Ground		
ID	kV	Real	Imag.	Mag.	Real	Imag.	Mag.	Real	Imag.	Mag.	Real	Imag.	Mag.
INFL PUMP 3 VFD PRI	0.48	6.270	-30.946	31.575	6.729	-29.682	30.435	26.800	5.430	27.345	-30.351	8.815	31.605
INFL PUMP 4 TERMINALS	0.48	8.451	-20.435	22.114	9.020	-14.992	17.497	17.697	7.319	19.151	-21.958	-1.575	22.014
INFL PUMP 4 VFD	0.48	6.240	-29.738	30.385	6.828	-28.166	28.982	25.754	5.404	26.314	-29.393	7.949	30.449
INFL PUMP 4 VFD PRI	0.48	6.240	-29.738	30.385	6.828	-28.166	28.982	25.754	5.404	26.314	-29.393	7.949	30.449
INFL PUMP 5 TERMINALS	0.48	8.720	-20.966	22.707	9.310	-15.430	18.021	18.157	7.552	19.665	-22.561	-1.629	22.620
INFL PUMP 5 VFD	0.48	6.270	-30.946	31.575	6.729	-29.682	30.435	26.800	5.430	27.345	-30.351	8.815	31.605
INFL PUMP 5 VFD PRI	0.48	6.270	-30.946	31.575	6.729	-29.682	30.435	26.800	5.430	27.345	-30.351	8.815	31.605
INFL PUMP 6 TERMINALS	0.48	6.352	-22.236	23.125	6.791	-17.815	19.065	19.257	5.501	20.027	-22.580	1.857	22.656
INFL PUMP 6 VFD PRI	0.48	6.304	-28.977	29.655	6.957	-26.995	27.877	25.095	5.460	25.682	-28.799	7.142	29.671
LCP-HWOCS	0.48	4.057	-1.451	4.308	2.440	-0.549	2.501	1.257	3.513	3.731	-2.121	-3.363	3.976
MAIN SWGR "FILTER"	0.48	4.399	-49.755	49.949	4.776	-53.100	53.315	43.089	3.810	43.257	-45.699	24.654	51.925
MAIN SWGR "SLUDGE"	0.48	4.920	-57.705	57.915	5.767	-61.084	61.356	50.056	4.382	50.248	-53.253	27.990	60.161
MAIN SWGR BUS A PRI	0.48	4.399	-49.755	49.949	4.776	-53.100	53.315	43.089	3.810	43.257	-45.699	24.654	51.925
MAIN SWGR BUS B PRI	0.48	4.920	-57.705	57.915	5.767	-61.084	61.356	50.056	4.382	50.248	-53.253	27.990	60.161
MCC-DP2C	0.48	6.281	-15.018	16.279	5.390	-9.536	10.954	13.005	5.449	14.101	-15.231	-1.999	15.362
MCC-DP4A	0.48	1.700	-0.282	1.724	0.996	-0.132	1.005	0.244	1.472	1.493	-0.596	-1.431	1.550
MCC-DP4B	0.48	8.250	-47.867	48.572	10.945	-45.410	46.711	41.496	7.238	42.123	-47.948	14.191	50.004
MCC-GE	0.48	1.722	-15.199	15.296	2.166	-13.764	13.933	13.167	1.498	13.252	-14.380	4.771	15.151
MCC-GE PRI	0.48	10.352	-41.733	42.998	13.201	-35.752	38.111	36.162	9.041	37.275	-43.337	6.322	43.795
MCC-HW BUS A	0.48	6.453	-31.150	31.811	6.942	-30.099	30.889	26.977	5.589	27.550	-30.656	8.956	31.937
MCC-HW BUS A PRI	0.48	6.453	-31.150	31.811	6.942	-30.099	30.889	26.977	5.589	27.550	-30.656	8.956	31.937
MCC-HW BUS B	0.48	6.329	-30.672	31.318	6.852	-29.800	30.577	26.562	5.481	27.122	-30.219	8.993	31.529
MCC-HW BUS B PRI	0.48	6.329	-30.672	31.318	6.852	-29.800	30.577	26.562	5.481	27.122	-30.219	8.993	31.529
MCC-NA BUS A	2.40	0.748	-4.960	5.016	1.238	-4.374	4.546	4.296	0.648	4.344	-5.055	1.260	5.210
MCC-NA BUS A PRI	2.40	0.748	-4.960	5.016	1.238	-4.374	4.546	4.296	0.648	4.344	-5.055	1.260	5.210
MCC-NA BUS B	2.40	0.760	-5.034	5.091	1.257	-4.412	4.588	4.362	0.662	4.412	-5.125	1.253	5.276
MCC-NA BUS B PRI	2.40	0.760	-5.034	5.091	1.257	-4.412	4.588	4.362	0.662	4.412	-5.125	1.253	5.276
MCC-NC	0.48	2.723	-15.050	15.294	3.184	-15.936	16.251	13.034	2.358	13.245	-14.905	6.101	16.106
MCC-ND	0.48	2.468	-13.907	14.124	2.983	-15.052	15.344	12.045	2.142	12.234	-13.865	6.050	15.127
MCC-NE	0.48	3.042	-13.978	14.305	3.728	-14.176	14.658	12.105	2.635	12.388	-14.336	4.526	15.034
MCC-NF	0.48	2.734	-13.019	13.303	3.453	-13.512	13.946	11.276	2.372	11.523	-13.415	4.619	14.188
MCC-NG BUS A	0.48	3.275	-7.508	8.191	3.295	-5.655	6.545	6.502	2.836	7.094	-8.039	-0.610	8.062
MCC-NG BUS A PRI	0.48	3.275	-7.508	8.191	3.295	-5.655	6.545	6.502	2.836	7.094	-8.039	-0.610	8.062
MCC-NG BUS B	0.48	3.062	-7.642	8.233	3.221	-5.732	6.575	6.618	2.653	7.130	-8.144	-0.412	8.154

1/2 Cycle - 3-Phase, LG, LL, & LLG Fault Currents

Prefault Voltage = 100 % of the Bus Nominal Voltage

Bus		3-Phase Fault			Line-to-Ground Fault			Line-to-Line Fault			*Line-to-Line-to-Ground		
ID	kV	Real	Imag.	Mag.	Real	Imag.	Mag.	Real	Imag.	Mag.	Real	Imag.	Mag.
MCC-NG BUS B PRI	0.48	3.062	-7.642	8.233	3.221	-5.732	6.575	6.618	2.653	7.130	-8.144	-0.412	8.154
MCC-SH BUS A	0.48	3.325	-7.479	8.185	3.221	-5.332	6.230	6.477	2.880	7.089	-7.926	-0.849	7.972
MCC-SH BUS A PRI	0.48	3.325	-7.479	8.185	3.221	-5.332	6.230	6.477	2.880	7.089	-7.926	-0.849	7.972
MCC-SH BUS B	0.48	3.313	-7.411	8.118	3.198	-5.269	6.164	6.418	2.869	7.031	-7.854	-0.865	7.901
MCC-SH BUS B PRI	0.48	2.988	-6.797	7.425	3.048	-5.186	6.016	5.886	2.589	6.431	-7.323	-0.533	7.343
MS-HW BUS A	0.48	5.928	-33.208	33.733	5.947	-33.388	33.913	28.759	5.134	29.214	25.776	21.919	33.835
MS-HW BUS A PRI	0.48	5.928	-33.208	33.733	5.947	-33.388	33.913	28.759	5.134	29.214	25.776	21.919	33.835
MS-HW BUS B	0.48	5.809	-32.730	33.241	5.869	-33.063	33.580	28.345	5.030	28.788	-31.311	11.671	33.415
MS-HW BUS B PRI	0.48	5.809	-32.730	33.241	5.869	-33.063	33.580	28.345	5.030	28.788	-31.311	11.671	33.415
P52100.00 DISC	0.48	3.647	-1.639	3.998	2.261	-0.758	2.385	1.420	3.158	3.462	-2.233	-2.923	3.678
P52100.00 TERM	0.48	3.597	-1.612	3.942	2.228	-0.745	2.350	1.396	3.115	3.414	-2.198	-2.884	3.626
P52110.00 DISC	0.48	2.660	-0.899	2.808	1.597	-0.383	1.642	0.779	2.304	2.432	-1.346	-2.190	2.571
P52110.00 TERM	0.48	2.621	-0.885	2.766	1.573	-0.377	1.617	0.766	2.270	2.396	-1.325	-2.158	2.532
P52120.00 DISC	0.48	3.859	-1.756	4.240	2.401	-0.815	2.536	1.521	3.342	3.672	-2.386	-3.089	3.903
P52120.00 TERM	0.48	3.804	-1.725	4.177	2.364	-0.800	2.496	1.494	3.294	3.617	-2.346	-3.045	3.844
P52130.00 DISC	0.48	2.829	-0.962	2.989	1.703	-0.412	1.752	0.833	2.450	2.588	-1.439	-2.327	2.736
P52130.00 TERM	0.48	2.785	-0.946	2.941	1.675	-0.405	1.723	0.819	2.412	2.547	-1.415	-2.291	2.693
P52140.00 DISC	0.48	4.515	-2.142	4.998	2.842	-1.002	3.013	1.855	3.910	4.328	-2.884	-3.599	4.611
P52140.00 TERM	0.48	4.440	-2.096	4.910	2.790	-0.980	2.957	1.815	3.845	4.252	-2.824	-3.540	4.529
P52150.00 DISC	0.48	3.364	-1.176	3.564	2.039	-0.510	2.102	1.019	2.914	3.087	-1.747	-2.761	3.267
P52150.00 TERM	0.48	3.302	-1.150	3.497	2.000	-0.498	2.061	0.996	2.860	3.028	-1.710	-2.710	3.205
P52160.00 DISC	0.48	3.501	-1.228	3.710	2.124	-0.534	2.191	1.063	3.032	3.213	-1.822	-2.872	3.401
P52160.00 TERM	0.48	3.433	-1.199	3.637	2.081	-0.521	2.146	1.039	2.973	3.150	-1.781	-2.817	3.333
P52170.00 DISC	0.48	3.716	-1.329	3.946	2.264	-0.579	2.337	1.151	3.218	3.417	-1.960	-3.044	3.620
P52170.00 TERM	0.48	3.640	-1.295	3.863	2.215	-0.564	2.286	1.122	3.152	3.346	-1.913	-2.983	3.544
P52220.00 DISC	0.48	0.690	-0.060	0.693	0.401	-0.025	0.402	0.052	0.598	0.600	-0.193	-0.590	0.621
P52220.00 TERM	0.48	0.680	-0.059	0.683	0.395	-0.025	0.396	0.051	0.589	0.591	-0.190	-0.582	0.612
P52230.00 DISC	0.48	0.690	-0.060	0.693	0.401	-0.025	0.402	0.052	0.598	0.600	-0.193	-0.590	0.621
P52230.00 TERM	0.48	0.680	-0.059	0.683	0.395	-0.025	0.396	0.051	0.589	0.591	-0.190	-0.582	0.612
P52240.00 DISC	0.48	0.869	-0.078	0.872	0.506	-0.033	0.507	0.068	0.752	0.755	-0.246	-0.742	0.782
P52240.00 TERM	0.48	0.853	-0.077	0.856	0.496	-0.032	0.497	0.066	0.739	0.742	-0.241	-0.729	0.768
P52250.00 DISC	0.48	0.869	-0.078	0.872	0.506	-0.033	0.507	0.068	0.752	0.755	-0.246	-0.742	0.782
P52250.00 TERM	0.48	0.853	-0.077	0.856	0.496	-0.032	0.497	0.066	0.739	0.742	-0.241	-0.729	0.768
P54080.00 DISC	0.48	1.425	-0.146	1.432	0.833	-0.062	0.836	0.127	1.234	1.240	-0.421	-1.215	1.286

1/2 Cycle - 3-Phase, LG, LL, & LLG Fault Currents

Prefault Voltage = 100 % of the Bus Nominal Voltage

Bus		3-Phase Fault			Line-to-Ground Fault			Line-to-Line Fault			*Line-to-Line-to-Ground		
ID	kV	Real	Imag.	Mag.	Real	Imag.	Mag.	Real	Imag.	Mag.	Real	Imag.	Mag.
P54080.00 TERM	0.48	1.382	-0.140	1.389	0.808	-0.059	0.810	0.122	1.197	1.203	-0.407	-1.180	1.248
P54090.00 DISC	0.48	1.425	-0.146	1.432	0.833	-0.062	0.836	0.127	1.234	1.240	-0.421	-1.215	1.286
P54090.00 TERM	0.48	1.382	-0.140	1.389	0.808	-0.059	0.810	0.122	1.197	1.203	-0.407	-1.180	1.248
P55020.00 TERM	0.48	3.261	-0.955	3.398	1.929	-0.360	1.963	0.827	2.824	2.942	-1.508	-2.725	3.114
P55030.00 TERM	0.48	3.261	-0.955	3.398	1.929	-0.360	1.963	0.827	2.824	2.942	-1.508	-2.725	3.114
PNL DP2	0.48	7.339	-18.559	19.957	6.634	-12.360	14.028	16.072	6.371	17.289	-18.899	-1.796	18.984
PNL DP4	0.48	7.193	-52.911	53.398	9.727	-53.049	53.933	45.881	6.338	46.317	-51.881	20.123	55.647
PNL DPLC-1	0.21	1.065	-1.649	1.963	1.071	-1.681	1.993	1.428	0.922	1.700	0.889	1.779	1.989
PNL DPLC-2	0.21	1.007	-1.192	1.560	1.010	-1.314	1.658	1.032	0.872	1.351	0.532	1.598	1.685
PNL DPLC-3	0.21	1.100	-1.503	1.862	1.128	-1.431	1.822	1.301	0.953	1.613	-1.876	-0.272	1.896
PNL DPLC-4	0.21	0.612	-0.633	0.881	0.615	-0.623	0.876	0.548	0.530	0.763	-0.858	-0.224	0.886
PNL DPP1	0.48	11.847	-10.862	16.073	9.407	-6.040	11.179	9.407	10.260	13.919	-13.161	-8.301	15.560
PNL DPP1 PRI	0.48	11.847	-10.862	16.073	9.407	-6.040	11.179	9.407	10.260	13.919	-13.161	-8.301	15.560
SCR BLDG N OH DOOR DISC	0.48	1.233	-0.126	1.240	0.723	-0.057	0.725	0.109	1.068	1.074	-0.365	-1.050	1.112
SCR BLDG N OH DOOR TERM	0.48	1.201	-0.121	1.207	0.704	-0.055	0.706	0.105	1.040	1.046	-0.354	-1.023	1.083
SCR BLDG S OH DOOR DISC	0.48	1.340	-0.143	1.348	0.786	-0.064	0.789	0.124	1.161	1.167	-0.402	-1.141	1.210
SCR BLDG S OH DOOR TERM	0.48	1.303	-0.137	1.310	0.764	-0.061	0.766	0.119	1.128	1.134	-0.389	-1.109	1.175
SEP53000.00 DISC	0.48	0.740	-0.057	0.742	0.432	-0.026	0.433	0.050	0.641	0.643	-0.202	-0.633	0.664
SEP53000.00 TERM	0.48	0.728	-0.056	0.731	0.425	-0.025	0.426	0.049	0.631	0.633	-0.199	-0.623	0.654
SEP53010.00 DISC	0.48	0.740	-0.058	0.742	0.432	-0.026	0.432	0.050	0.641	0.643	-0.202	-0.633	0.664
SEP53010.00 TERM	0.48	0.728	-0.057	0.731	0.425	-0.025	0.426	0.049	0.631	0.633	-0.199	-0.623	0.654
SEP53020.00 DISC	0.48	0.717	-0.056	0.719	0.418	-0.025	0.419	0.048	0.621	0.623	-0.196	-0.613	0.644
SEP53020.00 TERM	0.48	0.706	-0.054	0.708	0.412	-0.025	0.413	0.047	0.612	0.613	-0.193	-0.604	0.634
SR-DAF	0.48	3.311	-9.373	9.941	3.644	-7.788	8.598	8.117	2.867	8.609	-9.960	0.414	9.969
SR-DAF PRI	0.48	3.311	-9.373	9.941	3.644	-7.788	8.598	8.117	2.867	8.609	-9.960	0.414	9.969
SWBD GDP	0.48	2.222	-24.283	24.385	3.417	-26.913	27.129	21.177	2.134	21.284	-23.347	12.794	26.623
SWBD-NB BUS A	0.48	2.706	-15.164	15.403	3.108	-16.255	16.550	13.132	2.343	13.340	-14.937	6.411	16.254
SWBD-NB BUS A PRI	0.48	2.706	-15.164	15.403	3.108	-16.255	16.550	13.132	2.343	13.340	-14.937	6.411	16.254
SWBD-NB BUS B	0.48	2.433	-14.036	14.246	2.876	-15.376	15.643	12.158	2.112	12.340	-13.881	6.383	15.278
SWBD-NB BUS B PRI	0.48	2.433	-14.036	14.246	2.876	-15.376	15.643	12.158	2.112	12.340	-13.881	6.383	15.278
TRANSF TA PRI	0.48	4.399	-49.755	49.949	4.776	-53.100	53.315	43.089	3.810	43.257	-45.699	24.654	51.925
TRANSF TB PRI	0.48	4.920	-57.705	57.915	5.767	-61.084	61.356	50.056	4.382	50.248	-53.253	27.990	60.161
TRANSF TB SEC	2.40	0.678	-5.653	5.694	0.796	-6.326	6.376	4.899	0.592	4.934	-5.369	2.996	6.148
TRANSF TC PRI	2.40	0.759	-4.928	4.986	1.246	-4.296	4.473	4.267	0.658	4.318	-5.022	1.198	5.163

1/2 Cycle - 3-Phase, LG, LL, & LLG Fault Currents

Prefault Voltage = 100 % of the Bus Nominal Voltage

Bus		3-Phase Fault			Line-to-Ground Fault			Line-to-Line Fault			*Line-to-Line-to-Ground		
ID	kV	Real	Imag.	Mag.	Real	Imag.	Mag.	Real	Imag.	Mag.	Real	Imag.	Mag.
TRANSF TC SEC	0.48	2.664	-15.330	15.560	2.928	-16.874	17.126	13.277	2.307	13.476	11.652	11.689	16.505
TRANSF TD PRI	2.40	0.774	-4.996	5.056	1.265	-4.330	4.511	4.329	0.674	4.381	-5.086	1.189	5.223
TRANSF TD SEC	0.48	2.388	-14.243	14.441	2.703	-15.980	16.207	12.336	2.072	12.509	-13.885	7.027	15.562
XFMR T-C4 PRI	0.48	7.724	-3.169	8.349	4.949	-1.415	5.148	2.744	6.690	7.231	-4.549	-6.268	7.745
XFMR T-C4 SEC	0.21	0.614	-0.666	0.906	0.619	-0.680	0.919	0.577	0.532	0.785	0.265	0.879	0.918
XFMR T-LC1 PRI	0.48	10.244	-6.231	11.990	7.148	-3.025	7.762	5.396	8.872	10.384	-8.089	-7.946	11.339
XFMR T-LC1 SEC	0.21	1.066	-1.671	1.982	1.071	-1.719	2.025	1.447	0.923	1.717	0.909	1.808	2.024
XFMR T-LC2 PRI	0.48	2.876	-0.691	2.958	1.724	-0.317	1.753	0.598	2.490	2.561	-1.213	-2.392	2.682
XFMR T-LC2 SEC	0.21	1.008	-1.197	1.565	1.010	-1.324	1.665	1.037	0.873	1.355	0.538	1.607	1.694

All fault currents are symmetrical momentary (1/2 Cycle network) values in rms kA

* LLG fault current is the larger of the two faulted line currents

Short-Circuit Summary Report

Bus		Positive Sequence Imp. (ohm)			Negative Sequence Imp. (ohm)			Zero Sequence Imp. (ohm)		
ID	kV	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance
ATS-L BUS A	0.480	0.00270	0.00871	0.00912	0.00270	0.00871	0.00912	0.00544	0.00961	0.01104
ATS-L BUS B	0.480	0.00489	0.00927	0.01048	0.00489	0.00927	0.01048	0.01228	0.01064	0.01625
ATS-L SEC	0.480	0.00270	0.00871	0.00912	0.00270	0.00871	0.00912	0.00544	0.00961	0.01104
B20100.00 TERMINALS	2.400	0.05306	0.28506	0.28996	0.05306	0.28506	0.28996	0.21464	0.39405	0.44871
B20200.00 TERMINALS	2.400	0.05651	0.28790	0.29340	0.05651	0.28790	0.29340	0.21673	0.39668	0.45202
B20400.00 TERMINALS	2.400	0.05437	0.28286	0.28804	0.05475	0.28252	0.28777	0.22195	0.40325	0.46030
B52180.00 DISC	0.480	0.04347	0.02150	0.04850	0.04347	0.02150	0.04850	0.13796	0.03931	0.14346
B52180.00 TERM	0.480	0.04495	0.02186	0.04999	0.04495	0.02186	0.04999	0.14285	0.04005	0.14835
B52190.00 DISC	0.480	0.06175	0.02246	0.06570	0.06175	0.02246	0.06570	0.19782	0.03869	0.20156
B52190.00 TERM	0.480	0.06321	0.02286	0.06722	0.06321	0.02286	0.06722	0.20270	0.03942	0.20650
B52210.00 DISC	0.480	0.17180	0.03146	0.17466	0.17180	0.03146	0.17466	0.55534	0.04514	0.55717
B52210.00 TERM	0.480	0.17548	0.03216	0.17840	0.17548	0.03216	0.17840	0.56763	0.04594	0.56948
B52220.00 DISC	0.480	0.18279	0.03341	0.18582	0.18279	0.03341	0.18582	0.59219	0.04754	0.59410
B52220.00 TERM	0.480	0.18645	0.03413	0.18955	0.18645	0.03413	0.18955	0.60448	0.04834	0.60641
BLWR BLDG TROLLEY	0.480	0.06057	0.01621	0.06270	0.06057	0.01621	0.06270	0.18773	0.02806	0.18982
BSN51240.00 DISC	0.480	0.36129	0.02769	0.36235	0.36129	0.02769	0.36235	1.13651	0.05566	1.13788
BSN51240.00 TERM	0.480	0.36728	0.02802	0.36835	0.36728	0.02802	0.36835	1.15541	0.05643	1.15679
BSN51250.00 DISC	0.480	0.36132	0.02783	0.36239	0.36132	0.02783	0.36239	1.13652	0.05566	1.13788
BSN51250.00 TERM	0.480	0.36730	0.02815	0.36838	0.36730	0.02815	0.36838	1.15542	0.05643	1.15679
BSN51260.00 DISC	0.480	0.36129	0.02769	0.36235	0.36129	0.02769	0.36235	1.13651	0.05566	1.13788
BSN51260.00 TERM	0.480	0.36728	0.02802	0.36835	0.36728	0.02802	0.36835	1.15541	0.05643	1.15679
BSN51270.00 DISC	0.480	0.36132	0.02783	0.36239	0.36132	0.02783	0.36239	1.13652	0.05566	1.13788
BSN51270.00 TERM	0.480	0.36730	0.02815	0.36838	0.36730	0.02815	0.36838	1.15542	0.05643	1.15679
COGEN TIE BUS	0.480	0.00041	0.00477	0.00479	0.00043	0.00475	0.00477	0.00044	0.00397	0.00400
COM53030.00 DISC	0.480	0.34731	0.02849	0.34848	0.34731	0.02849	0.34848	1.09871	0.05411	1.10004
COM53030.00 TERM	0.480	0.35323	0.02887	0.35441	0.35323	0.02887	0.35441	1.11761	0.05488	1.11896
COM53040.00 DISC	0.480	0.31773	0.02677	0.31885	0.31773	0.02677	0.31885	1.00422	0.05023	1.00547
COM53040.00 TERM	0.480	0.32365	0.02714	0.32479	0.32365	0.02714	0.32479	1.02312	0.05101	1.02439
CON51300.00 DISC	0.480	0.34582	0.03062	0.34717	0.34582	0.03062	0.34717	1.09871	0.05411	1.10004
CON51300.00 TERM	0.480	0.35168	0.03107	0.35305	0.35168	0.03107	0.35305	1.11761	0.05488	1.11896
CON51320.00 DISC	0.480	0.34582	0.03062	0.34717	0.34582	0.03062	0.34717	1.09871	0.05411	1.10004
CON51320.00 TERM	0.480	0.35168	0.03107	0.35305	0.35168	0.03107	0.35305	1.11761	0.05488	1.11896
CON53020.00 DISC	0.480	0.36929	0.03256	0.37072	0.36929	0.03256	0.37072	1.17432	0.05721	1.17571
CON53020.00 TERM	0.480	0.37515	0.03302	0.37660	0.37515	0.03302	0.37660	1.19322	0.05798	1.19462
CON53030.00 DISC	0.480	0.36929	0.03256	0.37072	0.36929	0.03256	0.37072	1.17432	0.05721	1.17571

Bus		Positive Sequence Imp. (ohm)			Negative Sequence Imp. (ohm)			Zero Sequence Imp. (ohm)		
ID	kV	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance
CON53030.00 TERM	0.480	0.37515	0.03302	0.37660	0.37515	0.03302	0.37660	1.19322	0.05798	1.19462
EFF PS SWGR BUS A	0.480	0.00291	0.01368	0.01399	0.00262	0.01401	0.01425	0.00197	0.01306	0.01321
EFF PS SWGR BUS A PRI	0.480	0.00291	0.01368	0.01399	0.00262	0.01401	0.01425	0.00197	0.01306	0.01321
EFF PS SWGR BUS B	0.480	0.00290	0.01369	0.01399	0.00260	0.01401	0.01425	0.00196	0.01306	0.01321
EFF PS SWGR BUS B PRI	0.480	0.00290	0.01369	0.01399	0.00260	0.01401	0.01425	0.00196	0.01306	0.01321
EFF PUMP NO. 2 VFD PRI	0.480	0.00336	0.01415	0.01454	0.00306	0.01452	0.01484	0.00359	0.01470	0.01513
EFF PUMP NO. 4 VFD PRI	0.480	0.00338	0.01414	0.01454	0.00308	0.01451	0.01483	0.00361	0.01470	0.01513
F52410.00 DISC	0.480	0.44088	0.02721	0.44171	0.44088	0.02721	0.44171	1.39166	0.05284	1.39267
F52410.00 STR	0.480	0.41111	0.02606	0.41194	0.41111	0.02606	0.41194	1.29716	0.05033	1.29814
F52420.00 DISC	0.480	0.54987	0.03150	0.55077	0.54987	0.03150	0.55077	1.73816	0.06204	1.73927
F52420.00 STR	0.480	0.52016	0.03032	0.52105	0.52016	0.03032	0.52105	1.64366	0.05953	1.64474
F54330.00 DISC	0.480	0.10911	0.01501	0.11014	0.10911	0.01501	0.11014	0.34272	0.02311	0.34349
F54330.00 TERM	0.480	0.11504	0.01541	0.11607	0.11504	0.01541	0.11607	0.36162	0.02389	0.36240
F55010.00 TERM	0.480	0.06265	0.02280	0.06667	0.06265	0.02280	0.06667	0.21073	0.03174	0.21311
GEN NO. 2 TERM	0.480	0.00156	0.01224	0.01234	0.00176	0.01201	0.01214	0.00241	0.00927	0.00958
GEN NO. 3 TERM	0.480	0.00147	0.01208	0.01217	0.00166	0.01186	0.01197	0.00228	0.00905	0.00933
GRIT SCR TROLLEY	0.480	0.37377	0.02806	0.37482	0.37377	0.02806	0.37482	1.17431	0.05721	1.17571
HVAC56100.00 DISC	0.480	0.04372	0.01439	0.04603	0.04372	0.01439	0.04603	0.13544	0.02327	0.13743
HVAC56100.00 TERM	0.480	0.04759	0.01474	0.04982	0.04759	0.01474	0.04982	0.14773	0.02407	0.14968
HVAC56110.00 DISC	0.480	0.10815	0.01717	0.10951	0.10815	0.01717	0.10951	0.33956	0.02928	0.34082
HVAC56110.00 TERM	0.480	0.11409	0.01755	0.11544	0.11409	0.01755	0.11544	0.35846	0.03005	0.35972
HW ELEVATOR	0.480	0.02967	0.01393	0.03278	0.02967	0.01393	0.03278	0.09040	0.02245	0.09314
HW GATES	0.480	0.66271	0.03375	0.66357	0.66271	0.03375	0.66357	2.08466	0.07124	2.08588
INFL PUMP 1 TERMINALS	0.480	0.00307	0.01102	0.01144	0.00307	0.01102	0.01144	0.00803	0.01652	0.01837
INFL PUMP 1 VFD PRI	0.480	0.00174	0.00860	0.00878	0.00174	0.00860	0.00878	0.00255	0.00944	0.00978
INFL PUMP 2 TERMINALS	0.480	0.00484	0.01168	0.01264	0.00484	0.01168	0.01264	0.01515	0.01785	0.02341
INFL PUMP 2 VFD	0.480	0.00193	0.00903	0.00923	0.00193	0.00903	0.00923	0.00324	0.01032	0.01082
INFL PUMP 2 VFD PRI	0.480	0.00193	0.00903	0.00923	0.00193	0.00903	0.00923	0.00324	0.01032	0.01082
INFL PUMP 3 TERMINALS	0.480	0.00469	0.01127	0.01220	0.00469	0.01127	0.01220	0.01446	0.01696	0.02229
INFL PUMP 3 VFD	0.480	0.00174	0.00860	0.00878	0.00174	0.00860	0.00878	0.00255	0.00944	0.00978
INFL PUMP 3 VFD PRI	0.480	0.00174	0.00860	0.00878	0.00174	0.00860	0.00878	0.00255	0.00944	0.00978
INFL PUMP 4 TERMINALS	0.480	0.00479	0.01158	0.01253	0.00479	0.01158	0.01253	0.01492	0.01755	0.02304
INFL PUMP 4 VFD	0.480	0.00187	0.00893	0.00912	0.00187	0.00893	0.00912	0.00301	0.01003	0.01047
INFL PUMP 4 VFD PRI	0.480	0.00187	0.00893	0.00912	0.00187	0.00893	0.00912	0.00301	0.01003	0.01047
INFL PUMP 5 TERMINALS	0.480	0.00469	0.01127	0.01220	0.00469	0.01127	0.01220	0.01446	0.01696	0.02229
INFL PUMP 5 VFD	0.480	0.00174	0.00860	0.00878	0.00174	0.00860	0.00878	0.00255	0.00944	0.00978
INFL PUMP 5 VFD PRI	0.480	0.00174	0.00860	0.00878	0.00174	0.00860	0.00878	0.00255	0.00944	0.00978

Bus		Positive Sequence Imp. (ohm)			Negative Sequence Imp. (ohm)			Zero Sequence Imp. (ohm)		
ID	kV	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance
INFL PUMP 6 TERMINALS	0.480	0.00329	0.01152	0.01198	0.00329	0.01152	0.01198	0.00895	0.01770	0.01984
INFL PUMP 6 VFD PRI	0.480	0.00199	0.00913	0.00934	0.00199	0.00913	0.00934	0.00347	0.01062	0.01117
LCP-HWOCS	0.480	0.06056	0.02167	0.06432	0.06056	0.02167	0.06432	0.20317	0.02963	0.20532
MAIN SWGR "FILTER"	0.480	0.00049	0.00553	0.00555	0.00049	0.00553	0.00555	0.00042	0.00448	0.00450
MAIN SWGR "SLUDGE"	0.480	0.00041	0.00477	0.00479	0.00043	0.00475	0.00477	0.00044	0.00397	0.00400
MAIN SWGR BUS A PRI	0.480	0.00049	0.00553	0.00555	0.00049	0.00553	0.00555	0.00042	0.00448	0.00450
MAIN SWGR BUS B PRI	0.480	0.00041	0.00477	0.00479	0.00043	0.00475	0.00477	0.00044	0.00397	0.00400
MCC-DP2C	0.480	0.00657	0.01571	0.01702	0.00659	0.01569	0.01702	0.02419	0.03467	0.04228
MCC-DP4A	0.480	0.15862	0.02632	0.16079	0.15864	0.02630	0.16081	0.50300	0.05606	0.50611
MCC-DP4B	0.480	0.00097	0.00562	0.00571	0.00099	0.00560	0.00569	0.00221	0.00608	0.00647
MCC-GE	0.480	0.00204	0.01800	0.01812	0.00205	0.01799	0.01810	0.00518	0.02295	0.02353
MCC-GE PRI	0.480	0.00155	0.00626	0.00645	0.00157	0.00624	0.00643	0.00443	0.00797	0.00912
MCC-HW BUS A	0.480	0.00177	0.00853	0.00871	0.00177	0.00853	0.00871	0.00251	0.00917	0.00950
MCC-HW BUS A PRI	0.480	0.00177	0.00853	0.00871	0.00177	0.00853	0.00871	0.00251	0.00917	0.00950
MCC-HW BUS B	0.480	0.00179	0.00867	0.00885	0.00179	0.00867	0.00885	0.00252	0.00917	0.00950
MCC-HW BUS B PRI	0.480	0.00179	0.00867	0.00885	0.00179	0.00867	0.00885	0.00252	0.00917	0.00950
MCC-NA BUS A	2.400	0.04118	0.27314	0.27623	0.04118	0.27314	0.27623	0.16660	0.33356	0.37285
MCC-NA BUS A PRI	2.400	0.04118	0.27314	0.27623	0.04118	0.27314	0.27623	0.16660	0.33356	0.37285
MCC-NA BUS B	2.400	0.04065	0.26910	0.27215	0.04103	0.26874	0.27186	0.16660	0.33356	0.37285
MCC-NA BUS B PRI	2.400	0.04065	0.26910	0.27215	0.04103	0.26874	0.27186	0.16660	0.33356	0.37285
MCC-NC	0.480	0.00323	0.01783	0.01812	0.00323	0.01783	0.01812	0.00357	0.01451	0.01494
MCC-ND	0.480	0.00343	0.01932	0.01962	0.00344	0.01931	0.01961	0.00366	0.01452	0.01498
MCC-NE	0.480	0.00412	0.01893	0.01937	0.00412	0.01893	0.01937	0.00618	0.01699	0.01808
MCC-NF	0.480	0.00428	0.02039	0.02083	0.00429	0.02038	0.02082	0.00618	0.01699	0.01808
MCC-NG BUS A	0.480	0.01353	0.03101	0.03383	0.01353	0.03101	0.03383	0.03690	0.04774	0.06034
MCC-NG BUS A PRI	0.480	0.01353	0.03101	0.03383	0.01353	0.03101	0.03383	0.03690	0.04774	0.06034
MCC-NG BUS B	0.480	0.01252	0.03125	0.03366	0.01253	0.03124	0.03366	0.03690	0.04774	0.06034
MCC-NG BUS B PRI	0.480	0.01252	0.03125	0.03366	0.01253	0.03124	0.03366	0.03690	0.04774	0.06034
MCC-SH BUS A	0.480	0.01375	0.03094	0.03386	0.01375	0.03094	0.03386	0.04150	0.05236	0.06681
MCC-SH BUS A PRI	0.480	0.01375	0.03094	0.03386	0.01375	0.03094	0.03386	0.04150	0.05236	0.06681
MCC-SH BUS B	0.480	0.01393	0.03116	0.03414	0.01393	0.03116	0.03414	0.04212	0.05297	0.06767
MCC-SH BUS B PRI	0.480	0.01502	0.03417	0.03732	0.01503	0.03416	0.03732	0.03997	0.05082	0.06465
MS-HW BUS A	0.480	0.00144	0.00809	0.00822	0.00144	0.00809	0.00822	0.00141	0.00796	0.00808
MS-HW BUS A PRI	0.480	0.00144	0.00809	0.00822	0.00144	0.00809	0.00822	0.00141	0.00796	0.00808
MS-HW BUS B	0.480	0.00146	0.00821	0.00834	0.00146	0.00821	0.00834	0.00141	0.00796	0.00808
MS-HW BUS B PRI	0.480	0.00146	0.00821	0.00834	0.00146	0.00821	0.00834	0.00141	0.00796	0.00808
P52100.00 DISC	0.480	0.06322	0.02842	0.06932	0.06322	0.02842	0.06932	0.20411	0.05404	0.21115

Bus		Positive Sequence Imp. (ohm)			Negative Sequence Imp. (ohm)			Zero Sequence Imp. (ohm)		
ID	kV	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance
P52100.00 TERM	0.480	0.06415	0.02876	0.07030	0.06415	0.02876	0.07030	0.20726	0.05474	0.21437
P52110.00 DISC	0.480	0.09350	0.03159	0.09869	0.09350	0.03159	0.09869	0.30523	0.05492	0.31013
P52110.00 TERM	0.480	0.09492	0.03204	0.10018	0.09492	0.03204	0.10018	0.31011	0.05566	0.31507
P52120.00 DISC	0.480	0.05949	0.02707	0.06536	0.05949	0.02707	0.06536	0.19151	0.05123	0.19825
P52120.00 TERM	0.480	0.06043	0.02741	0.06635	0.06043	0.02741	0.06635	0.19466	0.05193	0.20147
P52130.00 DISC	0.480	0.08779	0.02986	0.09273	0.08779	0.02986	0.09273	0.28570	0.05197	0.29039
P52130.00 TERM	0.480	0.08922	0.03029	0.09422	0.08922	0.03029	0.09422	0.29058	0.05271	0.29533
P52140.00 DISC	0.480	0.05010	0.02377	0.05545	0.05010	0.02377	0.05545	0.16001	0.04422	0.16601
P52140.00 TERM	0.480	0.05104	0.02409	0.05645	0.05104	0.02409	0.05645	0.16316	0.04492	0.16923
P52150.00 DISC	0.480	0.07339	0.02566	0.07775	0.07339	0.02566	0.07775	0.23688	0.04459	0.24104
P52150.00 TERM	0.480	0.07484	0.02608	0.07926	0.07484	0.02608	0.07926	0.24176	0.04533	0.24597
P52160.00 DISC	0.480	0.07048	0.02472	0.07469	0.07048	0.02472	0.07469	0.22711	0.04311	0.23116
P52160.00 TERM	0.480	0.07194	0.02513	0.07620	0.07194	0.02513	0.07620	0.23199	0.04385	0.23610
P52170.00 DISC	0.480	0.06613	0.02365	0.07023	0.06613	0.02365	0.07023	0.21246	0.04090	0.21636
P52170.00 TERM	0.480	0.06759	0.02405	0.07174	0.06759	0.02405	0.07174	0.21735	0.04164	0.22130
P52220.00 DISC	0.480	0.39854	0.03473	0.40005	0.39854	0.03473	0.40005	1.26881	0.06108	1.27028
P52220.00 TERM	0.480	0.40439	0.03520	0.40592	0.40439	0.03520	0.40592	1.28771	0.06186	1.28920
P52230.00 DISC	0.480	0.39854	0.03473	0.40005	0.39854	0.03473	0.40005	1.26881	0.06108	1.27028
P52230.00 TERM	0.480	0.40439	0.03520	0.40592	0.40439	0.03520	0.40592	1.28771	0.06186	1.28920
P52240.00 DISC	0.480	0.31647	0.02854	0.31775	0.31647	0.02854	0.31775	1.00422	0.05023	1.00547
P52240.00 TERM	0.480	0.32235	0.02898	0.32365	0.32235	0.02898	0.32365	1.02312	0.05101	1.02439
P52250.00 DISC	0.480	0.31647	0.02854	0.31775	0.31647	0.02854	0.31775	1.00422	0.05023	1.00547
P52250.00 TERM	0.480	0.32235	0.02898	0.32365	0.32235	0.02898	0.32365	1.02312	0.05101	1.02439
P54080.00 DISC	0.480	0.19251	0.01975	0.19352	0.19251	0.01975	0.19352	0.60731	0.03396	0.60826
P54080.00 TERM	0.480	0.19843	0.02014	0.19945	0.19843	0.02014	0.19945	0.62621	0.03474	0.62718
P54090.00 DISC	0.480	0.19251	0.01975	0.19352	0.19251	0.01975	0.19352	0.60731	0.03396	0.60826
P54090.00 TERM	0.480	0.19843	0.02014	0.19945	0.19843	0.02014	0.19945	0.62621	0.03474	0.62718
P55020.00 TERM	0.480	0.07828	0.02292	0.08156	0.07828	0.02292	0.08156	0.25987	0.03196	0.26183
P55030.00 TERM	0.480	0.07828	0.02292	0.08156	0.07828	0.02292	0.08156	0.25987	0.03196	0.26183
PNL DP2	0.480	0.00511	0.01291	0.01389	0.00513	0.01290	0.01388	0.01780	0.02641	0.03185
PNL DP4	0.480	0.00070	0.00514	0.00519	0.00072	0.00512	0.00517	0.00136	0.00490	0.00508
PNL DPLC-1	0.208	0.03319	0.05140	0.06118	0.03319	0.05140	0.06118	0.03078	0.04961	0.05839
PNL DPLC-2	0.208	0.04967	0.05878	0.07696	0.04967	0.05878	0.07696	0.03310	0.05475	0.06398
PNL DPLC-3	0.208	0.03809	0.05204	0.06449	0.03809	0.05204	0.06449	0.04621	0.05119	0.06896
PNL DPLC-4	0.208	0.09477	0.09804	0.13636	0.09477	0.09804	0.13636	0.09954	0.09661	0.13871
PNL DPP1	0.480	0.01271	0.01165	0.01724	0.01271	0.01165	0.01724	0.03716	0.01688	0.04082
PNL DPP1 PRI	0.480	0.01271	0.01165	0.01724	0.01271	0.01165	0.01724	0.03716	0.01688	0.04082

Bus		Positive Sequence Imp. (ohm)			Negative Sequence Imp. (ohm)			Zero Sequence Imp. (ohm)		
ID	kV	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance
SCR BLDG N OH DOOR DISC	0.480	0.22240	0.02278	0.22356	0.22240	0.02278	0.22356	0.69866	0.04400	0.70005
SCR BLDG N OH DOOR TERM	0.480	0.22838	0.02310	0.22955	0.22838	0.02310	0.22955	0.71756	0.04477	0.71896
SCR BLDG S OH DOOR DISC	0.480	0.20445	0.02181	0.20561	0.20445	0.02181	0.20561	0.64196	0.04167	0.64332
SCR BLDG S OH DOOR TERM	0.480	0.21043	0.02213	0.21159	0.21043	0.02213	0.21159	0.66086	0.04245	0.66223
SEP53000.00 DISC	0.480	0.37224	0.02891	0.37336	0.37224	0.02891	0.37336	1.17431	0.05721	1.17571
SEP53000.00 TERM	0.480	0.37819	0.02926	0.37932	0.37819	0.02926	0.37932	1.19321	0.05798	1.19462
SEP53010.00 DISC	0.480	0.37226	0.02905	0.37339	0.37226	0.02905	0.37339	1.17432	0.05721	1.17571
SEP53010.00 TERM	0.480	0.37821	0.02939	0.37935	0.37821	0.02939	0.37935	1.19322	0.05798	1.19462
SEP53020.00 DISC	0.480	0.38416	0.02973	0.38531	0.38416	0.02973	0.38531	1.21212	0.05876	1.21354
SEP53020.00 TERM	0.480	0.39011	0.03008	0.39127	0.39011	0.03008	0.39127	1.23102	0.05953	1.23246
SR-DAF	0.480	0.00929	0.02629	0.02788	0.00929	0.02629	0.02788	0.02241	0.03501	0.04157
SR-DAF PRI	0.480	0.00929	0.02629	0.02788	0.00929	0.02629	0.02788	0.02241	0.03501	0.04157
SWBD GDP	0.480	0.00104	0.01132	0.01136	0.00122	0.01112	0.01119	0.00160	0.00796	0.00812
SWBD-NB BUS A	0.480	0.00316	0.01771	0.01799	0.00316	0.01771	0.01799	0.00311	0.01392	0.01426
SWBD-NB BUS A PRI	0.480	0.00316	0.01771	0.01799	0.00316	0.01771	0.01799	0.00311	0.01392	0.01426
SWBD-NB BUS B	0.480	0.00332	0.01917	0.01945	0.00333	0.01916	0.01945	0.00311	0.01392	0.01426
SWBD-NB BUS B PRI	0.480	0.00332	0.01917	0.01945	0.00333	0.01916	0.01945	0.00311	0.01392	0.01426
TRANSF TA PRI	0.480	0.00049	0.00553	0.00555	0.00049	0.00553	0.00555	0.00042	0.00448	0.00450
TRANSF TB PRI	0.480	0.00041	0.00477	0.00479	0.00043	0.00475	0.00477	0.00044	0.00397	0.00400
TRANSF TB SEC	2.400	0.02896	0.24164	0.24337	0.02936	0.24125	0.24303	0.02310	0.16398	0.16560
TRANSF TC PRI	2.400	0.04233	0.27468	0.27792	0.04233	0.27468	0.27792	0.17413	0.34322	0.38486
TRANSF TC SEC	0.480	0.00305	0.01755	0.01781	0.00305	0.01755	0.01781	0.00220	0.01274	0.01293
TRANSF TD PRI	2.400	0.04193	0.27084	0.27406	0.04231	0.27048	0.27377	0.17413	0.34322	0.38486
TRANSF TD SEC	0.480	0.00317	0.01893	0.01919	0.00318	0.01892	0.01918	0.00220	0.01274	0.01293
XFMR T-C4 PRI	0.480	0.03071	0.01260	0.03319	0.03071	0.01260	0.03319	0.09386	0.01920	0.09581
XFMR T-C4 SEC	0.208	0.08987	0.09740	0.13253	0.08987	0.09740	0.13253	0.08410	0.09504	0.12691
XFMR T-LC1 PRI	0.480	0.01975	0.01201	0.02311	0.01975	0.01201	0.02311	0.05915	0.01773	0.06175
XFMR T-LC1 SEC	0.208	0.03259	0.05107	0.06059	0.03259	0.05107	0.06059	0.02889	0.04882	0.05672
XFMR T-LC2 PRI	0.480	0.09111	0.02189	0.09370	0.09111	0.02189	0.09370	0.28412	0.04207	0.28722
XFMR T-LC2 SEC	0.208	0.04942	0.05872	0.07675	0.04942	0.05872	0.07675	0.03231	0.05461	0.06345

APPENDIX B4 – SHORT CIRCUIT STUDY (1/2-4 CYCLE SHORT-CIRCUIT SUMMARY REPORT)

Short-Circuit Summary Report

1.5-4 Cycle - 3-Phase, LG, LL, & LLG Fault Currents

Prefault Voltage = 100 % of the Bus Nominal Voltage

Bus		3-Phase Fault			Line-to-Ground Fault			Line-to-Line Fault			*Line-to-Line-to-Ground		
ID	kV	Real	Imag.	Mag.	Real	Imag.	Mag.	Real	Imag.	Mag.	Real	Imag.	Mag.
ATS-L BUS A	0.48	7.253	-24.550	25.599	9.774	-24.809	26.665	22.591	6.969	23.642	-27.309	4.297	27.645
ATS-L BUS B	0.48	10.014	-20.680	22.977	12.754	-17.488	21.645	18.716	9.500	20.989	-24.675	-2.505	24.802
ATS-L SEC	0.48	7.253	-24.550	25.599	9.774	-24.809	26.665	22.591	6.969	23.642	-27.309	4.297	27.645
B20100.00 TERMINALS	2.40	0.675	-3.924	3.982	1.179	-3.642	3.828	3.627	0.681	3.691	-4.195	0.830	4.276
B20200.00 TERMINALS	2.40	0.690	-3.898	3.959	1.185	-3.605	3.795	3.591	0.699	3.658	-4.160	0.806	4.237
B20400.00 TERMINALS	2.40	0.740	-4.034	4.102	1.229	-3.644	3.846	3.718	0.738	3.791	-4.297	0.752	4.362
B52180.00 DISC	0.48	4.922	-2.449	5.497	3.220	-1.170	3.426	2.087	4.319	4.796	-3.260	-3.931	5.107
B52180.00 TERM	0.48	4.796	-2.338	5.336	3.125	-1.114	3.317	1.992	4.207	4.654	-3.129	-3.838	4.951
B52190.00 DISC	0.48	3.856	-1.338	4.081	2.399	-0.603	2.474	1.134	3.365	3.550	-1.997	-3.168	3.745
B52190.00 TERM	0.48	3.773	-1.296	3.989	2.344	-0.584	2.416	1.098	3.292	3.470	-1.941	-3.102	3.659
B52210.00 DISC	0.48	1.530	-0.214	1.545	0.904	-0.093	0.908	0.181	1.327	1.340	-0.501	-1.297	1.391
B52210.00 TERM	0.48	1.498	-0.208	1.512	0.884	-0.090	0.889	0.176	1.299	1.311	-0.489	-1.270	1.361
B52220.00 DISC	0.48	1.437	-0.196	1.450	0.848	-0.085	0.852	0.166	1.247	1.257	-0.466	-1.219	1.305
B52220.00 TERM	0.48	1.408	-0.191	1.421	0.831	-0.083	0.835	0.161	1.222	1.232	-0.455	-1.195	1.279
BLWR BLDG TROLLEY	0.48	4.187	-1.229	4.364	2.581	-0.521	2.633	1.032	3.652	3.795	-1.958	-3.484	3.997
BSN51240.00 DISC	0.48	0.760	-0.061	0.763	0.445	-0.027	0.446	0.052	0.659	0.661	-0.209	-0.650	0.683
BSN51240.00 TERM	0.48	0.748	-0.060	0.750	0.438	-0.026	0.439	0.051	0.648	0.650	-0.205	-0.640	0.672
BSN51250.00 DISC	0.48	0.760	-0.061	0.763	0.445	-0.027	0.446	0.052	0.659	0.661	-0.209	-0.650	0.683
BSN51250.00 TERM	0.48	0.748	-0.060	0.750	0.438	-0.026	0.439	0.051	0.648	0.650	-0.206	-0.640	0.672
BSN51260.00 DISC	0.48	0.760	-0.061	0.763	0.445	-0.027	0.446	0.052	0.659	0.661	-0.209	-0.650	0.683
BSN51260.00 TERM	0.48	0.748	-0.060	0.750	0.438	-0.026	0.439	0.051	0.648	0.650	-0.205	-0.640	0.672
BSN51270.00 DISC	0.48	0.760	-0.061	0.763	0.445	-0.027	0.446	0.052	0.659	0.661	-0.209	-0.650	0.683
BSN51270.00 TERM	0.48	0.748	-0.060	0.750	0.438	-0.026	0.439	0.051	0.648	0.650	-0.206	-0.640	0.672
COGEN TIE BUS	0.48	3.546	-50.637	50.761	5.334	-57.668	57.914	46.172	3.945	46.340	-47.778	26.189	54.485
COM53030.00 DISC	0.48	0.786	-0.064	0.789	0.460	-0.028	0.461	0.054	0.681	0.683	-0.217	-0.672	0.706
COM53030.00 TERM	0.48	0.773	-0.063	0.776	0.453	-0.027	0.454	0.053	0.670	0.672	-0.213	-0.661	0.694
COM53040.00 DISC	0.48	0.860	-0.072	0.863	0.504	-0.031	0.505	0.061	0.745	0.747	-0.239	-0.735	0.773
COM53040.00 TERM	0.48	0.844	-0.071	0.847	0.494	-0.031	0.495	0.060	0.731	0.734	-0.234	-0.721	0.758
CON51300.00 DISC	0.48	0.786	-0.064	0.789	0.460	-0.028	0.461	0.054	0.681	0.683	-0.217	-0.672	0.706
CON51300.00 TERM	0.48	0.773	-0.063	0.776	0.453	-0.027	0.454	0.053	0.670	0.672	-0.213	-0.661	0.694
CON51320.00 DISC	0.48	0.786	-0.064	0.789	0.460	-0.028	0.461	0.054	0.681	0.683	-0.217	-0.672	0.706

1.5-4 Cycle - 3-Phase, LG, LL, & LLG Fault Currents

Prefault Voltage = 100 % of the Bus Nominal Voltage

Bus		3-Phase Fault			Line-to-Ground Fault			Line-to-Line Fault			*Line-to-Line-to-Ground		
ID	kV	Real	Imag.	Mag.	Real	Imag.	Mag.	Real	Imag.	Mag.	Real	Imag.	Mag.
CON51320.00 TERM	0.48	0.773	-0.063	0.776	0.453	-0.027	0.454	0.053	0.670	0.672	-0.213	-0.661	0.694
CON53020.00 DISC	0.48	0.736	-0.059	0.738	0.431	-0.026	0.432	0.050	0.638	0.640	-0.202	-0.629	0.661
CON53020.00 TERM	0.48	0.724	-0.057	0.727	0.424	-0.025	0.425	0.049	0.628	0.630	-0.199	-0.620	0.651
CON53030.00 DISC	0.48	0.736	-0.059	0.738	0.431	-0.026	0.432	0.050	0.638	0.640	-0.202	-0.629	0.661
CON53030.00 TERM	0.48	0.724	-0.057	0.727	0.424	-0.025	0.425	0.049	0.628	0.630	-0.199	-0.620	0.651
EFF PS SWGR BUS A	0.48	3.250	-18.193	18.481	3.397	-18.982	19.283	15.759	3.018	16.046	14.243	12.855	19.186
EFF PS SWGR BUS A PRI	0.48	3.250	-18.193	18.481	3.397	-18.982	19.283	15.759	3.018	16.046	14.243	12.855	19.186
EFF PS SWGR BUS B	0.48	3.222	-18.197	18.480	3.371	-18.986	19.283	15.763	2.994	16.045	14.259	12.833	19.183
EFF PS SWGR BUS B PRI	0.48	3.222	-18.197	18.480	3.371	-18.986	19.283	15.763	2.994	16.045	14.259	12.833	19.183
EFF PUMP NO. 2 VFD PRI	0.48	3.522	-17.348	17.701	3.949	-17.498	17.938	15.027	3.255	15.376	-16.979	5.637	17.890
EFF PUMP NO. 4 VFD PRI	0.48	3.547	-17.342	17.701	3.971	-17.493	17.938	15.023	3.277	15.376	-16.984	5.613	17.887
F52410.00 DISC	0.48	0.623	-0.039	0.624	0.364	-0.017	0.365	0.033	0.540	0.541	-0.162	-0.534	0.558
F52410.00 STR	0.48	0.668	-0.044	0.669	0.391	-0.019	0.391	0.037	0.579	0.580	-0.175	-0.573	0.599
F52420.00 DISC	0.48	0.499	-0.029	0.500	0.292	-0.013	0.292	0.024	0.433	0.433	-0.127	-0.428	0.447
F52420.00 STR	0.48	0.528	-0.031	0.529	0.308	-0.014	0.309	0.026	0.457	0.458	-0.135	-0.453	0.473
F54330.00 DISC	0.48	2.464	-0.356	2.490	1.464	-0.140	1.470	0.297	2.139	2.160	-0.817	-2.096	2.249
F54330.00 TERM	0.48	2.340	-0.327	2.363	1.388	-0.129	1.394	0.273	2.031	2.049	-0.766	-1.991	2.133
F55010.00 TERM	0.48	3.779	-1.207	3.967	2.329	-0.507	2.384	1.089	3.335	3.509	-1.897	-3.190	3.711
GEN NO. 2 TERM	0.48	2.624	-21.655	21.814	4.018	-23.797	24.134	19.091	2.569	19.263	-21.449	10.230	23.763
GEN NO. 3 TERM	0.48	2.537	-21.959	22.105	3.929	-24.233	24.550	19.365	2.496	19.526	-21.676	10.592	24.125
GRIT SCR TROLLEY	0.48	0.736	-0.058	0.738	0.431	-0.026	0.432	0.050	0.638	0.640	-0.202	-0.629	0.661
HVAC56100.00 DISC	0.48	5.535	-1.990	5.882	3.510	-0.843	3.609	1.670	4.847	5.126	-2.938	-4.576	5.438
HVAC56100.00 TERM	0.48	5.159	-1.739	5.444	3.241	-0.733	3.323	1.459	4.511	4.741	-2.627	-4.276	5.018
HVAC56110.00 DISC	0.48	2.469	-0.416	2.504	1.471	-0.171	1.481	0.348	2.144	2.172	-0.871	-2.090	2.264
HVAC56110.00 TERM	0.48	2.345	-0.381	2.376	1.395	-0.157	1.404	0.319	2.036	2.061	-0.815	-1.986	2.147
HW ELEVATOR	0.48	7.266	-3.774	8.188	4.934	-1.716	5.224	3.196	6.418	7.170	-5.007	-5.858	7.706
HW GATES	0.48	0.417	-0.022	0.417	0.243	-0.010	0.244	0.019	0.361	0.361	-0.105	-0.358	0.373
INFL PUMP 1 TERMINALS	0.48	5.619	-19.832	20.613	6.629	-17.983	19.166	18.329	5.283	19.075	-21.149	2.107	21.253
INFL PUMP 1 VFD PRI	0.48	5.338	-25.865	26.411	6.392	-27.608	28.338	23.990	5.093	24.525	-26.595	7.879	27.737
INFL PUMP 2 TERMINALS	0.48	7.327	-17.395	18.875	8.483	-14.152	16.500	16.037	6.800	17.420	-19.671	-1.433	19.723
INFL PUMP 2 VFD	0.48	5.432	-24.811	25.398	6.577	-25.820	26.644	22.950	5.141	23.518	-25.764	6.756	26.635
INFL PUMP 2 VFD PRI	0.48	5.432	-24.811	25.398	6.577	-25.820	26.644	22.950	5.141	23.518	-25.764	6.756	26.635
INFL PUMP 3 TERMINALS	0.48	7.501	-17.933	19.438	8.808	-14.726	17.159	16.541	6.995	17.959	-20.330	-1.375	20.377
INFL PUMP 3 VFD	0.48	5.339	-25.866	26.411	6.395	-27.608	28.338	23.990	5.096	24.525	-26.594	7.877	27.736

1.5-4 Cycle - 3-Phase, LG, LL, & LLG Fault Currents

Prefault Voltage = 100 % of the Bus Nominal Voltage

Bus		3-Phase Fault			Line-to-Ground Fault			Line-to-Line Fault			*Line-to-Line-to-Ground		
ID	kV	Real	Imag.	Mag.	Real	Imag.	Mag.	Real	Imag.	Mag.	Real	Imag.	Mag.
INFL PUMP 3 VFD PRI	0.48	5.339	-25.866	26.411	6.395	-27.608	28.338	23.990	5.096	24.525	-26.594	7.877	27.736
INFL PUMP 4 TERMINALS	0.48	7.374	-17.552	19.038	8.577	-14.330	16.701	16.181	6.846	17.569	-19.867	-1.399	19.916
INFL PUMP 4 VFD	0.48	5.401	-25.113	25.687	6.514	-26.354	27.147	23.235	5.113	23.791	-26.000	7.120	26.957
INFL PUMP 4 VFD PRI	0.48	5.401	-25.113	25.687	6.514	-26.354	27.147	23.235	5.113	23.791	-26.000	7.120	26.957
INFL PUMP 5 TERMINALS	0.48	7.501	-17.933	19.438	8.808	-14.726	17.159	16.541	6.995	17.959	-20.330	-1.375	20.377
INFL PUMP 5 VFD	0.48	5.339	-25.866	26.411	6.395	-27.608	28.338	23.990	5.096	24.525	-26.594	7.877	27.736
INFL PUMP 5 VFD PRI	0.48	5.339	-25.866	26.411	6.395	-27.608	28.338	23.990	5.096	24.525	-26.594	7.877	27.736
INFL PUMP 6 TERMINALS	0.48	5.570	-19.017	19.816	6.481	-16.927	18.126	17.555	5.205	18.310	-20.310	1.663	20.378
INFL PUMP 6 VFD PRI	0.48	5.459	-24.515	25.115	6.627	-25.305	26.158	22.671	5.161	23.251	-25.528	6.414	26.322
LCP-HWOCS	0.48	3.921	-1.237	4.112	2.418	-0.515	2.472	1.113	3.460	3.635	-1.953	-3.313	3.845
MAIN SWGR "FILTER"	0.48	3.075	-44.503	44.609	4.333	-50.408	50.594	40.079	3.328	40.217	37.479	29.650	47.789
MAIN SWGR "SLUDGE"	0.48	3.546	-50.637	50.761	5.334	-57.668	57.914	46.172	3.945	46.340	-47.778	26.189	54.485
MAIN SWGR BUS A PRI	0.48	3.075	-44.503	44.609	4.333	-50.408	50.594	40.079	3.328	40.217	37.479	29.650	47.789
MAIN SWGR BUS B PRI	0.48	3.546	-50.637	50.761	5.334	-57.668	57.914	46.172	3.945	46.340	-47.778	26.189	54.485
MCC-DP2C	0.48	5.761	-13.634	14.801	5.278	-9.300	10.693	12.291	5.293	13.382	-14.305	-1.944	14.436
MCC-DP4A	0.48	1.686	-0.281	1.709	0.993	-0.131	1.002	0.240	1.461	1.480	-0.592	-1.418	1.537
MCC-DP4B	0.48	6.443	-43.016	43.496	10.147	-43.549	44.715	38.818	6.475	39.355	-43.999	14.054	46.189
MCC-GE	0.48	1.434	-13.351	13.428	2.097	-13.148	13.314	12.223	1.469	12.311	-13.081	4.410	13.804
MCC-GE PRI	0.48	8.541	-37.621	38.578	12.426	-34.498	36.668	33.920	8.253	34.909	-40.069	6.611	40.611
MCC-HW BUS A	0.48	5.451	-26.022	26.586	6.573	-27.928	28.691	24.079	5.216	24.637	-26.790	8.051	27.973
MCC-HW BUS A PRI	0.48	5.451	-26.022	26.586	6.573	-27.928	28.691	24.079	5.216	24.637	-26.790	8.051	27.973
MCC-HW BUS B	0.48	5.442	-25.878	26.444	6.532	-27.782	28.539	23.892	5.168	24.444	-26.637	8.083	27.836
MCC-HW BUS B PRI	0.48	5.442	-25.878	26.444	6.532	-27.782	28.539	23.892	5.168	24.444	-26.637	8.083	27.836
MCC-NA BUS A	2.40	0.570	-4.121	4.160	1.123	-4.075	4.227	3.815	0.588	3.860	-4.394	1.188	4.551
MCC-NA BUS A PRI	2.40	0.570	-4.121	4.160	1.123	-4.075	4.227	3.815	0.588	3.860	-4.394	1.188	4.551
MCC-NA BUS B	2.40	0.615	-4.280	4.324	1.171	-4.160	4.321	3.952	0.627	4.001	-4.548	1.167	4.695
MCC-NA BUS B PRI	2.40	0.615	-4.280	4.324	1.171	-4.160	4.321	3.952	0.627	4.001	-4.548	1.167	4.695
MCC-NC	0.48	1.837	-11.269	11.418	2.778	-13.799	14.076	10.690	1.993	10.874	-11.681	5.296	12.826
MCC-ND	0.48	1.893	-11.193	11.352	2.789	-13.571	13.855	10.467	1.990	10.655	-11.584	5.311	12.743
MCC-NE	0.48	2.039	-10.683	10.876	3.193	-12.462	12.864	10.054	2.172	10.286	-11.448	4.163	12.182
MCC-NF	0.48	2.075	-10.628	10.828	3.160	-12.302	12.701	9.876	2.150	10.107	-11.350	4.204	12.103
MCC-NG BUS A	0.48	2.486	-6.422	6.887	2.994	-5.349	6.130	5.796	2.410	6.277	-7.096	-0.233	7.100
MCC-NG BUS A PRI	0.48	2.486	-6.422	6.887	2.994	-5.349	6.130	5.796	2.410	6.277	-7.096	-0.233	7.100
MCC-NG BUS B	0.48	2.483	-6.533	6.989	3.005	-5.423	6.200	5.934	2.397	6.400	-7.231	-0.226	7.234

1.5-4 Cycle - 3-Phase, LG, LL, & LLG Fault Currents

Prefault Voltage = 100 % of the Bus Nominal Voltage

Bus		3-Phase Fault			Line-to-Ground Fault			Line-to-Line Fault			*Line-to-Line-to-Ground		
ID	kV	Real	Imag.	Mag.	Real	Imag.	Mag.	Real	Imag.	Mag.	Real	Imag.	Mag.
MCC-NG BUS B PRI	0.48	2.483	-6.533	6.989	3.005	-5.423	6.200	5.934	2.397	6.400	-7.231	-0.226	7.234
MCC-SH BUS A	0.48	2.451	-6.040	6.519	2.854	-4.900	5.671	5.433	2.360	5.923	-6.657	-0.389	6.669
MCC-SH BUS A PRI	0.48	2.451	-6.040	6.519	2.854	-4.900	5.671	5.433	2.360	5.923	-6.657	-0.389	6.669
MCC-SH BUS B	0.48	2.445	-5.992	6.472	2.836	-4.846	5.614	5.387	2.352	5.878	-6.602	-0.406	6.615
MCC-SH BUS B PRI	0.48	2.468	-6.138	6.615	2.877	-5.016	5.783	5.494	2.345	5.973	-6.761	-0.313	6.768
MS-HW BUS A	0.48	5.083	-27.582	28.047	5.741	-30.862	31.391	25.628	4.866	26.086	22.367	19.679	29.791
MS-HW BUS A PRI	0.48	5.083	-27.582	28.047	5.741	-30.862	31.391	25.628	4.866	26.086	22.367	19.679	29.791
MS-HW BUS B	0.48	5.076	-27.439	27.905	5.707	-30.704	31.230	25.441	4.821	25.894	22.181	19.641	29.627
MS-HW BUS B PRI	0.48	5.076	-27.439	27.905	5.707	-30.704	31.230	25.441	4.821	25.894	22.181	19.641	29.627
P52100.00 DISC	0.48	3.536	-1.521	3.850	2.236	-0.728	2.351	1.298	3.089	3.350	-2.105	-2.848	3.541
P52100.00 TERM	0.48	3.489	-1.493	3.795	2.203	-0.715	2.317	1.274	3.047	3.303	-2.070	-2.810	3.490
P52110.00 DISC	0.48	2.597	-0.763	2.706	1.580	-0.351	1.618	0.649	2.259	2.351	-1.214	-2.145	2.464
P52110.00 TERM	0.48	2.558	-0.748	2.665	1.556	-0.344	1.593	0.636	2.226	2.315	-1.192	-2.114	2.426
P52120.00 DISC	0.48	3.738	-1.643	4.083	2.374	-0.786	2.501	1.401	3.267	3.555	-2.260	-3.007	3.761
P52120.00 TERM	0.48	3.686	-1.611	4.022	2.338	-0.771	2.462	1.374	3.221	3.502	-2.219	-2.966	3.704
P52130.00 DISC	0.48	2.761	-0.830	2.883	1.685	-0.380	1.727	0.705	2.403	2.505	-1.308	-2.279	2.628
P52130.00 TERM	0.48	2.718	-0.812	2.837	1.657	-0.372	1.699	0.690	2.366	2.464	-1.283	-2.244	2.585
P52140.00 DISC	0.48	4.357	-2.044	4.813	2.809	-0.976	2.974	1.742	3.816	4.195	-2.761	-3.493	4.452
P52140.00 TERM	0.48	4.286	-1.996	4.728	2.758	-0.953	2.918	1.701	3.753	4.121	-2.702	-3.437	4.372
P52150.00 DISC	0.48	3.280	-1.057	3.446	2.019	-0.479	2.075	0.897	2.858	2.995	-1.621	-2.702	3.150
P52150.00 TERM	0.48	3.220	-1.029	3.380	1.980	-0.467	2.034	0.873	2.805	2.938	-1.583	-2.653	3.089
P52160.00 DISC	0.48	3.410	-1.115	3.587	2.103	-0.505	2.163	0.945	2.972	3.119	-1.699	-2.807	3.281
P52160.00 TERM	0.48	3.344	-1.084	3.516	2.060	-0.492	2.118	0.919	2.915	3.057	-1.658	-2.754	3.215
P52170.00 DISC	0.48	3.618	-1.218	3.818	2.241	-0.550	2.308	1.033	3.155	3.320	-1.838	-2.976	3.498
P52170.00 TERM	0.48	3.545	-1.182	3.737	2.193	-0.534	2.257	1.003	3.091	3.250	-1.790	-2.917	3.422
P52220.00 DISC	0.48	0.682	-0.053	0.684	0.399	-0.023	0.400	0.045	0.591	0.592	-0.186	-0.583	0.612
P52220.00 TERM	0.48	0.672	-0.052	0.674	0.393	-0.023	0.394	0.044	0.582	0.584	-0.183	-0.575	0.603
P52230.00 DISC	0.48	0.682	-0.053	0.684	0.399	-0.023	0.400	0.045	0.591	0.592	-0.186	-0.583	0.612
P52230.00 TERM	0.48	0.672	-0.052	0.674	0.393	-0.023	0.394	0.044	0.582	0.584	-0.183	-0.575	0.603
P52240.00 DISC	0.48	0.860	-0.072	0.863	0.504	-0.031	0.505	0.061	0.745	0.747	-0.239	-0.735	0.773
P52240.00 TERM	0.48	0.844	-0.071	0.847	0.494	-0.031	0.495	0.060	0.731	0.734	-0.234	-0.721	0.758
P52250.00 DISC	0.48	0.860	-0.072	0.863	0.504	-0.031	0.505	0.061	0.745	0.747	-0.239	-0.735	0.773
P52250.00 TERM	0.48	0.844	-0.071	0.847	0.494	-0.031	0.495	0.060	0.731	0.734	-0.234	-0.721	0.758
P54080.00 DISC	0.48	1.412	-0.148	1.420	0.831	-0.061	0.833	0.124	1.224	1.230	-0.418	-1.205	1.275

1.5-4 Cycle - 3-Phase, LG, LL, & LLG Fault Currents

Prefault Voltage = 100 % of the Bus Nominal Voltage

Bus		3-Phase Fault			Line-to-Ground Fault			Line-to-Line Fault			*Line-to-Line-to-Ground		
ID	kV	Real	Imag.	Mag.	Real	Imag.	Mag.	Real	Imag.	Mag.	Real	Imag.	Mag.
P54080.00 TERM	0.48	1.370	-0.141	1.377	0.806	-0.059	0.808	0.118	1.188	1.194	-0.404	-1.169	1.237
P54090.00 DISC	0.48	1.412	-0.148	1.420	0.831	-0.061	0.833	0.124	1.224	1.230	-0.418	-1.205	1.275
P54090.00 TERM	0.48	1.370	-0.141	1.377	0.806	-0.059	0.808	0.118	1.188	1.194	-0.404	-1.169	1.237
P55020.00 TERM	0.48	3.158	-0.814	3.261	1.913	-0.337	1.942	0.727	2.778	2.871	-1.392	-2.680	3.020
P55030.00 TERM	0.48	3.158	-0.814	3.261	1.913	-0.337	1.942	0.727	2.778	2.871	-1.392	-2.680	3.020
PNL DP2	0.48	6.642	-17.018	18.269	6.469	-12.076	13.700	15.268	6.122	16.449	-17.831	-1.657	17.907
PNL DP4	0.48	5.438	-46.978	47.292	8.944	-50.484	51.271	42.610	5.645	42.983	-47.066	19.394	50.905
PNL DPLC-1	0.21	1.057	-1.643	1.953	1.068	-1.678	1.989	1.424	0.918	1.695	0.887	1.772	1.982
PNL DPLC-2	0.21	1.001	-1.189	1.555	1.008	-1.313	1.655	1.031	0.869	1.348	0.532	1.593	1.680
PNL DPLC-3	0.21	1.092	-1.498	1.854	1.125	-1.429	1.819	1.299	0.949	1.608	-1.871	-0.268	1.890
PNL DPLC-4	0.21	0.610	-0.633	0.879	0.615	-0.623	0.875	0.548	0.529	0.762	-0.857	-0.222	0.885
PNL DPP1	0.48	10.388	-10.546	14.803	9.095	-6.063	10.930	9.182	9.477	13.196	-12.754	-7.388	14.739
PNL DPP1 PRI	0.48	10.388	-10.546	14.803	9.095	-6.063	10.930	9.182	9.477	13.196	-12.754	-7.388	14.739
SCR BLDG N OH DOOR DISC	0.48	1.227	-0.134	1.235	0.722	-0.058	0.724	0.113	1.064	1.070	-0.368	-1.045	1.109
SCR BLDG N OH DOOR TERM	0.48	1.196	-0.129	1.202	0.703	-0.055	0.705	0.109	1.036	1.042	-0.357	-1.019	1.079
SCR BLDG S OH DOOR DISC	0.48	1.334	-0.152	1.342	0.785	-0.065	0.788	0.128	1.156	1.163	-0.406	-1.135	1.206
SCR BLDG S OH DOOR TERM	0.48	1.296	-0.146	1.304	0.763	-0.062	0.765	0.123	1.124	1.130	-0.393	-1.104	1.172
SEP53000.00 DISC	0.48	0.736	-0.059	0.738	0.431	-0.026	0.432	0.050	0.638	0.640	-0.202	-0.629	0.661
SEP53000.00 TERM	0.48	0.725	-0.057	0.727	0.424	-0.025	0.425	0.049	0.628	0.630	-0.198	-0.620	0.651
SEP53010.00 DISC	0.48	0.736	-0.059	0.738	0.431	-0.026	0.432	0.050	0.638	0.640	-0.202	-0.629	0.661
SEP53010.00 TERM	0.48	0.724	-0.057	0.727	0.424	-0.025	0.425	0.049	0.628	0.630	-0.199	-0.620	0.651
SEP53020.00 DISC	0.48	0.713	-0.056	0.715	0.418	-0.025	0.418	0.048	0.618	0.620	-0.195	-0.610	0.640
SEP53020.00 TERM	0.48	0.702	-0.055	0.705	0.411	-0.024	0.412	0.047	0.609	0.610	-0.192	-0.601	0.631
SR-DAF	0.48	2.402	-7.829	8.189	3.250	-7.275	7.967	7.164	2.396	7.554	-8.630	0.741	8.662
SR-DAF PRI	0.48	2.402	-7.829	8.189	3.250	-7.275	7.967	7.164	2.396	7.554	-8.630	0.741	8.662
SWBD GDP	0.48	2.030	-23.494	23.582	3.332	-26.519	26.728	20.755	2.065	20.858	-22.698	12.603	25.962
SWBD-NB BUS A	0.48	1.817	-11.364	11.508	2.715	-14.054	14.313	10.772	1.975	10.951	-11.692	5.552	12.944
SWBD-NB BUS A PRI	0.48	1.817	-11.364	11.508	2.715	-14.054	14.313	10.772	1.975	10.951	-11.692	5.552	12.944
SWBD-NB BUS B	0.48	1.860	-11.304	11.456	2.699	-13.852	14.113	10.568	1.962	10.749	-11.588	5.593	12.867
SWBD-NB BUS B PRI	0.48	1.860	-11.304	11.456	2.699	-13.852	14.113	10.568	1.962	10.749	-11.588	5.593	12.867
TRANSF TA PRI	0.48	3.075	-44.503	44.609	4.333	-50.408	50.594	40.079	3.328	40.217	37.479	29.650	47.789
TRANSF TB PRI	0.48	3.546	-50.637	50.761	5.334	-57.668	57.914	46.172	3.945	46.340	-47.778	26.189	54.485
TRANSF TB SEC	2.40	0.526	-4.880	4.909	0.755	-5.914	5.962	4.480	0.553	4.514	3.990	3.759	5.482
TRANSF TC PRI	2.40	0.580	-4.093	4.133	1.131	-4.005	4.162	3.789	0.597	3.836	-4.365	1.132	4.510

1.5-4 Cycle - 3-Phase, LG, LL, & LLG Fault Currents

Prefault Voltage = 100 % of the Bus Nominal Voltage

Bus		3-Phase Fault			Line-to-Ground Fault			Line-to-Line Fault			*Line-to-Line-to-Ground		
ID	kV	Real	Imag.	Mag.	Real	Imag.	Mag.	Real	Imag.	Mag.	Real	Imag.	Mag.
TRANSF TC SEC	0.48	1.773	-11.558	11.693	2.567	-14.587	14.811	10.939	1.936	11.109	9.351	9.617	13.414
TRANSF TD PRI	2.40	0.626	-4.248	4.294	1.178	-4.085	4.251	3.921	0.637	3.973	-4.516	1.109	4.650
TRANSF TD SEC	0.48	1.814	-11.512	11.654	2.553	-14.393	14.618	10.752	1.922	10.922	9.187	9.677	13.344
XFMR T-C4 PRI	0.48	7.353	-3.373	8.090	4.896	-1.457	5.109	2.839	6.484	7.078	-4.627	-6.014	7.588
XFMR T-C4 SEC	0.21	0.612	-0.665	0.904	0.618	-0.679	0.918	0.576	0.531	0.784	0.265	0.878	0.917
XFMR T-LC1 PRI	0.48	9.419	-6.406	11.391	7.016	-3.091	7.667	5.467	8.428	10.046	-8.097	-7.409	10.975
XFMR T-LC1 SEC	0.21	1.058	-1.664	1.972	1.068	-1.716	2.021	1.443	0.919	1.711	0.908	1.801	2.017
XFMR T-LC2 PRI	0.48	2.839	-0.731	2.932	1.719	-0.323	1.749	0.618	2.469	2.545	-1.232	-2.364	2.666
XFMR T-LC2 SEC	0.21	1.001	-1.194	1.559	1.007	-1.323	1.662	1.035	0.869	1.352	0.538	1.602	1.690

All fault currents are symmetrical momentary (1.5-4 Cycle network) values in rms kA

* LLG fault current is the larger of the two faulted line currents

Short-Circuit Summary Report

Bus		Positive Sequence Imp. (ohm)			Negative Sequence Imp. (ohm)			Zero Sequence Imp. (ohm)		
ID	kV	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance
ATS-L BUS A	0.480	0.00307	0.01038	0.01083	0.00292	0.00902	0.00948	0.00544	0.00961	0.01104
ATS-L BUS B	0.480	0.00526	0.01086	0.01206	0.00509	0.00954	0.01081	0.01228	0.01064	0.01625
ATS-L SEC	0.480	0.00307	0.01038	0.01083	0.00292	0.00902	0.00948	0.00544	0.00961	0.01104
B20100.00 TERMINALS	2.400	0.05900	0.34298	0.34802	0.06096	0.29615	0.30236	0.21464	0.39405	0.44871
B20200.00 TERMINALS	2.400	0.06098	0.34468	0.35004	0.06431	0.29929	0.30612	0.21673	0.39668	0.45202
B20400.00 TERMINALS	2.400	0.06098	0.33229	0.33784	0.06237	0.28874	0.29539	0.22195	0.40325	0.46030
B52180.00 DISC	0.480	0.04513	0.02246	0.05041	0.04497	0.02108	0.04967	0.13796	0.03931	0.14346
B52180.00 TERM	0.480	0.04668	0.02276	0.05194	0.04652	0.02138	0.05120	0.14285	0.04005	0.14835
B52190.00 DISC	0.480	0.06415	0.02226	0.06790	0.06396	0.02091	0.06730	0.19782	0.03869	0.20156
B52190.00 TERM	0.480	0.06570	0.02256	0.06947	0.06551	0.02121	0.06886	0.20270	0.03942	0.20650
B52210.00 DISC	0.480	0.17764	0.02490	0.17938	0.17740	0.02354	0.17895	0.55534	0.04514	0.55717
B52210.00 TERM	0.480	0.18154	0.02523	0.18329	0.18129	0.02386	0.18286	0.56763	0.04594	0.56948
B52220.00 DISC	0.480	0.18932	0.02583	0.19107	0.18908	0.02441	0.19064	0.59219	0.04754	0.59410
B52220.00 TERM	0.480	0.19322	0.02616	0.19498	0.19297	0.02473	0.19455	0.60448	0.04834	0.60641
BLWR BLDG TROLLEY	0.480	0.06094	0.01788	0.06351	0.06079	0.01652	0.06299	0.18773	0.02806	0.18982
BSN51240.00 DISC	0.480	0.36214	0.02910	0.36330	0.36199	0.02774	0.36305	1.13651	0.05566	1.13788
BSN51240.00 TERM	0.480	0.36814	0.02942	0.36931	0.36799	0.02805	0.36905	1.15541	0.05643	1.15679
BSN51250.00 DISC	0.480	0.36216	0.02916	0.36333	0.36199	0.02784	0.36306	1.13652	0.05566	1.13788
BSN51250.00 TERM	0.480	0.36816	0.02947	0.36933	0.36799	0.02815	0.36907	1.15542	0.05643	1.15679
BSN51260.00 DISC	0.480	0.36214	0.02910	0.36330	0.36199	0.02774	0.36305	1.13651	0.05566	1.13788
BSN51260.00 TERM	0.480	0.36814	0.02942	0.36931	0.36799	0.02805	0.36905	1.15541	0.05643	1.15679
BSN51270.00 DISC	0.480	0.36216	0.02916	0.36333	0.36199	0.02784	0.36306	1.13652	0.05566	1.13788
BSN51270.00 TERM	0.480	0.36816	0.02947	0.36933	0.36799	0.02815	0.36907	1.15542	0.05643	1.15679
COGEN TIE BUS	0.480	0.00038	0.00545	0.00546	0.00050	0.00487	0.00490	0.00044	0.00397	0.00400
COM53030.00 DISC	0.480	0.35013	0.02848	0.35129	0.34998	0.02711	0.35102	1.09871	0.05411	1.10004
COM53030.00 TERM	0.480	0.35613	0.02879	0.35729	0.35598	0.02742	0.35703	1.11761	0.05488	1.11896
COM53040.00 DISC	0.480	0.32015	0.02695	0.32128	0.31999	0.02563	0.32101	1.00422	0.05023	1.00547
COM53040.00 TERM	0.480	0.32615	0.02727	0.32729	0.32598	0.02595	0.32702	1.02312	0.05101	1.02439
CON51300.00 DISC	0.480	0.35013	0.02848	0.35128	0.34996	0.02710	0.35101	1.09871	0.05411	1.10004
CON51300.00 TERM	0.480	0.35613	0.02880	0.35729	0.35596	0.02742	0.35702	1.11761	0.05488	1.11896
CON51320.00 DISC	0.480	0.35013	0.02848	0.35128	0.34996	0.02710	0.35101	1.09871	0.05411	1.10004
CON51320.00 TERM	0.480	0.35613	0.02880	0.35729	0.35596	0.02742	0.35702	1.11761	0.05488	1.11896
CON53020.00 DISC	0.480	0.37414	0.02980	0.37533	0.37397	0.02846	0.37505	1.17432	0.05721	1.17571
CON53020.00 TERM	0.480	0.38014	0.03011	0.38133	0.37996	0.02878	0.38105	1.19322	0.05798	1.19462
CON53030.00 DISC	0.480	0.37414	0.02980	0.37533	0.37397	0.02846	0.37505	1.17432	0.05721	1.17571

Bus		Positive Sequence Imp. (ohm)			Negative Sequence Imp. (ohm)			Zero Sequence Imp. (ohm)		
ID	kV	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance
CON53030.00 TERM	0.480	0.38014	0.03011	0.38133	0.37996	0.02878	0.38105	1.19322	0.05798	1.19462
EFF PS SWGR BUS A	0.480	0.00264	0.01476	0.01500	0.00299	0.01462	0.01492	0.00197	0.01306	0.01321
EFF PS SWGR BUS A PRI	0.480	0.00264	0.01476	0.01500	0.00299	0.01462	0.01492	0.00197	0.01306	0.01321
EFF PS SWGR BUS B	0.480	0.00261	0.01477	0.01500	0.00297	0.01462	0.01492	0.00196	0.01306	0.01321
EFF PS SWGR BUS B PRI	0.480	0.00261	0.01477	0.01500	0.00297	0.01462	0.01492	0.00196	0.01306	0.01321
EFF PUMP NO. 2 VFD PRI	0.480	0.00312	0.01534	0.01566	0.00349	0.01517	0.01556	0.00359	0.01470	0.01513
EFF PUMP NO. 4 VFD PRI	0.480	0.00314	0.01534	0.01566	0.00352	0.01516	0.01556	0.00361	0.01470	0.01513
F52410.00 DISC	0.480	0.44313	0.02796	0.44401	0.44298	0.02659	0.44378	1.39166	0.05284	1.39267
F52410.00 STR	0.480	0.41313	0.02694	0.41401	0.41298	0.02557	0.41377	1.29716	0.05033	1.29814
F52420.00 DISC	0.480	0.55313	0.03170	0.55404	0.55298	0.03033	0.55381	1.73816	0.06204	1.73927
F52420.00 STR	0.480	0.52313	0.03068	0.52403	0.52298	0.02931	0.52380	1.64366	0.05953	1.64474
F54330.00 DISC	0.480	0.11015	0.01593	0.11130	0.10999	0.01461	0.11096	0.34272	0.02311	0.34349
F54330.00 TERM	0.480	0.11615	0.01624	0.11728	0.11599	0.01492	0.11694	0.36162	0.02389	0.36240
F55010.00 TERM	0.480	0.06655	0.02125	0.06986	0.06350	0.02121	0.06694	0.21073	0.03174	0.21311
GEN NO. 2 TERM	0.480	0.00153	0.01261	0.01270	0.00179	0.01208	0.01222	0.00241	0.00927	0.00958
GEN NO. 3 TERM	0.480	0.00144	0.01245	0.01254	0.00170	0.01193	0.01205	0.00228	0.00905	0.00933
GRIT SCR TROLLEY	0.480	0.37414	0.02973	0.37532	0.37399	0.02837	0.37506	1.17431	0.05721	1.17571
HVAC56100.00 DISC	0.480	0.04434	0.01594	0.04711	0.04419	0.01457	0.04653	0.13544	0.02327	0.13743
HVAC56100.00 TERM	0.480	0.04824	0.01626	0.05090	0.04809	0.01490	0.05034	0.14773	0.02407	0.14968
HVAC56110.00 DISC	0.480	0.10914	0.01838	0.11067	0.10898	0.01701	0.11030	0.33956	0.02928	0.34082
HVAC56110.00 TERM	0.480	0.11514	0.01869	0.11664	0.11498	0.01733	0.11628	0.35846	0.03005	0.35972
HW ELEVATOR	0.480	0.03004	0.01560	0.03385	0.02989	0.01424	0.03311	0.09040	0.02245	0.09314
HW GATES	0.480	0.66314	0.03544	0.66408	0.66299	0.03407	0.66386	2.08466	0.07124	2.08588
INFL PUMP 1 TERMINALS	0.480	0.00366	0.01294	0.01344	0.00330	0.01124	0.01172	0.00803	0.01652	0.01837
INFL PUMP 1 VFD PRI	0.480	0.00212	0.01028	0.01049	0.00194	0.00887	0.00908	0.00255	0.00944	0.00978
INFL PUMP 2 TERMINALS	0.480	0.00570	0.01353	0.01468	0.00506	0.01184	0.01287	0.01515	0.01785	0.02341
INFL PUMP 2 VFD	0.480	0.00233	0.01066	0.01091	0.00213	0.00926	0.00950	0.00324	0.01032	0.01082
INFL PUMP 2 VFD PRI	0.480	0.00233	0.01066	0.01091	0.00213	0.00926	0.00950	0.00324	0.01032	0.01082
INFL PUMP 3 TERMINALS	0.480	0.00550	0.01315	0.01426	0.00491	0.01146	0.01247	0.01446	0.01696	0.02229
INFL PUMP 3 VFD	0.480	0.00212	0.01028	0.01049	0.00195	0.00887	0.00908	0.00255	0.00944	0.00978
INFL PUMP 3 VFD PRI	0.480	0.00212	0.01028	0.01049	0.00195	0.00887	0.00908	0.00255	0.00944	0.00978
INFL PUMP 4 TERMINALS	0.480	0.00564	0.01342	0.01456	0.00501	0.01174	0.01276	0.01492	0.01755	0.02304
INFL PUMP 4 VFD	0.480	0.00227	0.01055	0.01079	0.00207	0.00916	0.00939	0.00301	0.01003	0.01047
INFL PUMP 4 VFD PRI	0.480	0.00227	0.01055	0.01079	0.00207	0.00916	0.00939	0.00301	0.01003	0.01047
INFL PUMP 5 TERMINALS	0.480	0.00550	0.01315	0.01426	0.00491	0.01146	0.01247	0.01446	0.01696	0.02229
INFL PUMP 5 VFD	0.480	0.00212	0.01028	0.01049	0.00195	0.00887	0.00908	0.00255	0.00944	0.00978
INFL PUMP 5 VFD PRI	0.480	0.00212	0.01028	0.01049	0.00195	0.00887	0.00908	0.00255	0.00944	0.00978

Bus		Positive Sequence Imp. (ohm)			Negative Sequence Imp. (ohm)			Zero Sequence Imp. (ohm)		
ID	kV	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance
INFL PUMP 6 TERMINALS	0.480	0.00393	0.01342	0.01399	0.00352	0.01171	0.01223	0.00895	0.01770	0.01984
INFL PUMP 6 VFD PRI	0.480	0.00240	0.01077	0.01103	0.00218	0.00936	0.00961	0.00347	0.01062	0.01117
LCP-HWOCS	0.480	0.06428	0.02027	0.06740	0.06144	0.02016	0.06466	0.20317	0.02963	0.20532
MAIN SWGR "FILTER"	0.480	0.00043	0.00620	0.00621	0.00056	0.00570	0.00572	0.00042	0.00448	0.00450
MAIN SWGR "SLUDGE"	0.480	0.00038	0.00545	0.00546	0.00050	0.00487	0.00490	0.00044	0.00397	0.00400
MAIN SWGR BUS A PRI	0.480	0.00043	0.00620	0.00621	0.00056	0.00570	0.00572	0.00042	0.00448	0.00450
MAIN SWGR BUS B PRI	0.480	0.00038	0.00545	0.00546	0.00050	0.00487	0.00490	0.00044	0.00397	0.00400
MCC-DP2C	0.480	0.00729	0.01725	0.01872	0.00690	0.01570	0.01715	0.02419	0.03467	0.04228
MCC-DP4A	0.480	0.15992	0.02662	0.16212	0.16004	0.02605	0.16214	0.50300	0.05606	0.50611
MCC-DP4B	0.480	0.00094	0.00630	0.00637	0.00106	0.00573	0.00583	0.00221	0.00608	0.00647
MCC-GE	0.480	0.00220	0.02052	0.02064	0.00245	0.01819	0.01836	0.00518	0.02295	0.02353
MCC-GE PRI	0.480	0.00159	0.00701	0.00718	0.00166	0.00635	0.00657	0.00443	0.00797	0.00912
MCC-HW BUS A	0.480	0.00214	0.01020	0.01042	0.00199	0.00884	0.00906	0.00251	0.00917	0.00950
MCC-HW BUS A PRI	0.480	0.00214	0.01020	0.01042	0.00199	0.00884	0.00906	0.00251	0.00917	0.00950
MCC-HW BUS B	0.480	0.00216	0.01026	0.01048	0.00199	0.00894	0.00916	0.00252	0.00917	0.00950
MCC-HW BUS B PRI	0.480	0.00216	0.01026	0.01048	0.00199	0.00894	0.00916	0.00252	0.00917	0.00950
MCC-NA BUS A	2.400	0.04565	0.32992	0.33307	0.04897	0.28453	0.28872	0.16660	0.33356	0.37285
MCC-NA BUS A PRI	2.400	0.04565	0.32992	0.33307	0.04897	0.28453	0.28872	0.16660	0.33356	0.37285
MCC-NA BUS B	2.400	0.04555	0.31719	0.32044	0.04849	0.27525	0.27948	0.16660	0.33356	0.37285
MCC-NA BUS B PRI	2.400	0.04555	0.31719	0.32044	0.04849	0.27525	0.27948	0.16660	0.33356	0.37285
MCC-NC	0.480	0.00391	0.02395	0.02427	0.00418	0.01944	0.01988	0.00357	0.01451	0.01494
MCC-ND	0.480	0.00407	0.02407	0.02441	0.00435	0.02019	0.02065	0.00366	0.01452	0.01498
MCC-NE	0.480	0.00478	0.02503	0.02548	0.00508	0.02058	0.02120	0.00618	0.01699	0.01808
MCC-NF	0.480	0.00490	0.02512	0.02559	0.00520	0.02129	0.02191	0.00618	0.01699	0.01808
MCC-NG BUS A	0.480	0.01453	0.03753	0.04024	0.01483	0.03308	0.03625	0.03690	0.04774	0.06034
MCC-NG BUS A PRI	0.480	0.01453	0.03753	0.04024	0.01483	0.03308	0.03625	0.03690	0.04774	0.06034
MCC-NG BUS B	0.480	0.01409	0.03707	0.03965	0.01400	0.03247	0.03537	0.03690	0.04774	0.06034
MCC-NG BUS B PRI	0.480	0.01409	0.03707	0.03965	0.01400	0.03247	0.03537	0.03690	0.04774	0.06034
MCC-SH BUS A	0.480	0.01598	0.03939	0.04251	0.01630	0.03494	0.03855	0.04150	0.05236	0.06681
MCC-SH BUS A PRI	0.480	0.01598	0.03939	0.04251	0.01630	0.03494	0.03855	0.04150	0.05236	0.06681
MCC-SH BUS B	0.480	0.01618	0.03964	0.04282	0.01650	0.03519	0.03886	0.04212	0.05297	0.06767
MCC-SH BUS B PRI	0.480	0.01563	0.03887	0.04189	0.01592	0.03504	0.03849	0.03997	0.05082	0.06465
MS-HW BUS A	0.480	0.00179	0.00972	0.00988	0.00164	0.00836	0.00852	0.00141	0.00796	0.00808
MS-HW BUS A PRI	0.480	0.00179	0.00972	0.00988	0.00164	0.00836	0.00852	0.00141	0.00796	0.00808
MS-HW BUS B	0.480	0.00181	0.00977	0.00993	0.00164	0.00845	0.00861	0.00141	0.00796	0.00808
MS-HW BUS B PRI	0.480	0.00181	0.00977	0.00993	0.00164	0.00845	0.00861	0.00141	0.00796	0.00808
P52100.00 DISC	0.480	0.06613	0.02845	0.07199	0.06596	0.02705	0.07129	0.20411	0.05404	0.21115

Bus		Positive Sequence Imp. (ohm)			Negative Sequence Imp. (ohm)			Zero Sequence Imp. (ohm)		
ID	kV	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance
P52100.00 TERM	0.480	0.06713	0.02873	0.07302	0.06695	0.02733	0.07232	0.20726	0.05474	0.21437
P52110.00 DISC	0.480	0.09824	0.02887	0.10240	0.09802	0.02749	0.10180	0.30523	0.05492	0.31013
P52110.00 TERM	0.480	0.09979	0.02917	0.10397	0.09957	0.02779	0.10337	0.31011	0.05566	0.31507
P52120.00 DISC	0.480	0.06213	0.02731	0.06787	0.06196	0.02591	0.06716	0.19151	0.05123	0.19825
P52120.00 TERM	0.480	0.06313	0.02759	0.06890	0.06296	0.02620	0.06819	0.19466	0.05193	0.20147
P52130.00 DISC	0.480	0.09205	0.02767	0.09611	0.09183	0.02630	0.09552	0.28570	0.05197	0.29039
P52130.00 TERM	0.480	0.09360	0.02797	0.09768	0.09337	0.02660	0.09709	0.29058	0.05271	0.29533
P52140.00 DISC	0.480	0.05213	0.02446	0.05758	0.05197	0.02307	0.05686	0.16001	0.04422	0.16601
P52140.00 TERM	0.480	0.05313	0.02474	0.05861	0.05297	0.02335	0.05789	0.16316	0.04492	0.16923
P52150.00 DISC	0.480	0.07655	0.02466	0.08042	0.07635	0.02331	0.07983	0.23688	0.04459	0.24104
P52150.00 TERM	0.480	0.07810	0.02496	0.08199	0.07790	0.02361	0.08139	0.24176	0.04533	0.24597
P52160.00 DISC	0.480	0.07343	0.02401	0.07726	0.07325	0.02261	0.07666	0.22711	0.04311	0.23116
P52160.00 TERM	0.480	0.07498	0.02431	0.07882	0.07479	0.02291	0.07822	0.23199	0.04385	0.23610
P52170.00 DISC	0.480	0.06880	0.02316	0.07259	0.06861	0.02181	0.07199	0.21246	0.04090	0.21636
P52170.00 TERM	0.480	0.07035	0.02346	0.07416	0.07016	0.02211	0.07356	0.21735	0.04164	0.22130
P52220.00 DISC	0.480	0.40412	0.03132	0.40533	0.40395	0.02994	0.40506	1.26881	0.06108	1.27028
P52220.00 TERM	0.480	0.41012	0.03164	0.41134	0.40995	0.03025	0.41107	1.28771	0.06186	1.28920
P52230.00 DISC	0.480	0.40412	0.03132	0.40533	0.40395	0.02994	0.40506	1.26881	0.06108	1.27028
P52230.00 TERM	0.480	0.41012	0.03164	0.41134	0.40995	0.03025	0.41107	1.28771	0.06186	1.28920
P52240.00 DISC	0.480	0.32015	0.02696	0.32128	0.31997	0.02563	0.32100	1.00422	0.05023	1.00547
P52240.00 TERM	0.480	0.32615	0.02727	0.32729	0.32597	0.02594	0.32700	1.02312	0.05101	1.02439
P52250.00 DISC	0.480	0.32015	0.02696	0.32128	0.31997	0.02563	0.32100	1.00422	0.05023	1.00547
P52250.00 TERM	0.480	0.32615	0.02727	0.32729	0.32597	0.02594	0.32700	1.02312	0.05101	1.02439
P54080.00 DISC	0.480	0.19413	0.02029	0.19519	0.19398	0.01892	0.19490	0.60731	0.03396	0.60826
P54080.00 TERM	0.480	0.20013	0.02060	0.20119	0.19998	0.01923	0.20090	0.62621	0.03474	0.62718
P54090.00 DISC	0.480	0.19413	0.02029	0.19519	0.19398	0.01892	0.19490	0.60731	0.03396	0.60826
P54090.00 TERM	0.480	0.20013	0.02060	0.20119	0.19998	0.01923	0.20090	0.62621	0.03474	0.62718
P55020.00 TERM	0.480	0.08228	0.02122	0.08497	0.07944	0.02110	0.08219	0.25987	0.03196	0.26183
P55030.00 TERM	0.480	0.08228	0.02122	0.08497	0.07944	0.02110	0.08219	0.25987	0.03196	0.26183
PNL DP2	0.480	0.00552	0.01413	0.01517	0.00534	0.01295	0.01401	0.01780	0.02641	0.03185
PNL DP4	0.480	0.00067	0.00582	0.00586	0.00079	0.00525	0.00531	0.00136	0.00490	0.00508
PNL DPLC-1	0.208	0.03326	0.05171	0.06149	0.03324	0.05146	0.06126	0.03078	0.04961	0.05839
PNL DPLC-2	0.208	0.04975	0.05910	0.07725	0.04972	0.05884	0.07704	0.03310	0.05475	0.06398
PNL DPLC-3	0.208	0.03816	0.05235	0.06479	0.03814	0.05210	0.06456	0.04621	0.05119	0.06896
PNL DPLC-4	0.208	0.09485	0.09836	0.13664	0.09482	0.09810	0.13644	0.09954	0.09661	0.13871
PNL DPP1	0.480	0.01314	0.01334	0.01872	0.01299	0.01197	0.01766	0.03716	0.01688	0.04082
PNL DPP1 PRI	0.480	0.01314	0.01334	0.01872	0.01299	0.01197	0.01766	0.03716	0.01688	0.04082

Bus		Positive Sequence Imp. (ohm)			Negative Sequence Imp. (ohm)			Zero Sequence Imp. (ohm)		
ID	kV	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance
SCR BLDG N OH DOOR DISC	0.480	0.22314	0.02436	0.22446	0.22299	0.02300	0.22417	0.69866	0.04400	0.70005
SCR BLDG N OH DOOR TERM	0.480	0.22914	0.02468	0.23046	0.22899	0.02331	0.23017	0.71756	0.04477	0.71896
SCR BLDG S OH DOOR DISC	0.480	0.20514	0.02342	0.20647	0.20499	0.02205	0.20617	0.64196	0.04167	0.64332
SCR BLDG S OH DOOR TERM	0.480	0.21114	0.02373	0.21247	0.21099	0.02237	0.21217	0.66086	0.04245	0.66223
SEP53000.00 DISC	0.480	0.37413	0.02973	0.37531	0.37398	0.02837	0.37506	1.17431	0.05721	1.17571
SEP53000.00 TERM	0.480	0.38013	0.03005	0.38132	0.37998	0.02868	0.38106	1.19321	0.05798	1.19462
SEP53010.00 DISC	0.480	0.37415	0.02979	0.37534	0.37399	0.02847	0.37507	1.17432	0.05721	1.17571
SEP53010.00 TERM	0.480	0.38015	0.03010	0.38134	0.37999	0.02878	0.38108	1.19322	0.05798	1.19462
SEP53020.00 DISC	0.480	0.38615	0.03042	0.38735	0.38599	0.02910	0.38708	1.21212	0.05876	1.21354
SEP53020.00 TERM	0.480	0.39215	0.03073	0.39335	0.39199	0.02941	0.39309	1.23102	0.05953	1.23246
SR-DAF	0.480	0.00993	0.03235	0.03384	0.01023	0.02791	0.02972	0.02241	0.03501	0.04157
SR-DAF PRI	0.480	0.00993	0.03235	0.03384	0.01023	0.02791	0.02972	0.02241	0.03501	0.04157
SWBD GDP	0.480	0.00101	0.01171	0.01175	0.00127	0.01119	0.01126	0.00160	0.00796	0.00812
SWBD-NB BUS A	0.480	0.00380	0.02378	0.02408	0.00410	0.01933	0.01976	0.00311	0.01392	0.01426
SWBD-NB BUS A PRI	0.480	0.00380	0.02378	0.02408	0.00410	0.01933	0.01976	0.00311	0.01392	0.01426
SWBD-NB BUS B	0.480	0.00393	0.02387	0.02419	0.00422	0.02004	0.02048	0.00311	0.01392	0.01426
SWBD-NB BUS B PRI	0.480	0.00393	0.02387	0.02419	0.00422	0.02004	0.02048	0.00311	0.01392	0.01426
TRANSF TA PRI	0.480	0.00043	0.00620	0.00621	0.00056	0.00570	0.00572	0.00042	0.00448	0.00450
TRANSF TB PRI	0.480	0.00038	0.00545	0.00546	0.00050	0.00487	0.00490	0.00044	0.00397	0.00400
TRANSF TB SEC	2.400	0.03027	0.28065	0.28228	0.03490	0.24705	0.24950	0.02310	0.16398	0.16560
TRANSF TC PRI	2.400	0.04707	0.33190	0.33522	0.05027	0.28618	0.29056	0.17413	0.34322	0.38486
TRANSF TC SEC	0.480	0.00359	0.02343	0.02370	0.00393	0.01912	0.01952	0.00220	0.01274	0.01293
TRANSF TD PRI	2.400	0.04703	0.31924	0.32269	0.04987	0.27703	0.28148	0.17413	0.34322	0.38486
TRANSF TD SEC	0.480	0.00370	0.02349	0.02378	0.00403	0.01977	0.02018	0.00220	0.01274	0.01293
XFMR T-C4 PRI	0.480	0.03114	0.01428	0.03426	0.03099	0.01292	0.03357	0.09386	0.01920	0.09581
XFMR T-C4 SEC	0.208	0.08995	0.09772	0.13282	0.08992	0.09746	0.13261	0.08410	0.09504	0.12691
XFMR T-LC1 PRI	0.480	0.02012	0.01368	0.02433	0.01997	0.01232	0.02346	0.05915	0.01773	0.06175
XFMR T-LC1 SEC	0.208	0.03266	0.05139	0.06089	0.03264	0.05113	0.06066	0.02889	0.04882	0.05672
XFMR T-LC2 PRI	0.480	0.09154	0.02358	0.09452	0.09139	0.02221	0.09405	0.28412	0.04207	0.28722
XFMR T-LC2 SEC	0.208	0.04950	0.05904	0.07704	0.04947	0.05878	0.07683	0.03231	0.05461	0.06345

APPENDIX B5 – SHORT CIRCUIT STUDY (30 CYCLE SHORT-CIRCUIT SUMMARY REPORT)

Short-Circuit Summary Report

30 Cycle - 3-Phase, LG, LL, & LLG Fault Currents

Prefault Voltage = 100 % of the Bus Nominal Voltage

Bus		3-Phase Fault			Line-to-Ground Fault			Line-to-Line Fault			*Line-to-Line-to-Ground		
ID	kV	Real	Imag.	Mag.	Real	Imag.	Mag.	Real	Imag.	Mag.	Real	Imag.	Mag.
ATS-L BUS A	0.48	6.528	-21.977	22.926	8.354	-22.218	23.737	19.033	5.653	19.854	-24.193	5.441	24.797
ATS-L BUS B	0.48	8.863	-18.934	20.905	11.148	-16.424	19.851	16.397	7.676	18.105	-22.611	-0.822	22.626
ATS-L SEC	0.48	6.528	-21.977	22.926	8.354	-22.218	23.737	19.033	5.653	19.854	-24.193	5.441	24.797
B20100.00 TERMINALS	2.40	0.592	-3.447	3.498	0.965	-3.251	3.392	2.985	0.513	3.029	-3.616	0.985	3.748
B20200.00 TERMINALS	2.40	0.596	-3.440	3.491	0.967	-3.237	3.379	2.979	0.516	3.024	-3.609	0.972	3.738
B20400.00 TERMINALS	2.40	0.639	-3.534	3.591	1.020	-3.276	3.431	3.082	0.565	3.133	-3.709	0.909	3.819
B52180.00 DISC	0.48	4.793	-2.492	5.403	3.176	-1.202	3.396	2.158	4.151	4.679	-3.333	-3.778	5.037
B52180.00 TERM	0.48	4.676	-2.381	5.248	3.083	-1.145	3.289	2.062	4.050	4.544	-3.200	-3.694	4.887
B52190.00 DISC	0.48	3.796	-1.377	4.038	2.381	-0.623	2.461	1.192	3.287	3.497	-2.055	-3.098	3.718
B52190.00 TERM	0.48	3.716	-1.333	3.948	2.326	-0.603	2.403	1.155	3.218	3.419	-1.997	-3.035	3.633
B52210.00 DISC	0.48	1.524	-0.223	1.540	0.902	-0.096	0.907	0.193	1.320	1.334	-0.513	-1.291	1.389
B52210.00 TERM	0.48	1.492	-0.216	1.508	0.883	-0.093	0.888	0.187	1.292	1.306	-0.500	-1.264	1.359
B52220.00 DISC	0.48	1.432	-0.204	1.446	0.846	-0.088	0.851	0.177	1.240	1.252	-0.477	-1.213	1.304
B52220.00 TERM	0.48	1.403	-0.198	1.417	0.829	-0.086	0.834	0.172	1.215	1.227	-0.466	-1.189	1.277
BLWR BLDG TROLLEY	0.48	4.121	-1.283	4.316	2.562	-0.547	2.620	1.111	3.569	3.737	-2.035	-3.409	3.971
BSN51240.00 DISC	0.48	0.759	-0.063	0.762	0.445	-0.028	0.446	0.055	0.657	0.660	-0.212	-0.649	0.683
BSN51240.00 TERM	0.48	0.747	-0.062	0.749	0.438	-0.027	0.438	0.054	0.647	0.649	-0.208	-0.639	0.672
BSN51250.00 DISC	0.48	0.759	-0.063	0.762	0.445	-0.028	0.446	0.055	0.657	0.660	-0.212	-0.649	0.683
BSN51250.00 TERM	0.48	0.747	-0.062	0.749	0.438	-0.027	0.438	0.054	0.647	0.649	-0.208	-0.639	0.672
BSN51260.00 DISC	0.48	0.759	-0.063	0.762	0.445	-0.028	0.446	0.055	0.657	0.660	-0.212	-0.649	0.683
BSN51260.00 TERM	0.48	0.747	-0.062	0.749	0.438	-0.027	0.438	0.054	0.647	0.649	-0.208	-0.639	0.672
BSN51270.00 DISC	0.48	0.759	-0.063	0.762	0.445	-0.028	0.446	0.055	0.657	0.660	-0.212	-0.649	0.683
BSN51270.00 TERM	0.48	0.747	-0.062	0.749	0.438	-0.027	0.438	0.054	0.647	0.649	-0.208	-0.639	0.672
COGEN TIE BUS	0.48	2.843	-44.458	44.549	4.013	-51.154	51.311	39.230	2.663	39.321	-41.458	26.247	49.068
COM53030.00 DISC	0.48	0.785	-0.066	0.788	0.460	-0.029	0.461	0.058	0.680	0.682	-0.220	-0.671	0.706
COM53030.00 TERM	0.48	0.772	-0.065	0.775	0.452	-0.028	0.453	0.056	0.668	0.671	-0.216	-0.660	0.694
COM53040.00 DISC	0.48	0.858	-0.075	0.861	0.503	-0.033	0.504	0.065	0.743	0.746	-0.243	-0.733	0.772
COM53040.00 TERM	0.48	0.842	-0.073	0.846	0.494	-0.032	0.495	0.063	0.729	0.732	-0.238	-0.720	0.758
CON51300.00 DISC	0.48	0.785	-0.066	0.788	0.460	-0.029	0.461	0.058	0.680	0.682	-0.220	-0.671	0.706
CON51300.00 TERM	0.48	0.772	-0.065	0.775	0.452	-0.028	0.453	0.056	0.668	0.671	-0.216	-0.660	0.694
CON51320.00 DISC	0.48	0.785	-0.066	0.788	0.460	-0.029	0.461	0.058	0.680	0.682	-0.220	-0.671	0.706

30 Cycle - 3-Phase, LG, LL, & LLG Fault Currents

Prefault Voltage = 100 % of the Bus Nominal Voltage

Bus		3-Phase Fault			Line-to-Ground Fault			Line-to-Line Fault			*Line-to-Line-to-Ground		
ID	kV	Real	Imag.	Mag.	Real	Imag.	Mag.	Real	Imag.	Mag.	Real	Imag.	Mag.
CON51320.00 TERM	0.48	0.772	-0.065	0.775	0.452	-0.028	0.453	0.056	0.668	0.671	-0.216	-0.660	0.694
CON53020.00 DISC	0.48	0.735	-0.061	0.737	0.431	-0.027	0.431	0.053	0.636	0.639	-0.205	-0.628	0.661
CON53020.00 TERM	0.48	0.723	-0.059	0.726	0.424	-0.026	0.425	0.051	0.626	0.629	-0.201	-0.619	0.650
CON53030.00 DISC	0.48	0.735	-0.061	0.737	0.431	-0.027	0.431	0.053	0.636	0.639	-0.205	-0.628	0.661
CON53030.00 TERM	0.48	0.723	-0.059	0.726	0.424	-0.026	0.425	0.051	0.626	0.629	-0.201	-0.619	0.650
EFF PS SWGR BUS A	0.48	2.660	-17.398	17.600	2.800	-18.388	18.600	15.067	2.304	15.242	13.589	12.053	18.164
EFF PS SWGR BUS A PRI	0.48	2.660	-17.398	17.600	2.800	-18.388	18.600	15.067	2.304	15.242	13.589	12.053	18.164
EFF PS SWGR BUS B	0.48	2.633	-17.402	17.600	2.774	-18.392	18.600	15.071	2.280	15.242	13.605	12.031	18.161
EFF PS SWGR BUS B PRI	0.48	2.633	-17.402	17.600	2.774	-18.392	18.600	15.071	2.280	15.242	13.605	12.031	18.161
EFF PUMP NO. 2 VFD PRI	0.48	2.931	-16.550	16.808	3.359	-16.959	17.289	14.333	2.538	14.556	-16.248	6.148	17.372
EFF PUMP NO. 4 VFD PRI	0.48	2.956	-16.545	16.807	3.382	-16.954	17.288	14.329	2.560	14.555	-16.254	6.124	17.369
F52410.00 DISC	0.48	0.622	-0.041	0.624	0.364	-0.018	0.364	0.035	0.539	0.540	-0.164	-0.533	0.558
F52410.00 STR	0.48	0.667	-0.045	0.669	0.390	-0.020	0.391	0.039	0.578	0.579	-0.177	-0.572	0.599
F52420.00 DISC	0.48	0.499	-0.030	0.500	0.292	-0.013	0.292	0.026	0.432	0.433	-0.129	-0.428	0.447
F52420.00 STR	0.48	0.527	-0.032	0.528	0.308	-0.014	0.309	0.028	0.457	0.458	-0.137	-0.452	0.473
F54330.00 DISC	0.48	2.449	-0.378	2.478	1.460	-0.148	1.467	0.328	2.121	2.146	-0.847	-2.080	2.245
F54330.00 TERM	0.48	2.327	-0.347	2.352	1.385	-0.137	1.391	0.301	2.015	2.037	-0.793	-1.977	2.130
F55010.00 TERM	0.48	3.706	-1.112	3.869	2.289	-0.480	2.339	0.963	3.209	3.350	-1.787	-3.068	3.550
GEN NO. 2 TERM	0.48	2.189	-18.883	19.009	3.566	-22.251	22.535	17.399	2.195	17.537	-19.216	9.622	21.491
GEN NO. 3 TERM	0.48	2.112	-19.139	19.256	3.479	-22.639	22.905	17.635	2.128	17.763	-19.402	9.953	21.806
GRIT SCR TROLLEY	0.48	0.735	-0.061	0.737	0.431	-0.027	0.431	0.053	0.636	0.639	-0.205	-0.628	0.661
HVAC56100.00 DISC	0.48	5.404	-2.072	5.787	3.470	-0.888	3.582	1.794	4.680	5.012	-3.060	-4.424	5.379
HVAC56100.00 TERM	0.48	5.049	-1.814	5.365	3.208	-0.773	3.300	1.571	4.372	4.646	-2.737	-4.150	4.971
HVAC56110.00 DISC	0.48	2.452	-0.438	2.491	1.466	-0.180	1.477	0.380	2.124	2.157	-0.902	-2.072	2.260
HVAC56110.00 TERM	0.48	2.330	-0.401	2.364	1.391	-0.165	1.401	0.348	2.018	2.048	-0.842	-1.970	2.143
HW ELEVATOR	0.48	6.980	-3.858	7.976	4.833	-1.792	5.155	3.341	6.045	6.907	-5.154	-5.515	7.549
HW GATES	0.48	0.416	-0.023	0.417	0.243	-0.010	0.243	0.020	0.361	0.361	-0.106	-0.357	0.373
INFL PUMP 1 TERMINALS	0.48	5.241	-17.696	18.456	5.915	-16.184	17.231	15.325	4.539	15.983	-18.498	2.864	18.718
INFL PUMP 1 VFD PRI	0.48	5.032	-22.958	23.503	5.683	-24.273	24.929	19.882	4.358	20.354	-23.113	8.509	24.630
INFL PUMP 2 TERMINALS	0.48	6.810	-15.577	17.001	7.632	-12.911	14.998	13.490	5.898	14.723	-17.395	-0.528	17.403
INFL PUMP 2 VFD	0.48	5.129	-22.147	22.734	5.873	-22.893	23.634	19.180	4.442	19.688	-22.539	7.388	23.719
INFL PUMP 2 VFD PRI	0.48	5.129	-22.147	22.734	5.873	-22.893	23.634	19.180	4.442	19.688	-22.539	7.388	23.719
INFL PUMP 3 TERMINALS	0.48	6.926	-16.015	17.449	7.870	-13.408	15.547	13.870	5.998	15.111	-17.944	-0.387	17.948
INFL PUMP 3 VFD	0.48	5.032	-22.958	23.503	5.683	-24.273	24.929	19.882	4.358	20.354	-23.113	8.509	24.630

30 Cycle - 3-Phase, LG, LL, & LLG Fault Currents

Prefault Voltage = 100 % of the Bus Nominal Voltage

Bus		3-Phase Fault			Line-to-Ground Fault			Line-to-Line Fault			*Line-to-Line-to-Ground		
ID	kV	Real	Imag.	Mag.	Real	Imag.	Mag.	Real	Imag.	Mag.	Real	Imag.	Mag.
INFL PUMP 3 VFD PRI	0.48	5.032	-22.958	23.503	5.683	-24.273	24.929	19.882	4.358	20.354	-23.113	8.509	24.630
INFL PUMP 4 TERMINALS	0.48	6.851	-15.719	17.147	7.711	-13.071	15.176	13.613	5.933	14.849	-17.573	-0.486	17.580
INFL PUMP 4 VFD	0.48	5.105	-22.411	22.985	5.822	-23.336	24.052	19.408	4.421	19.905	-22.735	7.738	24.015
INFL PUMP 4 VFD PRI	0.48	5.105	-22.411	22.985	5.822	-23.336	24.052	19.408	4.421	19.905	-22.735	7.738	24.015
INFL PUMP 5 TERMINALS	0.48	6.926	-16.015	17.449	7.870	-13.408	15.547	13.870	5.998	15.111	-17.944	-0.387	17.948
INFL PUMP 5 VFD	0.48	5.032	-22.958	23.503	5.683	-24.273	24.929	19.882	4.358	20.354	-23.113	8.509	24.630
INFL PUMP 5 VFD PRI	0.48	5.032	-22.958	23.503	5.683	-24.273	24.929	19.882	4.358	20.354	-23.113	8.509	24.630
INFL PUMP 6 TERMINALS	0.48	5.223	-17.027	17.810	5.828	-15.300	16.372	14.746	4.523	15.424	-17.825	2.369	17.982
INFL PUMP 6 VFD PRI	0.48	5.151	-21.890	22.488	5.916	-22.464	23.230	18.957	4.461	19.475	-22.340	7.055	23.428
LCP-HWOCS	0.48	3.844	-1.145	4.011	2.377	-0.489	2.426	0.992	3.329	3.474	-1.848	-3.186	3.683
MAIN SWGR "FILTER"	0.48	2.602	-41.045	41.128	3.275	-46.143	46.259	35.546	2.254	35.617	-37.672	24.085	44.713
MAIN SWGR "SLUDGE"	0.48	2.843	-44.458	44.549	4.013	-51.154	51.311	39.230	2.663	39.321	-41.458	26.247	49.068
MAIN SWGR BUS A PRI	0.48	2.602	-41.045	41.128	3.275	-46.143	46.259	35.546	2.254	35.617	-37.672	24.085	44.713
MAIN SWGR BUS B PRI	0.48	2.843	-44.458	44.549	4.013	-51.154	51.311	39.230	2.663	39.321	-41.458	26.247	49.068
MCC-DP2C	0.48	5.336	-12.563	13.649	4.928	-8.825	10.108	10.921	4.677	11.880	-13.042	-1.324	13.109
MCC-DP4A	0.48	1.683	-0.288	1.708	0.992	-0.133	1.001	0.249	1.458	1.479	-0.600	-1.416	1.538
MCC-DP4B	0.48	5.234	-38.525	38.879	8.322	-39.903	40.762	33.890	4.762	34.223	-39.230	15.194	42.070
MCC-GE	0.48	1.271	-12.013	12.080	1.750	-11.908	12.035	10.455	1.119	10.514	-11.518	4.716	12.446
MCC-GE PRI	0.48	7.193	-33.851	34.607	10.653	-31.980	33.707	29.700	6.471	30.397	-35.967	8.109	36.869
MCC-HW BUS A	0.48	5.102	-23.170	23.725	5.805	-24.628	25.303	20.066	4.418	20.546	-23.395	8.715	24.966
MCC-HW BUS A PRI	0.48	5.102	-23.170	23.725	5.805	-24.628	25.303	20.066	4.418	20.546	-23.395	8.715	24.966
MCC-HW BUS B	0.48	5.119	-23.166	23.724	5.819	-24.624	25.302	20.062	4.433	20.546	-23.398	8.699	24.962
MCC-HW BUS B PRI	0.48	5.119	-23.166	23.724	5.819	-24.624	25.302	20.062	4.433	20.546	-23.398	8.699	24.962
MCC-NA BUS A	2.40	0.503	-3.612	3.647	0.900	-3.602	3.713	3.128	0.436	3.158	-3.776	1.317	3.999
MCC-NA BUS A PRI	2.40	0.503	-3.612	3.647	0.900	-3.602	3.713	3.128	0.436	3.158	-3.776	1.317	3.999
MCC-NA BUS B	2.40	0.532	-3.738	3.775	0.950	-3.699	3.819	3.261	0.471	3.295	-3.910	1.295	4.119
MCC-NA BUS B PRI	2.40	0.532	-3.738	3.775	0.950	-3.699	3.819	3.261	0.471	3.295	-3.910	1.295	4.119
MCC-NC	0.48	1.581	-9.424	9.556	2.059	-11.216	11.403	8.162	1.369	8.276	-9.595	5.549	11.084
MCC-ND	0.48	1.638	-9.586	9.725	2.150	-11.394	11.595	8.333	1.434	8.456	-9.789	5.523	11.240
MCC-NE	0.48	1.717	-9.033	9.194	2.372	-10.366	10.634	7.823	1.487	7.963	-9.535	4.565	10.572
MCC-NF	0.48	1.767	-9.185	9.354	2.446	-10.525	10.806	7.983	1.547	8.132	-9.700	4.545	10.712
MCC-NG BUS A	0.48	2.120	-5.807	6.182	2.558	-4.989	5.606	5.029	1.836	5.353	-6.407	0.291	6.414
MCC-NG BUS A PRI	0.48	2.120	-5.807	6.182	2.558	-4.989	5.606	5.029	1.836	5.353	-6.407	0.291	6.414
MCC-NG BUS B	0.48	2.164	-5.864	6.251	2.596	-5.018	5.650	5.088	1.885	5.426	-6.468	0.247	6.473

30 Cycle - 3-Phase, LG, LL, & LLG Fault Currents

Prefault Voltage = 100 % of the Bus Nominal Voltage

Bus		3-Phase Fault			Line-to-Ground Fault			Line-to-Line Fault			*Line-to-Line-to-Ground		
ID	kV	Real	Imag.	Mag.	Real	Imag.	Mag.	Real	Imag.	Mag.	Real	Imag.	Mag.
MCC-NG BUS B PRI	0.48	2.164	-5.864	6.251	2.596	-5.018	5.650	5.088	1.885	5.426	-6.468	0.247	6.473
MCC-SH BUS A	0.48	2.104	-5.495	5.884	2.466	-4.603	5.222	4.759	1.822	5.096	-6.053	0.105	6.054
MCC-SH BUS A PRI	0.48	2.104	-5.495	5.884	2.466	-4.603	5.222	4.759	1.822	5.096	-6.053	0.105	6.054
MCC-SH BUS B	0.48	2.101	-5.456	5.846	2.454	-4.556	5.175	4.725	1.819	5.063	-6.008	0.083	6.008
MCC-SH BUS B PRI	0.48	2.152	-5.648	6.044	2.533	-4.751	5.384	4.901	1.874	5.247	-6.223	0.119	6.224
MS-HW BUS A	0.48	4.837	-24.426	24.900	5.179	-26.906	27.400	21.153	4.189	21.564	18.372	19.161	26.546
MS-HW BUS A PRI	0.48	4.837	-24.426	24.900	5.179	-26.906	27.400	21.153	4.189	21.564	18.372	19.161	26.546
MS-HW BUS B	0.48	4.855	-24.422	24.900	5.196	-26.903	27.400	21.150	4.205	21.564	18.362	19.176	26.549
MS-HW BUS B PRI	0.48	4.855	-24.422	24.900	5.196	-26.903	27.400	21.150	4.205	21.564	18.362	19.176	26.549
P52100.00 DISC	0.48	3.476	-1.549	3.806	2.216	-0.745	2.337	1.342	3.010	3.296	-2.149	-2.776	3.511
P52100.00 TERM	0.48	3.431	-1.521	3.753	2.184	-0.731	2.303	1.317	2.971	3.250	-2.113	-2.741	3.461
P52110.00 DISC	0.48	2.572	-0.783	2.688	1.572	-0.360	1.613	0.678	2.227	2.328	-1.242	-2.116	2.454
P52110.00 TERM	0.48	2.535	-0.767	2.648	1.548	-0.353	1.588	0.664	2.195	2.293	-1.220	-2.086	2.416
P52120.00 DISC	0.48	3.670	-1.674	4.034	2.351	-0.804	2.485	1.449	3.178	3.493	-2.308	-2.926	3.727
P52120.00 TERM	0.48	3.620	-1.641	3.974	2.316	-0.788	2.447	1.421	3.135	3.442	-2.266	-2.887	3.670
P52130.00 DISC	0.48	2.733	-0.852	2.863	1.676	-0.390	1.721	0.738	2.367	2.479	-1.340	-2.246	2.616
P52130.00 TERM	0.48	2.691	-0.833	2.817	1.649	-0.382	1.693	0.722	2.330	2.440	-1.314	-2.212	2.573
P52140.00 DISC	0.48	4.260	-2.082	4.742	2.776	-1.001	2.951	1.803	3.690	4.106	-2.823	-3.377	4.402
P52140.00 TERM	0.48	4.193	-2.033	4.660	2.727	-0.977	2.897	1.761	3.631	4.036	-2.762	-3.326	4.323
P52150.00 DISC	0.48	3.238	-1.086	3.416	2.006	-0.494	2.066	0.941	2.804	2.958	-1.664	-2.653	3.132
P52150.00 TERM	0.48	3.180	-1.058	3.351	1.967	-0.481	2.026	0.916	2.754	2.902	-1.625	-2.606	3.072
P52160.00 DISC	0.48	3.362	-1.148	3.553	2.089	-0.521	2.153	0.994	2.912	3.077	-1.748	-2.753	3.261
P52160.00 TERM	0.48	3.299	-1.117	3.483	2.047	-0.507	2.109	0.967	2.857	3.017	-1.705	-2.702	3.195
P52170.00 DISC	0.48	3.566	-1.253	3.780	2.225	-0.568	2.296	1.085	3.088	3.273	-1.889	-2.916	3.474
P52170.00 TERM	0.48	3.495	-1.216	3.701	2.178	-0.551	2.246	1.053	3.027	3.205	-1.840	-2.859	3.400
P52220.00 DISC	0.48	0.681	-0.055	0.683	0.399	-0.024	0.399	0.047	0.589	0.591	-0.188	-0.582	0.612
P52220.00 TERM	0.48	0.671	-0.054	0.673	0.393	-0.024	0.394	0.046	0.581	0.583	-0.185	-0.574	0.603
P52230.00 DISC	0.48	0.681	-0.055	0.683	0.399	-0.024	0.399	0.047	0.589	0.591	-0.188	-0.582	0.612
P52230.00 TERM	0.48	0.671	-0.054	0.673	0.393	-0.024	0.394	0.046	0.581	0.583	-0.185	-0.574	0.603
P52240.00 DISC	0.48	0.858	-0.075	0.861	0.503	-0.033	0.504	0.065	0.743	0.746	-0.243	-0.733	0.772
P52240.00 TERM	0.48	0.842	-0.073	0.846	0.494	-0.032	0.495	0.063	0.729	0.732	-0.238	-0.720	0.758
P52250.00 DISC	0.48	0.858	-0.075	0.861	0.503	-0.033	0.504	0.065	0.743	0.746	-0.243	-0.733	0.772
P52250.00 TERM	0.48	0.842	-0.073	0.846	0.494	-0.032	0.495	0.063	0.729	0.732	-0.238	-0.720	0.758
P54080.00 DISC	0.48	1.408	-0.155	1.416	0.829	-0.064	0.832	0.135	1.219	1.226	-0.428	-1.200	1.275

30 Cycle - 3-Phase, LG, LL, & LLG Fault Currents

Prefault Voltage = 100 % of the Bus Nominal Voltage

Bus		3-Phase Fault			Line-to-Ground Fault			Line-to-Line Fault			*Line-to-Line-to-Ground		
ID	kV	Real	Imag.	Mag.	Real	Imag.	Mag.	Real	Imag.	Mag.	Real	Imag.	Mag.
P54080.00 TERM	0.48	1.366	-0.149	1.374	0.805	-0.061	0.807	0.129	1.183	1.190	-0.414	-1.165	1.236
P54090.00 DISC	0.48	1.408	-0.155	1.416	0.829	-0.064	0.832	0.135	1.219	1.226	-0.428	-1.200	1.275
P54090.00 TERM	0.48	1.366	-0.149	1.374	0.805	-0.061	0.807	0.129	1.183	1.190	-0.414	-1.165	1.236
P55020.00 TERM	0.48	3.104	-0.762	3.196	1.886	-0.323	1.913	0.660	2.688	2.768	-1.335	-2.593	2.917
P55030.00 TERM	0.48	3.104	-0.762	3.196	1.886	-0.323	1.913	0.660	2.688	2.768	-1.335	-2.593	2.917
PNL DP2	0.48	6.067	-15.742	16.870	5.999	-11.500	12.971	13.701	5.336	14.704	-16.375	-0.883	16.398
PNL DP4	0.48	4.362	-41.640	41.868	7.085	-45.537	46.085	36.688	4.006	36.906	-41.418	20.176	46.070
PNL DPLC-1	0.21	1.051	-1.638	1.946	1.062	-1.673	1.982	1.418	0.910	1.685	0.882	1.765	1.973
PNL DPLC-2	0.21	0.997	-1.187	1.550	1.003	-1.310	1.650	1.028	0.863	1.342	0.530	1.588	1.674
PNL DPLC-3	0.21	1.086	-1.494	1.847	1.119	-1.426	1.813	1.294	0.941	1.600	-1.867	-0.261	1.885
PNL DPLC-4	0.21	0.609	-0.632	0.877	0.613	-0.622	0.874	0.547	0.527	0.760	-0.856	-0.221	0.884
PNL DPP1	0.48	9.502	-10.227	13.960	8.562	-6.131	10.531	8.857	8.229	12.090	-12.491	-6.231	13.959
PNL DPP1 PRI	0.48	9.502	-10.227	13.960	8.562	-6.131	10.531	8.857	8.229	12.090	-12.491	-6.231	13.959
SCR BLDG N OH DOOR DISC	0.48	1.224	-0.140	1.232	0.721	-0.060	0.723	0.121	1.060	1.067	-0.376	-1.042	1.108
SCR BLDG N OH DOOR TERM	0.48	1.192	-0.134	1.200	0.702	-0.058	0.704	0.116	1.033	1.039	-0.365	-1.015	1.079
SCR BLDG S OH DOOR DISC	0.48	1.329	-0.159	1.339	0.784	-0.068	0.787	0.138	1.151	1.160	-0.416	-1.131	1.205
SCR BLDG S OH DOOR TERM	0.48	1.292	-0.152	1.301	0.762	-0.065	0.764	0.132	1.119	1.127	-0.402	-1.100	1.171
SEP53000.00 DISC	0.48	0.735	-0.061	0.737	0.431	-0.027	0.431	0.053	0.636	0.639	-0.205	-0.628	0.661
SEP53000.00 TERM	0.48	0.723	-0.059	0.726	0.424	-0.026	0.425	0.051	0.627	0.629	-0.201	-0.619	0.650
SEP53010.00 DISC	0.48	0.735	-0.061	0.737	0.431	-0.027	0.431	0.053	0.636	0.639	-0.205	-0.628	0.661
SEP53010.00 TERM	0.48	0.723	-0.059	0.726	0.424	-0.026	0.425	0.051	0.626	0.629	-0.201	-0.619	0.650
SEP53020.00 DISC	0.48	0.712	-0.058	0.715	0.417	-0.026	0.418	0.050	0.617	0.619	-0.198	-0.609	0.640
SEP53020.00 TERM	0.48	0.701	-0.057	0.704	0.411	-0.025	0.412	0.049	0.607	0.609	-0.195	-0.600	0.631
SR-DAF	0.48	2.018	-6.914	7.203	2.651	-6.565	7.080	5.988	1.747	6.238	-7.578	1.313	7.691
SR-DAF PRI	0.48	2.018	-6.914	7.203	2.651	-6.565	7.080	5.988	1.747	6.238	-7.578	1.313	7.691
SWBD GDP	0.48	1.669	-20.429	20.497	2.914	-24.662	24.833	18.824	1.734	18.904	-20.224	11.764	23.396
SWBD-NB BUS A	0.48	1.561	-9.515	9.643	2.007	-11.417	11.592	8.241	1.352	8.351	-9.621	5.778	11.223
SWBD-NB BUS A PRI	0.48	1.561	-9.515	9.643	2.007	-11.417	11.592	8.241	1.352	8.351	-9.621	5.778	11.223
SWBD-NB BUS B	0.48	1.608	-9.686	9.818	2.075	-11.614	11.798	8.420	1.409	8.538	-9.799	5.778	11.376
SWBD-NB BUS B PRI	0.48	1.608	-9.686	9.818	2.075	-11.614	11.798	8.420	1.409	8.538	-9.799	5.778	11.376
TRANSF TA PRI	0.48	2.602	-41.045	41.128	3.275	-46.143	46.259	35.546	2.254	35.617	-37.672	24.085	44.713
TRANSF TB PRI	0.48	2.843	-44.458	44.549	4.013	-51.154	51.311	39.230	2.663	39.321	-41.458	26.247	49.068
TRANSF TB SEC	2.40	0.444	-4.295	4.318	0.582	-5.154	5.186	3.753	0.397	3.774	-4.119	2.759	4.958
TRANSF TC PRI	2.40	0.512	-3.587	3.623	0.909	-3.544	3.659	3.106	0.444	3.138	-3.751	1.264	3.959

30 Cycle - 3-Phase, LG, LL, & LLG Fault Currents

Prefault Voltage = 100 % of the Bus Nominal Voltage

Bus		3-Phase Fault			Line-to-Ground Fault			Line-to-Line Fault			*Line-to-Line-to-Ground		
ID	kV	Real	Imag.	Mag.	Real	Imag.	Mag.	Real	Imag.	Mag.	Real	Imag.	Mag.
TRANSF TC SEC	0.48	1.518	-9.702	9.820	1.888	-11.836	11.986	8.402	1.315	8.505	-9.648	6.272	11.508
TRANSF TD PRI	2.40	0.541	-3.710	3.750	0.959	-3.637	3.761	3.237	0.480	3.273	-3.883	1.241	4.077
TRANSF TD SEC	0.48	1.564	-9.880	10.003	1.953	-12.050	12.207	8.590	1.371	8.699	-9.831	6.281	11.666
XFMR T-C4 PRI	0.48	7.083	-3.481	7.893	4.807	-1.538	5.047	3.015	6.134	6.835	-4.803	-5.695	7.450
XFMR T-C4 SEC	0.21	0.611	-0.665	0.903	0.616	-0.679	0.917	0.576	0.529	0.782	0.265	0.876	0.915
XFMR T-LC1 PRI	0.48	8.852	-6.431	10.941	6.777	-3.215	7.501	5.569	7.666	9.475	-8.216	-6.706	10.605
XFMR T-LC1 SEC	0.21	1.052	-1.659	1.965	1.062	-1.711	2.013	1.437	0.911	1.702	0.902	1.794	2.008
XFMR T-LC2 PRI	0.48	2.811	-0.758	2.911	1.711	-0.335	1.744	0.656	2.434	2.521	-1.269	-2.333	2.656
XFMR T-LC2 SEC	0.21	0.997	-1.192	1.554	1.002	-1.320	1.657	1.032	0.864	1.346	0.536	1.596	1.684

All fault currents are symmetrical momentary (30 Cycle network) values in rms kA

* LLG fault current is the larger of the two faulted line currents

Short-Circuit Summary Report

Bus		Positive Sequence Imp. (ohm)			Negative Sequence Imp. (ohm)			Zero Sequence Imp. (ohm)		
ID	kV	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance
ATS-L BUS A	0.480	0.00344	0.01159	0.01209	0.00344	0.01159	0.01209	0.00544	0.00961	0.01104
ATS-L BUS B	0.480	0.00562	0.01201	0.01326	0.00562	0.01201	0.01326	0.01228	0.01064	0.01625
ATS-L SEC	0.480	0.00344	0.01159	0.01209	0.00344	0.01159	0.01209	0.00544	0.00961	0.01104
B20100.00 TERMINALS	2.400	0.06711	0.39044	0.39617	0.06711	0.39044	0.39617	0.21464	0.39405	0.44871
B20200.00 TERMINALS	2.400	0.06774	0.39106	0.39688	0.06774	0.39106	0.39688	0.21673	0.39668	0.45202
B20400.00 TERMINALS	2.400	0.06861	0.37968	0.38583	0.06943	0.37376	0.38015	0.22195	0.40325	0.46030
B52180.00 DISC	0.480	0.04551	0.02366	0.05130	0.04551	0.02366	0.05130	0.13796	0.03931	0.14346
B52180.00 TERM	0.480	0.04706	0.02396	0.05281	0.04706	0.02396	0.05281	0.14285	0.04005	0.14835
B52190.00 DISC	0.480	0.06452	0.02341	0.06863	0.06452	0.02341	0.06863	0.19782	0.03869	0.20156
B52190.00 TERM	0.480	0.06607	0.02371	0.07019	0.06607	0.02371	0.07019	0.20270	0.03942	0.20650
B52210.00 DISC	0.480	0.17802	0.02603	0.17991	0.17802	0.02603	0.17991	0.55534	0.04514	0.55717
B52210.00 TERM	0.480	0.18192	0.02636	0.18382	0.18192	0.02636	0.18382	0.56763	0.04594	0.56948
B52220.00 DISC	0.480	0.18971	0.02701	0.19162	0.18971	0.02701	0.19162	0.59219	0.04754	0.59410
B52220.00 TERM	0.480	0.19361	0.02733	0.19553	0.19361	0.02733	0.19553	0.60448	0.04834	0.60641
BLWR BLDG TROLLEY	0.480	0.06131	0.01909	0.06421	0.06131	0.01909	0.06421	0.18773	0.02806	0.18982
BSN51240.00 DISC	0.480	0.36251	0.03031	0.36378	0.36251	0.03031	0.36378	1.13651	0.05566	1.13788
BSN51240.00 TERM	0.480	0.36851	0.03062	0.36978	0.36851	0.03062	0.36978	1.15541	0.05643	1.15679
BSN51250.00 DISC	0.480	0.36252	0.03031	0.36378	0.36252	0.03031	0.36378	1.13652	0.05566	1.13788
BSN51250.00 TERM	0.480	0.36852	0.03062	0.36979	0.36852	0.03062	0.36979	1.15542	0.05643	1.15679
BSN51260.00 DISC	0.480	0.36251	0.03031	0.36378	0.36251	0.03031	0.36378	1.13651	0.05566	1.13788
BSN51260.00 TERM	0.480	0.36851	0.03062	0.36978	0.36851	0.03062	0.36978	1.15541	0.05643	1.15679
BSN51270.00 DISC	0.480	0.36252	0.03031	0.36378	0.36252	0.03031	0.36378	1.13652	0.05566	1.13788
BSN51270.00 TERM	0.480	0.36852	0.03062	0.36979	0.36852	0.03062	0.36979	1.15542	0.05643	1.15679
COGEN TIE BUS	0.480	0.00040	0.00621	0.00622	0.00043	0.00597	0.00599	0.00044	0.00397	0.00400
COM53030.00 DISC	0.480	0.35051	0.02968	0.35177	0.35051	0.02968	0.35177	1.09871	0.05411	1.10004
COM53030.00 TERM	0.480	0.35651	0.02999	0.35777	0.35651	0.02999	0.35777	1.11761	0.05488	1.11896
COM53040.00 DISC	0.480	0.32052	0.02810	0.32175	0.32052	0.02810	0.32175	1.00422	0.05023	1.00547
COM53040.00 TERM	0.480	0.32652	0.02842	0.32775	0.32652	0.02842	0.32775	1.02312	0.05101	1.02439
CON51300.00 DISC	0.480	0.35051	0.02968	0.35177	0.35051	0.02968	0.35177	1.09871	0.05411	1.10004
CON51300.00 TERM	0.480	0.35651	0.02999	0.35777	0.35651	0.02999	0.35777	1.11761	0.05488	1.11896
CON51320.00 DISC	0.480	0.35051	0.02968	0.35177	0.35051	0.02968	0.35177	1.09871	0.05411	1.10004
CON51320.00 TERM	0.480	0.35651	0.02999	0.35777	0.35651	0.02999	0.35777	1.11761	0.05488	1.11896
CON53020.00 DISC	0.480	0.37452	0.03094	0.37580	0.37452	0.03094	0.37580	1.17432	0.05721	1.17571
CON53020.00 TERM	0.480	0.38052	0.03125	0.38180	0.38052	0.03125	0.38180	1.19322	0.05798	1.19462
CON53030.00 DISC	0.480	0.37452	0.03094	0.37580	0.37452	0.03094	0.37580	1.17432	0.05721	1.17571

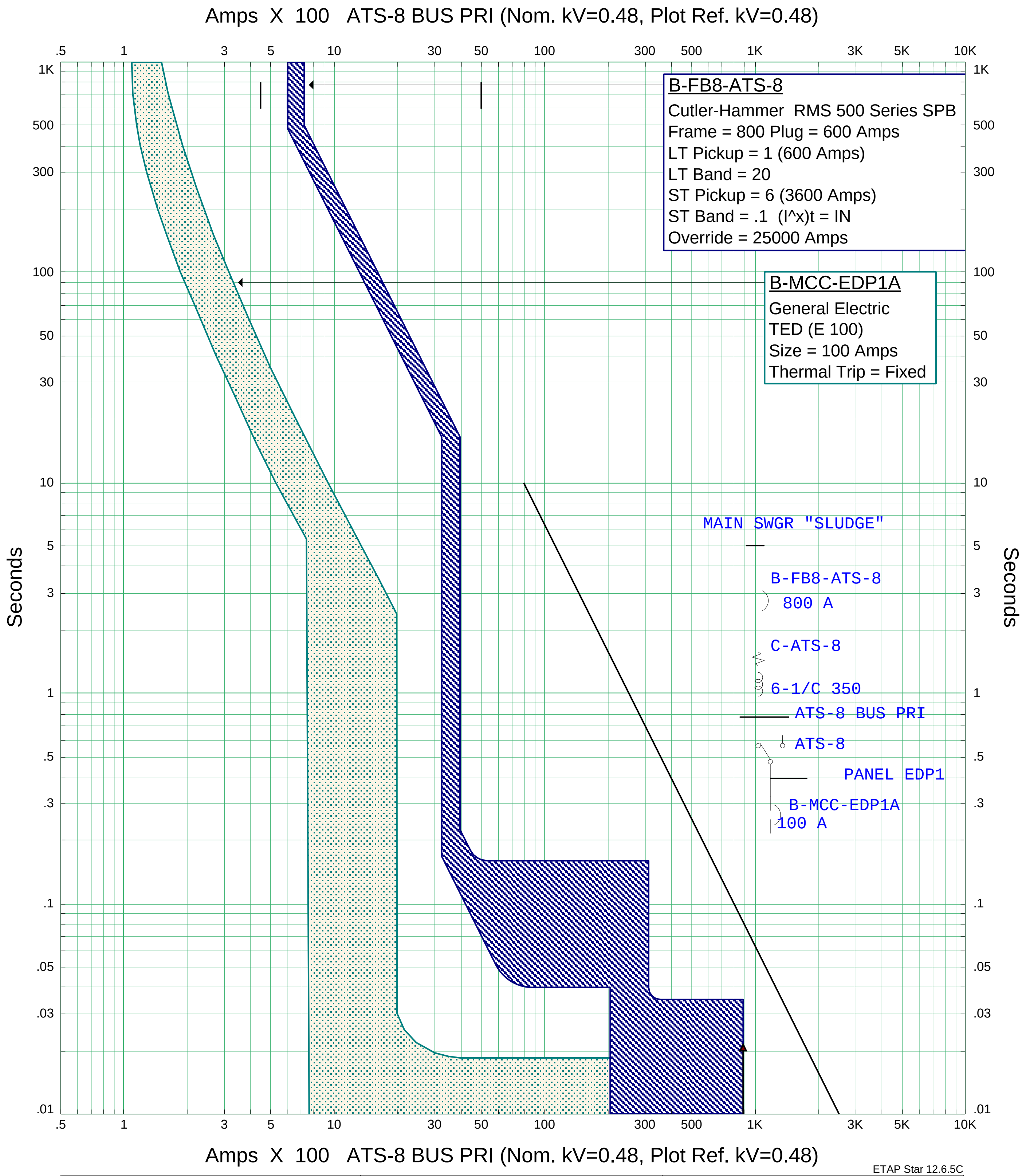
Bus		Positive Sequence Imp. (ohm)			Negative Sequence Imp. (ohm)			Zero Sequence Imp. (ohm)		
ID	kV	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance
CON53030.00 TERM	0.480	0.38052	0.03125	0.38180	0.38052	0.03125	0.38180	1.19322	0.05798	1.19462
EFF PS SWGR BUS A	0.480	0.00238	0.01557	0.01575	0.00238	0.01557	0.01575	0.00197	0.01306	0.01321
EFF PS SWGR BUS A PRI	0.480	0.00238	0.01557	0.01575	0.00238	0.01557	0.01575	0.00197	0.01306	0.01321
EFF PS SWGR BUS B	0.480	0.00236	0.01557	0.01575	0.00236	0.01557	0.01575	0.00196	0.01306	0.01321
EFF PS SWGR BUS B PRI	0.480	0.00236	0.01557	0.01575	0.00236	0.01557	0.01575	0.00196	0.01306	0.01321
EFF PUMP NO. 2 VFD PRI	0.480	0.00288	0.01624	0.01649	0.00288	0.01624	0.01649	0.00359	0.01470	0.01513
EFF PUMP NO. 4 VFD PRI	0.480	0.00290	0.01623	0.01649	0.00290	0.01623	0.01649	0.00361	0.01470	0.01513
F52410.00 DISC	0.480	0.44351	0.02916	0.44447	0.44351	0.02916	0.44447	1.39166	0.05284	1.39267
F52410.00 STR	0.480	0.41351	0.02814	0.41447	0.41351	0.02814	0.41447	1.29716	0.05033	1.29814
F52420.00 DISC	0.480	0.55351	0.03290	0.55449	0.55351	0.03290	0.55449	1.73816	0.06204	1.73927
F52420.00 STR	0.480	0.52351	0.03188	0.52448	0.52351	0.03188	0.52448	1.64366	0.05953	1.64474
F54330.00 DISC	0.480	0.11052	0.01708	0.11183	0.11052	0.01708	0.11183	0.34272	0.02311	0.34349
F54330.00 TERM	0.480	0.11652	0.01739	0.11781	0.11652	0.01739	0.11781	0.36162	0.02389	0.36240
F55010.00 TERM	0.480	0.06861	0.02058	0.07163	0.06861	0.02058	0.07163	0.21073	0.03174	0.21311
GEN NO. 2 TERM	0.480	0.00168	0.01448	0.01458	0.00175	0.01267	0.01279	0.00241	0.00927	0.00958
GEN NO. 3 TERM	0.480	0.00158	0.01431	0.01439	0.00166	0.01252	0.01263	0.00228	0.00905	0.00933
GRIT SCR TROLLEY	0.480	0.37451	0.03094	0.37579	0.37451	0.03094	0.37579	1.17431	0.05721	1.17571
HVAC56100.00 DISC	0.480	0.04471	0.01714	0.04789	0.04471	0.01714	0.04789	0.13544	0.02327	0.13743
HVAC56100.00 TERM	0.480	0.04861	0.01747	0.05165	0.04861	0.01747	0.05165	0.14773	0.02407	0.14968
HVAC56110.00 DISC	0.480	0.10951	0.01958	0.11125	0.10951	0.01958	0.11125	0.33956	0.02928	0.34082
HVAC56110.00 TERM	0.480	0.11551	0.01990	0.11721	0.11551	0.01990	0.11721	0.35846	0.03005	0.35972
HW ELEVATOR	0.480	0.03041	0.01681	0.03475	0.03041	0.01681	0.03475	0.09040	0.02245	0.09314
HW GATES	0.480	0.66351	0.03664	0.66452	0.66351	0.03664	0.66452	2.08466	0.07124	2.08588
INFL PUMP 1 TERMINALS	0.480	0.00426	0.01440	0.01502	0.00426	0.01440	0.01502	0.00803	0.01652	0.01837
INFL PUMP 1 VFD PRI	0.480	0.00252	0.01152	0.01179	0.00252	0.01152	0.01179	0.00255	0.00944	0.00978
INFL PUMP 2 TERMINALS	0.480	0.00653	0.01494	0.01630	0.00653	0.01494	0.01630	0.01515	0.01785	0.02341
INFL PUMP 2 VFD	0.480	0.00275	0.01188	0.01219	0.00275	0.01188	0.01219	0.00324	0.01032	0.01082
INFL PUMP 2 VFD PRI	0.480	0.00275	0.01188	0.01219	0.00275	0.01188	0.01219	0.00324	0.01032	0.01082
INFL PUMP 3 TERMINALS	0.480	0.00630	0.01458	0.01588	0.00630	0.01458	0.01588	0.01446	0.01696	0.02229
INFL PUMP 3 VFD	0.480	0.00252	0.01152	0.01179	0.00252	0.01152	0.01179	0.00255	0.00944	0.00978
INFL PUMP 3 VFD PRI	0.480	0.00252	0.01152	0.01179	0.00252	0.01152	0.01179	0.00255	0.00944	0.00978
INFL PUMP 4 TERMINALS	0.480	0.00646	0.01482	0.01616	0.00646	0.01482	0.01616	0.01492	0.01755	0.02304
INFL PUMP 4 VFD	0.480	0.00268	0.01176	0.01206	0.00268	0.01176	0.01206	0.00301	0.01003	0.01047
INFL PUMP 4 VFD PRI	0.480	0.00268	0.01176	0.01206	0.00268	0.01176	0.01206	0.00301	0.01003	0.01047
INFL PUMP 5 TERMINALS	0.480	0.00630	0.01458	0.01588	0.00630	0.01458	0.01588	0.01446	0.01696	0.02229
INFL PUMP 5 VFD	0.480	0.00252	0.01152	0.01179	0.00252	0.01152	0.01179	0.00255	0.00944	0.00978
INFL PUMP 5 VFD PRI	0.480	0.00252	0.01152	0.01179	0.00252	0.01152	0.01179	0.00255	0.00944	0.00978

Bus		Positive Sequence Imp. (ohm)			Negative Sequence Imp. (ohm)			Zero Sequence Imp. (ohm)		
ID	kV	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance
INFL PUMP 6 TERMINALS	0.480	0.00456	0.01488	0.01556	0.00456	0.01488	0.01556	0.00895	0.01770	0.01984
INFL PUMP 6 VFD PRI	0.480	0.00282	0.01200	0.01232	0.00282	0.01200	0.01232	0.00347	0.01062	0.01117
LCP-HWOCS	0.480	0.06621	0.01973	0.06909	0.06621	0.01973	0.06909	0.20317	0.02963	0.20532
MAIN SWGR "FILTER"	0.480	0.00043	0.00672	0.00674	0.00043	0.00672	0.00674	0.00042	0.00448	0.00450
MAIN SWGR "SLUDGE"	0.480	0.00040	0.00621	0.00622	0.00043	0.00597	0.00599	0.00044	0.00397	0.00400
MAIN SWGR BUS A PRI	0.480	0.00043	0.00672	0.00674	0.00043	0.00672	0.00674	0.00042	0.00448	0.00450
MAIN SWGR BUS B PRI	0.480	0.00040	0.00621	0.00622	0.00043	0.00597	0.00599	0.00044	0.00397	0.00400
MCC-DP2C	0.480	0.00794	0.01869	0.02030	0.00797	0.01845	0.02010	0.02419	0.03467	0.04228
MCC-DP4A	0.480	0.15994	0.02738	0.16227	0.15997	0.02715	0.16226	0.50300	0.05606	0.50611
MCC-DP4B	0.480	0.00096	0.00706	0.00713	0.00099	0.00683	0.00690	0.00221	0.00608	0.00647
MCC-GE	0.480	0.00241	0.02281	0.02294	0.00245	0.02258	0.02271	0.00518	0.02295	0.02353
MCC-GE PRI	0.480	0.00166	0.00783	0.00801	0.00170	0.00760	0.00778	0.00443	0.00797	0.00912
MCC-HW BUS A	0.480	0.00251	0.01141	0.01168	0.00251	0.01141	0.01168	0.00251	0.00917	0.00950
MCC-HW BUS A PRI	0.480	0.00251	0.01141	0.01168	0.00251	0.01141	0.01168	0.00251	0.00917	0.00950
MCC-HW BUS B	0.480	0.00252	0.01141	0.01168	0.00252	0.01141	0.01168	0.00252	0.00917	0.00950
MCC-HW BUS B PRI	0.480	0.00252	0.01141	0.01168	0.00252	0.01141	0.01168	0.00252	0.00917	0.00950
MCC-NA BUS A	2.400	0.05241	0.37630	0.37993	0.05241	0.37630	0.37993	0.16660	0.33356	0.37285
MCC-NA BUS A PRI	2.400	0.05241	0.37630	0.37993	0.05241	0.37630	0.37993	0.16660	0.33356	0.37285
MCC-NA BUS B	2.400	0.05167	0.36338	0.36704	0.05249	0.35746	0.36130	0.16660	0.33356	0.37285
MCC-NA BUS B PRI	2.400	0.05167	0.36338	0.36704	0.05249	0.35746	0.36130	0.16660	0.33356	0.37285
MCC-NC	0.480	0.00480	0.02860	0.02900	0.00480	0.02860	0.02900	0.00357	0.01451	0.01494
MCC-ND	0.480	0.00480	0.02809	0.02850	0.00483	0.02785	0.02827	0.00366	0.01452	0.01498
MCC-NE	0.480	0.00563	0.02961	0.03014	0.00563	0.02961	0.03014	0.00618	0.01699	0.01808
MCC-NF	0.480	0.00560	0.02909	0.02963	0.00563	0.02886	0.02940	0.00618	0.01699	0.01808
MCC-NG BUS A	0.480	0.01538	0.04211	0.04483	0.01538	0.04211	0.04483	0.03690	0.04774	0.06034
MCC-NG BUS A PRI	0.480	0.01538	0.04211	0.04483	0.01538	0.04211	0.04483	0.03690	0.04774	0.06034
MCC-NG BUS B	0.480	0.01535	0.04159	0.04434	0.01538	0.04136	0.04412	0.03690	0.04774	0.06034
MCC-NG BUS B PRI	0.480	0.01535	0.04159	0.04434	0.01538	0.04136	0.04412	0.03690	0.04774	0.06034
MCC-SH BUS A	0.480	0.01684	0.04399	0.04710	0.01684	0.04399	0.04710	0.04150	0.05236	0.06681
MCC-SH BUS A PRI	0.480	0.01684	0.04399	0.04710	0.01684	0.04399	0.04710	0.04150	0.05236	0.06681
MCC-SH BUS B	0.480	0.01704	0.04424	0.04740	0.01704	0.04424	0.04740	0.04212	0.05297	0.06767
MCC-SH BUS B PRI	0.480	0.01632	0.04284	0.04585	0.01636	0.04261	0.04564	0.03997	0.05082	0.06465
MS-HW BUS A	0.480	0.00216	0.01092	0.01113	0.00216	0.01092	0.01113	0.00141	0.00796	0.00808
MS-HW BUS A PRI	0.480	0.00216	0.01092	0.01113	0.00216	0.01092	0.01113	0.00141	0.00796	0.00808
MS-HW BUS B	0.480	0.00217	0.01092	0.01113	0.00217	0.01092	0.01113	0.00141	0.00796	0.00808
MS-HW BUS B PRI	0.480	0.00217	0.01092	0.01113	0.00217	0.01092	0.01113	0.00141	0.00796	0.00808
P52100.00 DISC	0.480	0.06651	0.02965	0.07282	0.06651	0.02965	0.07282	0.20411	0.05404	0.21115

Bus		Positive Sequence Imp. (ohm)			Negative Sequence Imp. (ohm)			Zero Sequence Imp. (ohm)		
ID	kV	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance
P52100.00 TERM	0.480	0.06751	0.02993	0.07385	0.06751	0.02993	0.07385	0.20726	0.05474	0.21437
P52110.00 DISC	0.480	0.09862	0.03001	0.10308	0.09862	0.03001	0.10308	0.30523	0.05492	0.31013
P52110.00 TERM	0.480	0.10017	0.03031	0.10465	0.10017	0.03031	0.10465	0.31011	0.05566	0.31507
P52120.00 DISC	0.480	0.06251	0.02851	0.06871	0.06251	0.02851	0.06871	0.19151	0.05123	0.19825
P52120.00 TERM	0.480	0.06351	0.02879	0.06973	0.06351	0.02879	0.06973	0.19466	0.05193	0.20147
P52130.00 DISC	0.480	0.09242	0.02881	0.09681	0.09242	0.02881	0.09681	0.28570	0.05197	0.29039
P52130.00 TERM	0.480	0.09397	0.02911	0.09837	0.09397	0.02911	0.09837	0.29058	0.05271	0.29533
P52140.00 DISC	0.480	0.05251	0.02566	0.05844	0.05251	0.02566	0.05844	0.16001	0.04422	0.16601
P52140.00 TERM	0.480	0.05351	0.02594	0.05947	0.05351	0.02594	0.05947	0.16316	0.04492	0.16923
P52150.00 DISC	0.480	0.07692	0.02581	0.08113	0.07692	0.02581	0.08113	0.23688	0.04459	0.24104
P52150.00 TERM	0.480	0.07847	0.02611	0.08270	0.07847	0.02611	0.08270	0.24176	0.04533	0.24597
P52160.00 DISC	0.480	0.07381	0.02521	0.07800	0.07381	0.02521	0.07800	0.22711	0.04311	0.23116
P52160.00 TERM	0.480	0.07536	0.02551	0.07956	0.07536	0.02551	0.07956	0.23199	0.04385	0.23610
P52170.00 DISC	0.480	0.06917	0.02431	0.07332	0.06917	0.02431	0.07332	0.21246	0.04090	0.21636
P52170.00 TERM	0.480	0.07072	0.02461	0.07488	0.07072	0.02461	0.07488	0.21735	0.04164	0.22130
P52220.00 DISC	0.480	0.40451	0.03251	0.40582	0.40451	0.03251	0.40582	1.26881	0.06108	1.27028
P52220.00 TERM	0.480	0.41051	0.03283	0.41182	0.41051	0.03283	0.41182	1.28771	0.06186	1.28920
P52230.00 DISC	0.480	0.40451	0.03251	0.40582	0.40451	0.03251	0.40582	1.26881	0.06108	1.27028
P52230.00 TERM	0.480	0.41051	0.03283	0.41182	0.41051	0.03283	0.41182	1.28771	0.06186	1.28920
P52240.00 DISC	0.480	0.32052	0.02810	0.32175	0.32052	0.02810	0.32175	1.00422	0.05023	1.00547
P52240.00 TERM	0.480	0.32652	0.02842	0.32775	0.32652	0.02842	0.32775	1.02312	0.05101	1.02439
P52250.00 DISC	0.480	0.32052	0.02810	0.32175	0.32052	0.02810	0.32175	1.00422	0.05023	1.00547
P52250.00 TERM	0.480	0.32652	0.02842	0.32775	0.32652	0.02842	0.32775	1.02312	0.05101	1.02439
P54080.00 DISC	0.480	0.19451	0.02149	0.19570	0.19451	0.02149	0.19570	0.60731	0.03396	0.60826
P54080.00 TERM	0.480	0.20051	0.02180	0.20169	0.20051	0.02180	0.20169	0.62621	0.03474	0.62718
P54090.00 DISC	0.480	0.19451	0.02149	0.19570	0.19451	0.02149	0.19570	0.60731	0.03396	0.60826
P54090.00 TERM	0.480	0.20051	0.02180	0.20169	0.20051	0.02180	0.20169	0.62621	0.03474	0.62718
P55020.00 TERM	0.480	0.08421	0.02067	0.08671	0.08421	0.02067	0.08671	0.25987	0.03196	0.26183
P55030.00 TERM	0.480	0.08421	0.02067	0.08671	0.08421	0.02067	0.08671	0.25987	0.03196	0.26183
PNL DP2	0.480	0.00591	0.01533	0.01643	0.00594	0.01509	0.01622	0.01780	0.02641	0.03185
PNL DP4	0.480	0.00069	0.00658	0.00662	0.00072	0.00635	0.00639	0.00136	0.00490	0.00508
PNL DPLC-1	0.208	0.03333	0.05194	0.06171	0.03333	0.05194	0.06171	0.03078	0.04961	0.05839
PNL DPLC-2	0.208	0.04982	0.05932	0.07747	0.04982	0.05932	0.07747	0.03310	0.05475	0.06398
PNL DPLC-3	0.208	0.03823	0.05258	0.06501	0.03823	0.05258	0.06501	0.04621	0.05119	0.06896
PNL DPLC-4	0.208	0.09492	0.09859	0.13685	0.09492	0.09859	0.13685	0.09954	0.09661	0.13871
PNL DPP1	0.480	0.01351	0.01454	0.01985	0.01351	0.01454	0.01985	0.03716	0.01688	0.04082
PNL DPP1 PRI	0.480	0.01351	0.01454	0.01985	0.01351	0.01454	0.01985	0.03716	0.01688	0.04082

Bus		Positive Sequence Imp. (ohm)			Negative Sequence Imp. (ohm)			Zero Sequence Imp. (ohm)		
ID	kV	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance
SCR BLDG N OH DOOR DISC	0.480	0.22351	0.02557	0.22497	0.22351	0.02557	0.22497	0.69866	0.04400	0.70005
SCR BLDG N OH DOOR TERM	0.480	0.22951	0.02588	0.23097	0.22951	0.02588	0.23097	0.71756	0.04477	0.71896
SCR BLDG S OH DOOR DISC	0.480	0.20551	0.02462	0.20698	0.20551	0.02462	0.20698	0.64196	0.04167	0.64332
SCR BLDG S OH DOOR TERM	0.480	0.21151	0.02494	0.21298	0.21151	0.02494	0.21298	0.66086	0.04245	0.66223
SEP53000.00 DISC	0.480	0.37451	0.03094	0.37579	0.37451	0.03094	0.37579	1.17431	0.05721	1.17571
SEP53000.00 TERM	0.480	0.38051	0.03125	0.38179	0.38051	0.03125	0.38179	1.19321	0.05798	1.19462
SEP53010.00 DISC	0.480	0.37452	0.03094	0.37580	0.37452	0.03094	0.37580	1.17432	0.05721	1.17571
SEP53010.00 TERM	0.480	0.38052	0.03125	0.38180	0.38052	0.03125	0.38180	1.19322	0.05798	1.19462
SEP53020.00 DISC	0.480	0.38652	0.03157	0.38781	0.38652	0.03157	0.38781	1.21212	0.05876	1.21354
SEP53020.00 TERM	0.480	0.39252	0.03188	0.39381	0.39252	0.03188	0.39381	1.23102	0.05953	1.23246
SR-DAF	0.480	0.01078	0.03694	0.03848	0.01078	0.03694	0.03848	0.02241	0.03501	0.04157
SR-DAF PRI	0.480	0.01078	0.03694	0.03848	0.01078	0.03694	0.03848	0.02241	0.03501	0.04157
SWBD GDP	0.480	0.00110	0.01348	0.01352	0.00123	0.01181	0.01187	0.00160	0.00796	0.00812
SWBD-NB BUS A	0.480	0.00465	0.02836	0.02874	0.00465	0.02836	0.02874	0.00311	0.01392	0.01426
SWBD-NB BUS A PRI	0.480	0.00465	0.02836	0.02874	0.00465	0.02836	0.02874	0.00311	0.01392	0.01426
SWBD-NB BUS B	0.480	0.00462	0.02784	0.02823	0.00466	0.02761	0.02800	0.00311	0.01392	0.01426
SWBD-NB BUS B PRI	0.480	0.00462	0.02784	0.02823	0.00466	0.02761	0.02800	0.00311	0.01392	0.01426
TRANSF TA PRI	0.480	0.00043	0.00672	0.00674	0.00043	0.00672	0.00674	0.00042	0.00448	0.00450
TRANSF TB PRI	0.480	0.00040	0.00621	0.00622	0.00043	0.00597	0.00599	0.00044	0.00397	0.00400
TRANSF TB SEC	2.400	0.03303	0.31918	0.32089	0.03385	0.31326	0.31508	0.02310	0.16398	0.16560
TRANSF TC PRI	2.400	0.05407	0.37860	0.38244	0.05407	0.37860	0.38244	0.17413	0.34322	0.38486
TRANSF TC SEC	0.480	0.00436	0.02788	0.02822	0.00436	0.02788	0.02822	0.00220	0.01274	0.01293
TRANSF TD PRI	2.400	0.05333	0.36568	0.36955	0.05415	0.35976	0.36381	0.17413	0.34322	0.38486
TRANSF TD SEC	0.480	0.00433	0.02736	0.02771	0.00437	0.02713	0.02748	0.00220	0.01274	0.01293
XFMR T-C4 PRI	0.480	0.03151	0.01549	0.03511	0.03151	0.01549	0.03511	0.09386	0.01920	0.09581
XFMR T-C4 SEC	0.208	0.09002	0.09795	0.13303	0.09002	0.09795	0.13303	0.08410	0.09504	0.12691
XFMR T-LC1 PRI	0.480	0.02049	0.01489	0.02533	0.02049	0.01489	0.02533	0.05915	0.01773	0.06175
XFMR T-LC1 SEC	0.208	0.03273	0.05161	0.06112	0.03273	0.05161	0.06112	0.02889	0.04882	0.05672
XFMR T-LC2 PRI	0.480	0.09191	0.02478	0.09519	0.09191	0.02478	0.09519	0.28412	0.04207	0.28722
XFMR T-LC2 SEC	0.208	0.04957	0.05926	0.07726	0.04957	0.05926	0.07726	0.03231	0.05461	0.06345

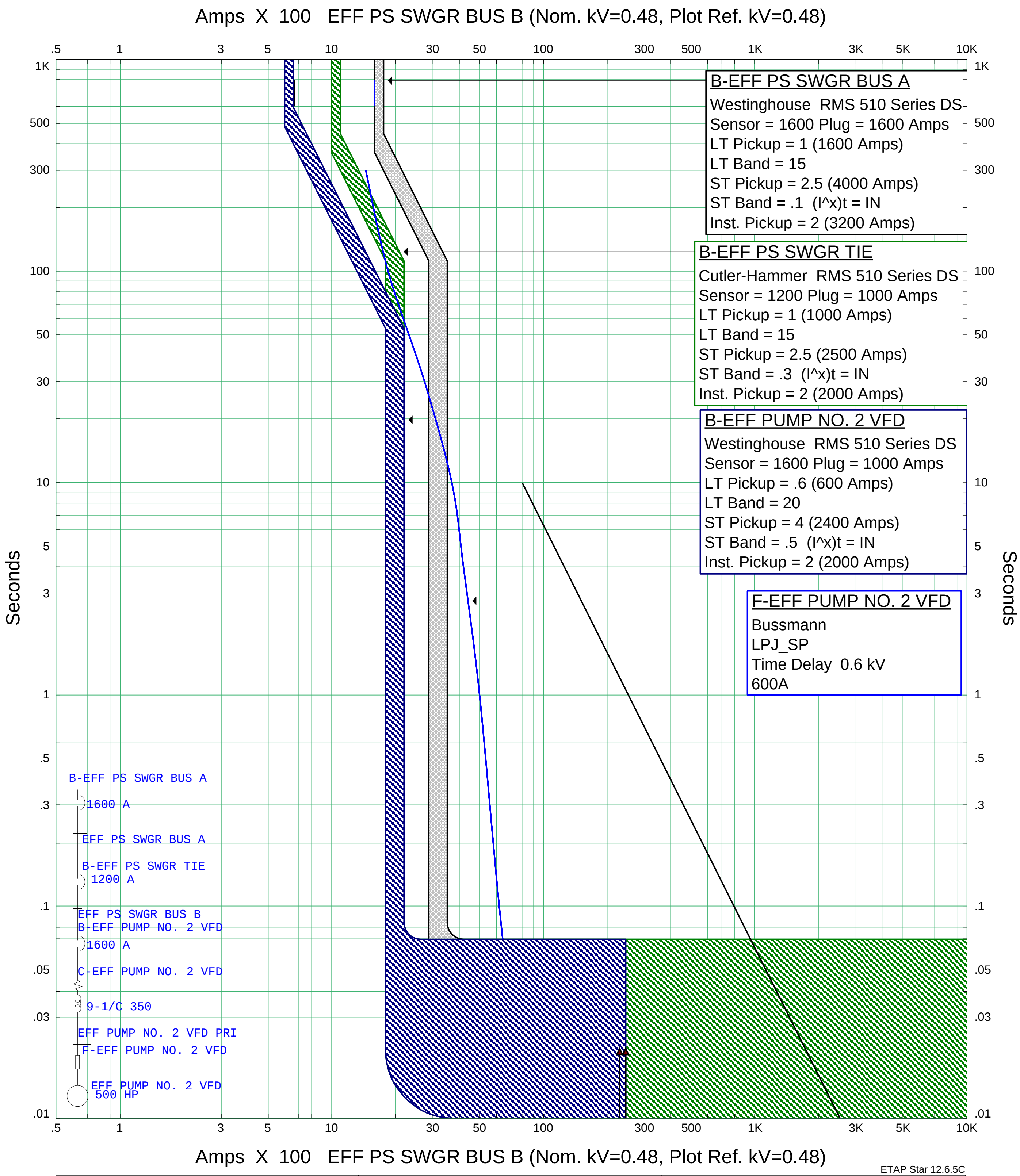
APPENDIX C – TIME CURRENT CURVES



ATS 8 TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

Date: 04-07-2015
SN: CAROLLOWAN
Rev: Base
Fault: Phase

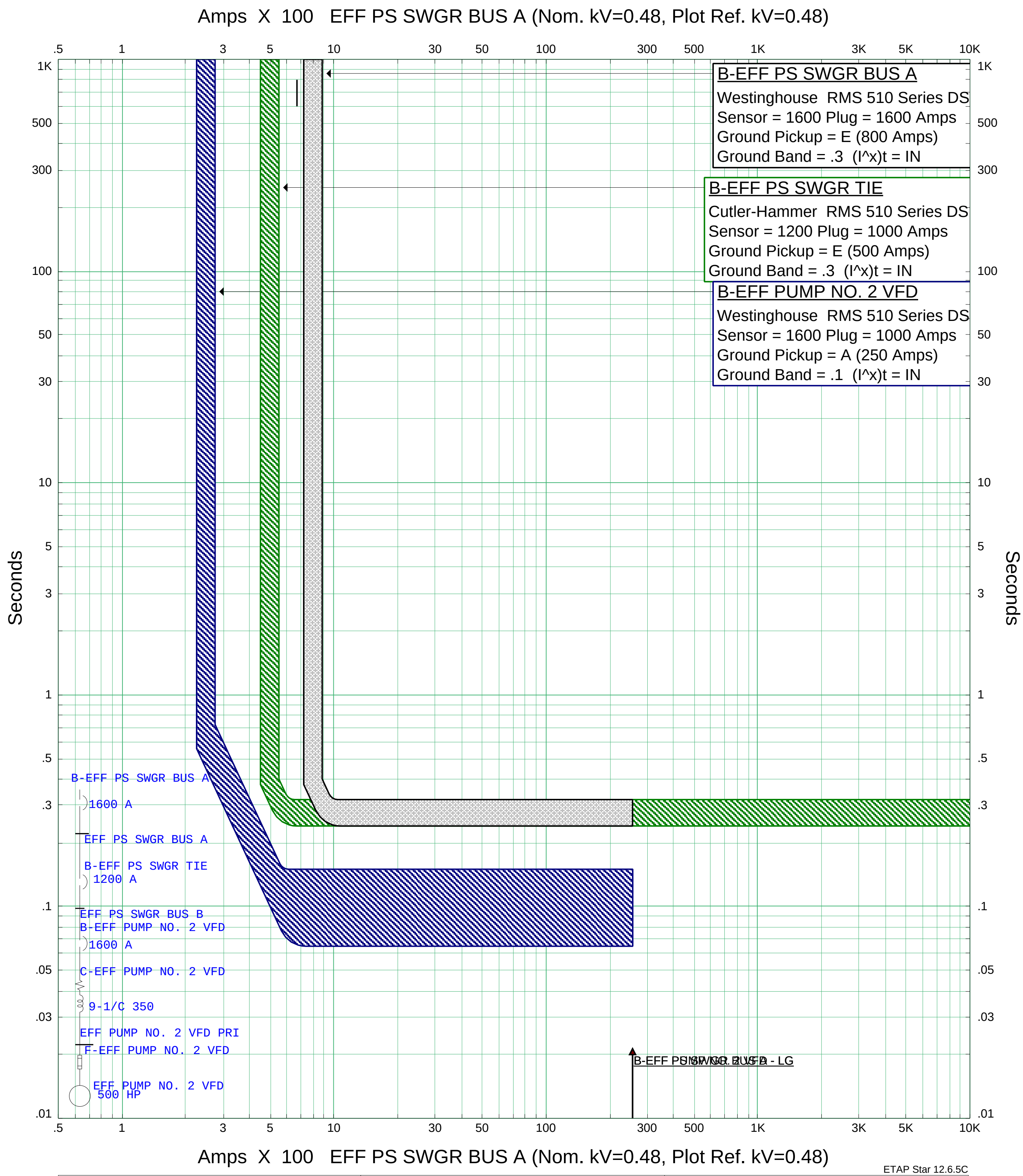


ETAP Star 12.6.5C

EFF PUMP NO 2 VFD TIE TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

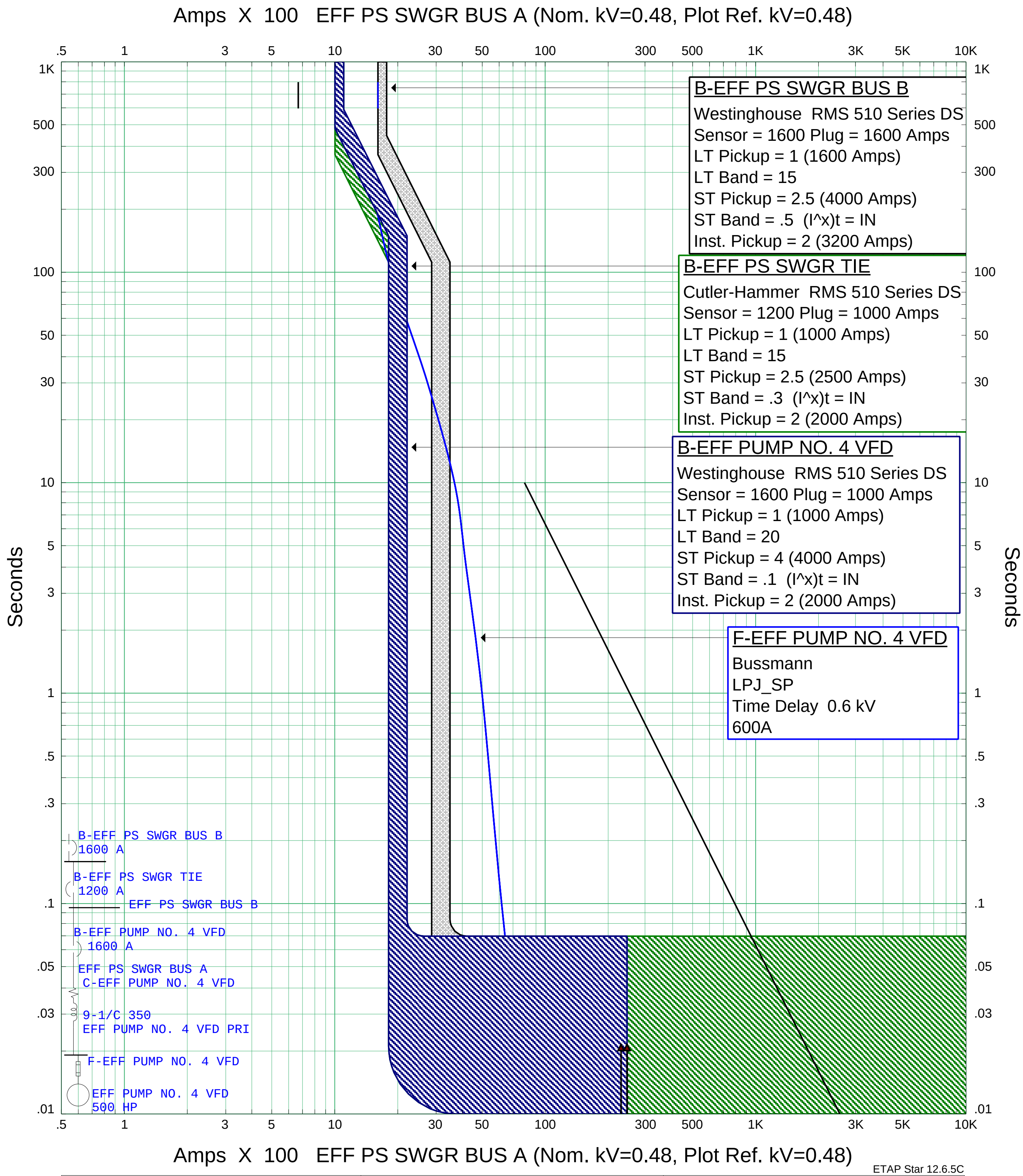
Date: 04-06-2015
SN: CAROLLOWAN
Rev: Base
Fault: Phase



EFF PUMP NO 2 VFD TIE TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

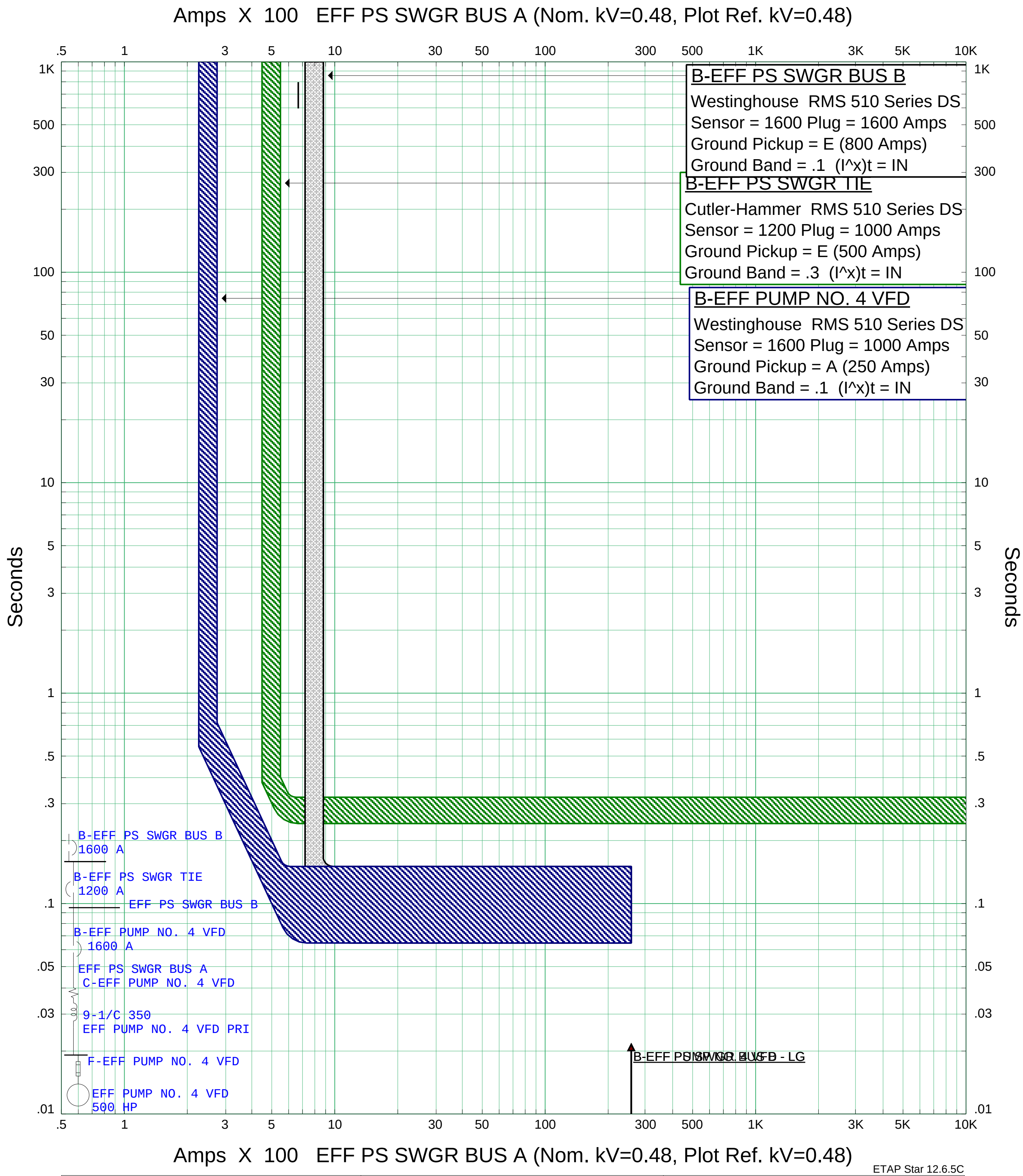
Date: 04-06-2015
SN: CAROLLOWAN
Rev: Base
Fault: Ground



EFF PUMP NO 4 VFD TIE TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

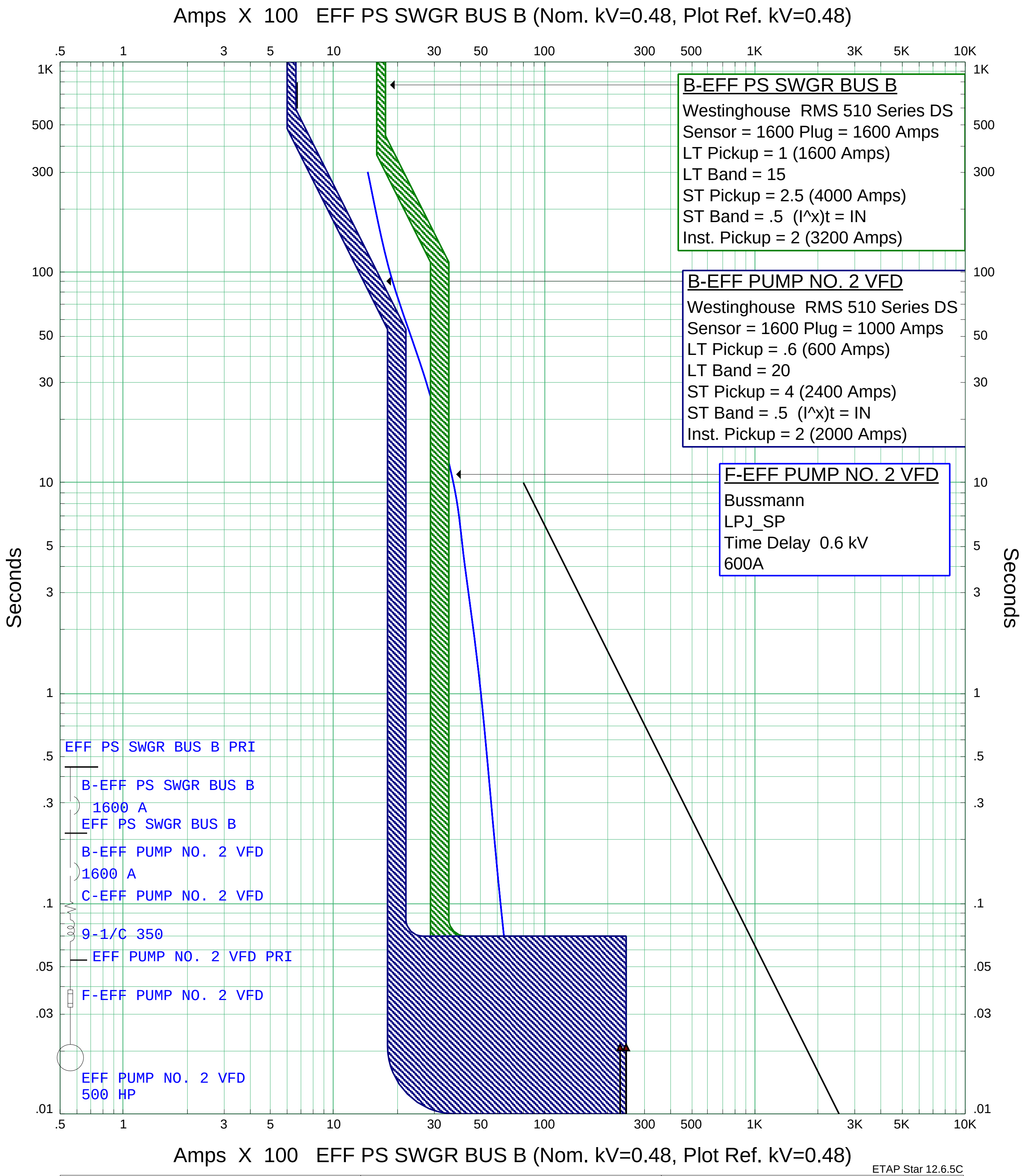
Date: 04-06-2015
SN: CAROLLOWAN
Rev: Base
Fault: Phase



EFF PUMP NO 4 VFD TIE TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

Date: 04-06-2015
SN: CAROLLOWAN
Rev: Base
Fault: Ground



EFF PUMP NO. 2 VFD TCC

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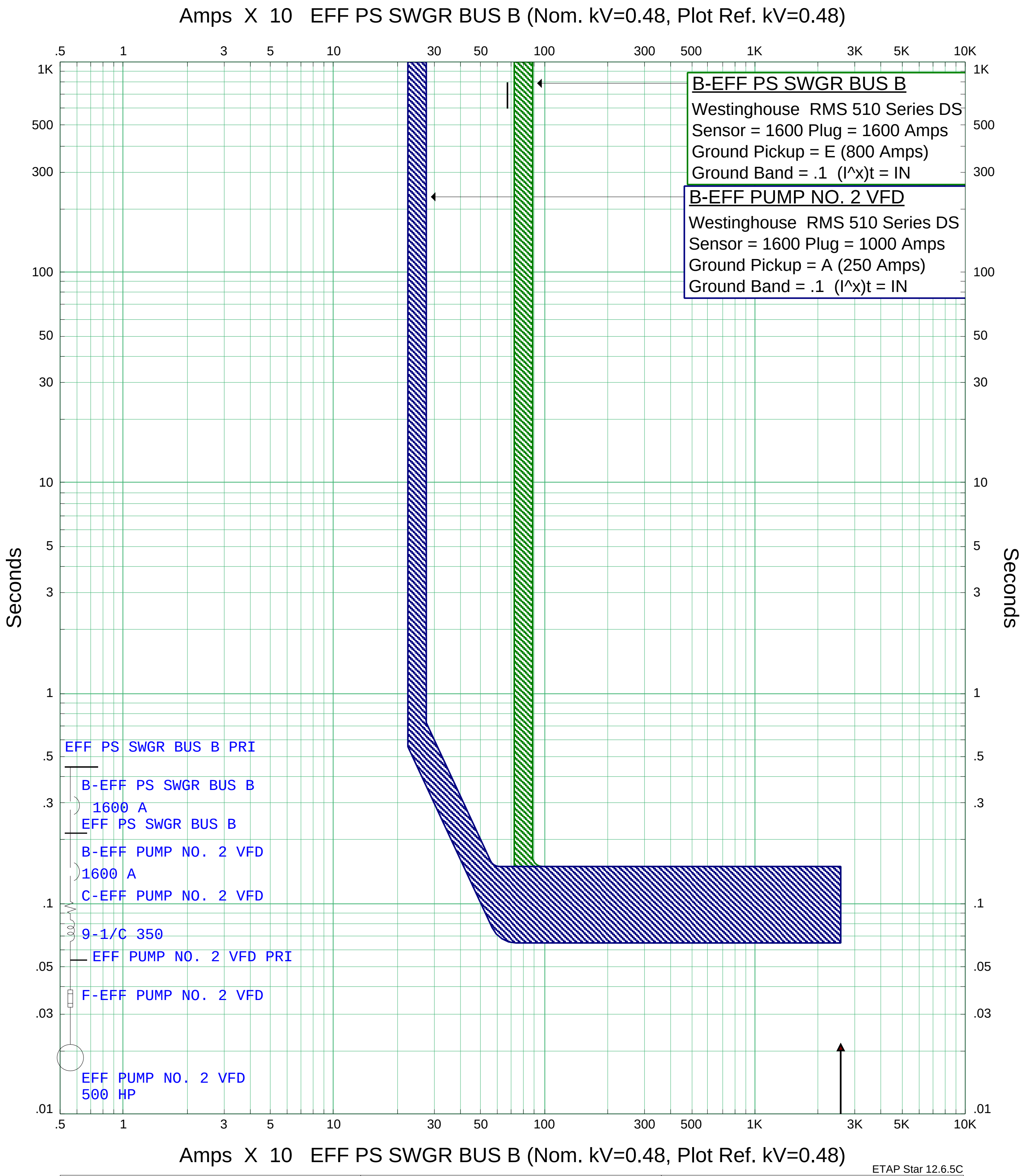

ETAP Star 12.6.5C

EFF PUMP NO. 2 VFD TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
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Date: 04-06-2015
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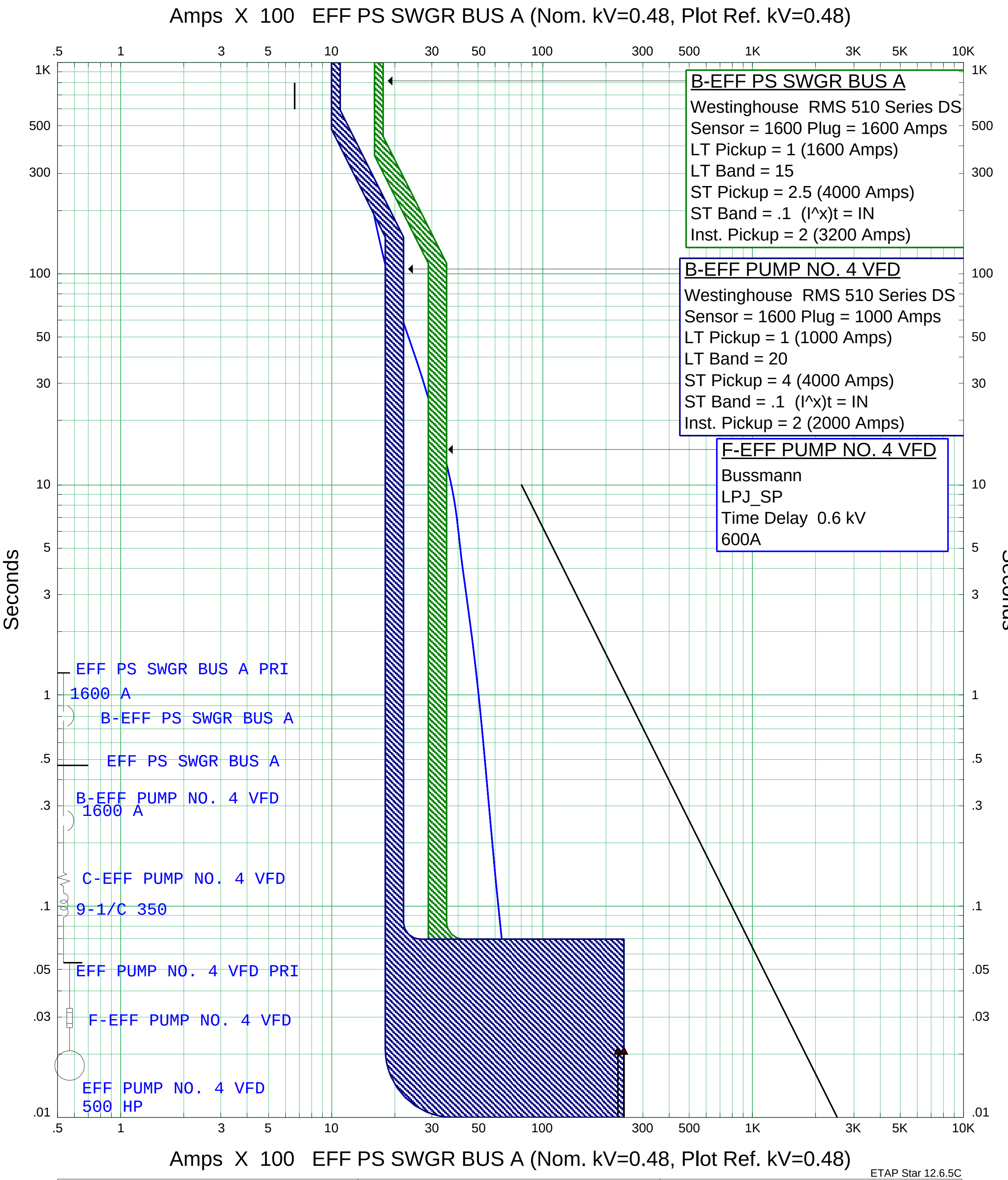
Rev: Base
Fault: Ground



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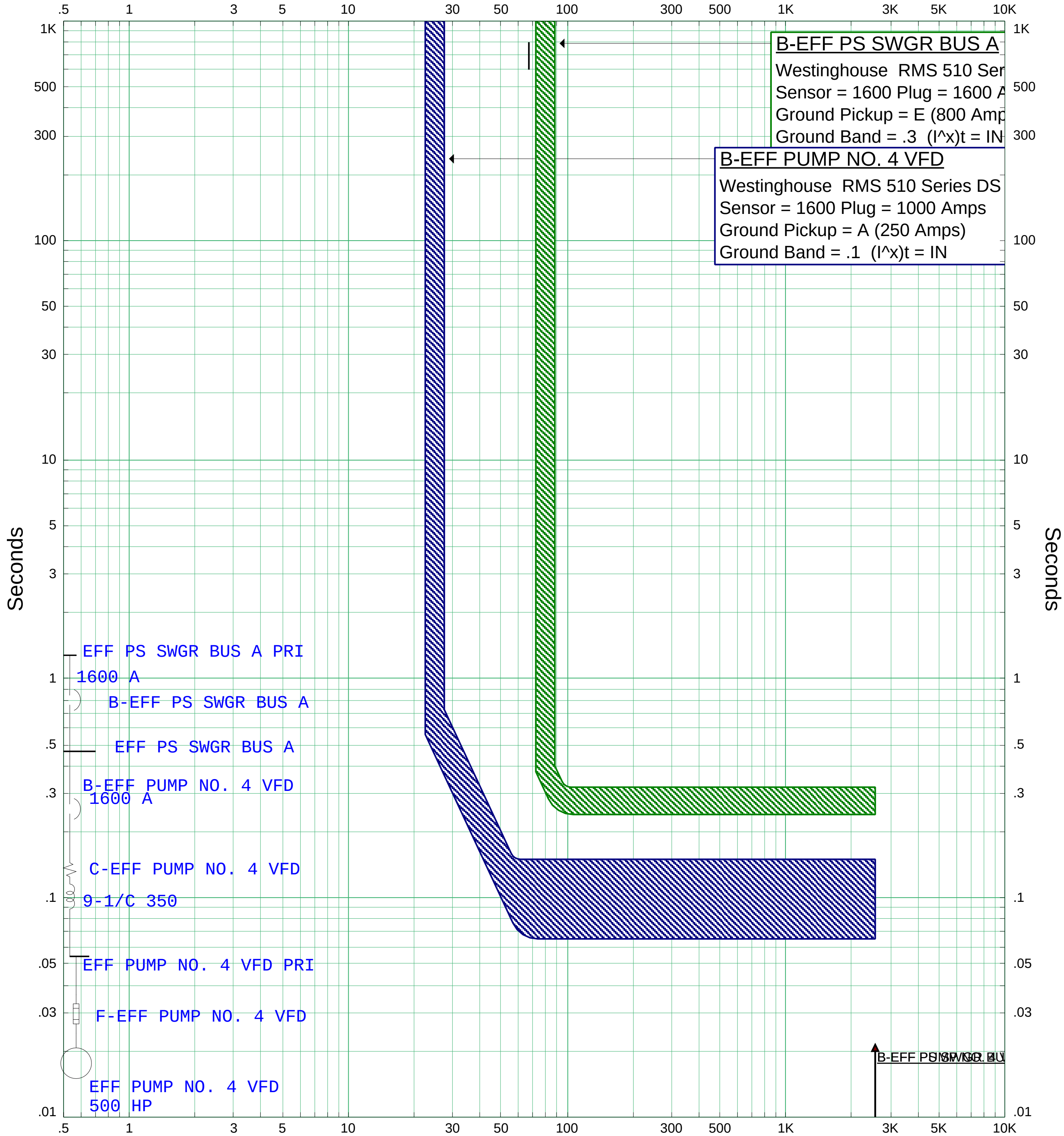
Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

Date: 04-06-2015
SN: CAROLLOWAN
Rev: Base
Fault: Phase

Amps X 10 EFF PS SWGR BUS A PRI (Nom. kV=0.48, Plot Ref. kV=0.48)



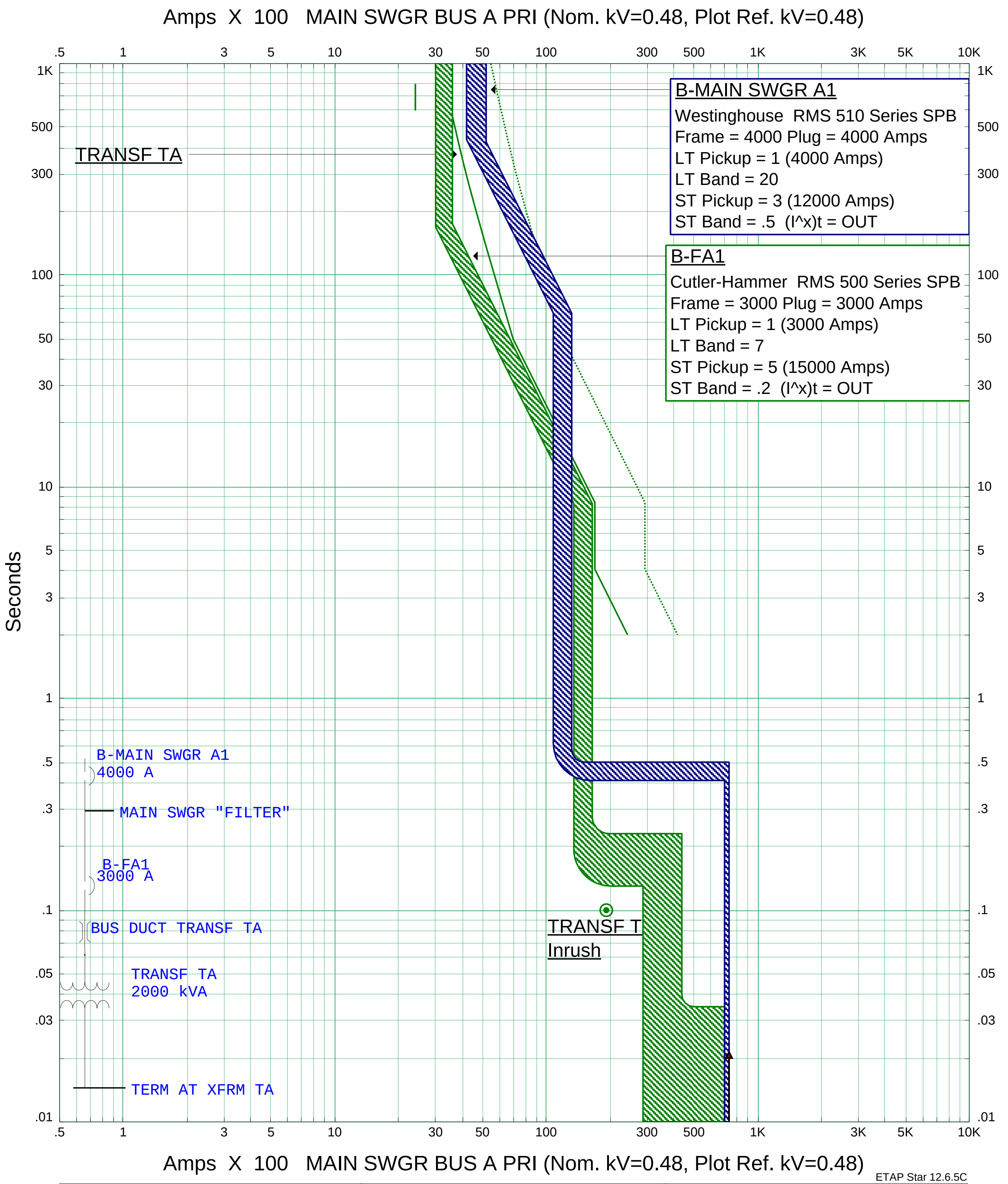
Amps X 10 EFF PS SWGR BUS A PRI (Nom. kV=0.48, Plot Ref. kV=0.48)

ETAP Star 12.6.5C

EFF PUMP NO. 4 VFD TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

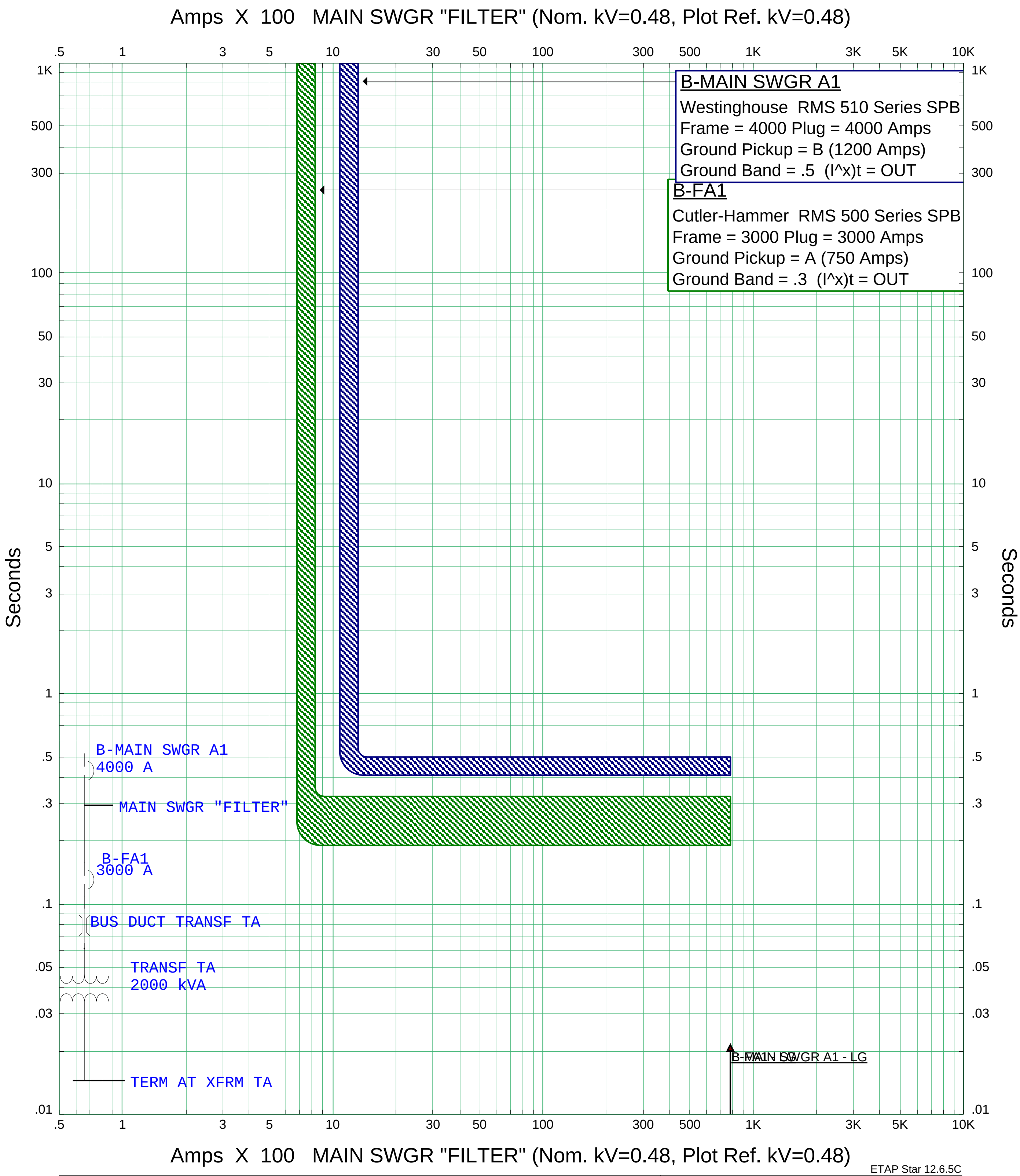
Date: 04-06-2015
SN: CAROLLOWAN
Rev: Base
Fault: Ground



MAIN SWGR FILTER TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

Date: 04-06-2015
SN: CAROLLOWAN
Rev: Base
Fault: Phase

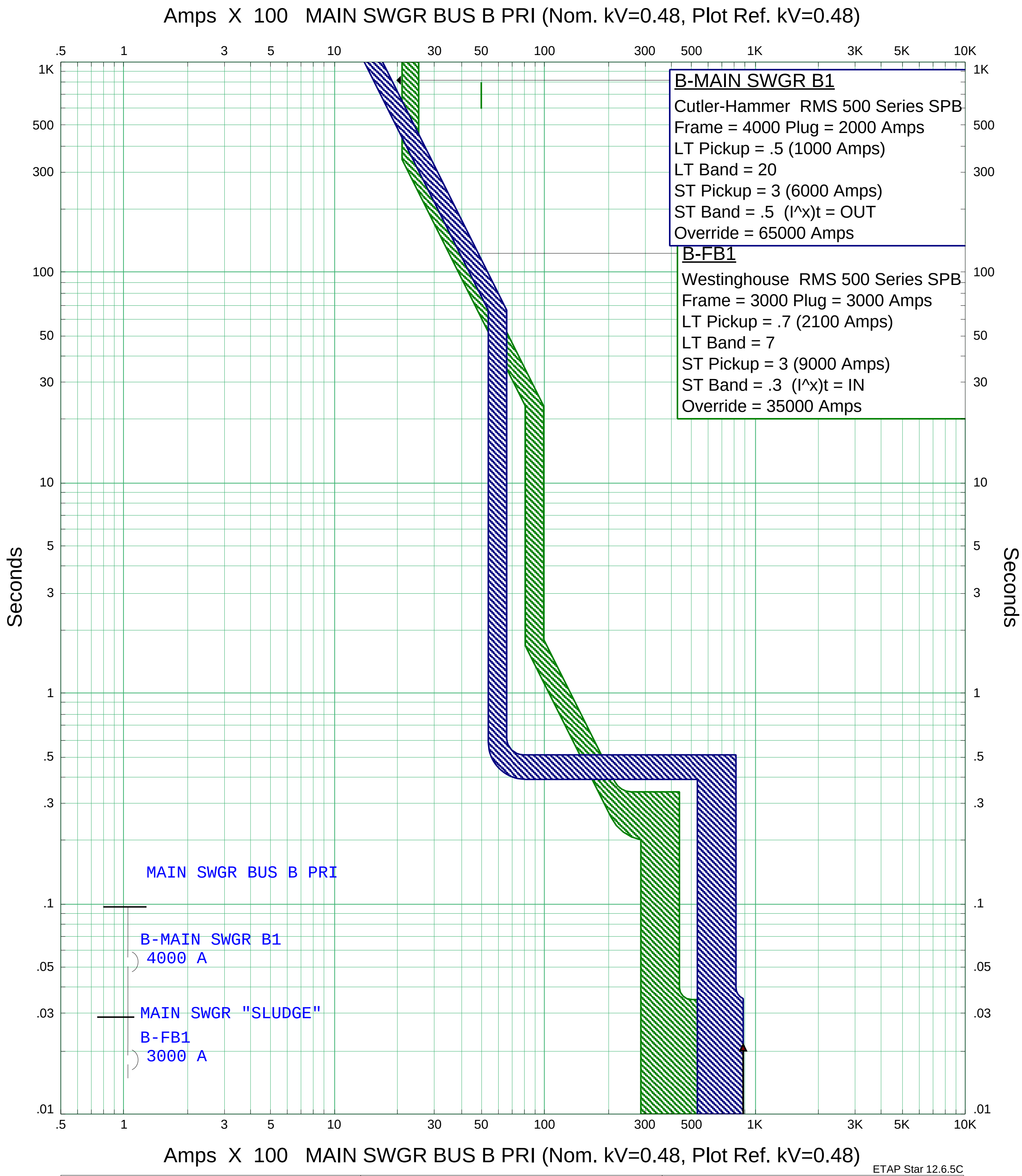


ETAP Star 12.6.5C

MAIN SWGR FILTER TCC

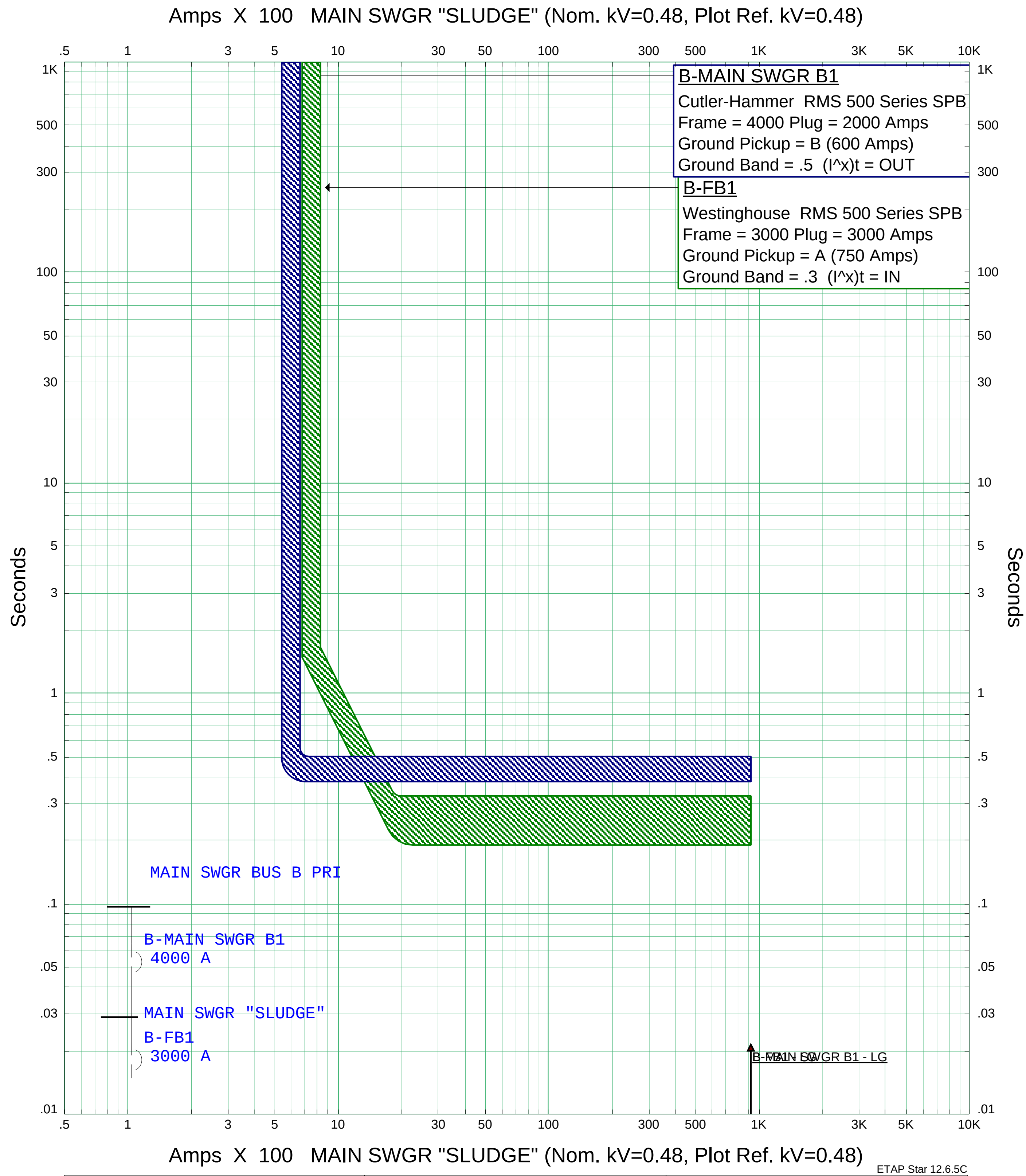
Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

Date: 04-06-2015
SN: CAROLLOWAN
Rev: Base
Fault: Ground



MAIN SWGR SLUDGE TCC

Project: OXNARD WWTP	Date: 04-06-2015
Location: OXNARD, CA	SN: CAROLLOWAN
Contract: 9587A.00	Rev: Base
Engineer: SKB	Fault: Phase
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI	



MAIN SWGR SLUDGE TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

Date: 04-06-2015
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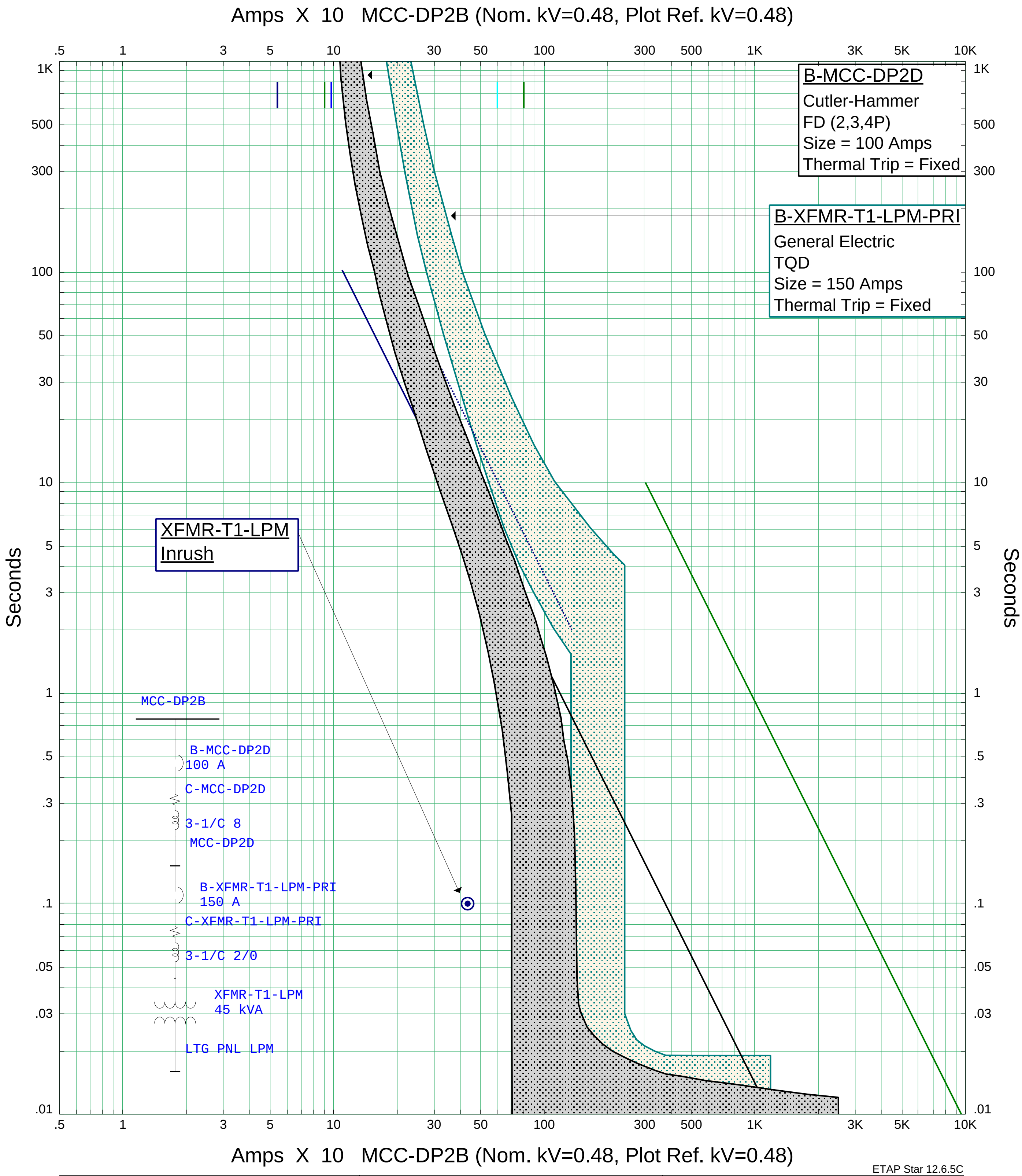
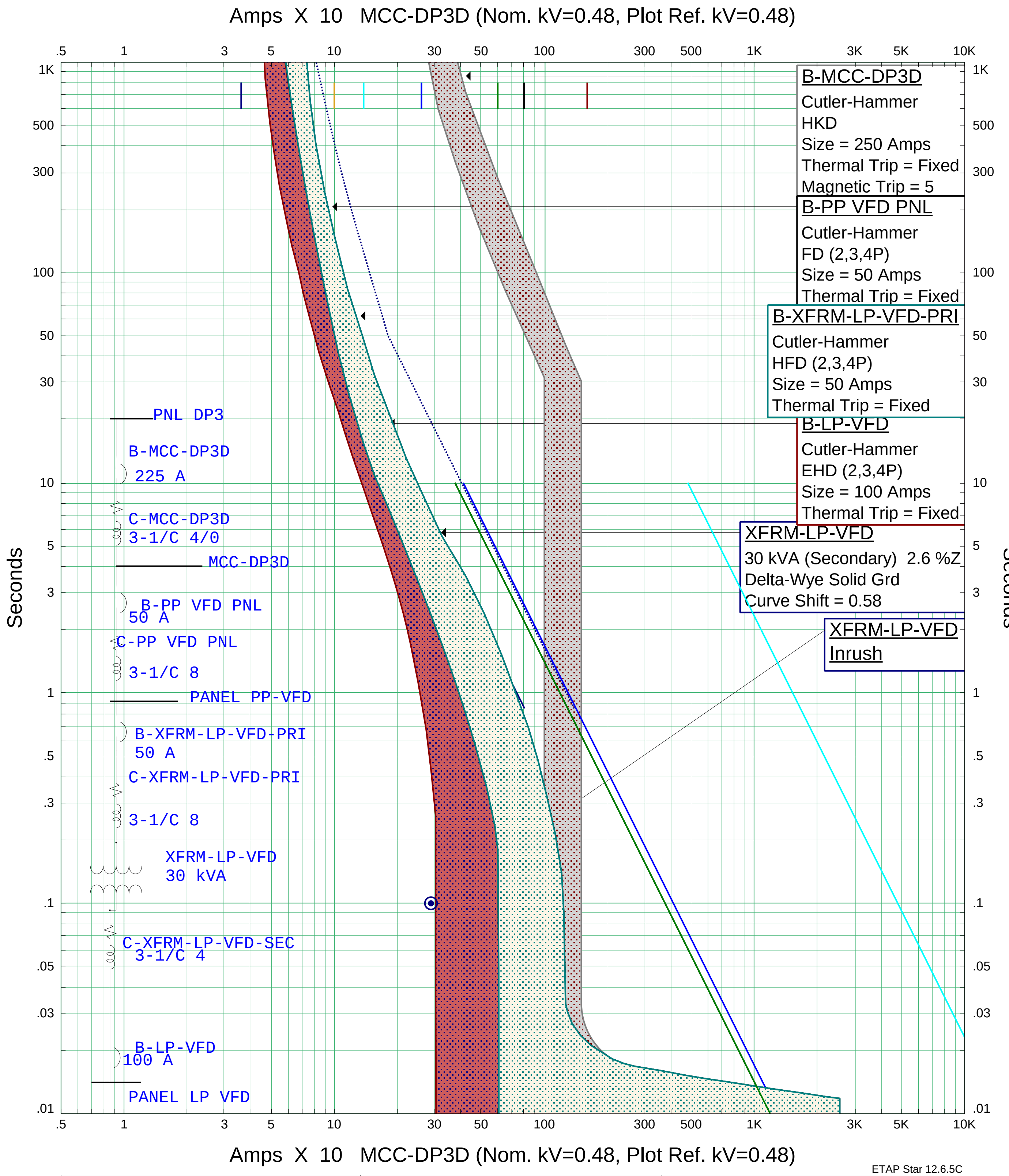
Rev: Base
Fault: Ground



MCC-DP2B TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

Date: 04-07-2015
SN: CAROLLOWAN
Rev: Base
Fault: Phase



MCC-DP3D TCC

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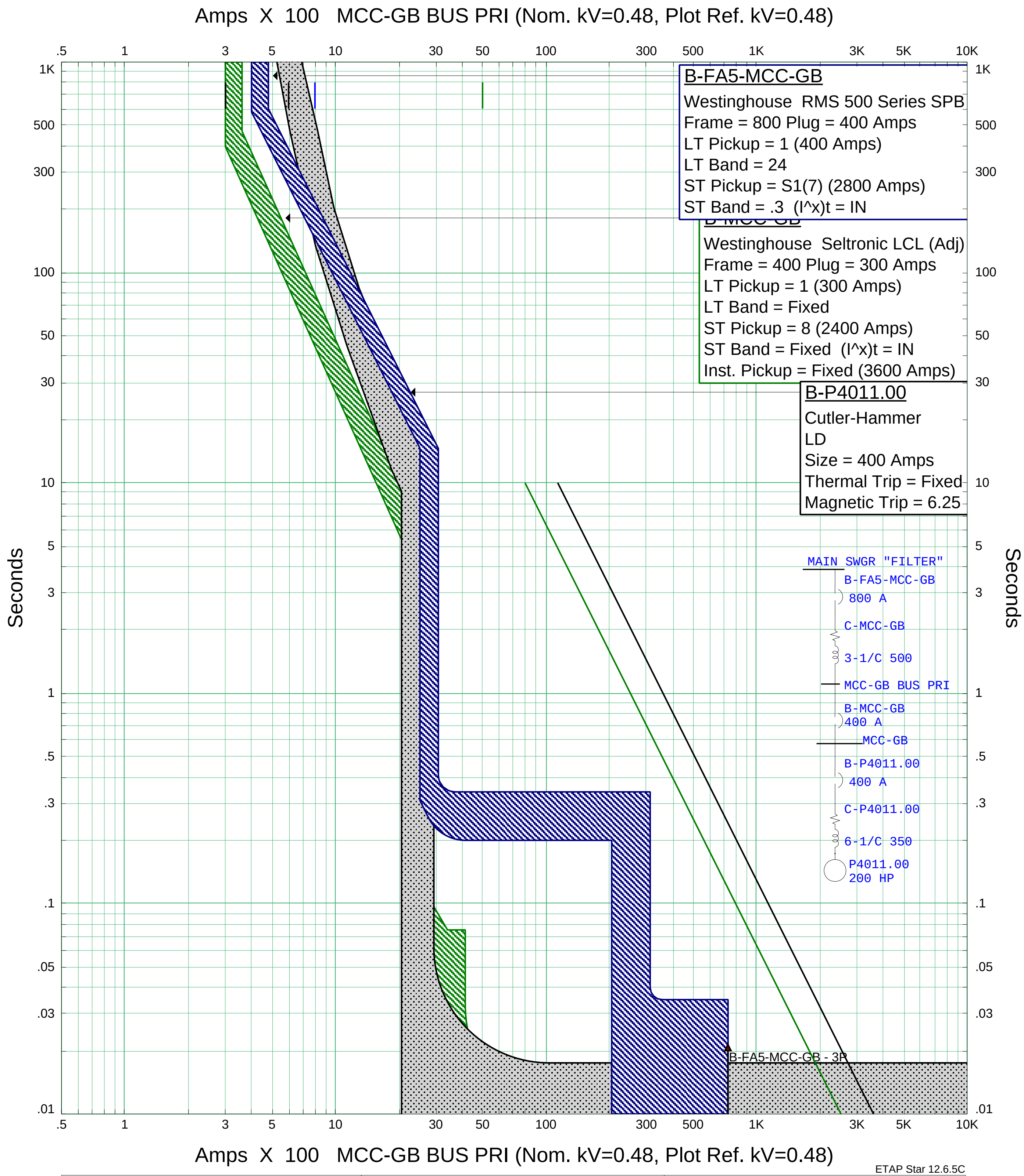
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

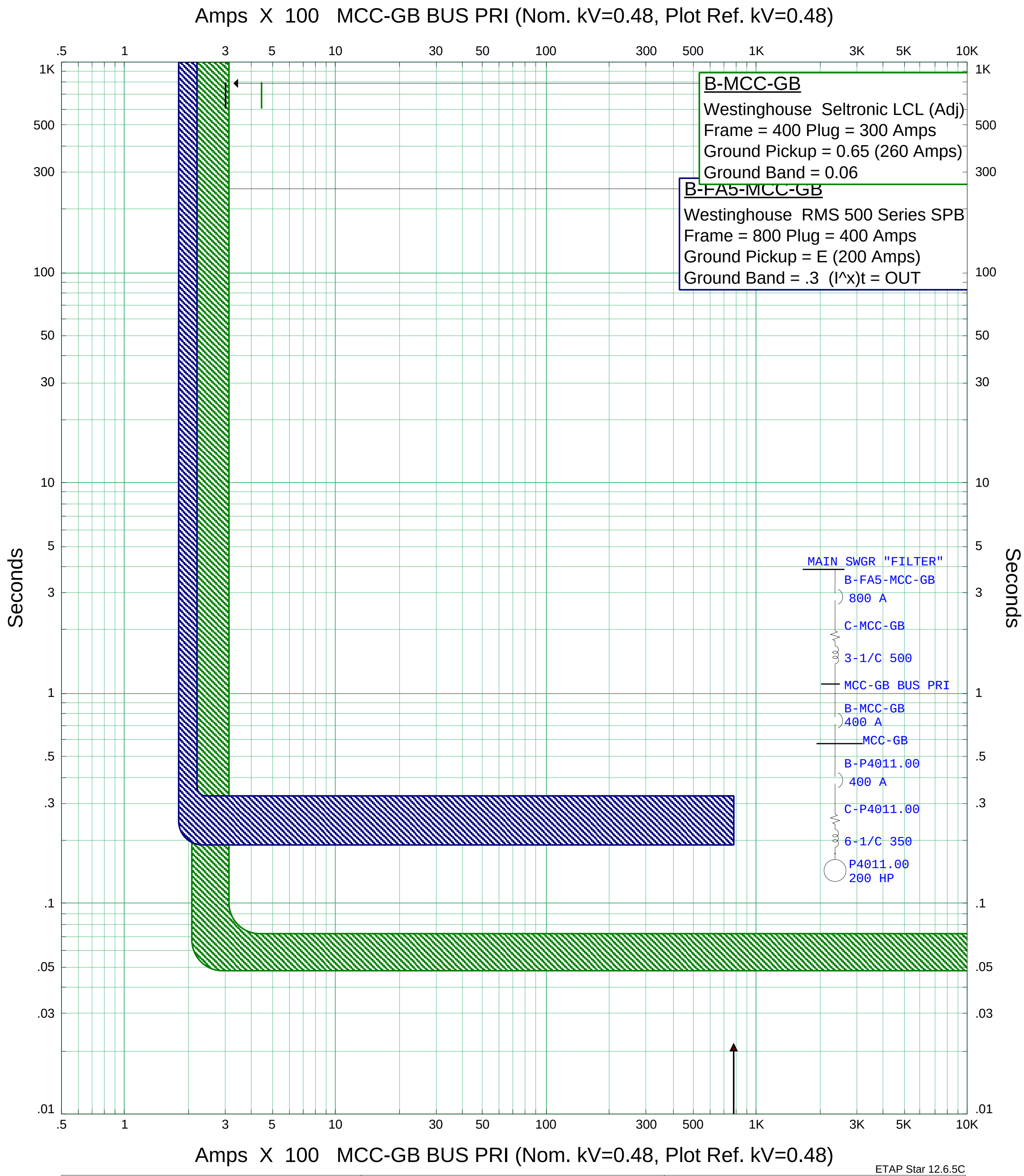
Date: 04-07-2015
SN: CAROLLOWAN
Rev: Base
Fault: Phase



MCC-GB TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

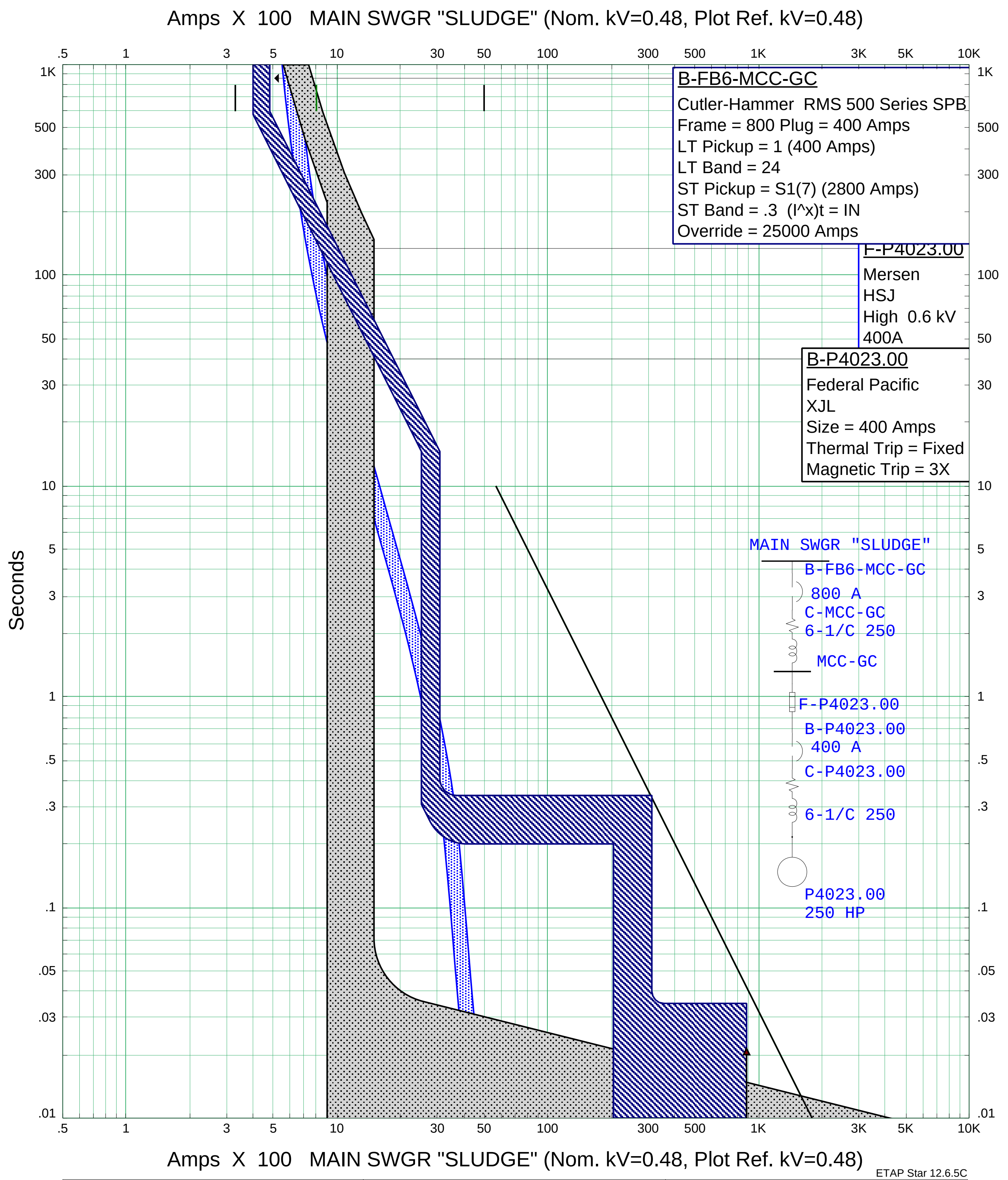
Date: 04-07-2015
SN: CAROLLOWAN
Rev: Base
Fault: Phase



MCC-GB TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

Date: 04-07-2015
SN: CAROLLOWAN
Rev: Base
Fault: Ground

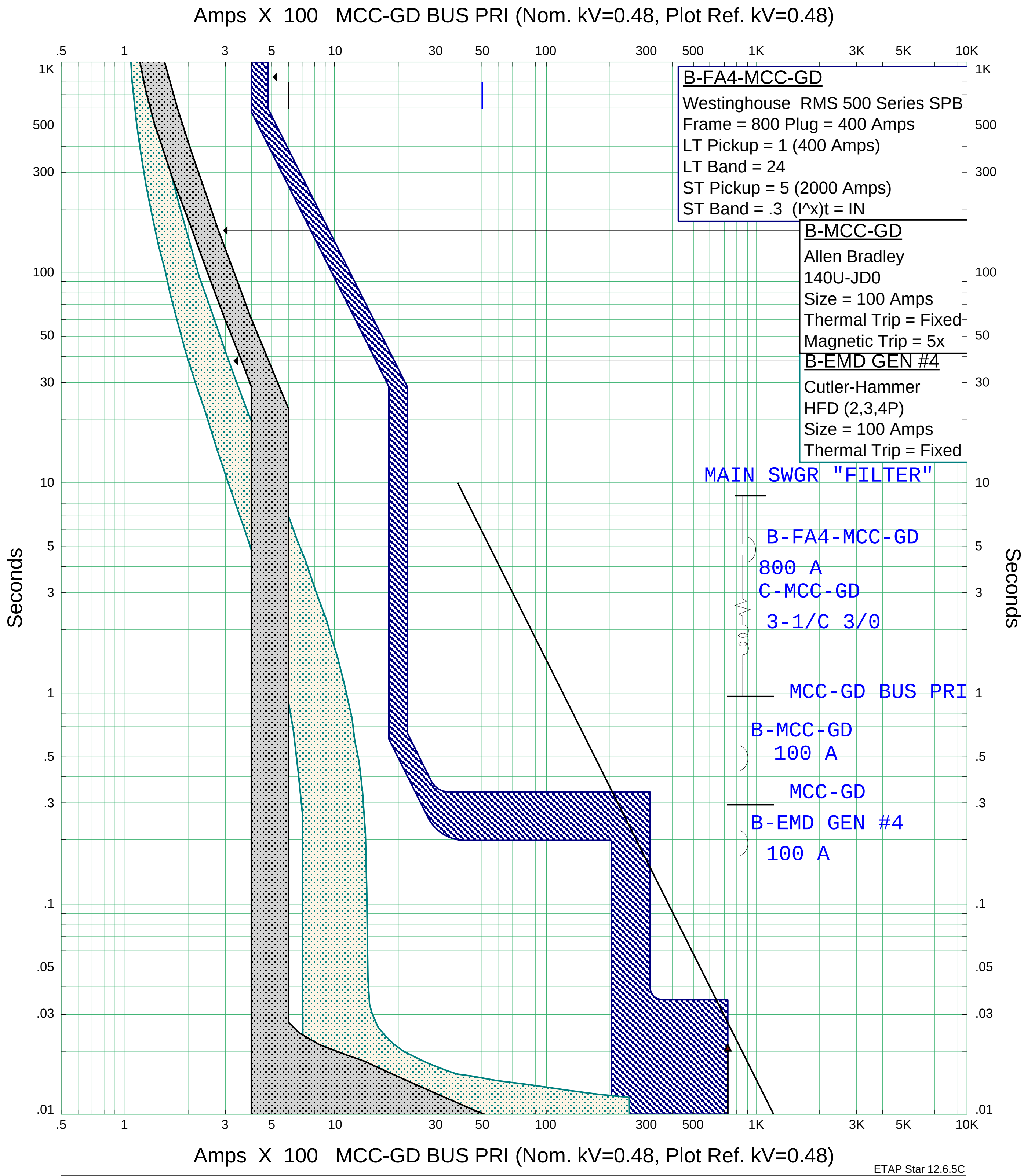


ETAP Star 12.6.5C

MCC-GC TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

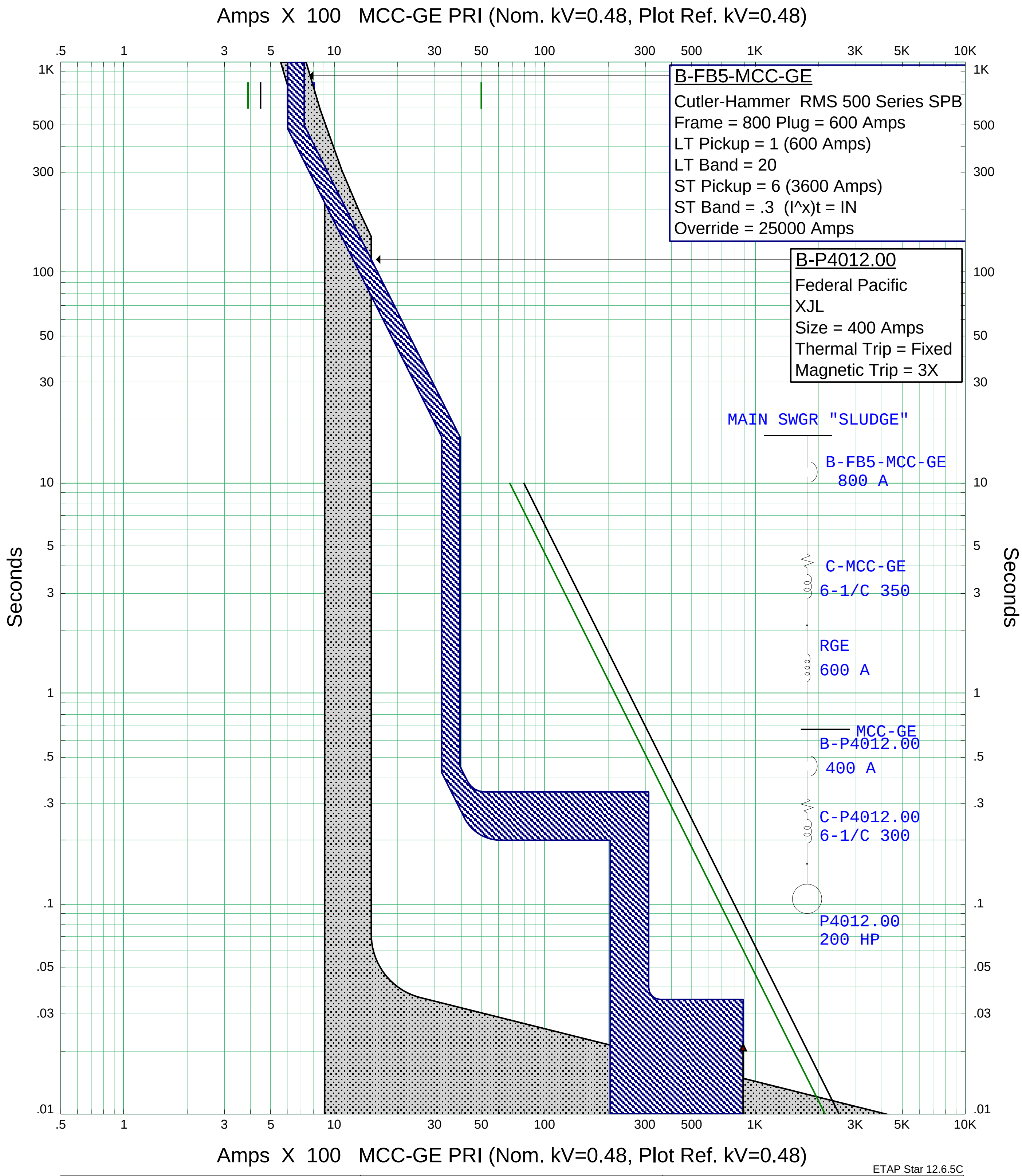
Date: 04-07-2015
SN: CAROLLOWAN
Rev: Base
Fault: Phase



MCC-GD TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

Date: 04-07-2015
SN: CAROLLOWAN
Rev: Base
Fault: Phase

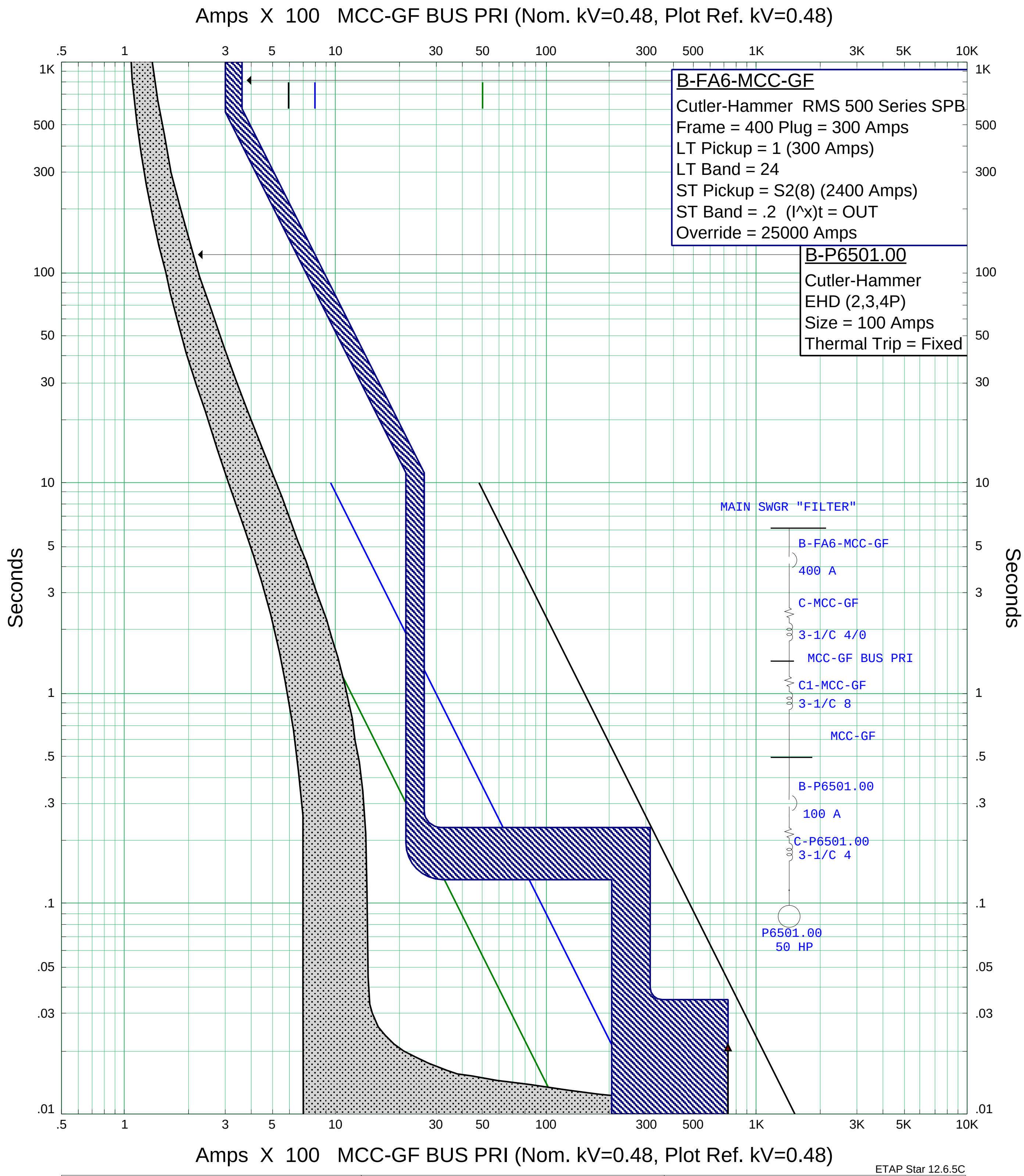


ETAP Star 12.6.5C

MCC-GE TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

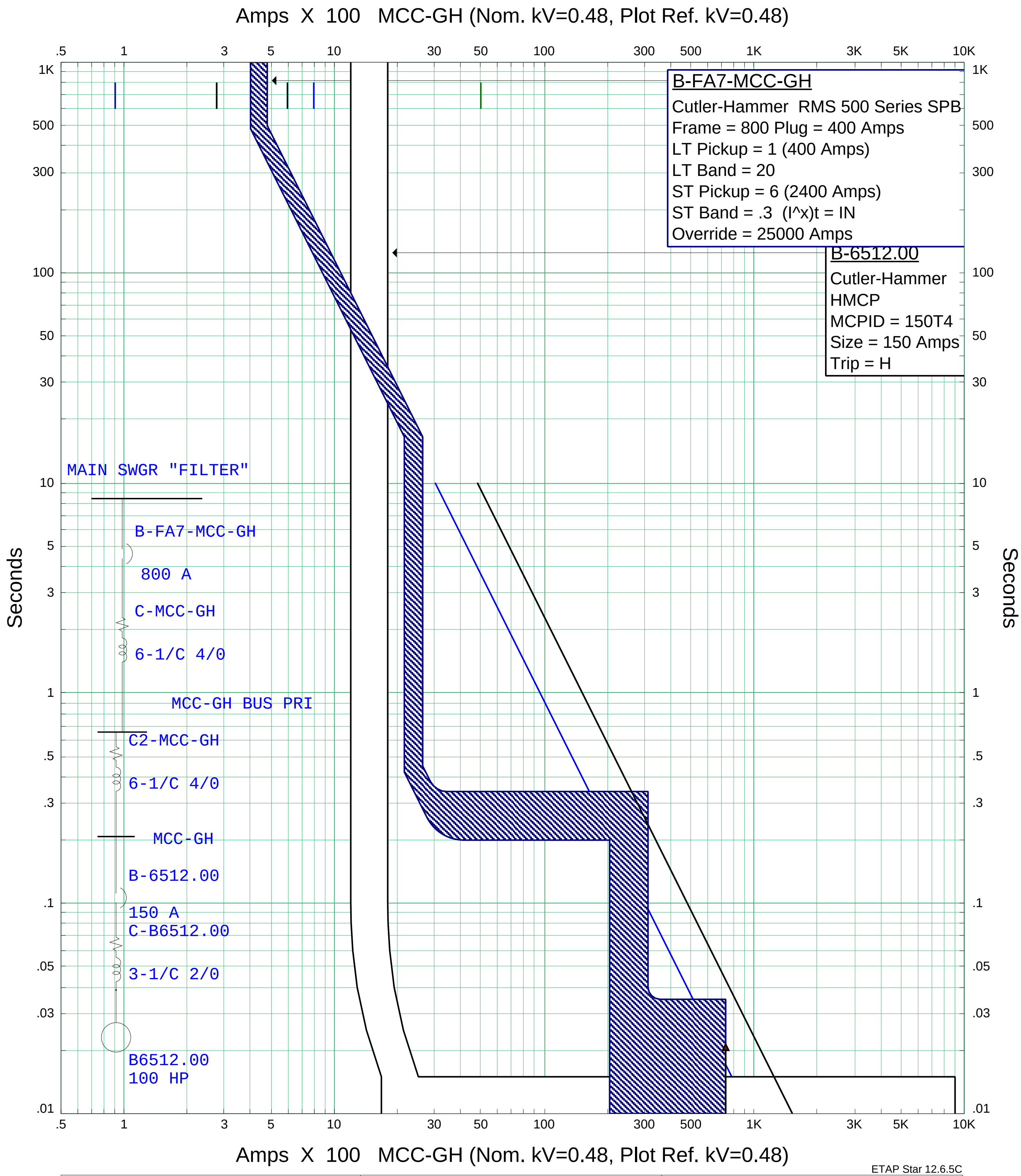
Date: 04-07-2015
SN: CAROLLOWAN
Rev: Base
Fault: Phase



MCC-GF TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

Date: 04-07-2015
SN: CAROLLOWAN
Rev: Base
Fault: Phase

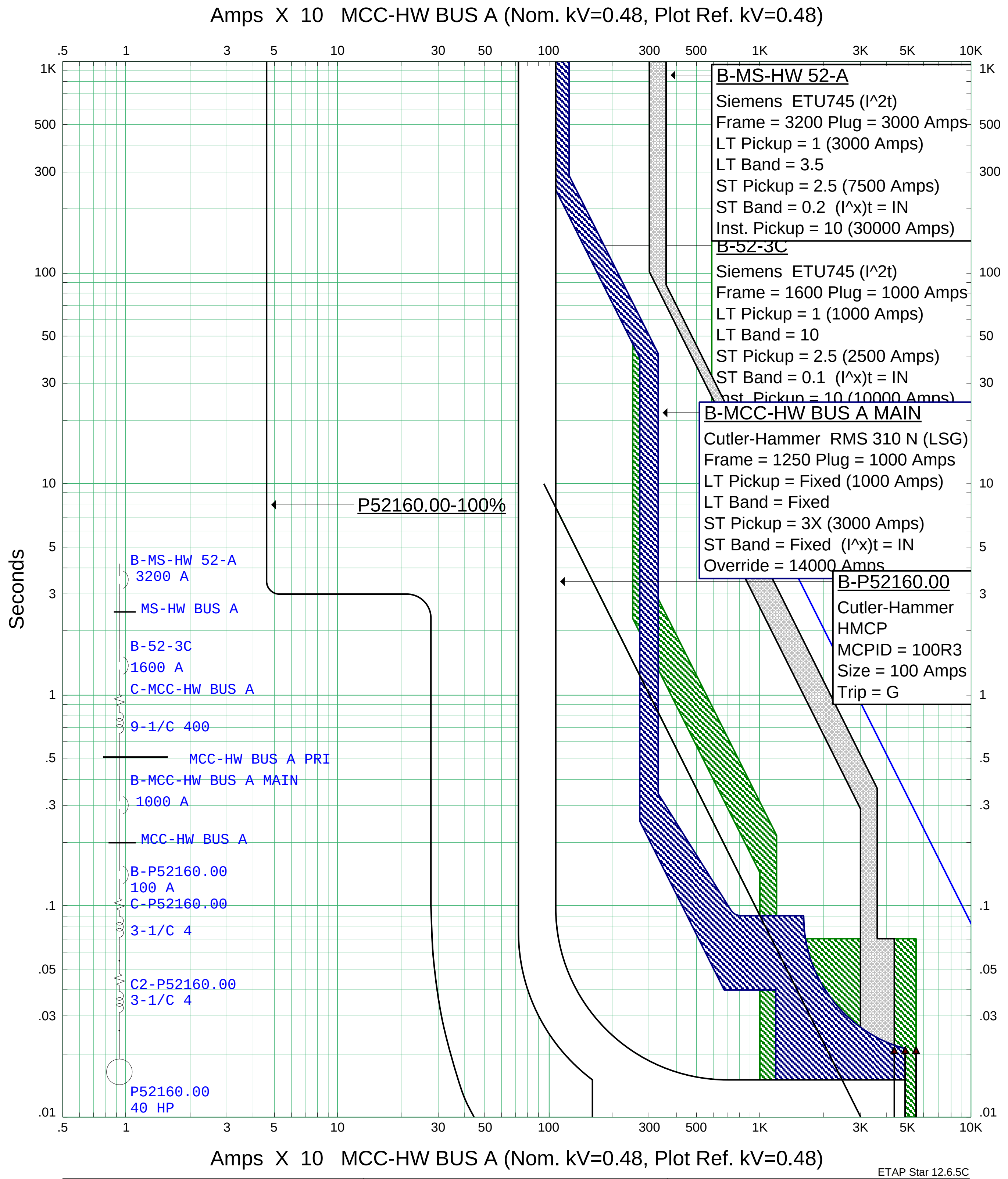


ETAP Star 12.6.5C

MCC-GH TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

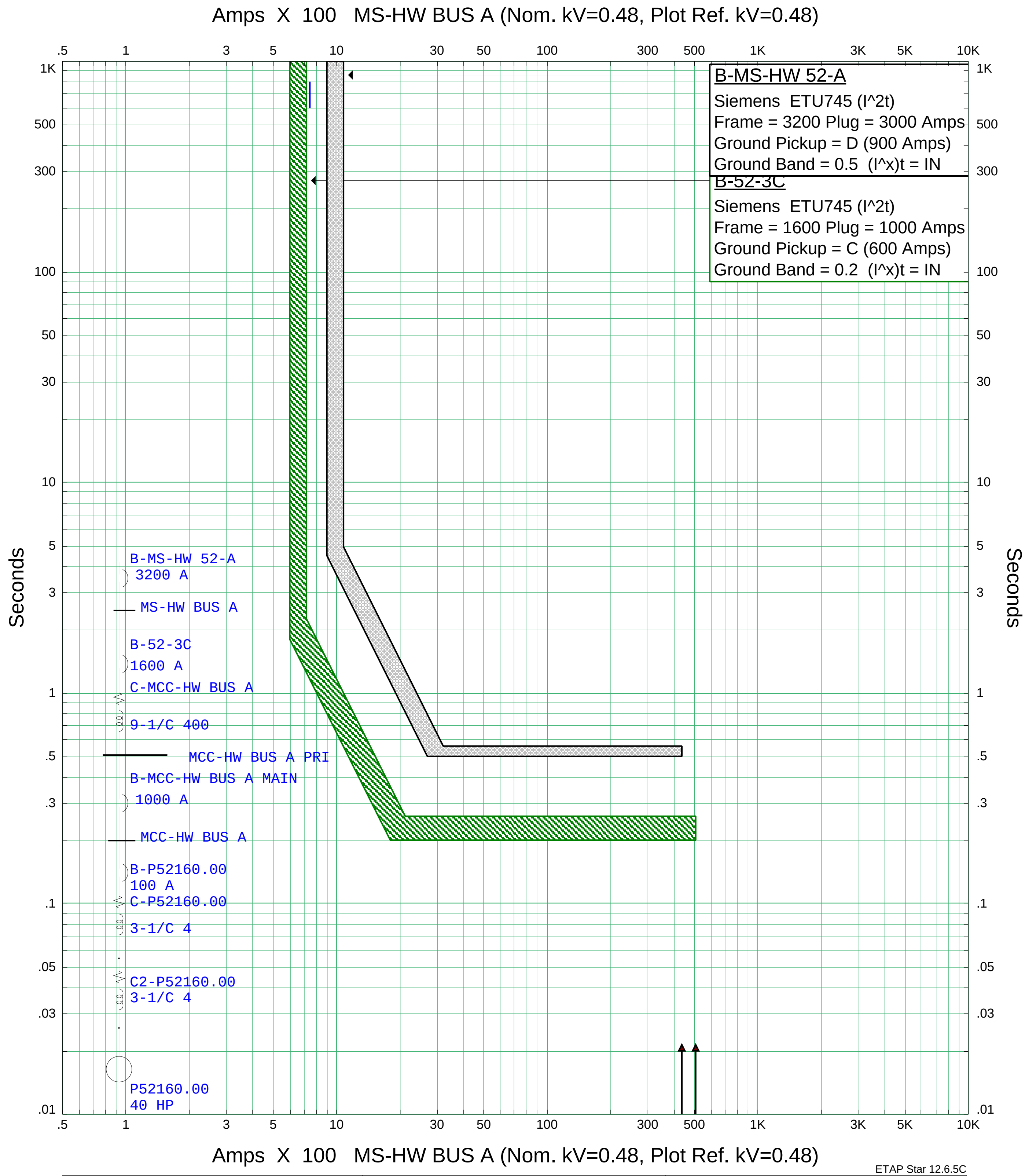
Date: 04-07-2015
SN: CAROLLOWAN
Rev: Base
Fault: Phase



MCC-HW BUS A TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

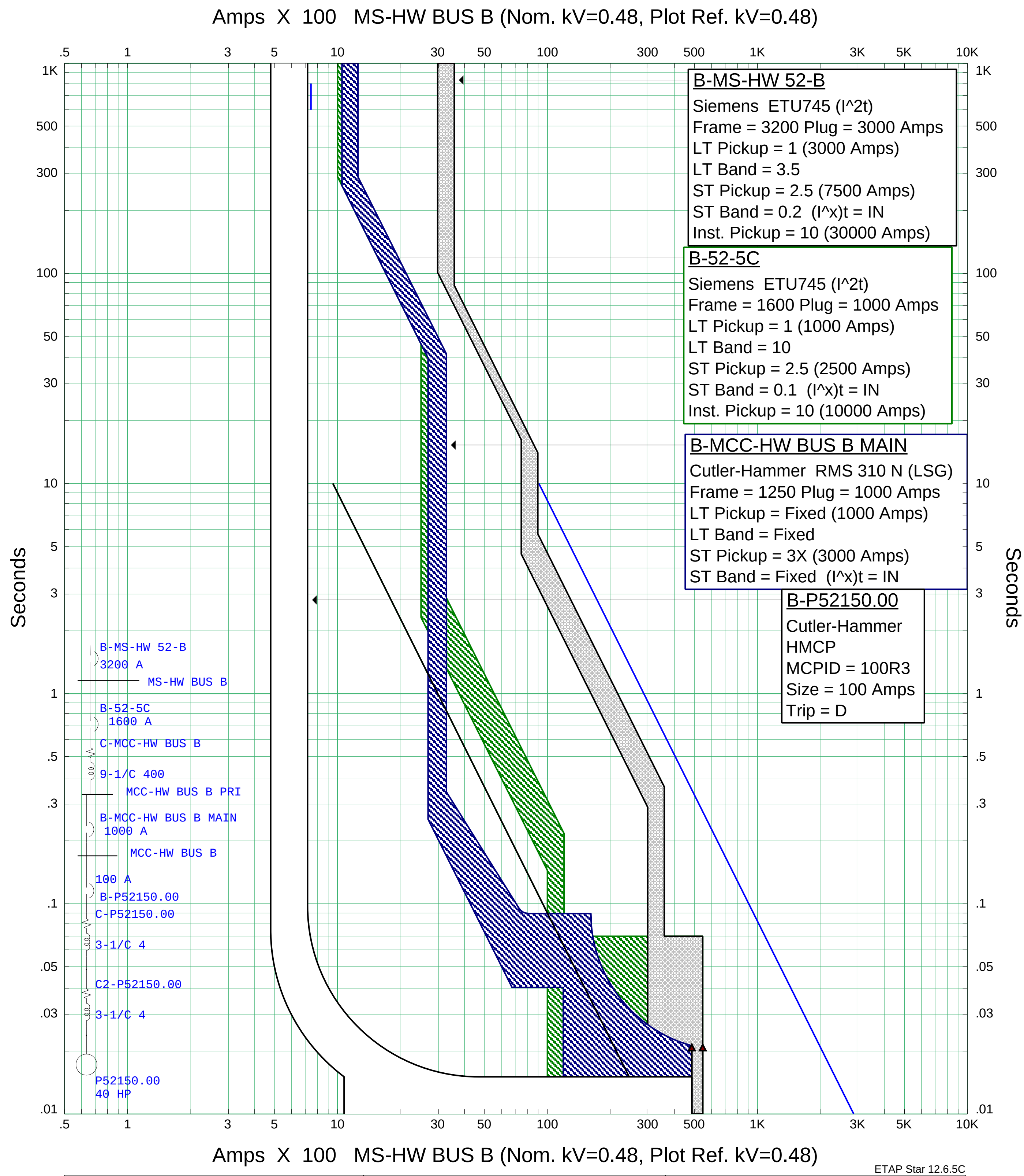
Date: 04-06-2015
SN: CAROLLOWAN
Rev: Base
Fault: Phase



MCC-HW BUS A TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

Date: 04-06-2015
SN: CAROLLOWAN
Rev: Base
Fault: Ground

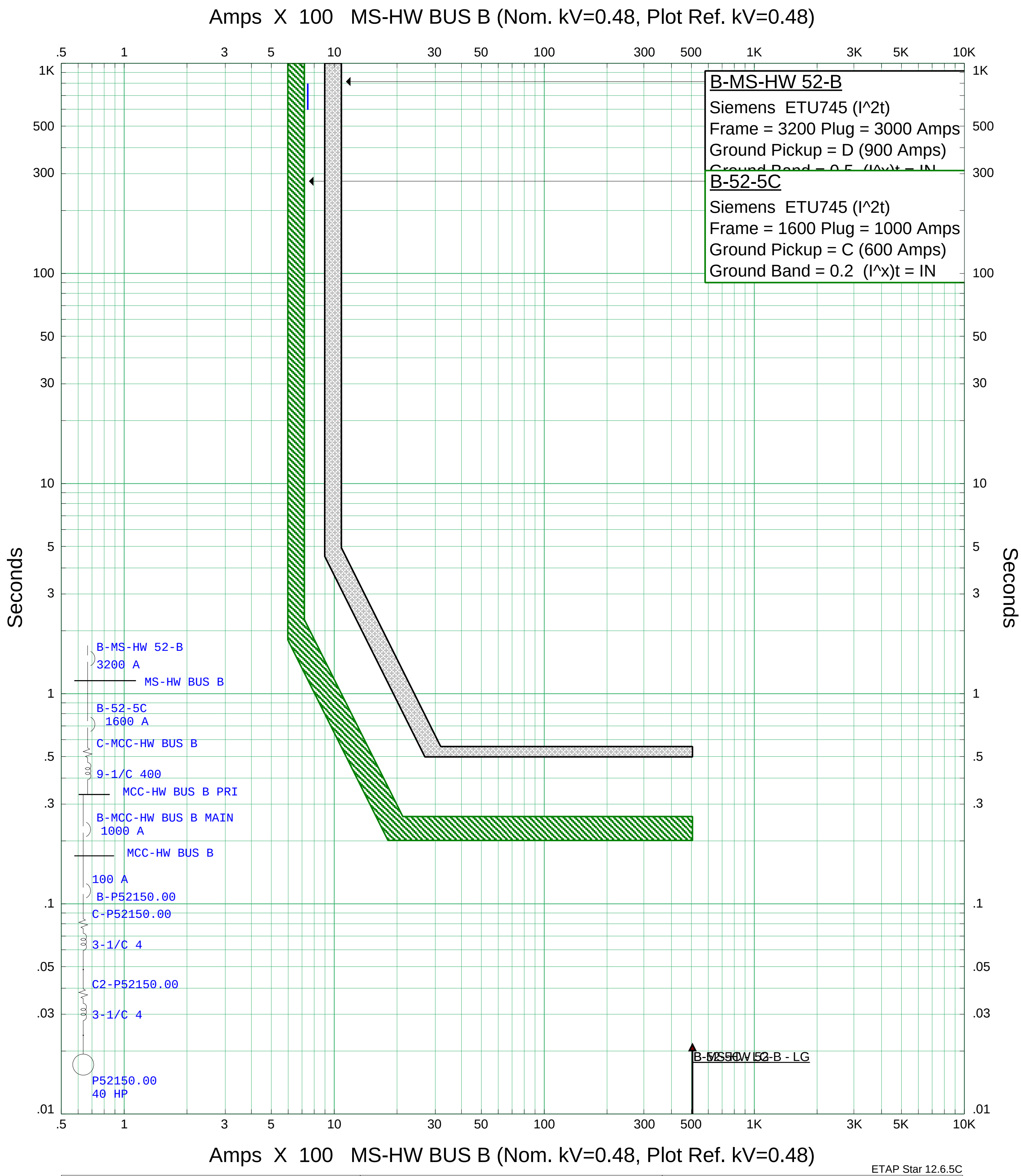


ETAP Star 12.6.5C

MCC-HW BUS B TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

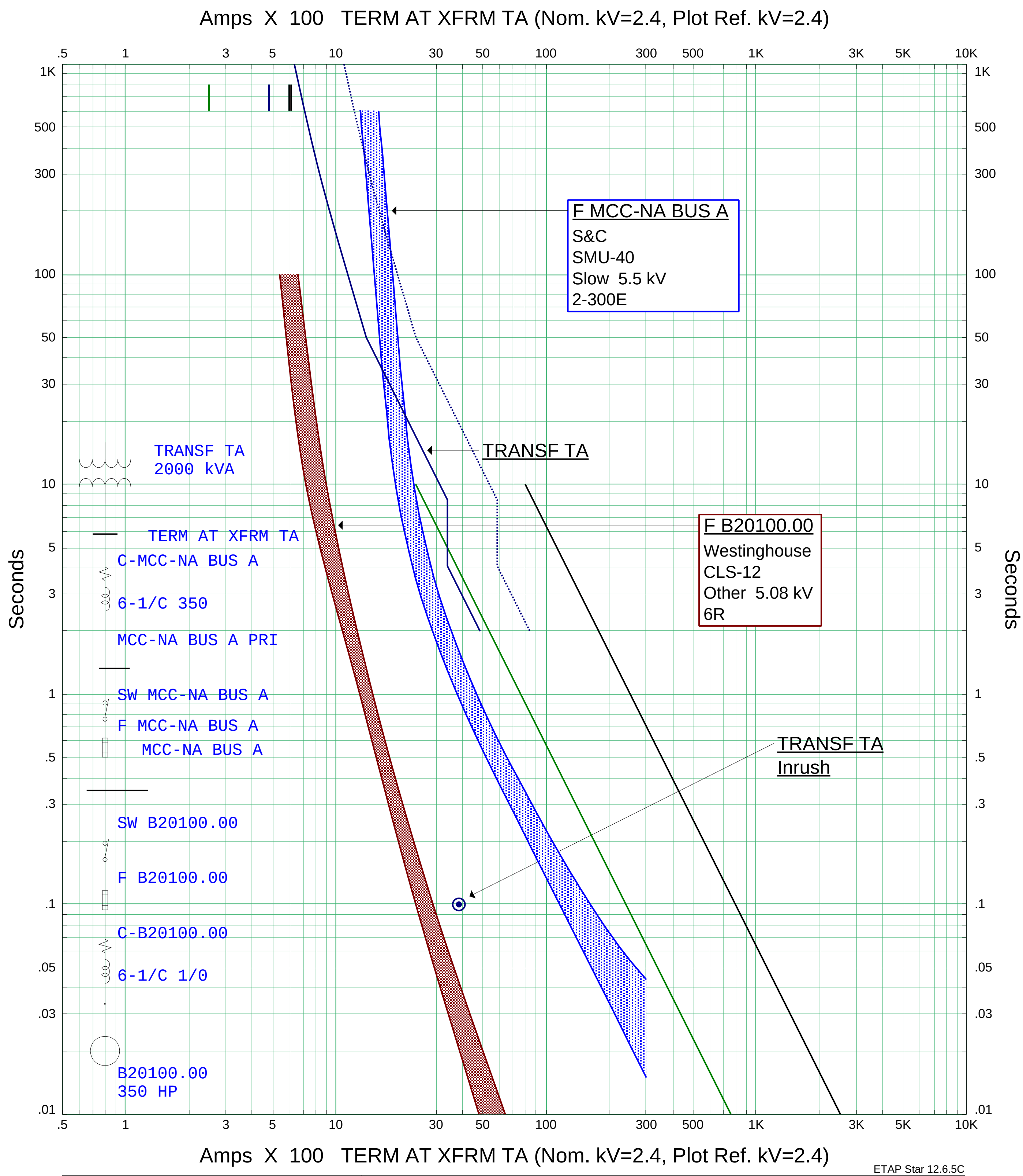
Date: 04-06-2015
SN: CAROLLOWAN
Rev: Base
Fault: Phase



MCC-HW BUS B TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

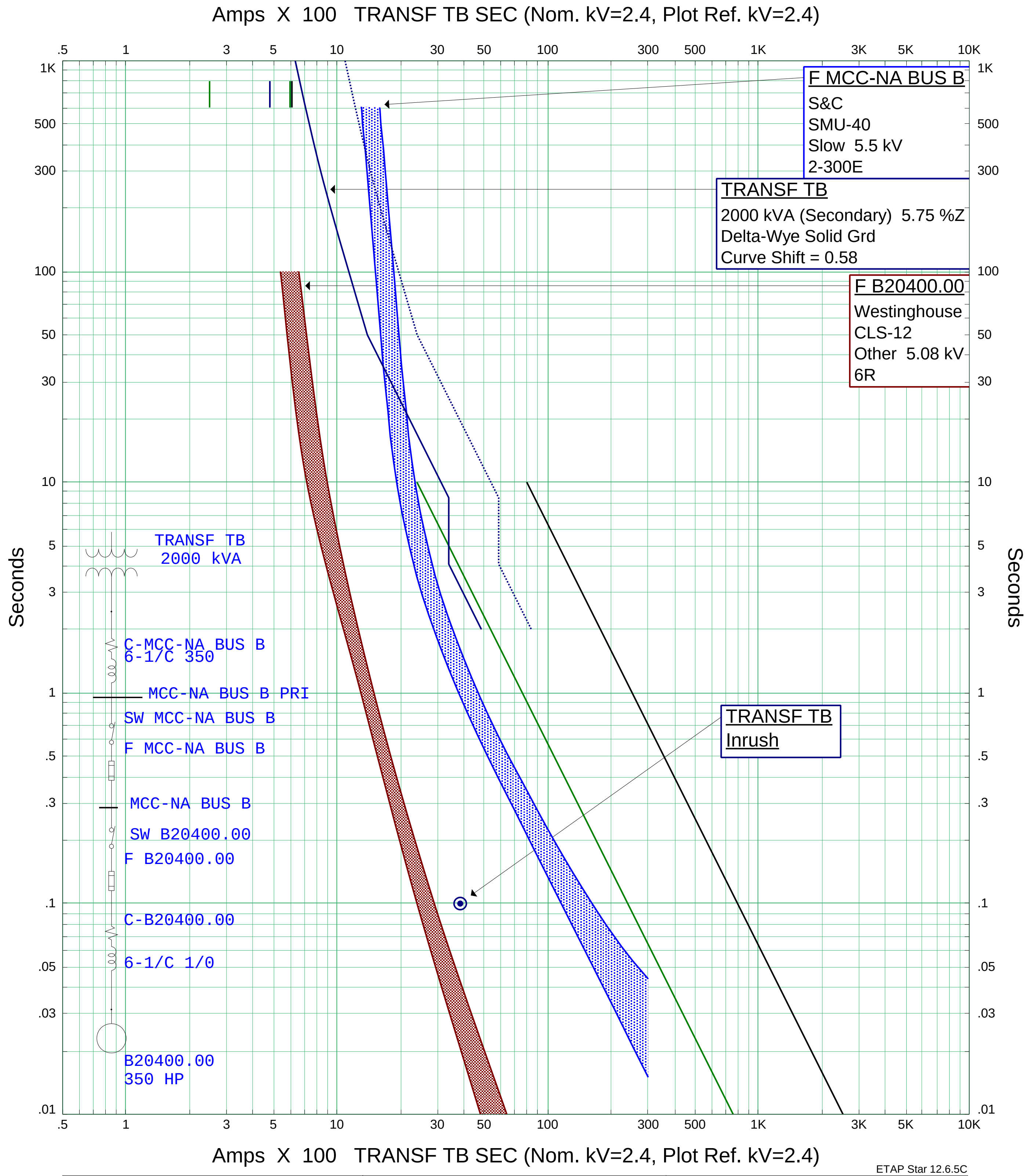
Date: 04-06-2015
SN: CAROLLOWAN
Rev: Base
Fault: Ground



MCC-NA BUA A TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

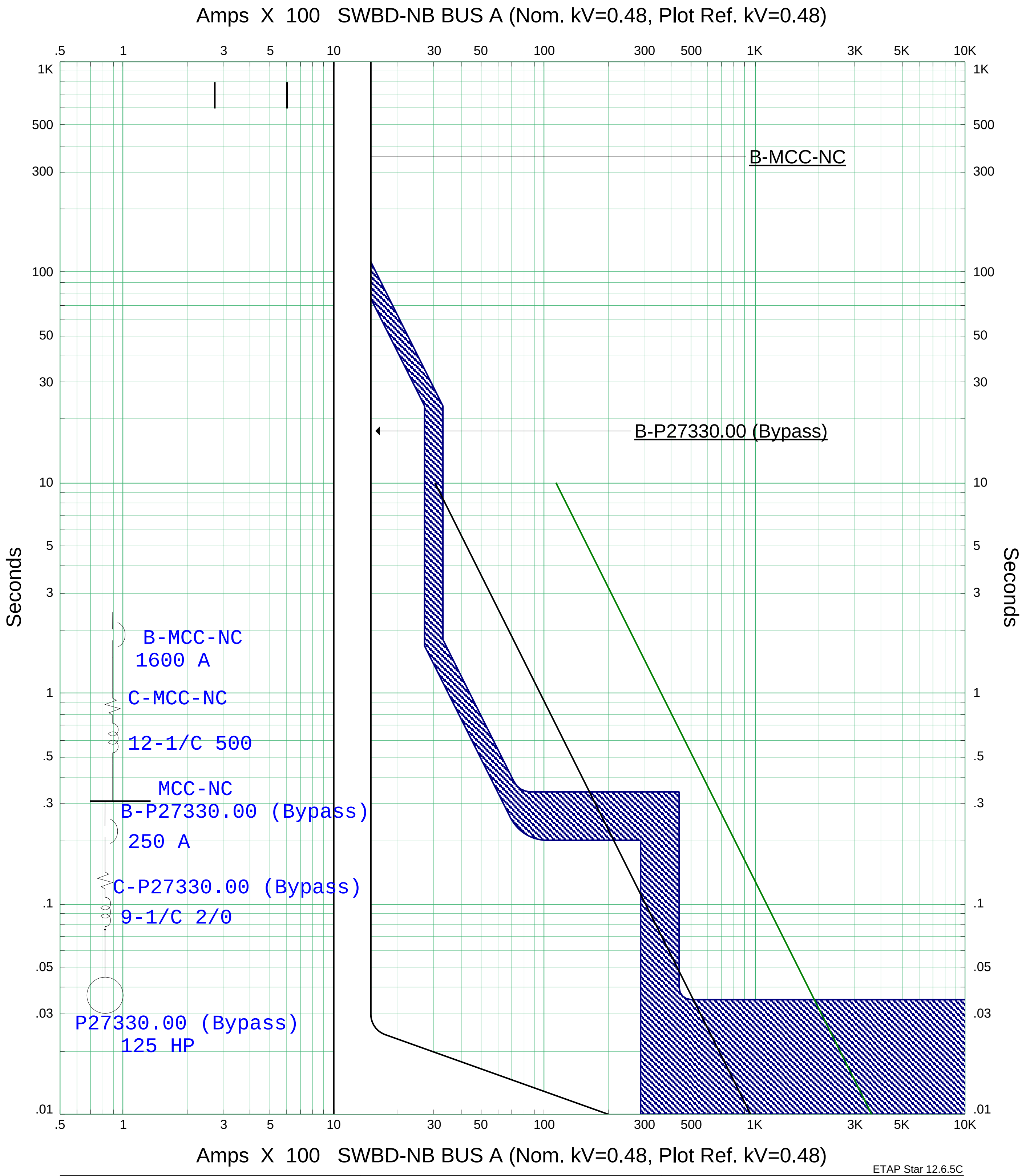
Date: 04-06-2015
SN: CAROLLOWAN
Rev: Base
Fault: Phase



MCC-NA BUS B TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

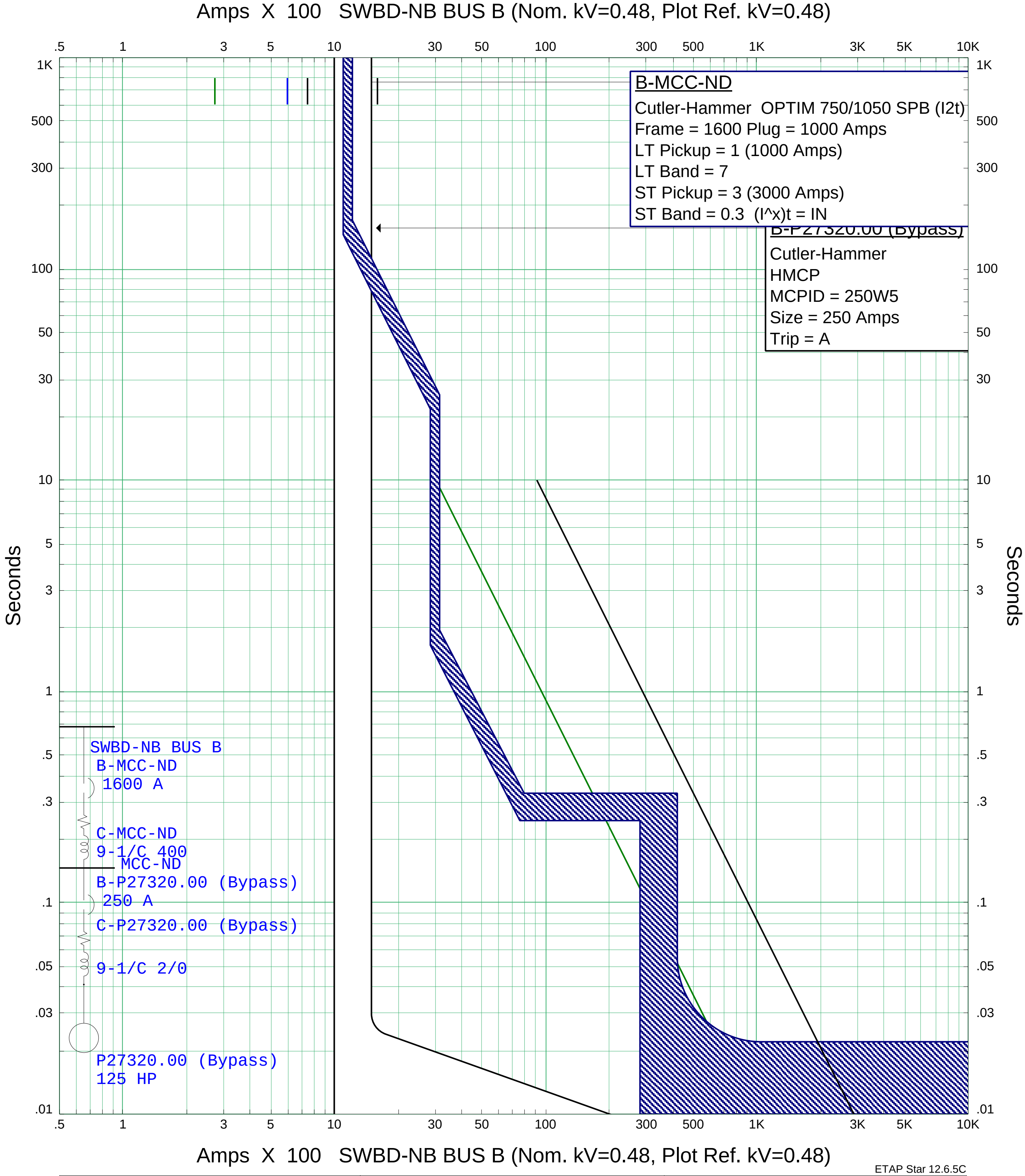
Date: 04-06-2015
SN: CAROLLOWAN
Rev: Base
Fault: Phase



MCC-NC TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

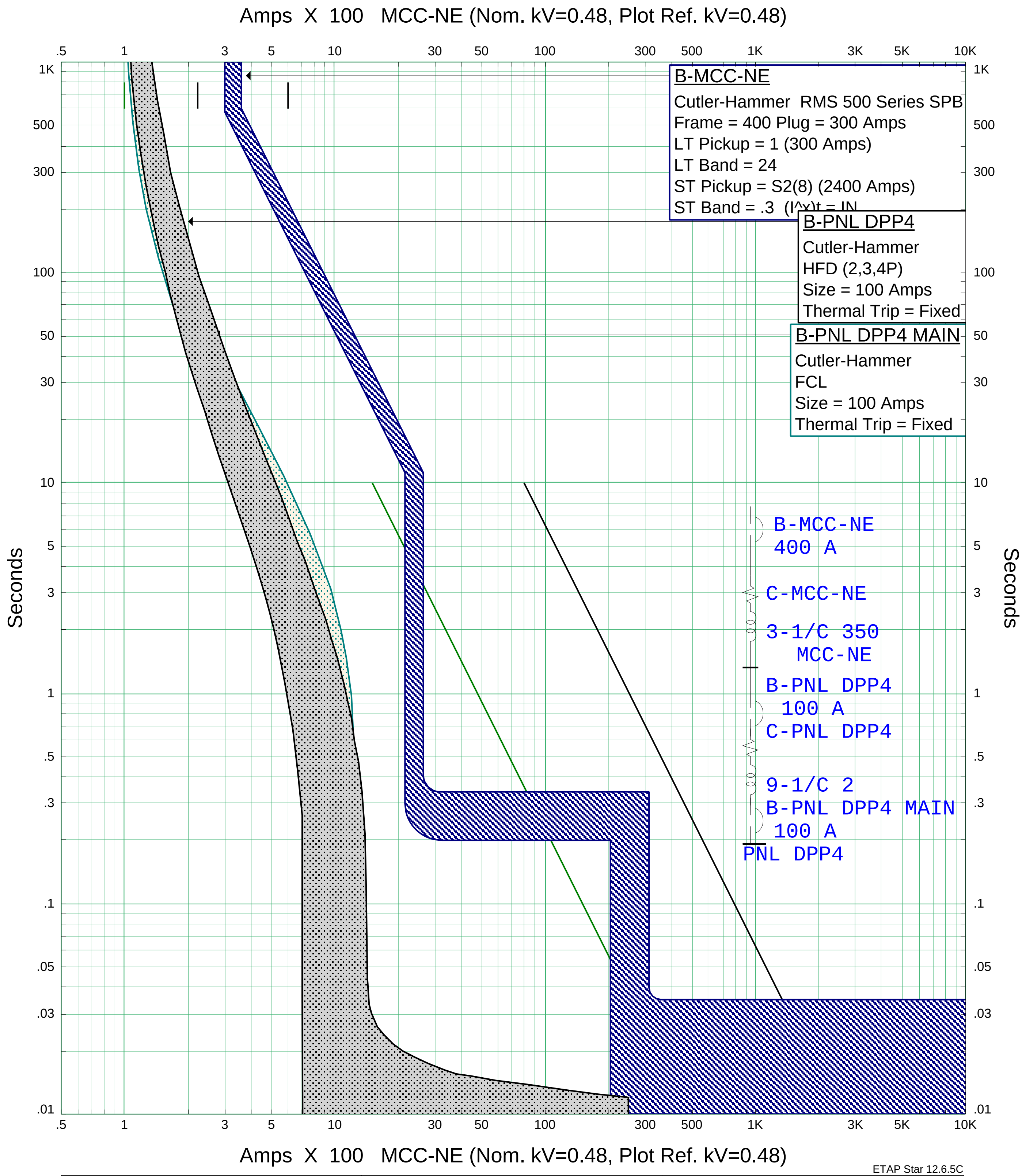
Date: 04-06-2015
SN: CAROLLOWAN
Rev: Base
Fault: Phase



MCC-ND TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

Date: 04-07-2015
SN: CAROLLOWAN
Rev: Base
Fault: Phase

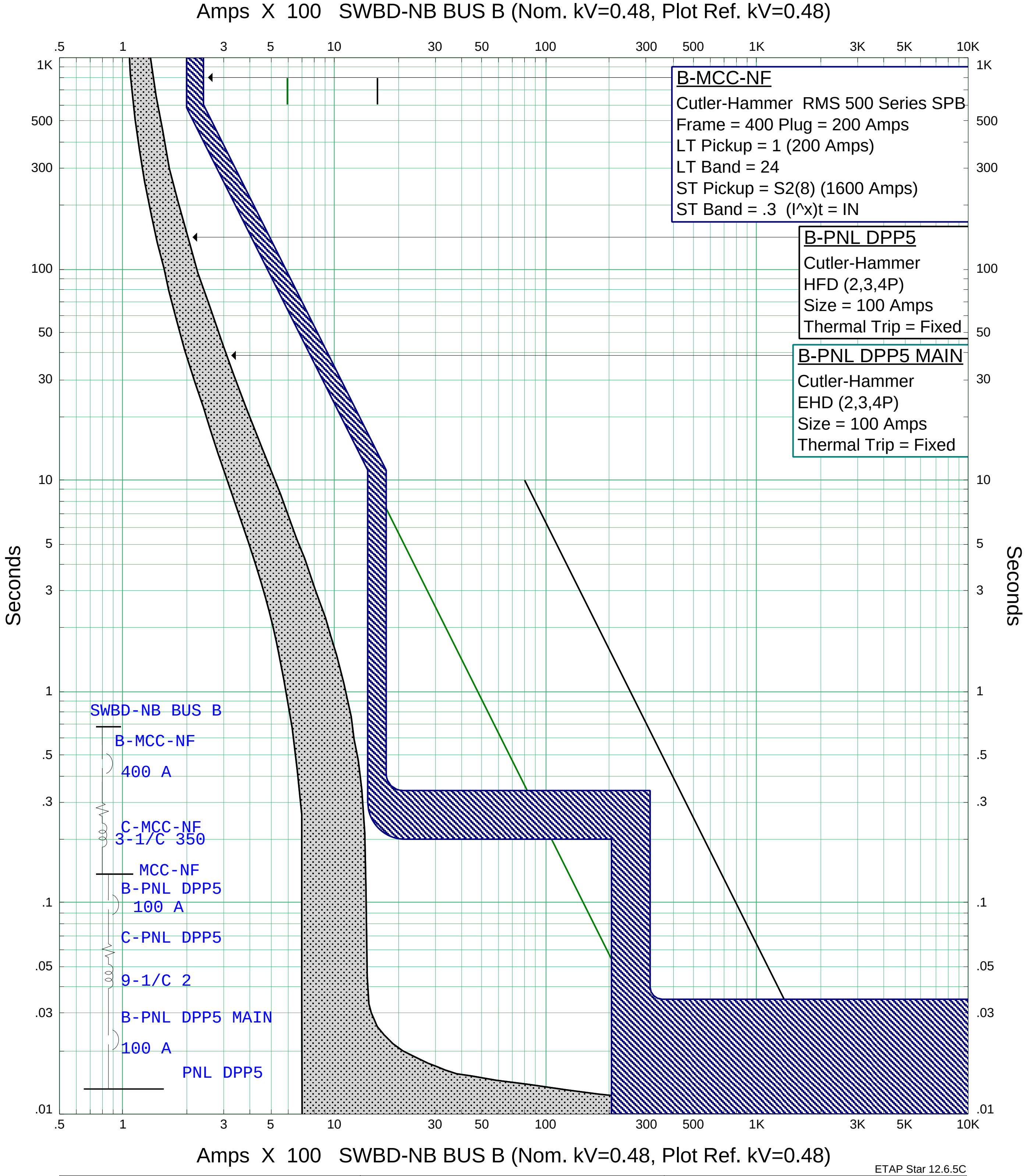


ETAP Star 12.6.5C

MCC-NE TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

Date: 04-06-2015
SN: CAROLLOWAN
Rev: Base
Fault: Phase

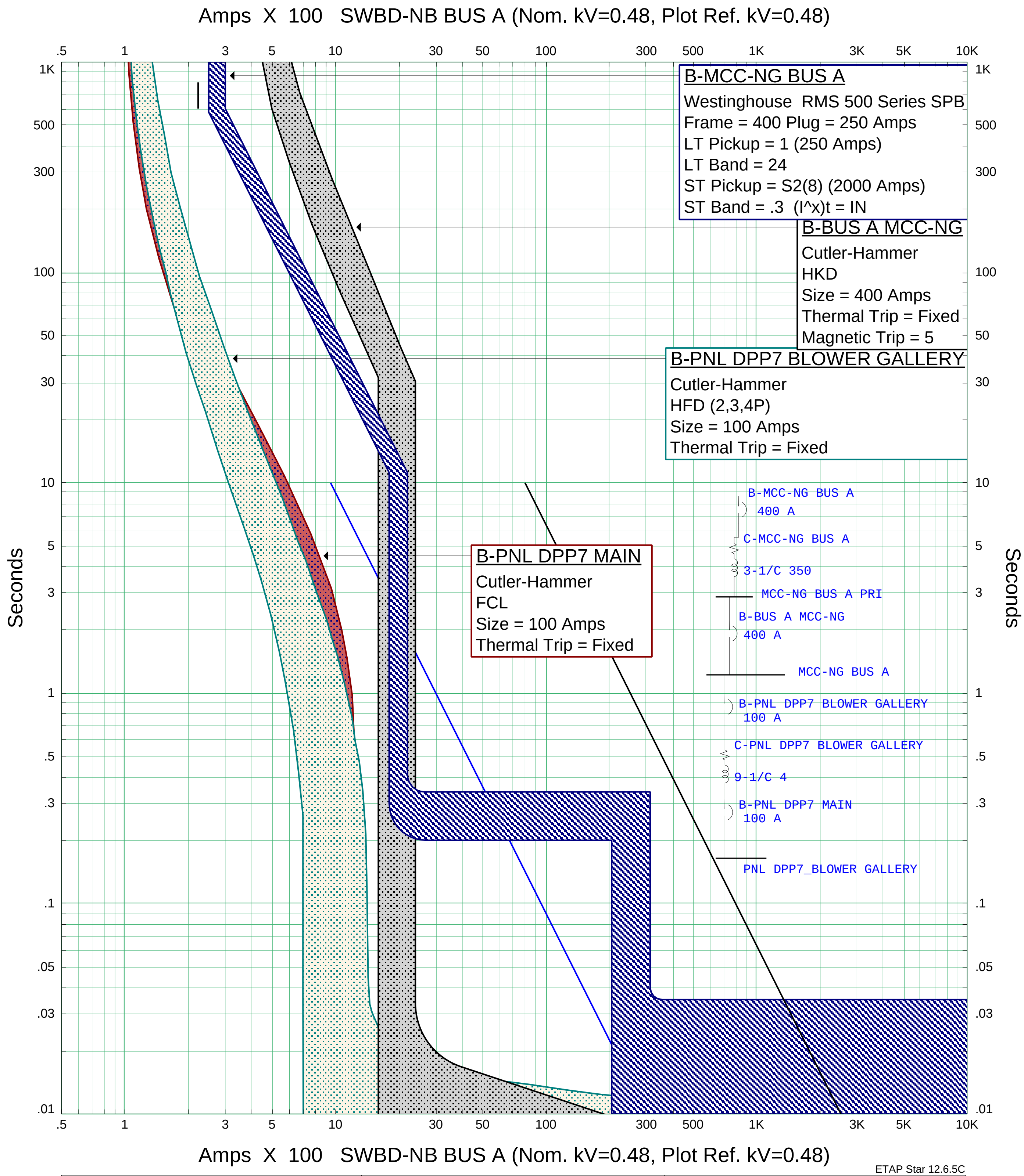


ETAP Star 12.6.5C

MCC-NF TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

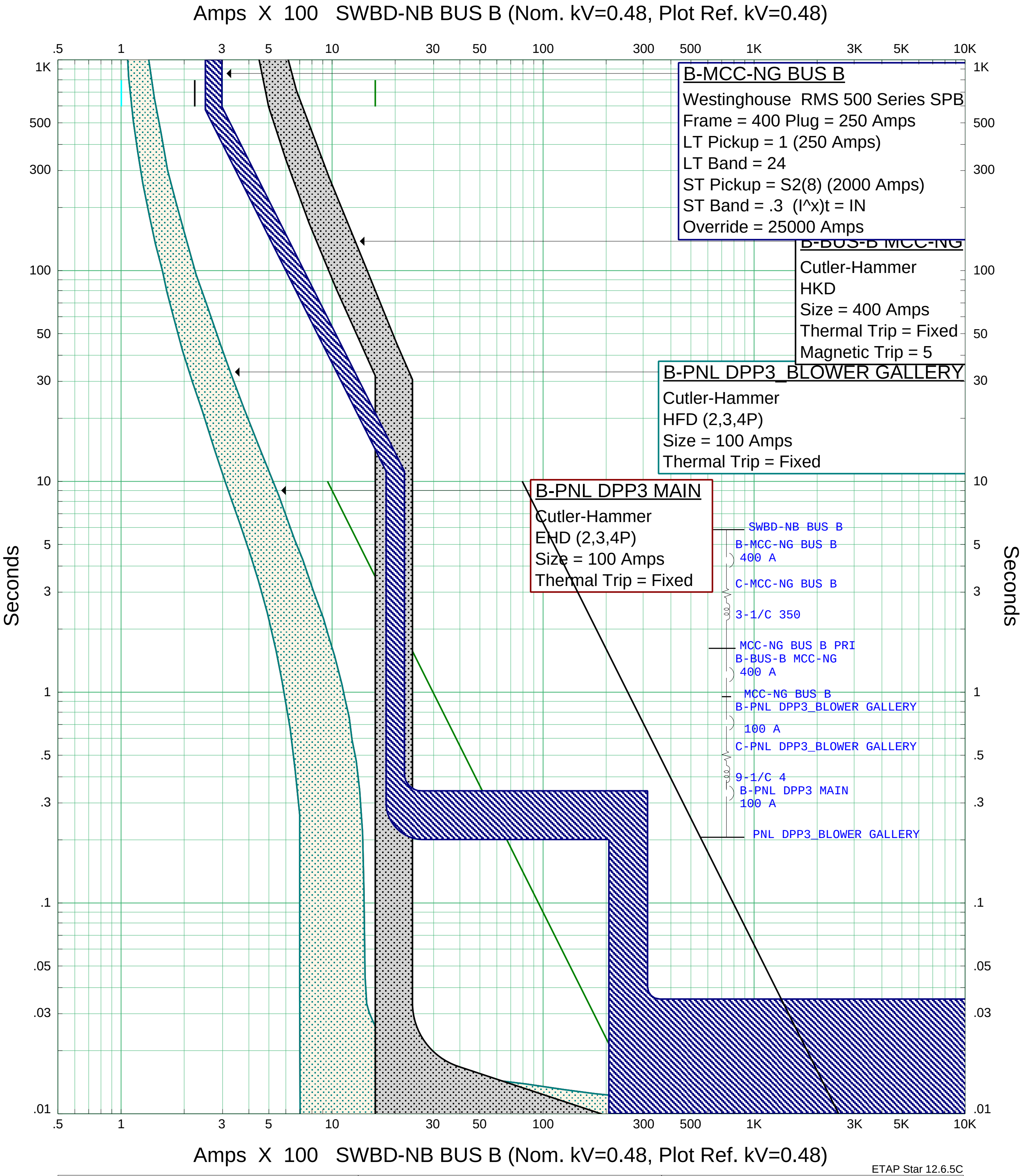
Date: 04-07-2015
SN: CAROLLOWAN
Rev: Base
Fault: Phase



MCC-NG BUS A TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

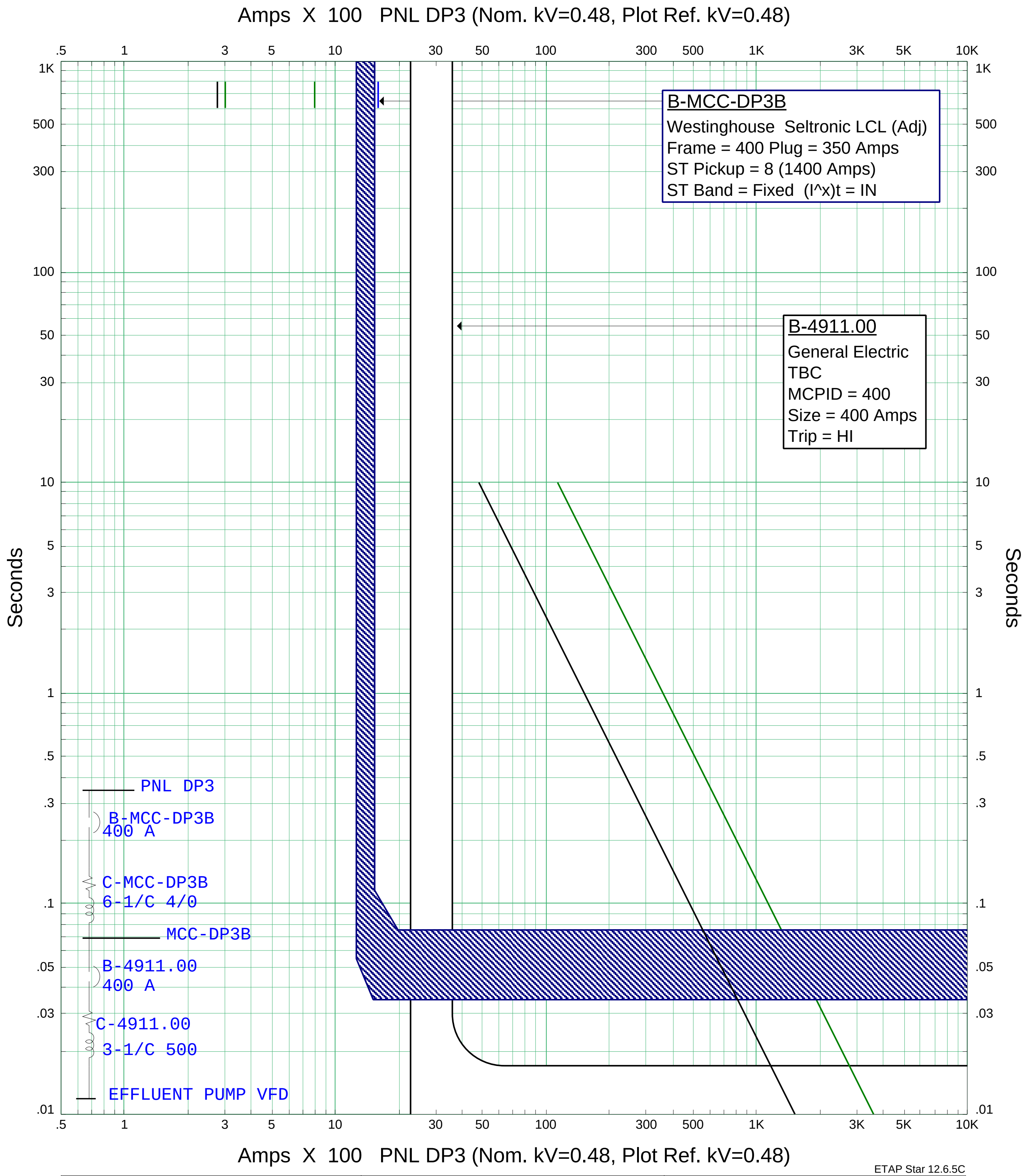
Date: 04-06-2015
SN: CAROLLOWAN
Rev: Base
Fault: Phase



MCC-NG-BUS B TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

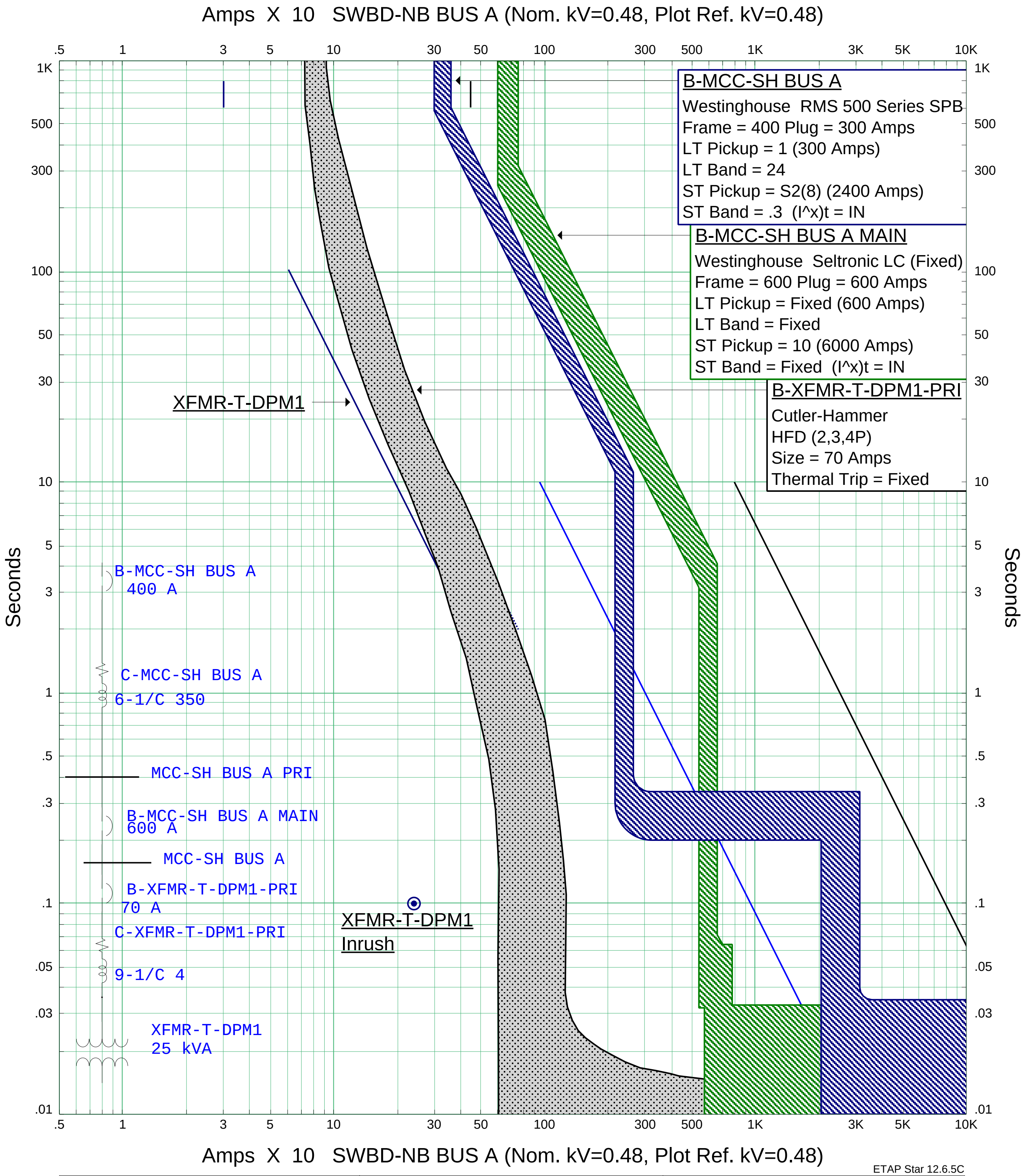
Date: 04-07-2015
SN: CAROLLOWAN
Rev: Base
Fault: Phase



MCC-PD3B TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

Date: 04-07-2015
SN: CAROLLOWAN
Rev: Base
Fault: Phase

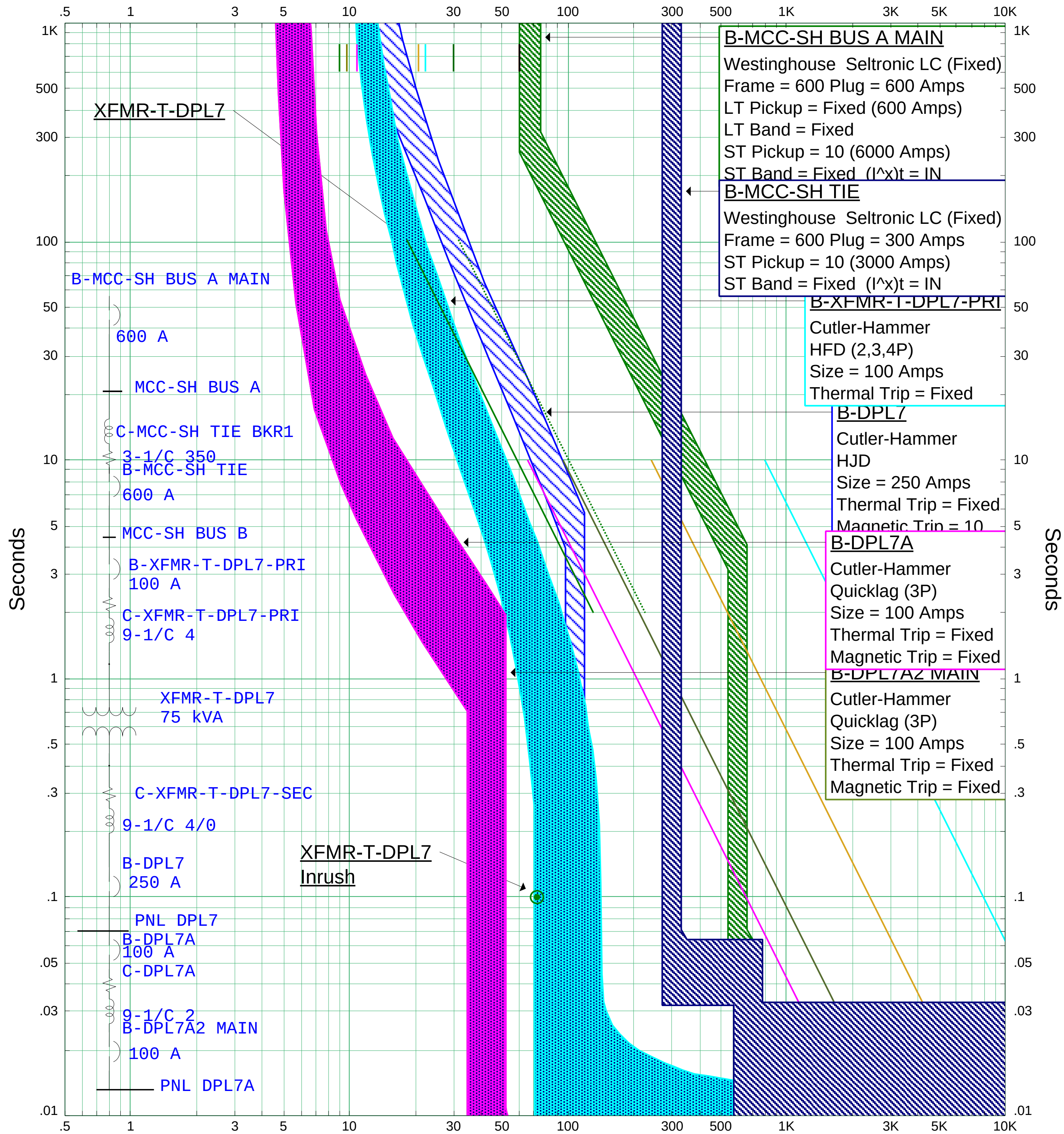


MCC-SH BUS A TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

Date: 04-06-2015
SN: CAROLLOWAN
Rev: Base
Fault: Phase

Amps X 10 MCC-SH BUS B (Nom. kV=0.48, Plot Ref. kV=0.48)



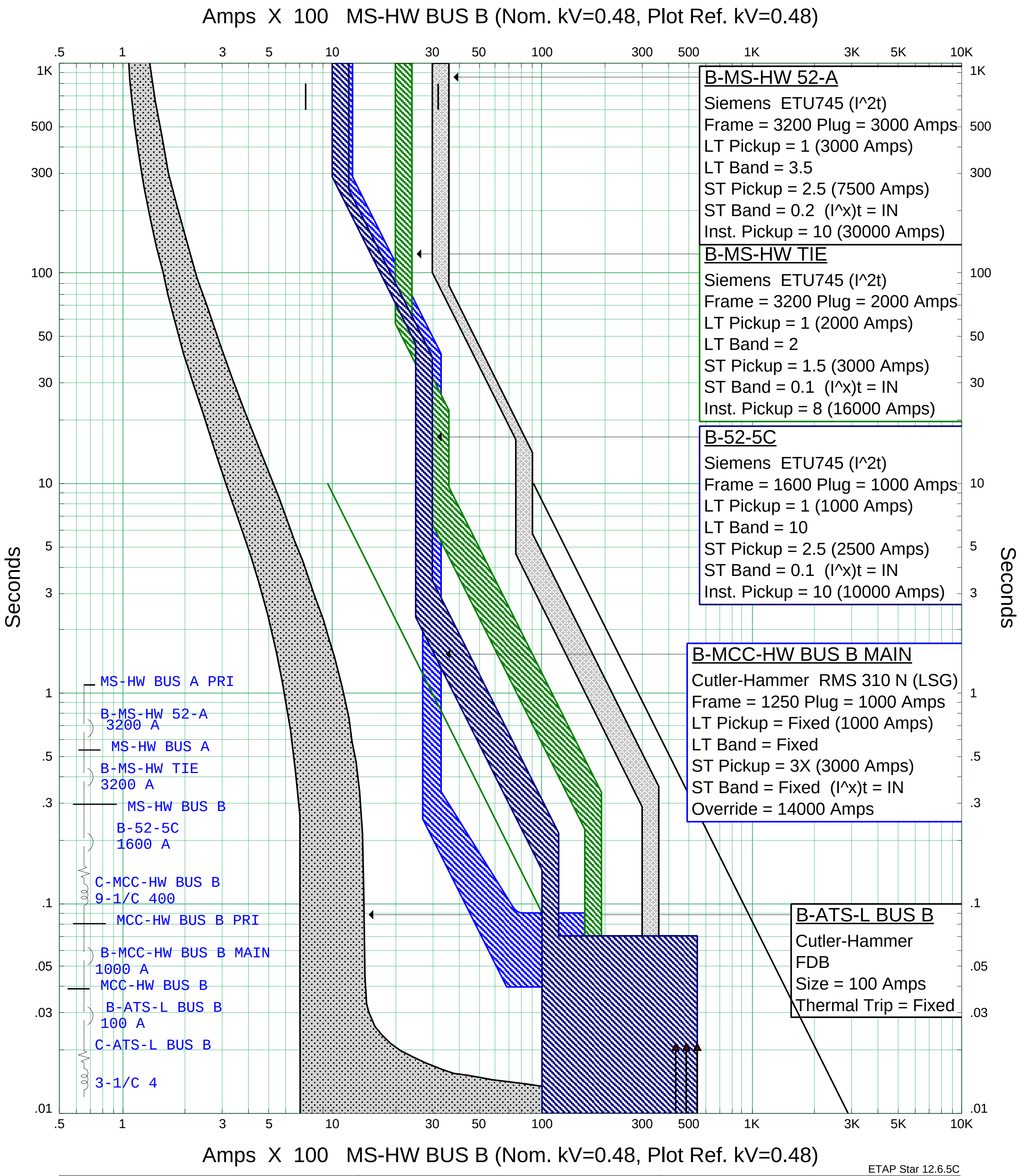
Amps X 10 MCC-SH BUS B (Nom. kV=0.48, Plot Ref. kV=0.48)

ETAP Star 12.6.5C

MCC-SH BUS B TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

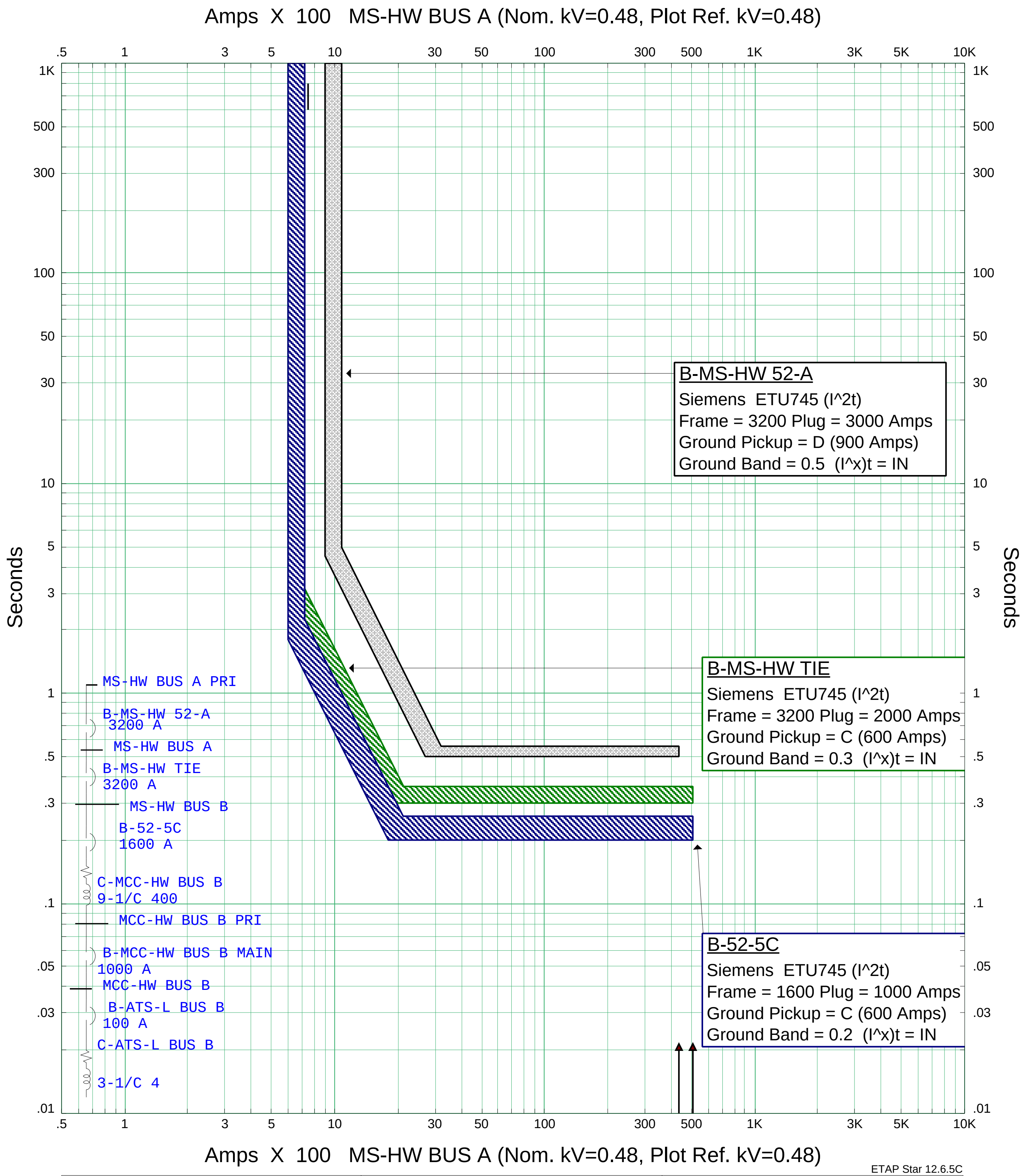
Date: 04-07-2015
SN: CAROLLOWAN
Rev: Base
Fault: Phase



MS-HW BUS A - TIE TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

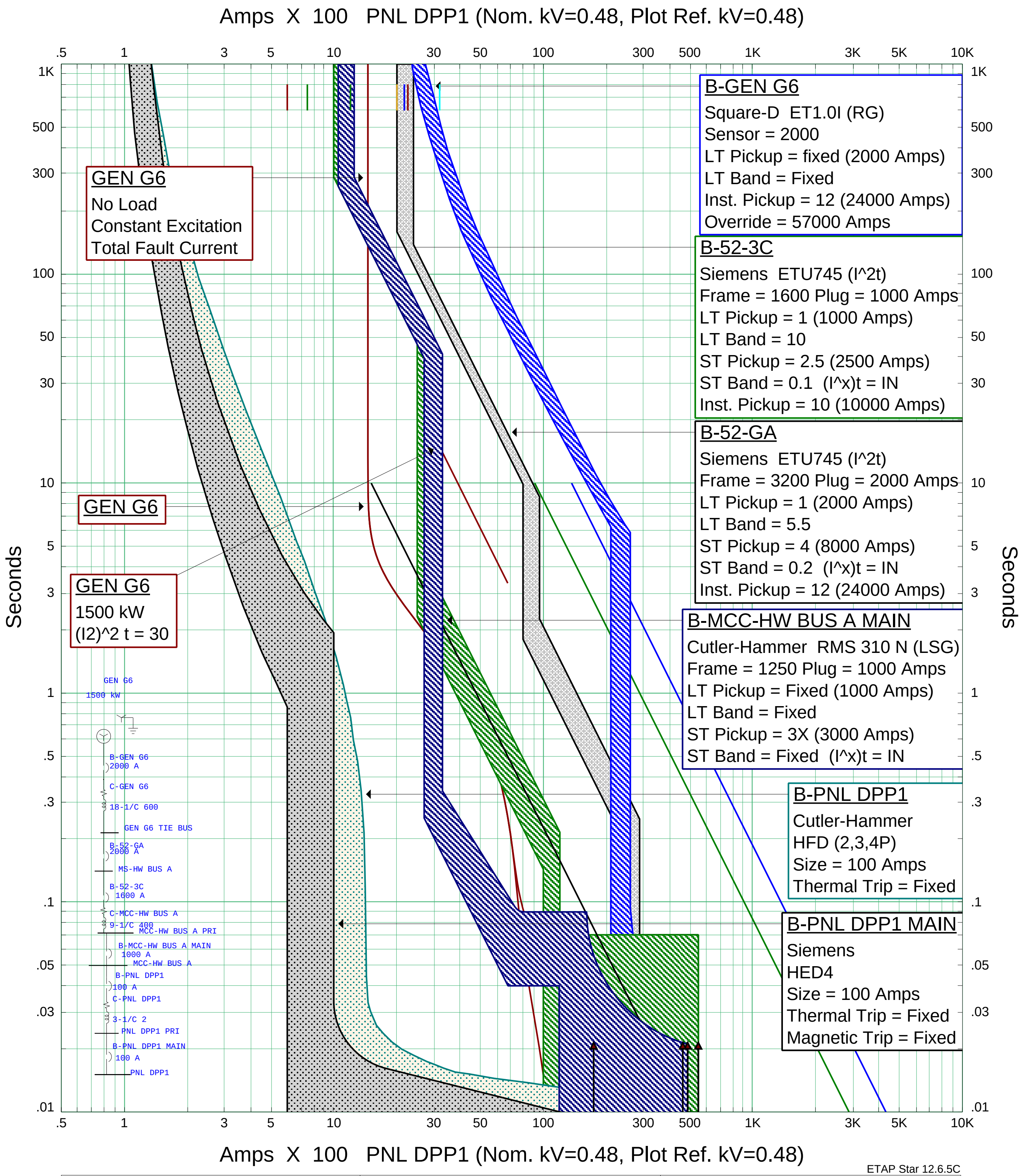
Date: 04-06-2015
SN: CAROLLOWAN
Rev: Base
Fault: Phase



MS-HW BUS A - TIE TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

Date: 04-06-2015
SN: CAROLLOWAN
Rev: Base
Fault: Ground

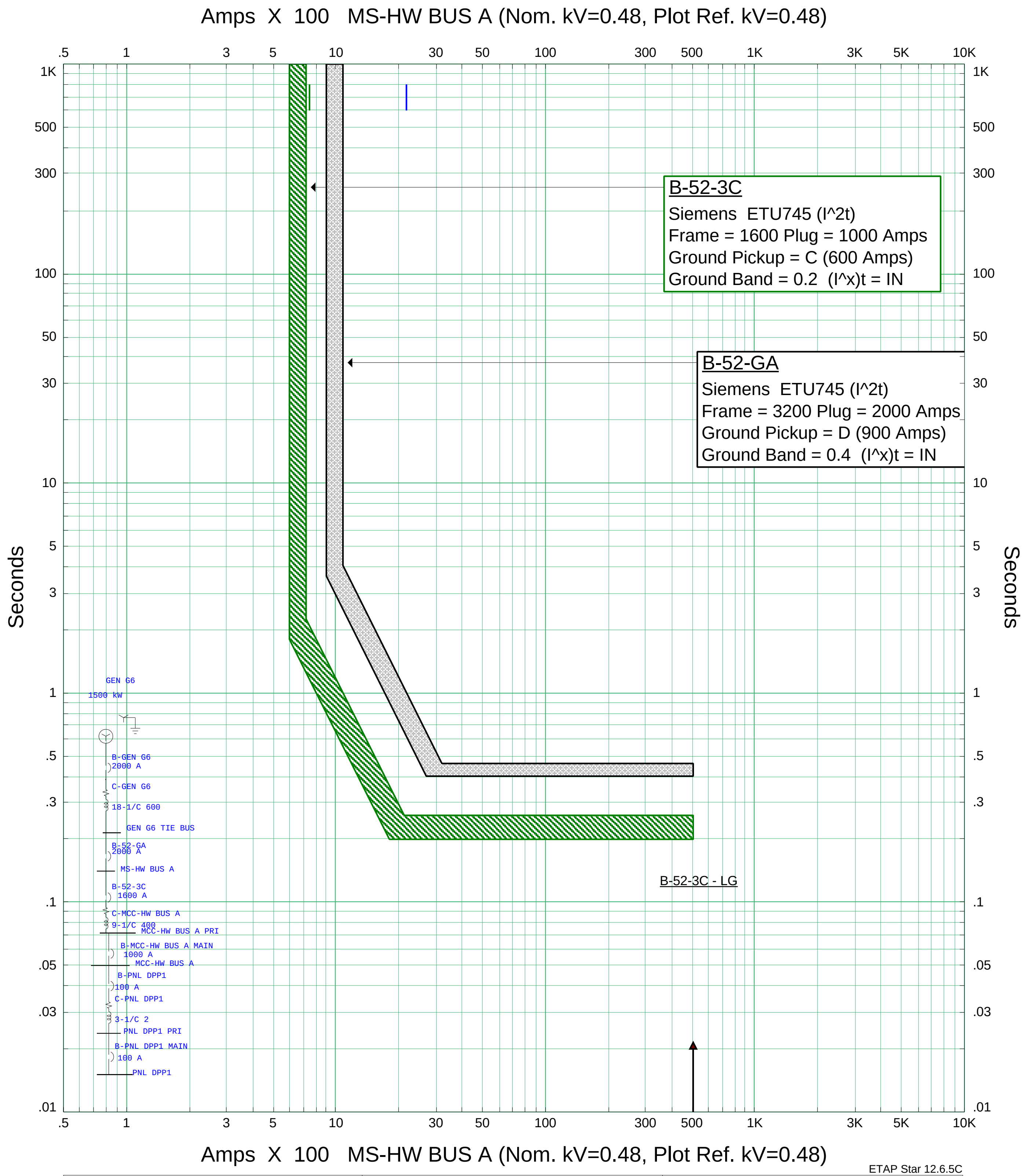


ETAP Star 12.6.5C

MS-HW BUS A GEN TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

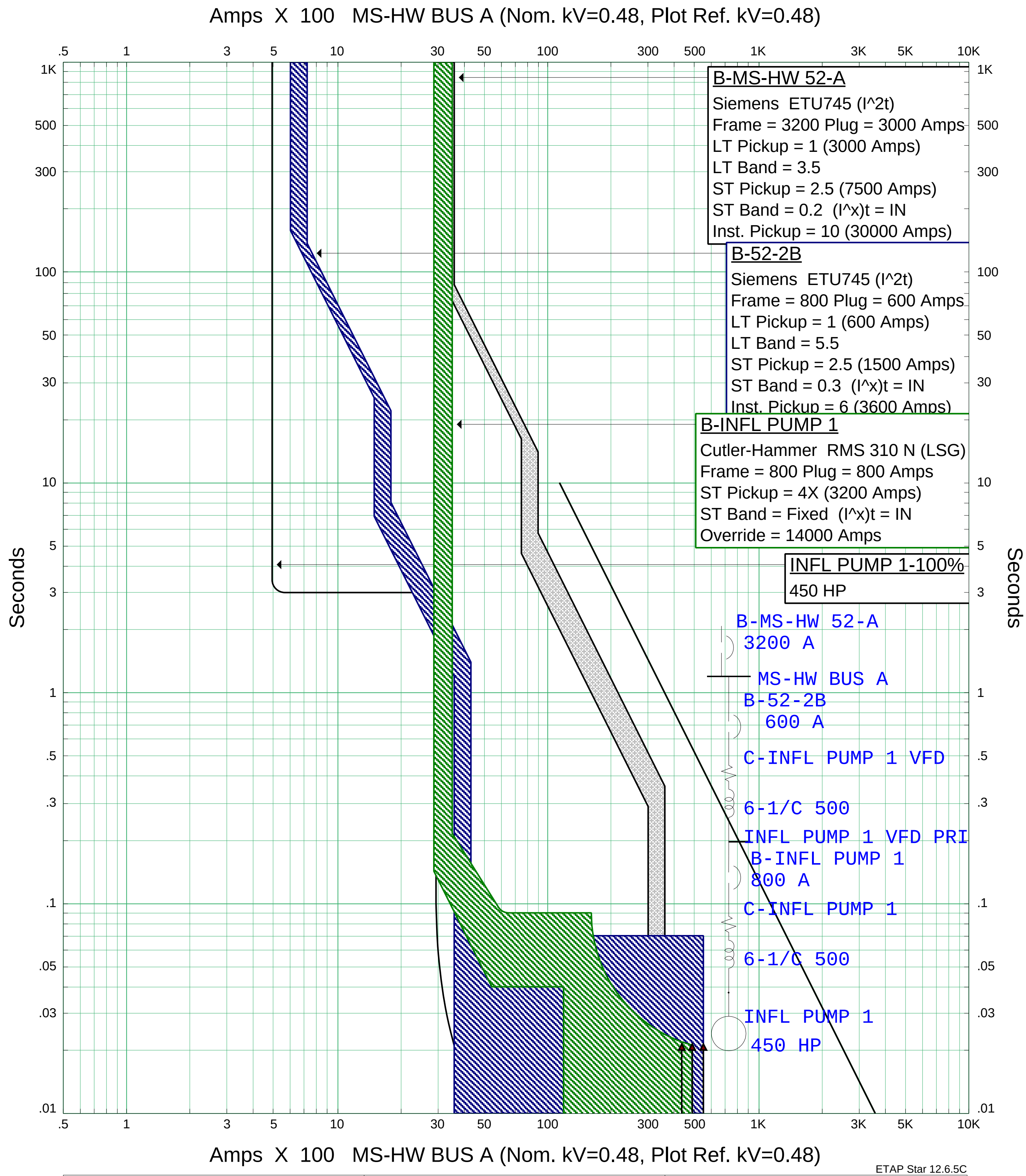
Date: 04-06-2015
SN: CAROLLOWAN
Rev: Base
Fault: Phase



MS-HW BUS A GEN TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

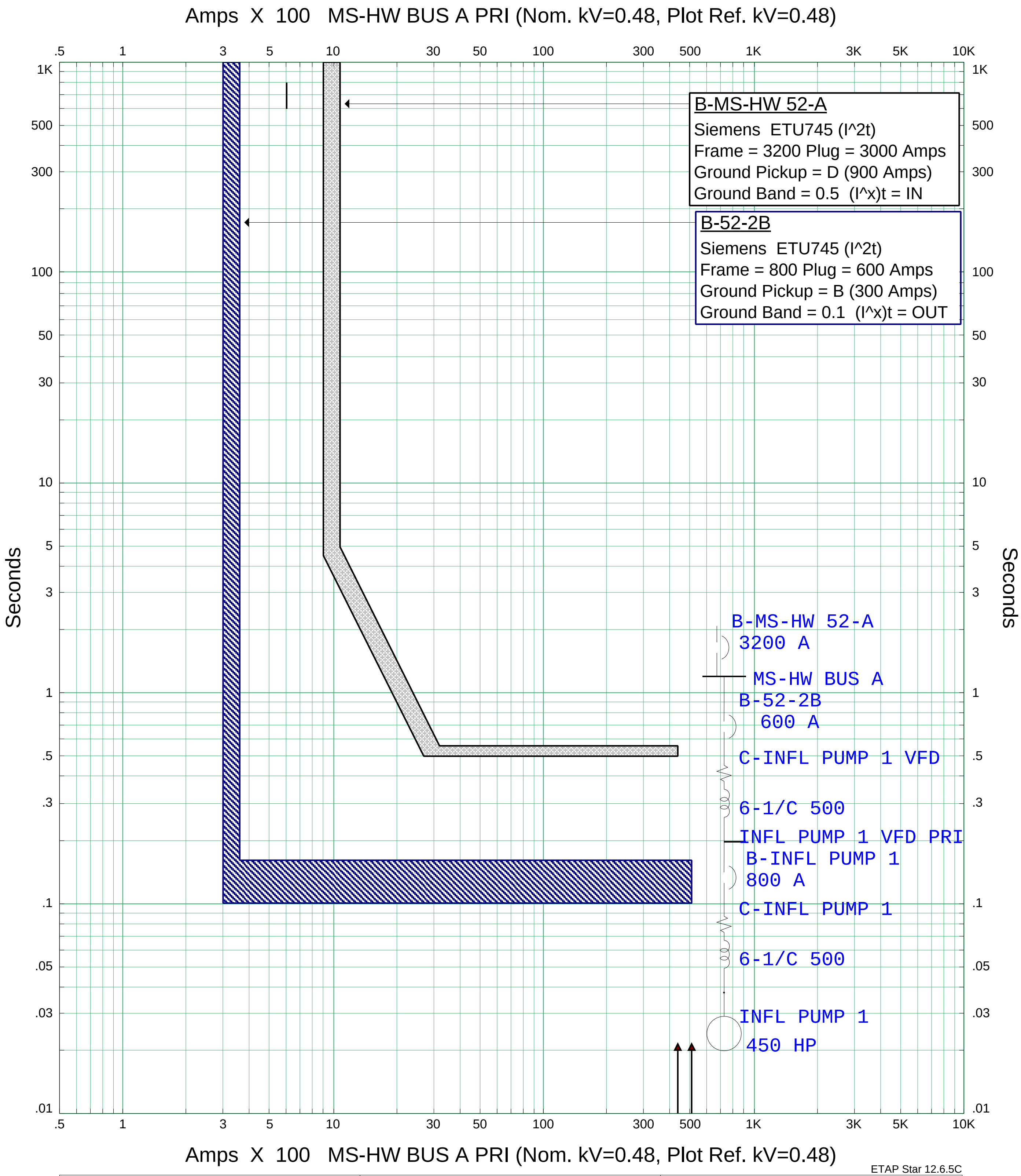
Date: 04-06-2015
SN: CAROLLOWAN
Rev: Base
Fault: Ground



MS-HW BUS A PUMP TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

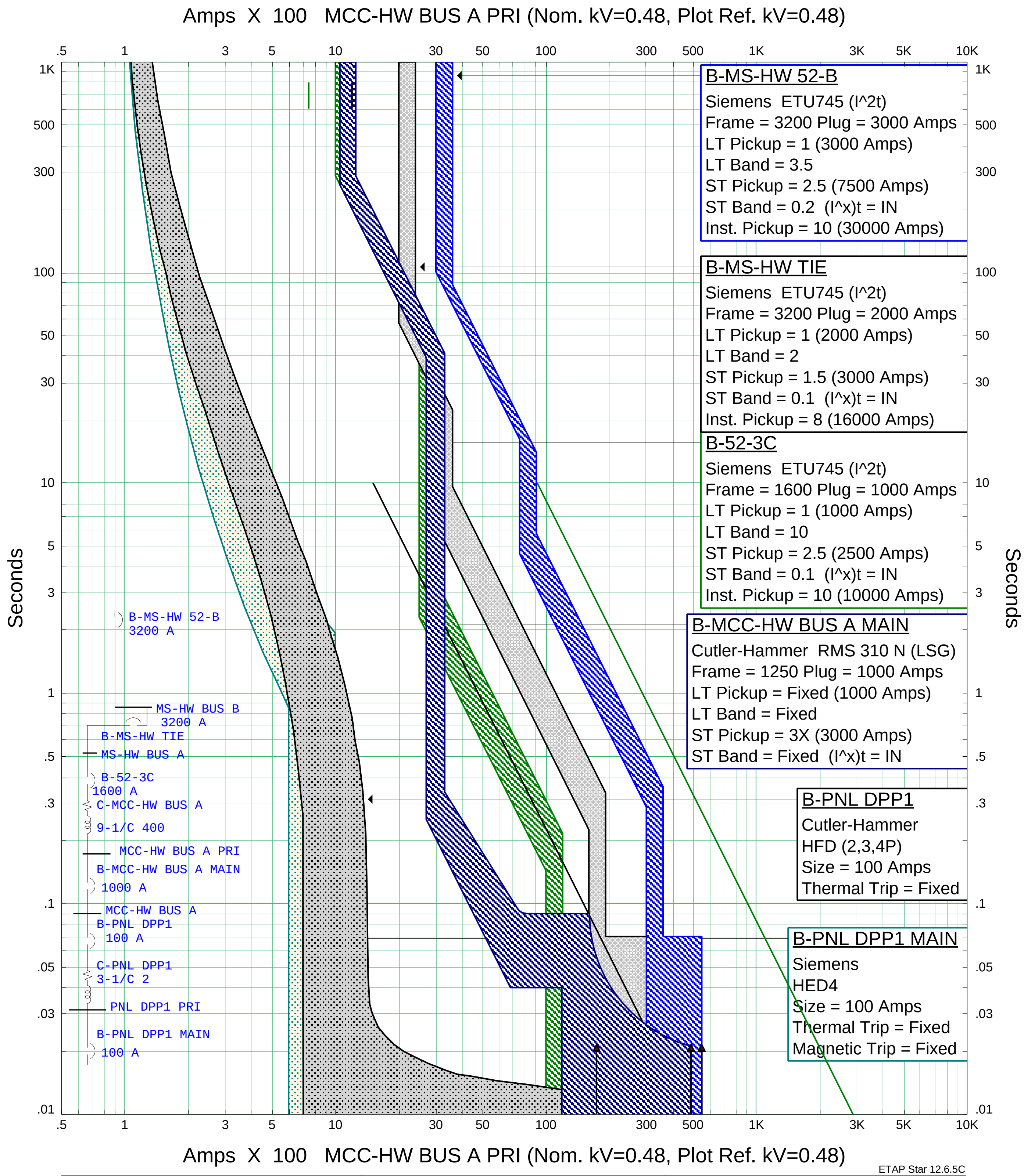
Date: 04-06-2015
SN: CAROLLOWAN
Rev: Base
Fault: Phase



MS-HW BUS A PUMP TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

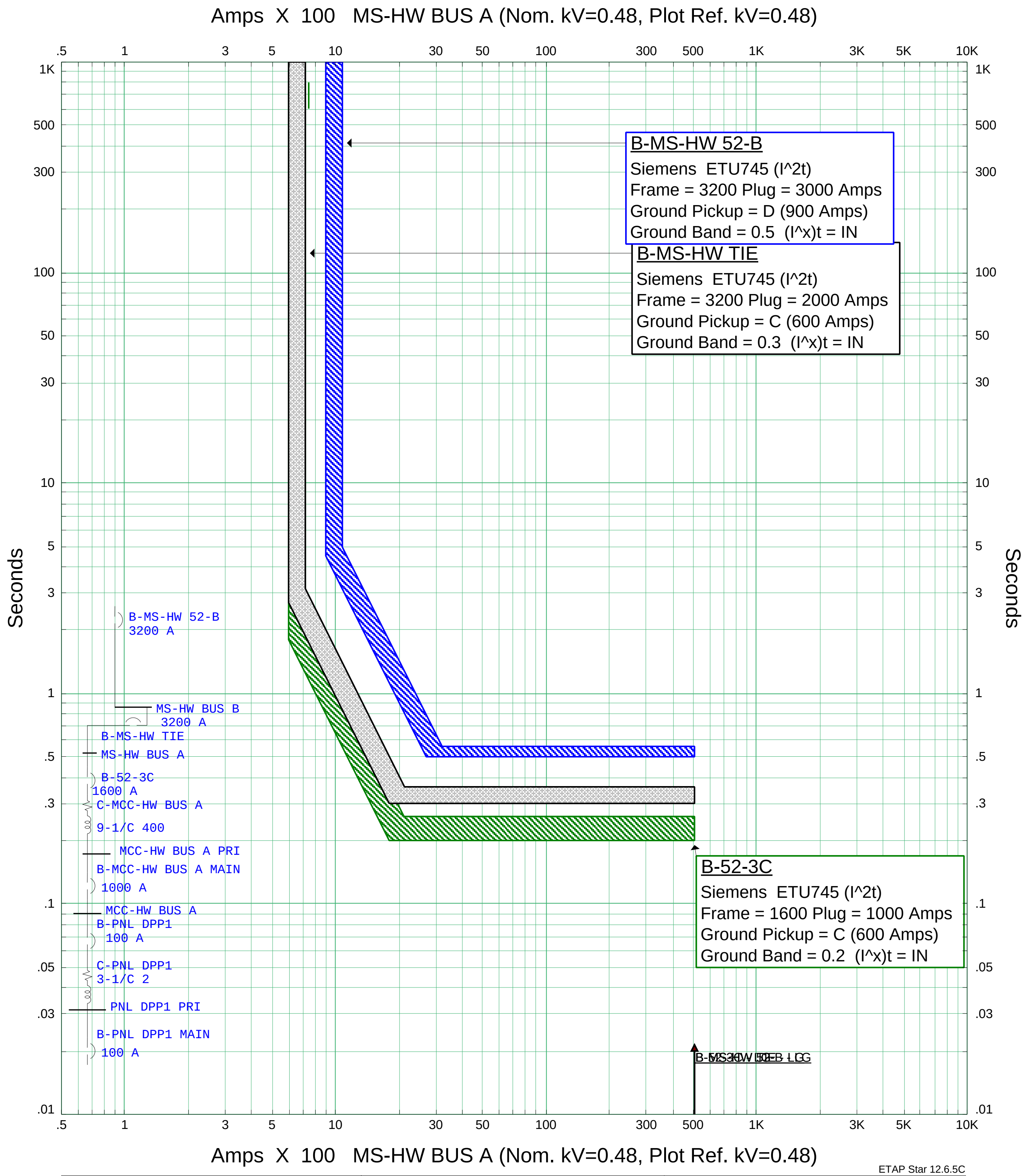
Date: 04-06-2015
SN: CAROLLOWAN
Rev: Base
Fault: Ground



MS-HW BUS B - TIE TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

Date: 04-06-2015
SN: CAROLLOWAN
Rev: Base
Fault: Phase

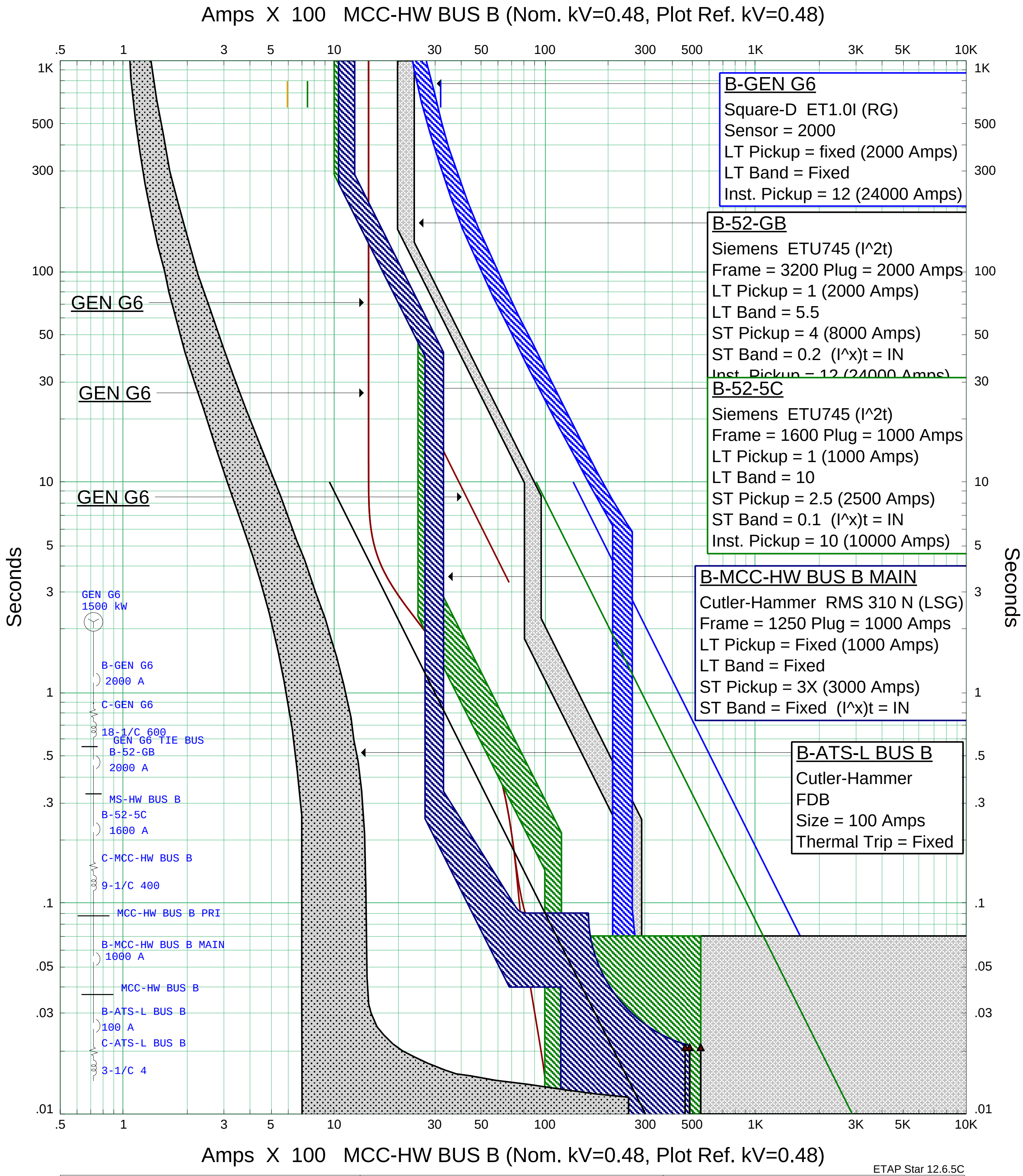


ETAP Star 12.6.5C

MS-HW BUS B - TIE TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

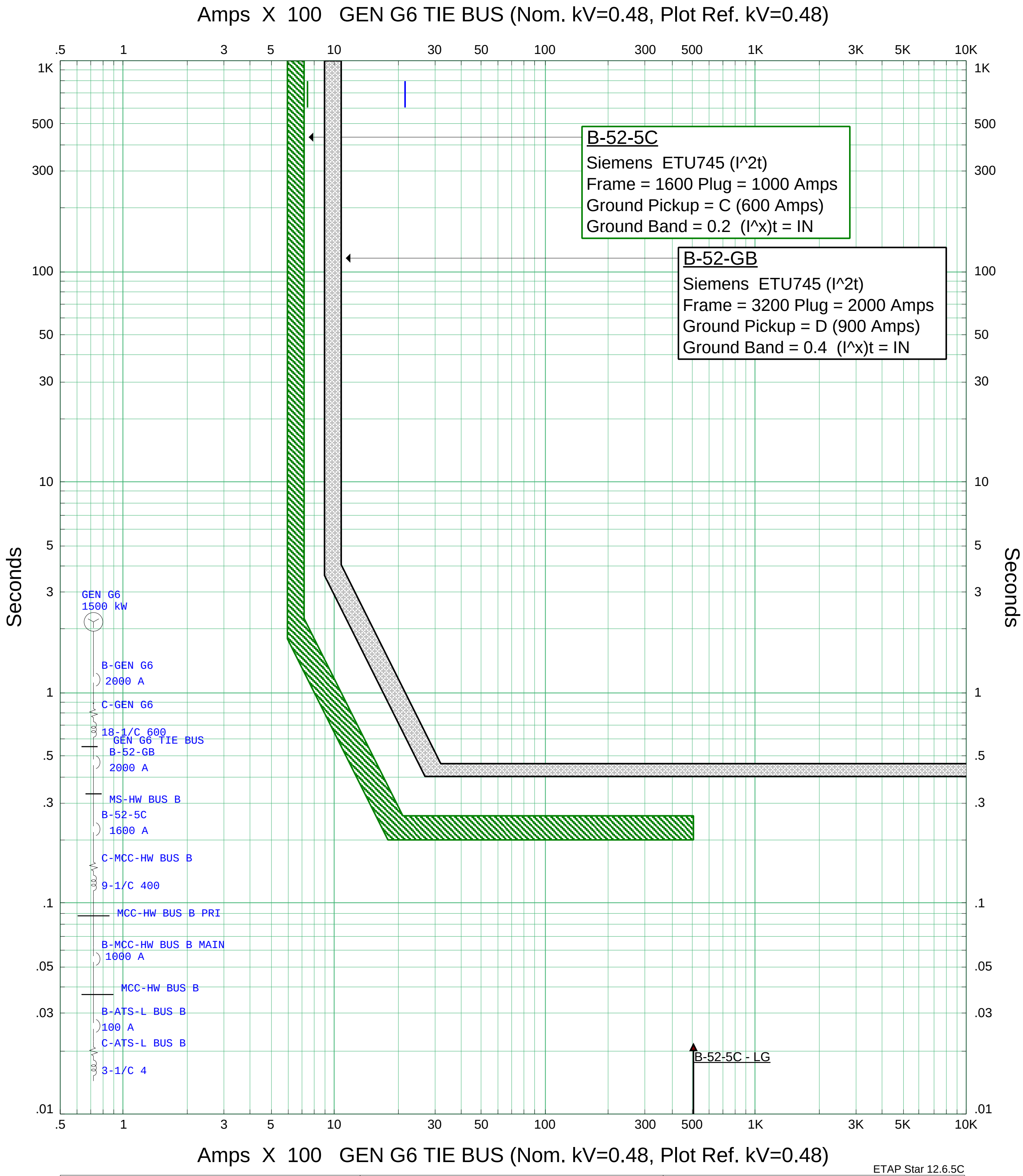
Date: 04-06-2015
SN: CAROLLOWAN
Rev: Base
Fault: Ground



MS-HW BUS B GEN TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

Date: 04-06-2015
SN: CAROLLOWAN
Rev: Base
Fault: Phase

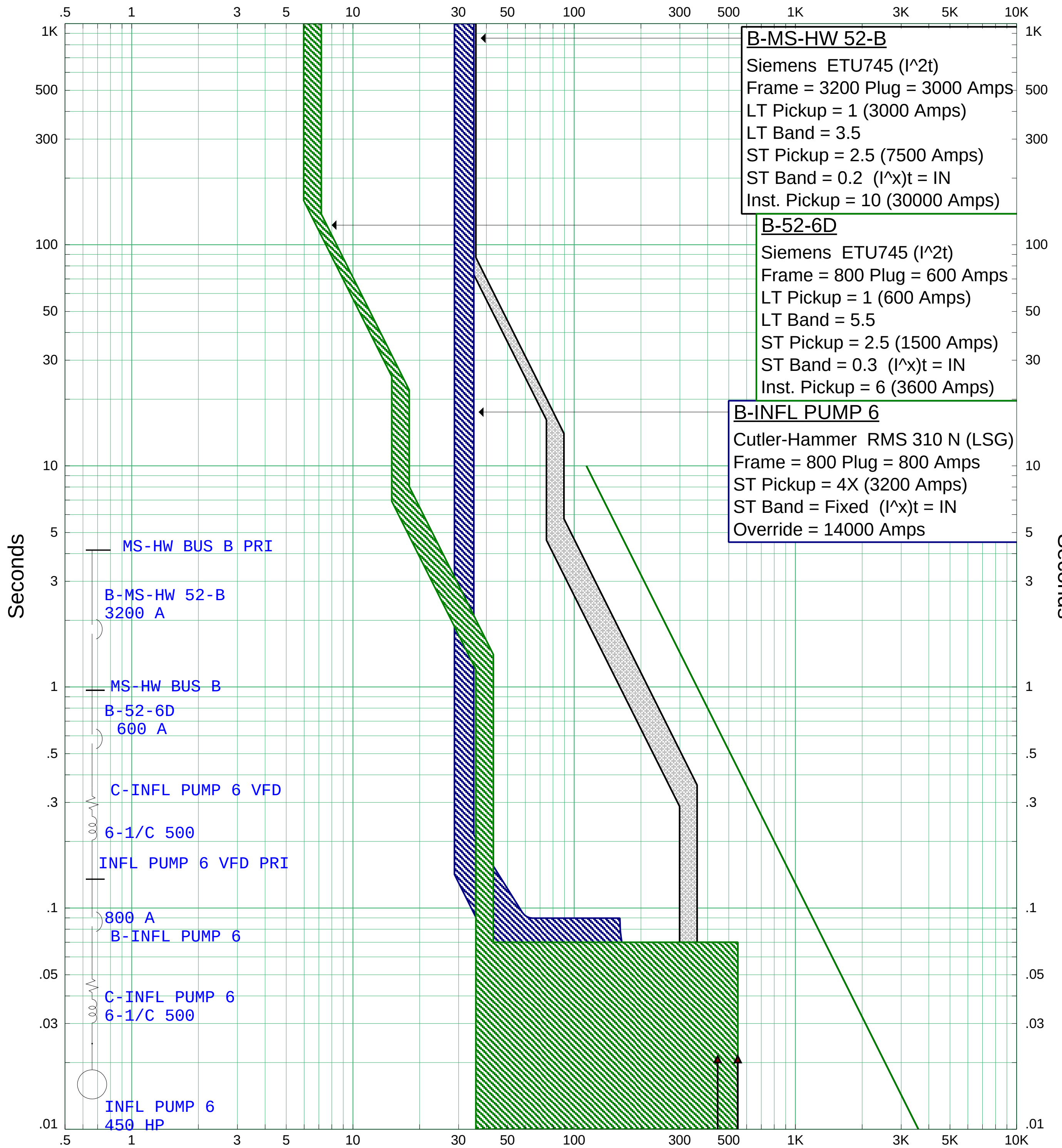


MS-HW BUS B GEN TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

Date: 04-06-2015
SN: CAROLLOWAN
Rev: Base
Fault: Ground

Amps X 100 INFL PUMP 6 VFD PRI (Nom. kV=0.48, Plot Ref. kV=0.48)



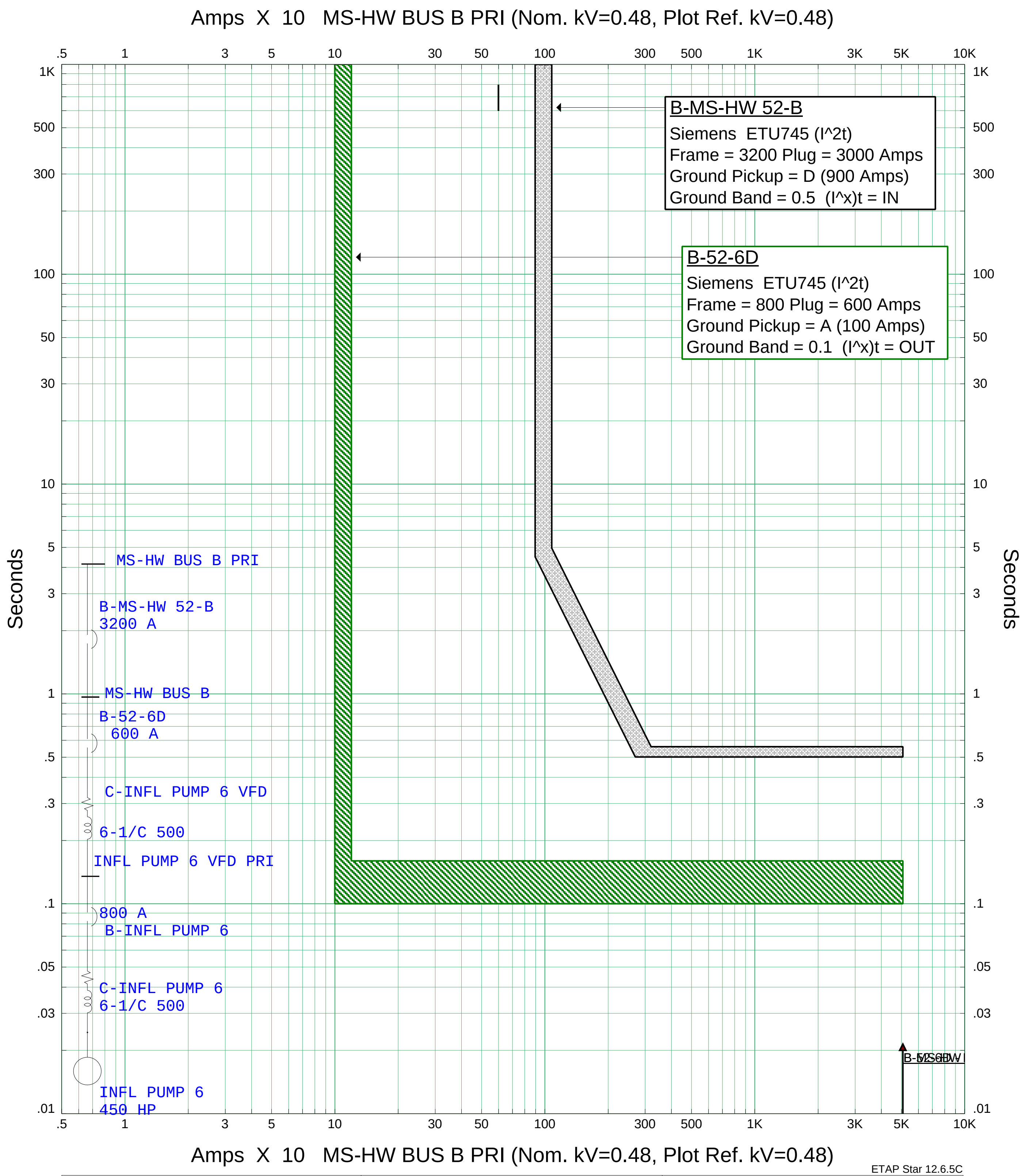
Amps X 100 INFL PUMP 6 VFD PRI (Nom. kV=0.48, Plot Ref. kV=0.48)

ETAP Star 12.6.5C

MS-HW BUS B PUMP TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

Date: 04-06-2015
SN: CAROLLOWAN
Rev: Base
Fault: Phase

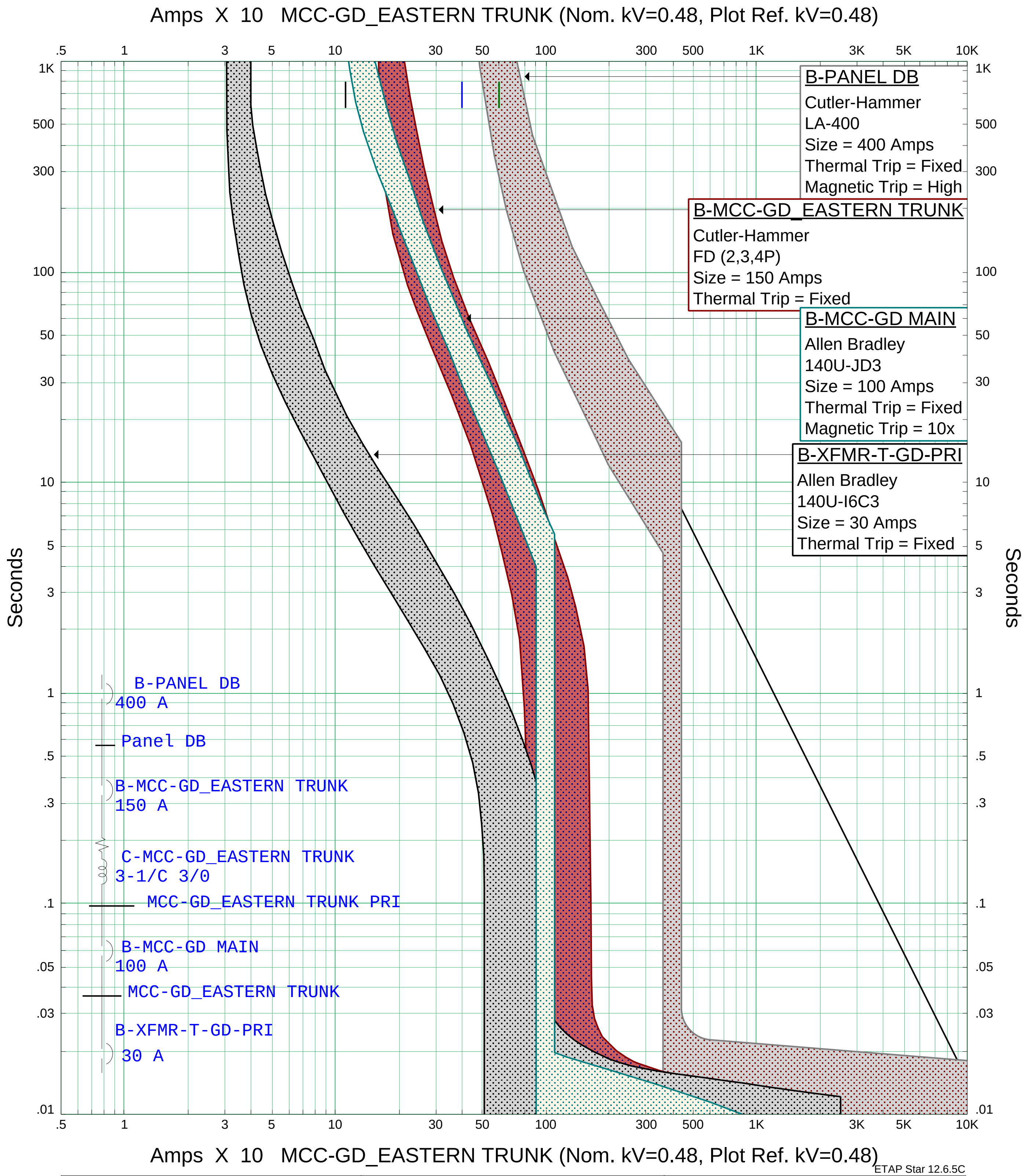


ETAP Star 12.6.5C

MS-HW BUS B PUMP TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

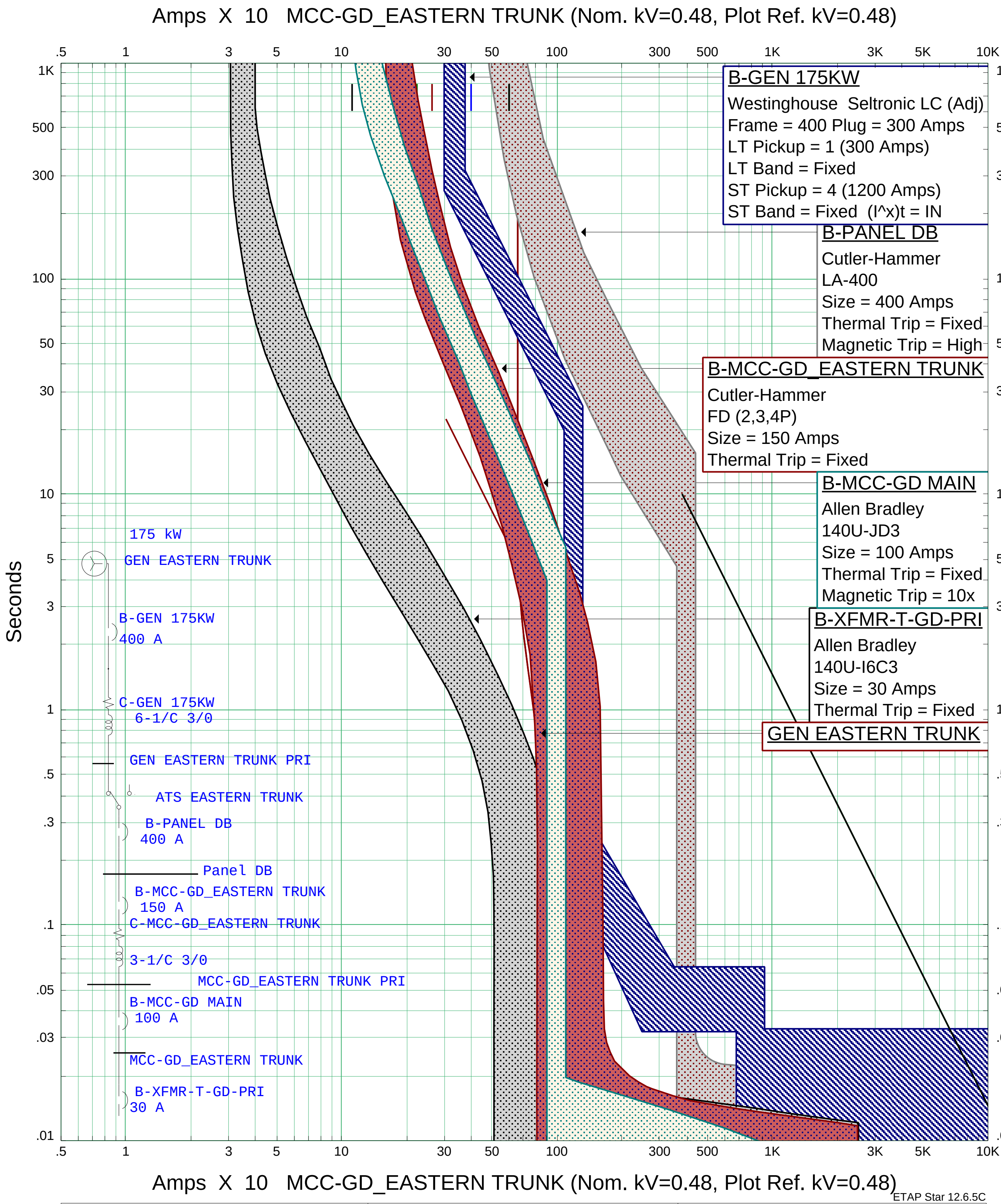
Date: 04-06-2015
SN: CAROLLOWAN
Rev: Base
Fault: Ground



PANEL DB - TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

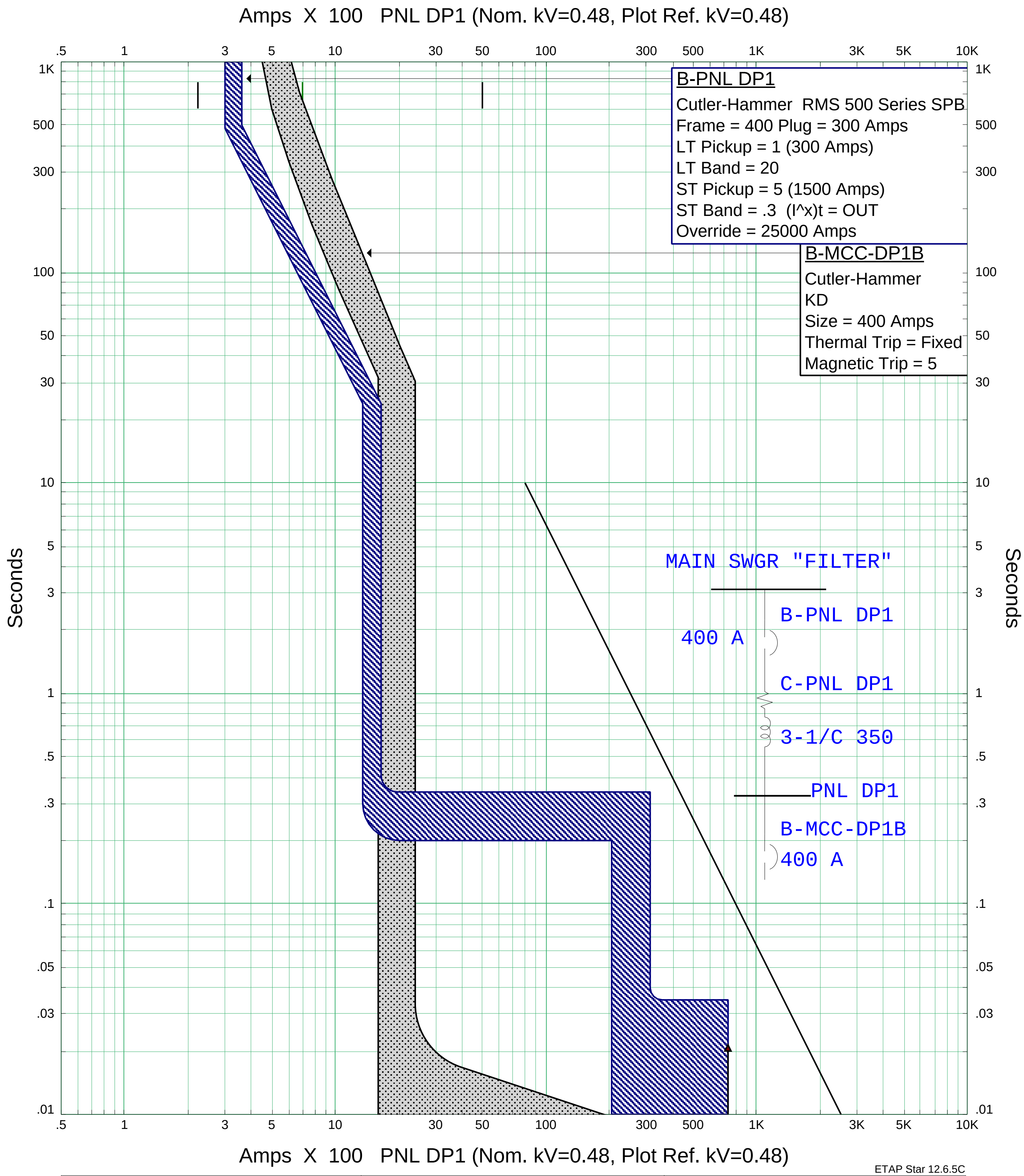
Date: 04-06-2015
SN: CAROLLOWAN
Rev: Base
Fault: Phase



PANEL DB GEN TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

Date: 04-06-2015
SN: CAROLLOWAN
Rev: Base
Fault: Phase

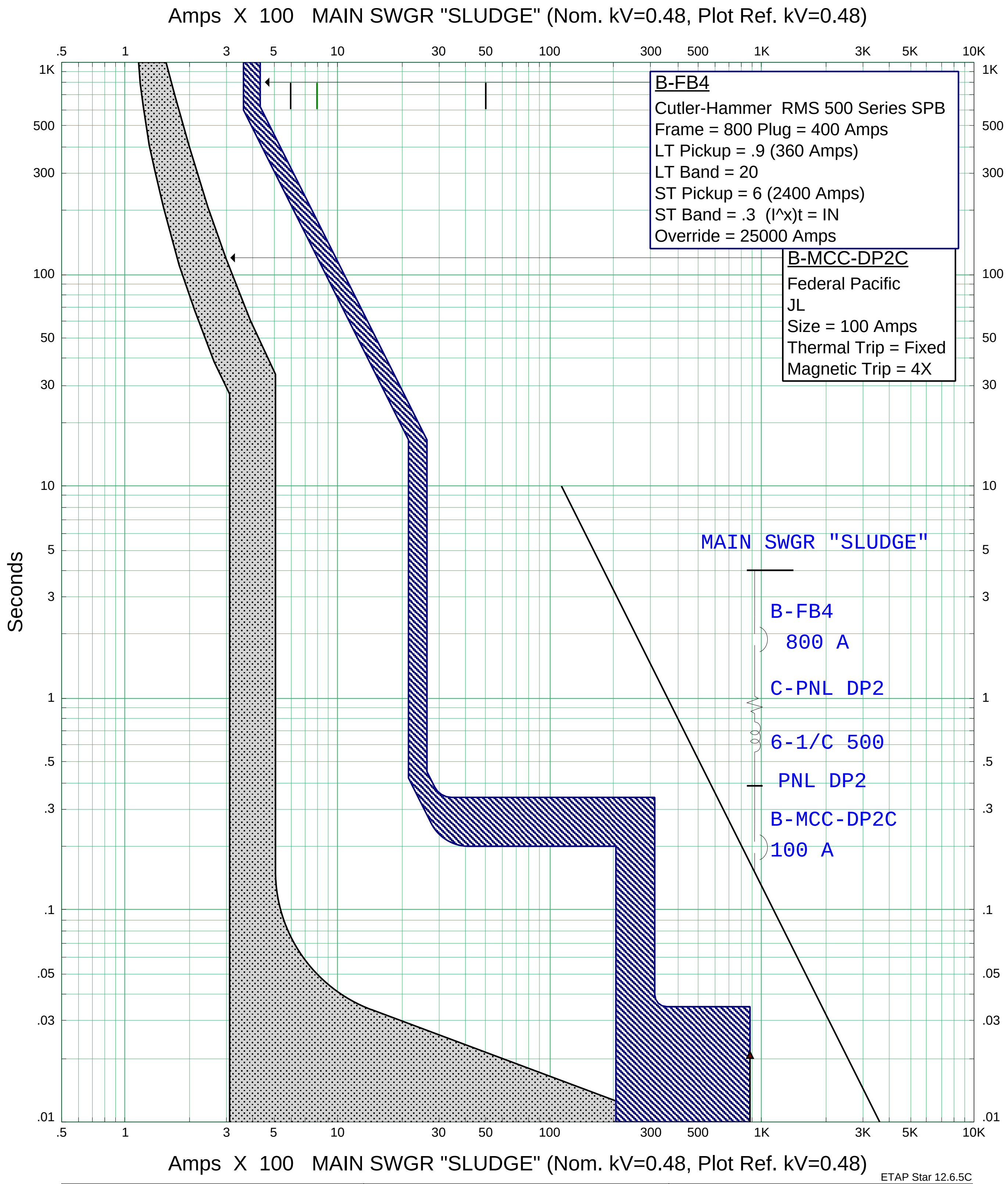


ETAP Star 12.6.5C

PNL DP1 TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

Date: 04-07-2015
SN: CAROLLOWAN
Rev: Base
Fault: Phase

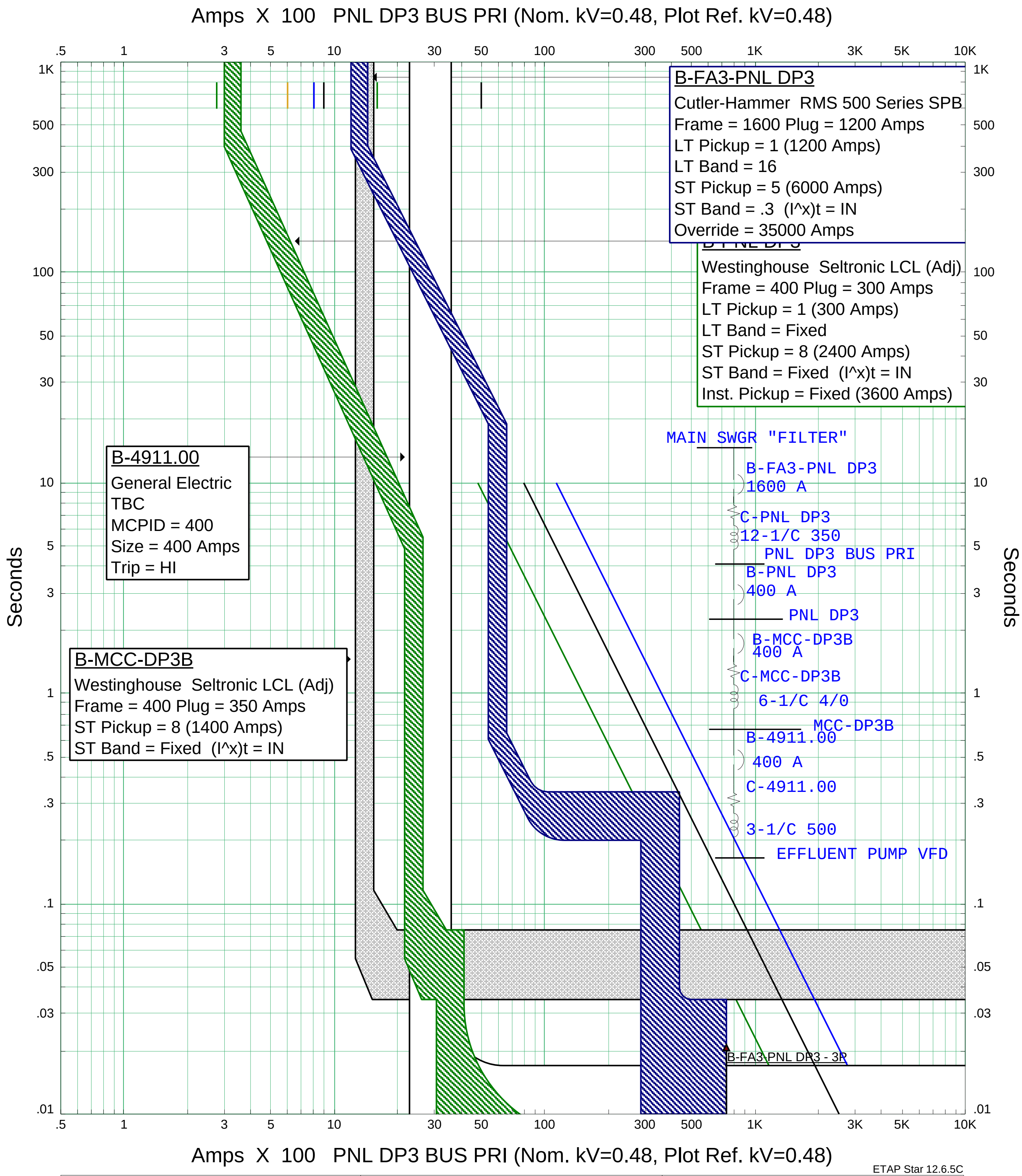


ETAP Star 12.6.5C

PNL DP2 TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

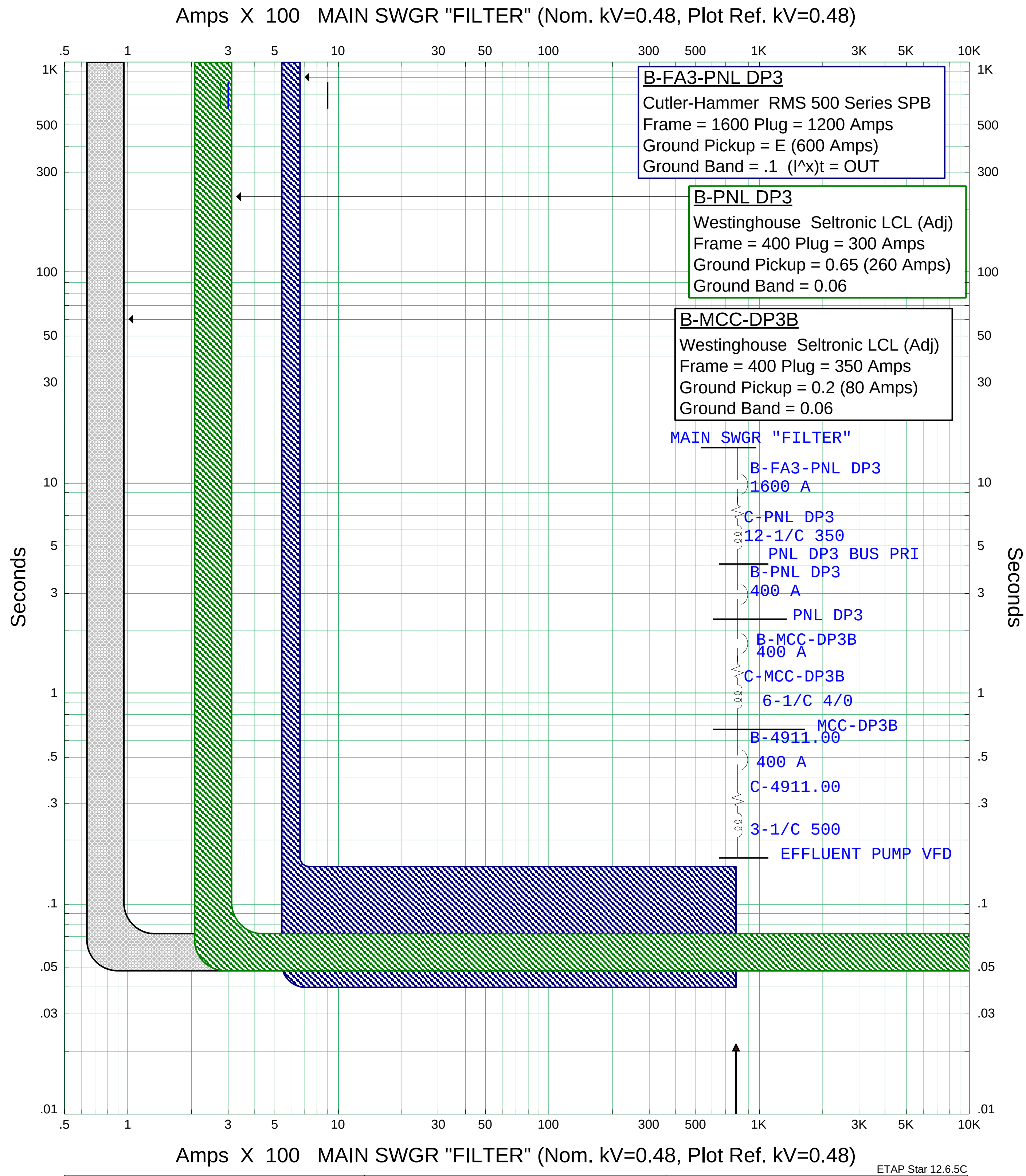
Date: 04-07-2015
SN: CAROLLOWAN
Rev: Base
Fault: Phase



PNL DP3 TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

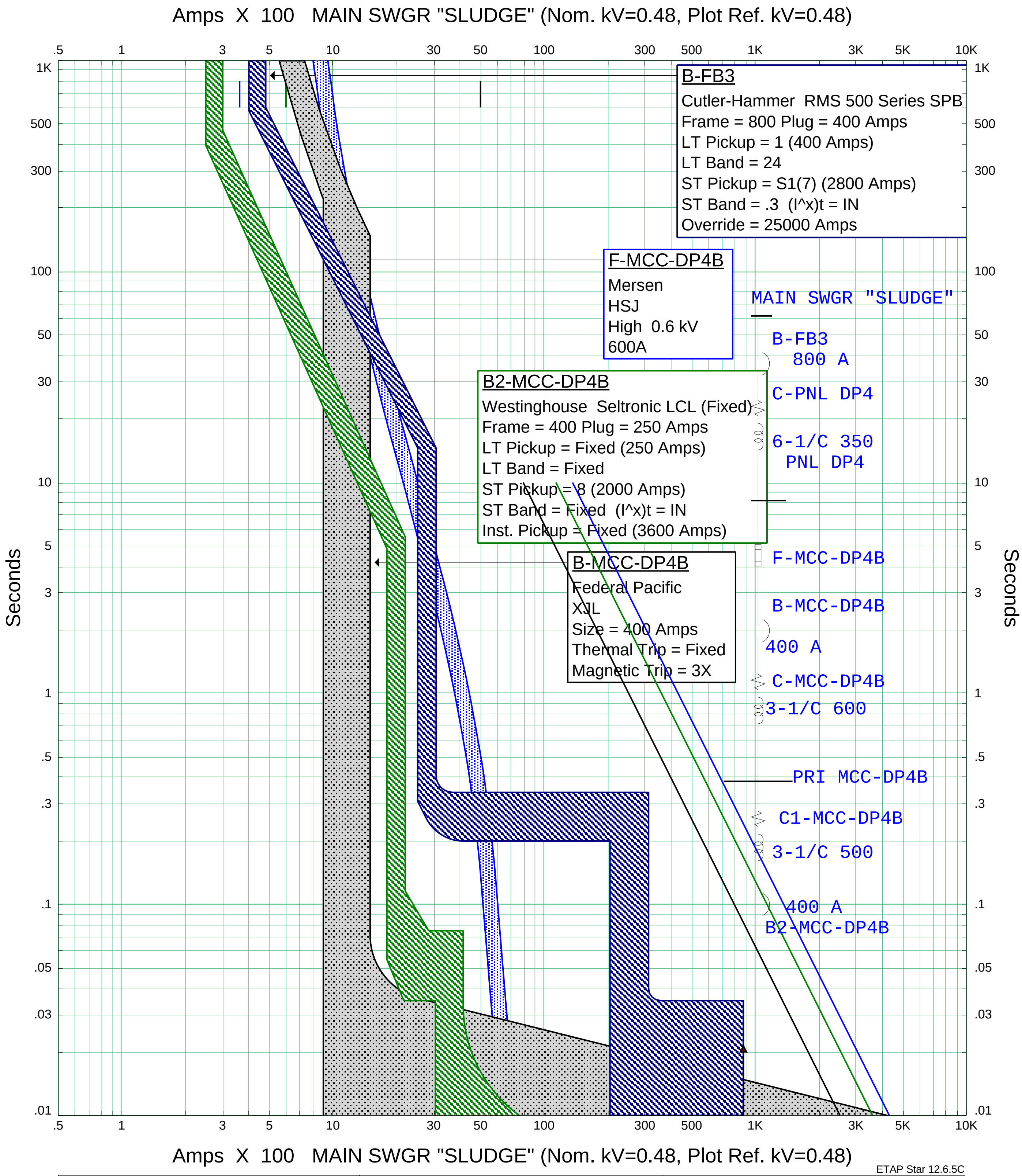
Date: 04-07-2015
SN: CAROLLOWAN
Rev: Base
Fault: Phase



PNL DP3 TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

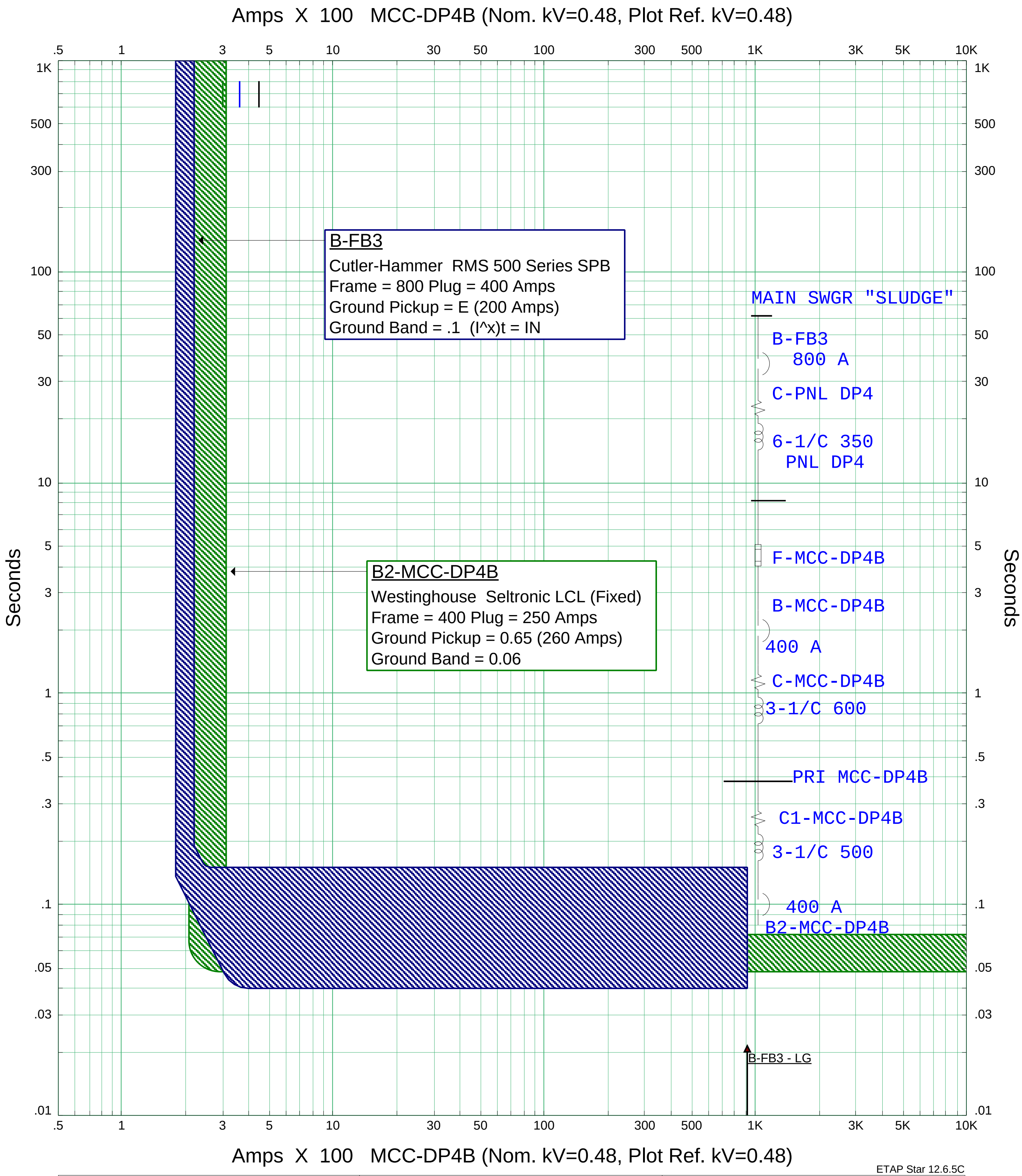
Date: 04-07-2015
SN: CAROLLOWAN
Rev: Base
Fault: Ground



PNL DP4 TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

Date: 04-07-2015
SN: CAROLLOWAN
Rev: Base
Fault: Phase

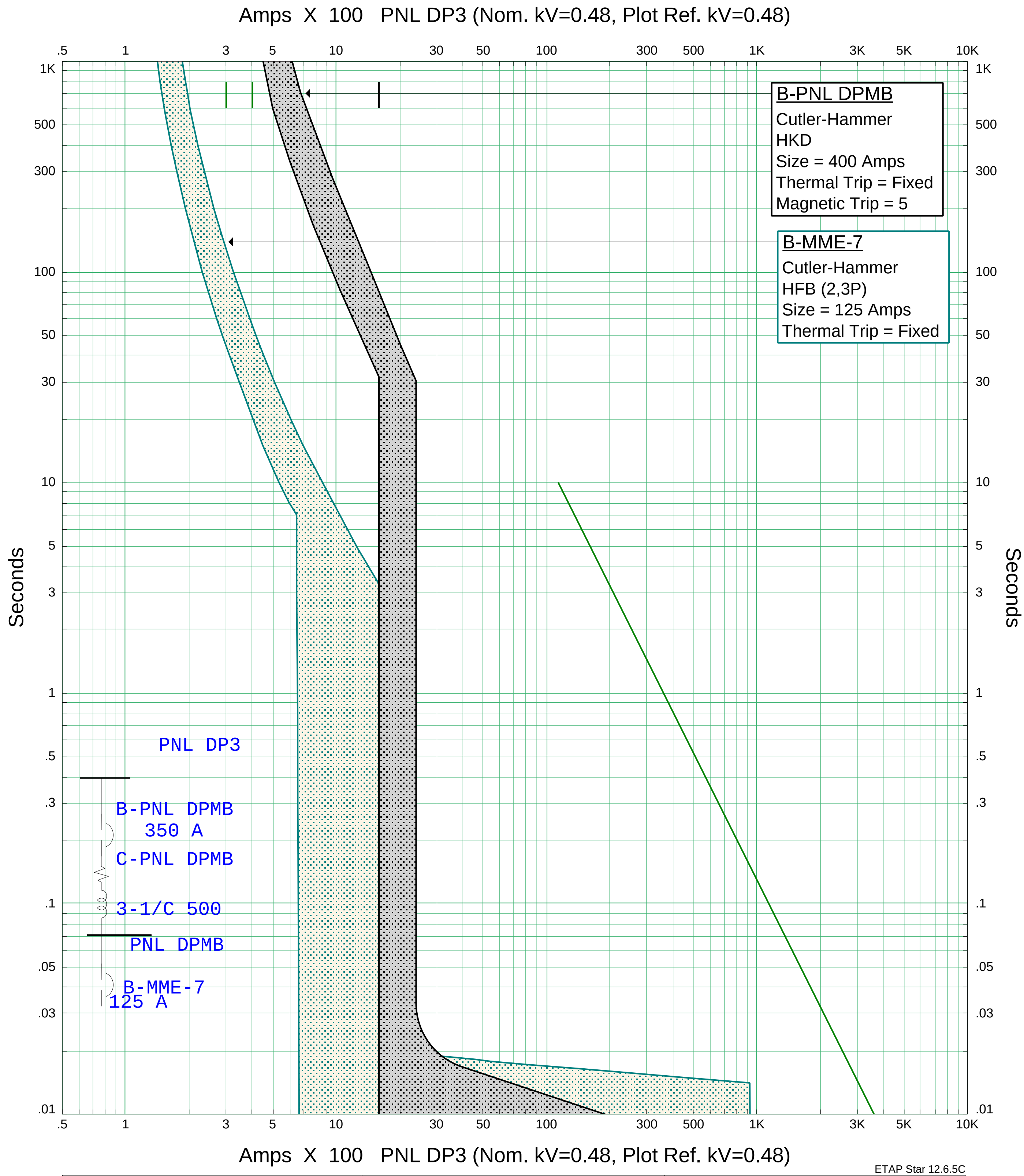


ETAP Star 12.6.5C

PNL DP4 TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

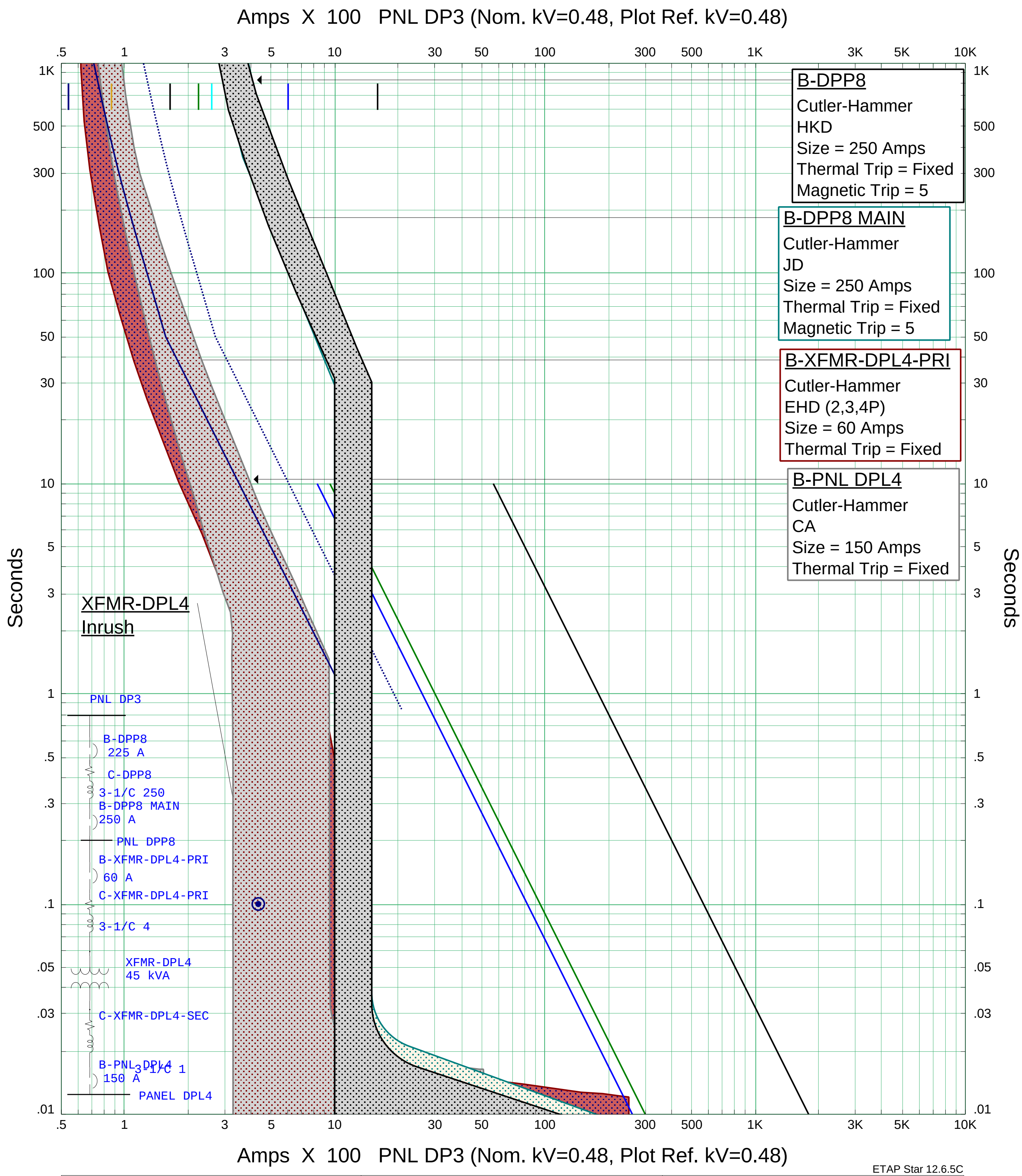
Date: 04-07-2015
SN: CAROLLOWAN
Rev: Base
Fault: Ground



PNL DPMB TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

Date: 04-07-2015
SN: CAROLLOWAN
Rev: Base
Fault: Phase

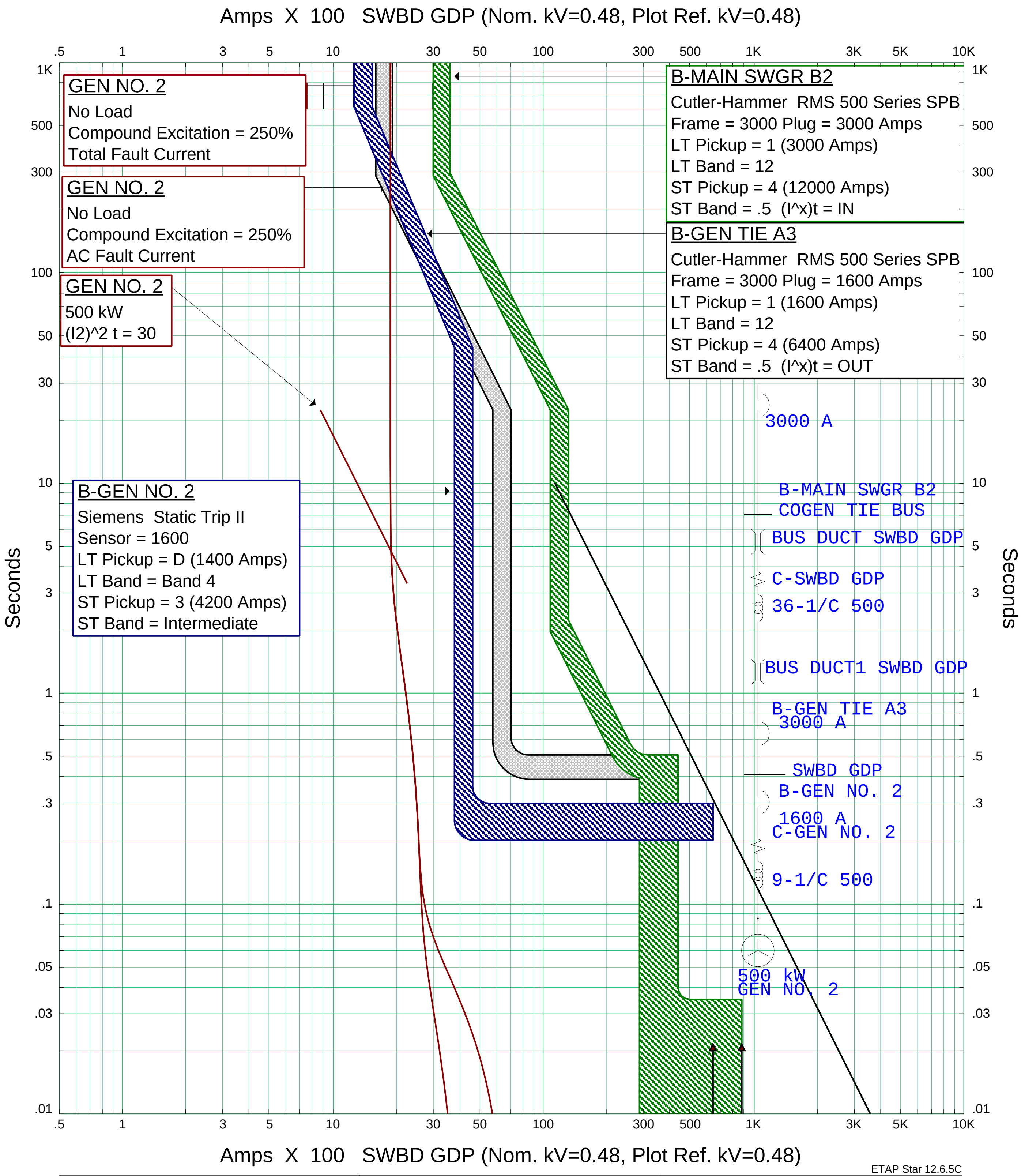


ETAP Star 12.6.5C

PNL DPP8 TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

Date: 04-07-2015
SN: CAROLLOWAN
Rev: Base
Fault: Phase

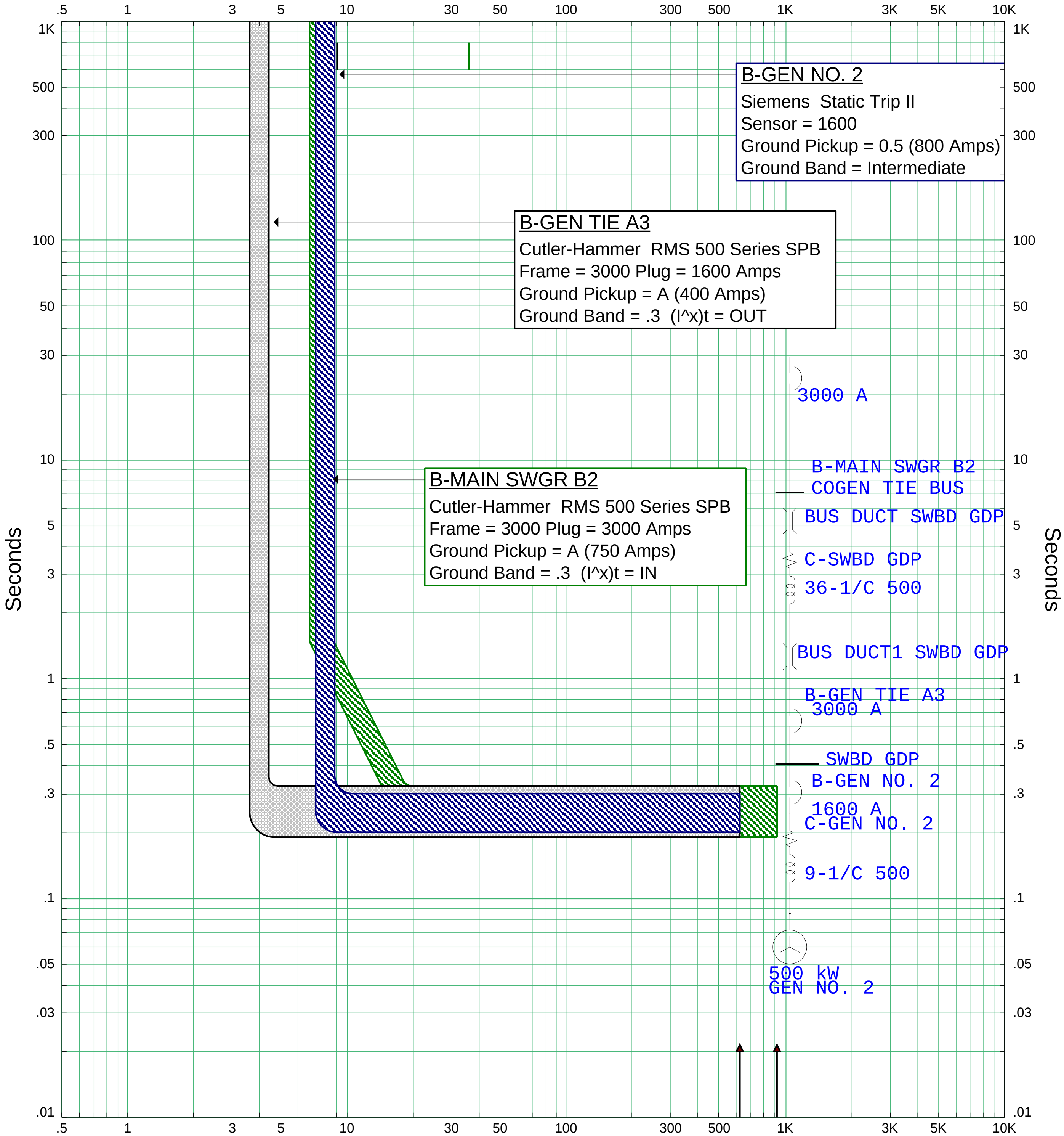


SWBD GDP TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

Date: 04-07-2015
SN: CAROLLOWAN
Rev: Base
Fault: Phase

Amps X 100 MAIN SWGR "SLUDGE" (Nom. kV=0.48, Plot Ref. kV=0.48)



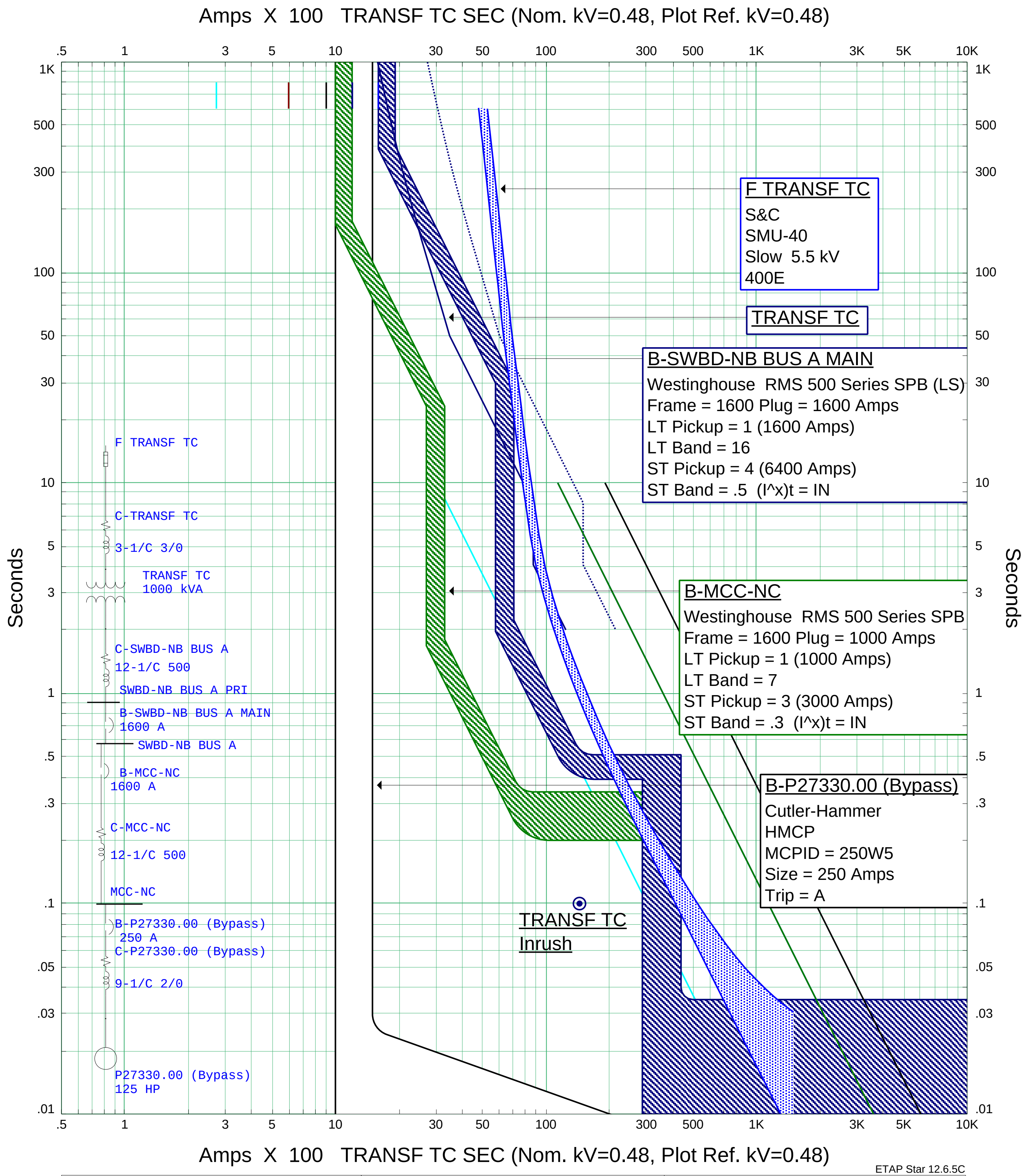
Amps X 100 MAIN SWGR "SLUDGE" (Nom. kV=0.48, Plot Ref. kV=0.48)

ETAP Star 12.6.5C

SWBD GDP TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

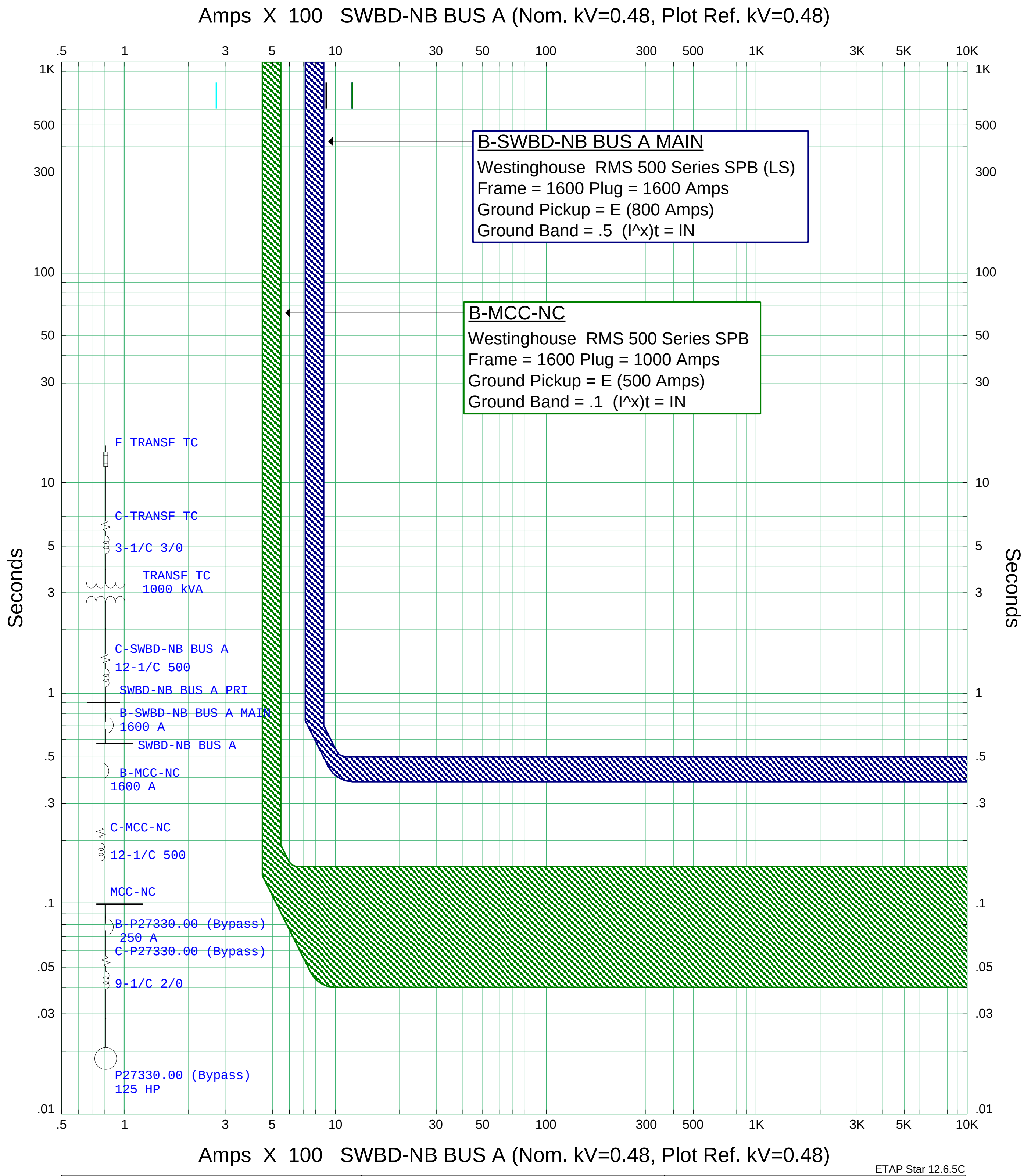
Date: 04-07-2015
SN: CAROLLOWAN
Rev: Base
Fault: Ground



SWBD-NB BUS A TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

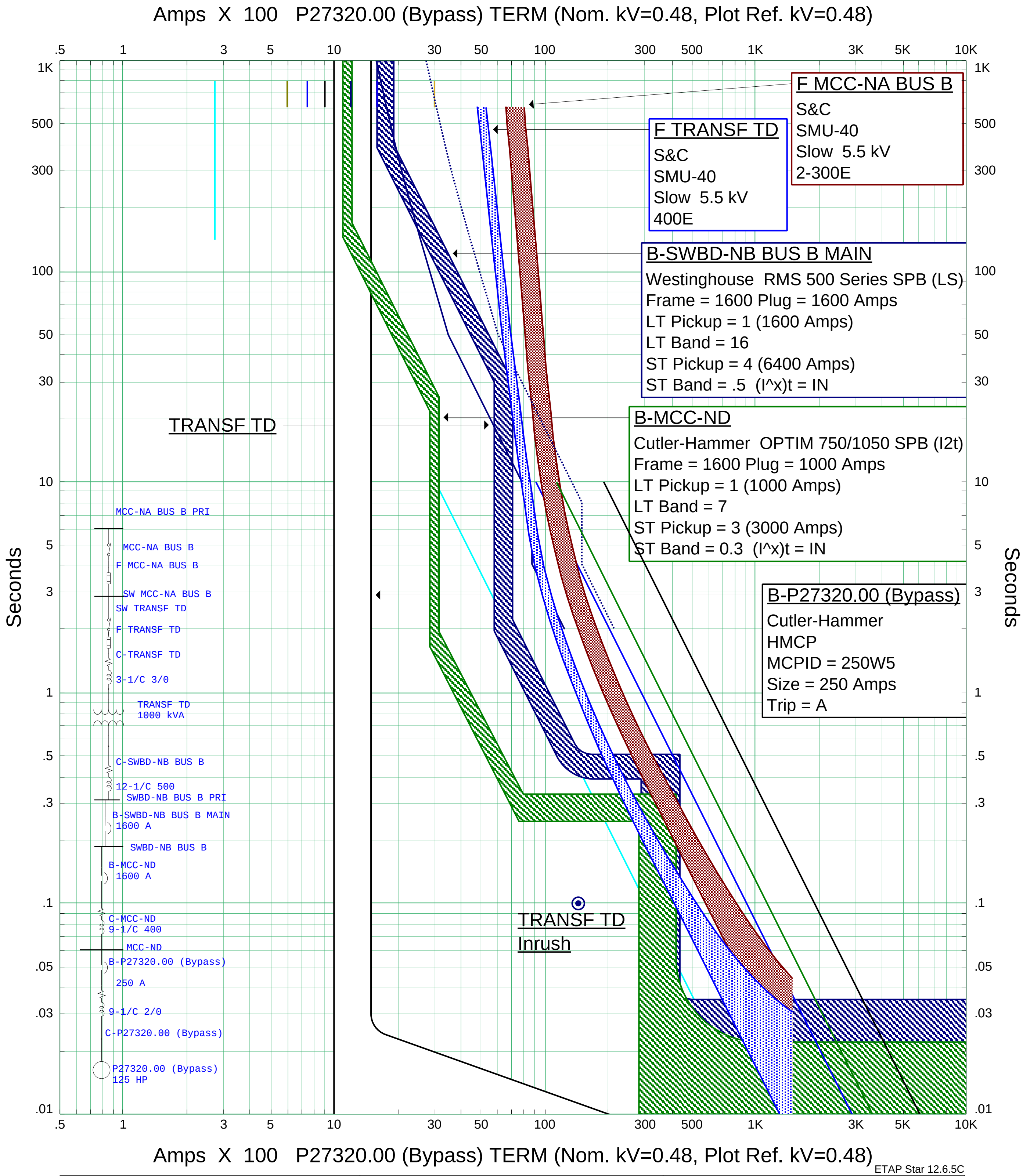
Date: 04-06-2015
SN: CAROLLOWAN
Rev: Base
Fault: Phase



SWBD-NB BUS A TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

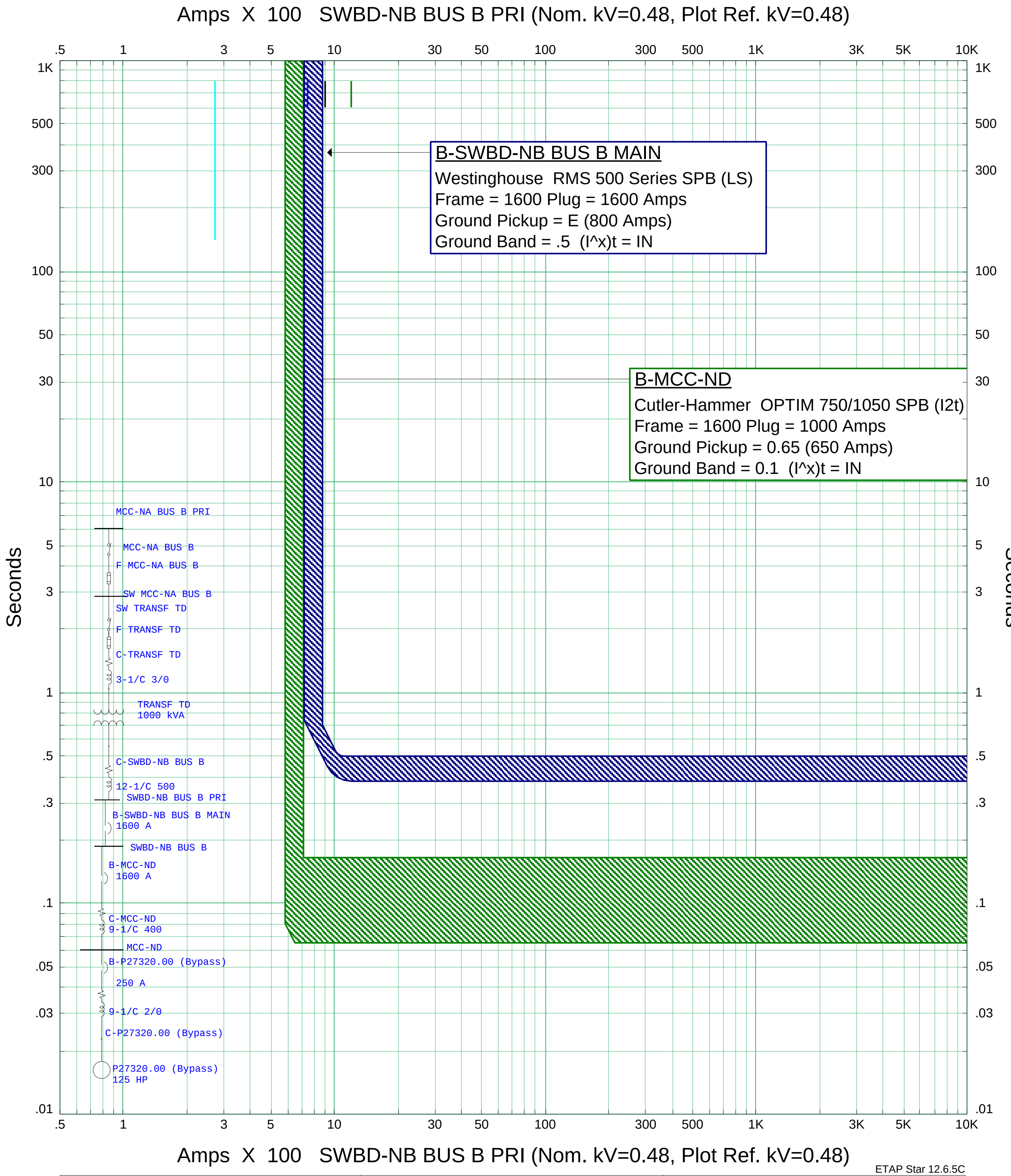
Date: 04-06-2015
SN: CAROLLOWAN
Rev: Base
Fault: Ground



SWBD-NB BUS B TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

Date: 04-06-2015
SN: CAROLLOWAN
Rev: Base
Fault: Phase



SWBD-NB BUS B TCC

Project: OXNARD WWTP
Location: OXNARD, CA
Contract: 9587A.00
Engineer: SKB
Filename: C:\Users\asukar\Desktop\Etap\OWTP.OTI

Date: 04-06-2015
SN: CAROLLOWAN
Rev: Base
Fault: Ground

APPENDIX D – ARC FLASH STUDY

ID	kV (kV)	Output Rpt.	Configuration	Total Energy (cal/cm²)	AFB (ft)	Energy Levels	Final FCT (sec)	Ia at FCT (kA)	Source PD ID	% Ia Variation
P52220.00 TERM	0.48	STANDBY	Standby	0.012057	0.2	Level A	0.015	0.683	B-P52220.00	
P52230.00 TERM	0.48	STANDBY	Standby	0.012057	0.2	Level A	0.015	0.683	B-P52230.00	
P52220.00 DISC	0.48	STANDBY	Standby	0.012234	0.2	Level A	0.015	0.693	B-P52220.00	
P52230.00 DISC	0.48	STANDBY	Standby	0.012234	0.2	Level A	0.015	0.693	B-P52230.00	
SEP53020.00 TERM	0.48	STANDBY	Standby	0.028641	0.2	Level A	0.015	0.666	B-SEP53020.00	
SEP53020.00 DISC	0.48	STANDBY	Standby	0.029068	0.2	Level A	0.015	0.675	B-SEP53020.00	
SEP53000.00 TERM	0.48	STANDBY	Standby	0.029508	0.2	Level A	0.015	0.684	B-SEP53000.00	
SEP53010.00 TERM	0.48	STANDBY	Standby	0.029508	0.2	Level A	0.015	0.684	B-SEP53010.00	
CON53020.00 TERM	0.48	STANDBY	Standby	0.029717	0.2	Level A	0.015	0.689	B-CON53020.00	
CON53030.00 TERM	0.48	STANDBY	Standby	0.029717	0.2	Level A	0.015	0.689	B-CON53030.00	
SEP53000.00 DISC	0.48	STANDBY	Standby	0.029962	0.2	Level A	0.015	0.694	B-SEP53000.00	
SEP53010.00 DISC	0.48	STANDBY	Standby	0.029962	0.2	Level A	0.015	0.694	B-SEP53010.00	
CON53020.00 DISC	0.48	STANDBY	Standby	0.030171	0.2	Level A	0.015	0.698	B-CON53020.00	
CON53030.00 DISC	0.48	STANDBY	Standby	0.030171	0.2	Level A	0.015	0.698	B-CON53030.00	
BSN51240.00 TERM	0.48	STANDBY	Standby	0.030355	0.2	Level A	0.015	0.702	B-BSN51240.00	
BSN51250.00 TERM	0.48	STANDBY	Standby	0.030355	0.2	Level A	0.015	0.702	B-BSN51250.00	
BSN51260.00 TERM	0.48	STANDBY	Standby	0.030355	0.2	Level A	0.015	0.702	B-BSN51260.00	
BSN51270.00 TERM	0.48	STANDBY	Standby	0.030355	0.2	Level A	0.015	0.702	B-BSN51270.00	
BSN51240.00 DISC	0.48	STANDBY	Standby	0.030839	0.2	Level A	0.015	0.713	B-BSN51240.00	
BSN51250.00 DISC	0.48	STANDBY	Standby	0.030839	0.2	Level A	0.015	0.713	B-BSN51250.00	
BSN51260.00 DISC	0.48	STANDBY	Standby	0.030839	0.2	Level A	0.015	0.713	B-BSN51260.00	
BSN51270.00 DISC	0.48	STANDBY	Standby	0.030839	0.2	Level A	0.015	0.713	B-BSN51270.00	
COM53030.00 TERM	0.48	STANDBY	Standby	0.031505	0.2	Level A	0.015	0.727	B-COM53030.00	
CON51300.00 TERM	0.48	STANDBY	Standby	0.031622	0.2	Level A	0.015	0.729	B-CON51300.00	
CON51320.00 TERM	0.48	STANDBY	Standby	0.031622	0.2	Level A	0.015	0.729	B-CON51320.00	
COM53030.00 DISC	0.48	STANDBY	Standby	0.032021	0.2	Level A	0.015	0.738	B-COM53030.00	
CON51300.00 DISC	0.48	STANDBY	Standby	0.032139	0.2	Level A	0.015	0.74	B-CON51300.00	
CON51320.00 DISC	0.48	STANDBY	Standby	0.032139	0.2	Level A	0.015	0.74	B-CON51320.00	
COM53040.00 TERM	0.48	STANDBY	Standby	0.034273	0.3	Level A	0.015	0.786	B-COM53040.00	
P52240.00 TERM	0.48	STANDBY	Standby	0.03439	0.3	Level A	0.015	0.788	B-P52240.00	
P52250.00 TERM	0.48	STANDBY	Standby	0.03439	0.3	Level A	0.015	0.788	B-P52250.00	
COM53040.00 DISC	0.48	STANDBY	Standby	0.034888	0.3	Level A	0.015	0.799	B-COM53040.00	
P52240.00 DISC	0.48	STANDBY	Standby	0.035005	0.3	Level A	0.015	0.801	B-P52240.00	
P52250.00 DISC	0.48	STANDBY	Standby	0.035005	0.3	Level A	0.015	0.801	B-P52250.00	
R BLDG N OH DOOR TE	0.48	STANDBY	Standby	0.053784	0.3	Level A	0.017	1.071	-SCR BLDG N OH DOO	
R BLDG N OH DOOR DI	0.48	STANDBY	Standby	0.054554	0.3	Level A	0.017	1.096	-SCR BLDG N OH DOO	
P54080.00 TERM	0.48	STANDBY	Standby	0.05484	0.3	Level A	0.015	1.214	B-P54080.00	
P54090.00 TERM	0.48	STANDBY	Standby	0.05484	0.3	Level A	0.015	1.214	B-P54090.00	
R BLDG S OH DOOR TE	0.48	STANDBY	Standby	0.056366	0.3	Level A	0.016	1.151	-SCR BLDG S OH DOO	
P54080.00 DISC	0.48	STANDBY	Standby	0.056461	0.3	Level A	0.015	1.247	B-P54080.00	
P54090.00 DISC	0.48	STANDBY	Standby	0.056461	0.3	Level A	0.015	1.247	B-P54090.00	
R BLDG S OH DOOR DI	0.48	STANDBY	Standby	0.057423	0.3	Level A	0.016	1.181	-SCR BLDG S OH DOO	
B52220.00 TERM	0.48	STANDBY	Standby	0.064502	0.3	Level A	0.017	1.27	B-B52220.00	
B52220.00 DISC	0.48	STANDBY	Standby	0.065324	0.3	Level A	0.017	1.293	B-B52220.00	
B52210.00 TERM	0.48	STANDBY	Standby	0.067089	0.4	Level A	0.016	1.341	B-B52210.00	
B52210.00 DISC	0.48	STANDBY	Standby	0.068048	0.4	Level A	0.016	1.367	B-B52210.00	
HVAC56110.00 TERM	0.48	STANDBY	Standby	0.087954	0.4	Level A	0.014	1.977	B-HVAC56110.00	
HVAC56110.00 DISC	0.48	STANDBY	Standby	0.091454	0.4	Level A	0.014	2.072	B-HVAC56110.00	
F54330.00 TERM	0.48	STANDBY	Standby	0.092474	0.4	Level A	0.015	1.968	B-F54330.00	
F54330.00 DISC	0.48	STANDBY	Standby	0.097274	0.4	Level A	0.015	2.063	B-F54330.00	
XFMR T-LC2 PRI	0.48	STANDBY	Standby	0.101032	0.3	Level A	0.015	2.32	B-XFMR T-LC2	

P52130.00 TERM	0.48	STANDBY	Standby	0.112944	0.5	Level A	0.015	2.368	B-P52130.00	
P52130.00 DISC	0.48	STANDBY	Standby	0.114684	0.5	Level A	0.015	2.402	B-P52130.00	
P55020.00 TERM	0.48	STANDBY	Standby	0.142762	0.4	Level A	0.018	2.617	B-LCP-HWOCS	
P52150.00 TERM	0.48	STANDBY	Standby	0.145169	0.5	Level A	0.016	2.762	B-P52150.00	
P52150.00 DISC	0.48	STANDBY	Standby	0.147085	0.5	Level A	0.016	2.81	B-P52150.00	
BLWR BLDG TROLLEY	0.48	STANDBY	Standby	0.152082	0.4	Level A	0.015	3.269	3-BLRW BLDG TROLLEY	
P52170.00 TERM	0.48	STANDBY	Standby	0.155725	0.5	Level A	0.016	3.019	B-P52170.00	
P55030.00 TERM	0.48	STANDBY	Standby	0.156021	0.5	Level A	0.018	2.697	B-LCP-HWOCS	
P52100.00 TERM	0.48	BASE	Normal	0.157882	0.5	Level A	0.016	3.068	B-P52100.00	
P52120.00 TERM	0.48	BASE	Normal	0.157946	0.5	Level A	0.015	3.23	B-P52120.00	
P52170.00 DISC	0.48	STANDBY	Standby	0.158173	0.5	Level A	0.016	3.076	B-P52170.00	
P52100.00 DISC	0.48	BASE	Normal	0.159545	0.5	Level A	0.016	3.107	B-P52100.00	
P52120.00 DISC	0.48	BASE	Normal	0.160248	0.5	Level A	0.015	3.273	B-P52120.00	
P52110.00 TERM	0.48	STANDBY	Standby	0.161184	0.5	Level A	0.023	2.242	B-P52110.00	
P52110.00 DISC	0.48	STANDBY	Standby	0.161749	0.6	Level A	0.022	2.272	B-P52110.00	
LCP-HWOCS	0.48	STANDBY	Standby	0.163488	0.4	Level A	0.017	3.205	B-LCP-HWOCS	
B52190.00 TERM	0.48	STANDBY	Standby	0.170336	0.6	Level A	0.016	3.199	B-B52190.00	
B52190.00 DISC	0.48	STANDBY	Standby	0.173001	0.6	Level A	0.016	3.264	B-B52190.00	
F55010.00 TERM	0.48	STANDBY	Standby	0.176902	0.6	Level A	0.017	3.227	B-LCP-HWOCS	
P52160.00 TERM	0.48	STANDBY	Standby	0.176908	0.6	Level A	0.019	2.859	B-P52160.00	
P52160.00 DISC	0.48	STANDBY	Standby	0.178512	0.6	Level A	0.019	2.91	B-P52160.00	
HVAC56100.00 TERM	0.48	STANDBY	Standby	0.178756	0.6	Level A	0.013	4.173	B-HVAC56100.00	
P52140.00 TERM	0.48	BASE	Normal	0.187729	0.6	Level A	0.015	3.73	B-P52140.00	
HVAC56100.00 DISC	0.48	STANDBY	Standby	0.189449	0.6	Level A	0.013	4.476	B-HVAC56100.00	
P52140.00 DISC	0.48	BASE	Normal	0.190561	0.6	Level A	0.015	3.79	B-P52140.00	
XFMR T-C4 PRI	0.48	BASE	Normal	0.195321	0.5	Level A	0.011	5.621	B-XFMR T-C4	
B52180.00 TERM	0.48	BASE	Normal	0.207464	0.6	Level A	0.015	4.157	B-B52180.00	
B52180.00 DISC	0.48	BASE	Normal	0.213587	0.6	Level A	0.015	4.27	B-B52180.00	
HW ELEVATOR	0.48	BASE	Normal	0.265548	0.6	Level A	0.015	5.682	B-HW ELEVATOR	
F52410.00 STR	0.48	STANDBY	Standby	0.334003	0.8	Level A	0.424	0.669	B-F52410.00	
F52410.00 DISC	0.48	STANDBY	Standby	0.340021	0.8	Level A	0.463	0.624	B-F52410.00	
PNL DPP1	0.48	BASE	Normal	0.343072	0.7	Level A	0.011	9.835	B-PNL DPP1 MAIN	
XFMR T-LC1 PRI	0.48	BASE	Normal	0.347395	0.7	Level A	0.014	7.657	B-ATS-L BUS A	
F52420.00 STR	0.48	STANDBY	Standby	0.355724	0.8	Level A	0.579	0.483	B-F52420.00	
F52420.00 DISC	0.48	STANDBY	Standby	0.361183	0.8	Level A	0.624	0.46	B-F52420.00	
HW GATES	0.48	STANDBY	Standby	0.378724	0.8	Level A	0.789	0.392	B-HW GATES	
MCC-DP4B	0.48	BASE	Normal	0.386607	0.8	Level A	0.004	25.872	F-MCC-DP4B	
B20400.00 TERMINALS	2.4	STANDBY	Standby	0.389522	0.5	Level A	0.045	4.209	F B20400.00	
B20100.00 TERMINALS	2.4	MinUtility	Normal	0.411293	0.5	Level A	0.058	3.459	F B20100.00	
B20200.00 TERMINALS	2.4	MinUtility	Normal	0.412669	0.5	Level A	0.059	3.453	F B20200.00	
PNL DPP1 PRI	0.48	BASE	Normal	0.439913	0.8	Level A	0.013	9.835	B-PNL DPP1	
MCC-NG BUS A	0.48	STANDBY	Standby	0.509439	0.9	Level A	0.016	9.662	B-BUS A MCC-NG	
MCC-NG BUS B	0.48	STANDBY	Standby	0.509791	0.9	Level A	0.016	9.667	B-BUS-B MCC-NG	
MCC-DP2C	0.48	BASE	Normal	0.56971	1	Level A	0.017	10.001	B-MCC-DP2C	
ATS-L BUS B	0.48	BASE	Normal	0.656259	1	Level A	0.013	15.053	B-ATS-L BUS B	
ATS-L BUS A	0.48	BASE	Normal	0.734519	1.1	Level A	0.013	16.948	B-ATS-L BUS A	
ATS-L SEC	0.48	BASE	Normal	0.734519	1.1	Level A	0.013	16.948	B-ATS-L BUS A	
GRIT SCR TROLLEY	0.48	STANDBY	Standby	0.736726	1.1	Level A	0.464	0.601	B-GRIT SCR TROLLEY	15%
NFL PUMP 2 TERMINAL	0.48	BASE	Normal	0.911308	1.3	Level A	0.018	14.142	B-INFL PUMP 2	
NFL PUMP 4 TERMINAL	0.48	BASE	Normal	0.918588	1.3	Level A	0.018	14.253	B-INFL PUMP 4	
NFL PUMP 3 TERMINAL	0.48	BASE	Normal	0.941289	1.3	Level A	0.018	14.593	B-INFL PUMP 3	
NFL PUMP 5 TERMINAL	0.48	BASE	Normal	0.941289	1.3	Level A	0.018	14.593	B-INFL PUMP 5	

MCC-SH BUS B	0.48	STANDBY	Standby	1.36	1.6	Level A	0.064	6.638	B-MCC-SH TIE	
EFF PS SWGR BUS A	0.48	BASE	Normal	1.65	2.5	Level A	0.07	10.382	B-EFF PS SWGR BUS A	
EFF PS SWGR BUS B	0.48	BASE	Normal	1.65	2.5	Level A	0.07	10.381	B-EFF PS SWGR BUS B	
MCC-NE	0.48	STANDBY	Standby	11.43	5.9	Level D	0.34	9.169	B-MCC-NE	
MCC-NF	0.48	STANDBY	Standby	11.43	5.9	Level D	0.34	9.169	B-MCC-NF	
MCC-ND	0.48	BASE	Normal	12.84	6.4	Level D	0.681	5.134	B-MCC-ND	15%
TRANSF TC PRI	2.4	STANDBY	Standby	13.26	5	Level D	2	2.524	B-SWBD-NB TIE	
MCC-NC	0.48	BASE	Normal	13.57	6.6	Level D	0.727	5.007	B-MCC-NC	15%
PNL DP4	0.48	BASE	Normal	17.55	12.4	Level D	0.34	22.123	B-FB3	
MCC-NA BUS A	2.4	BASE	Normal	2.1	2.7	Level B	0.234	4.085	B-FA1	
MCC-NA BUS A PRI	2.4	BASE	Normal	2.1	2.7	Level B	0.234	4.085	B-FA1	
TRANSF TA PRI	0.48	BASE	Normal	24.25	6.7	Level D	0.23	26.302	B-FA1	
SWBD-NB BUS A PRI	0.48	MinUtility	Normal	24.74	15.6	Level D	2	6.109	F TRANSF TC	
MCC-GE PRI	0.48	BASE	Normal	24.9	9.5	Level D	0.34	20.184	B-FB5-MCC-GE	
SWBD-NB BUS B	0.48	MinUtility	Normal	25.05	15.7	Level E	2	6.165	B-SWBD-NB BUS B MAIN	
SWBD-NB BUS B PRI	0.48	MinUtility	Normal	25.05	15.7	Level E	2	6.165	F TRANSF TD	
SWBD-NB BUS A	0.48	STANDBY	Standby	26.02	16.1	Level E	2	5.192	B-SWBD-NB TIE	
EFF PUMP NO. 2 VFD PR	0.48	BASE	Normal	3.17	2.4	Level B	0.07	11.596	B-EFF PUMP NO. 2 VFD	
EFF PUMP NO. 4 VFD PR	0.48	BASE	Normal	3.17	2.4	Level B	0.07	11.596	B-EFF PUMP NO. 4 VFD	
INFL PUMP 6 TERMINAL	0.48	BASE	Normal	3.8	2.7	Level B	0.07	12.709	B-52-6D	
INFL PUMP 1 TERMINAL	0.48	BASE	Normal	3.98	2.7	Level B	0.07	13.154	B-52-2B	
MAIN SWGR "FILTER"	0.48	STANDBY	Standby	34.79	19.7	Level E	2	5.675	B-FA1	
TRANSF TB PRI	0.48	BASE	Normal	39.92	8.6	Level E	0.34	28.955	B-FB1	
PNL DPLC-1	0.208	BASE	Normal	4	3.1	Level B		1.386		
PNL DPLC-2	0.208	BASE	Normal	4	3.1	Level B		1.18		
PNL DPLC-3	0.208	BASE	Normal	4	3.1	Level B		1.336		
PNL DPLC-4	0.208	BASE	Normal	4	3.1	Level B		0.79		
XFMR T-C4 SEC	0.208	BASE	Normal	4	3.1	Level B		0.806		
XFMR T-LC1 SEC	0.208	BASE	Normal	4	3.1	Level B		1.396		
XFMR T-LC2 SEC	0.208	BASE	Normal	4	3.1	Level B		1.182		
INFL PUMP 2 VFD	0.48	STANDBY	Standby	4.15	2.8	Level C	0.07	8.342	B-52-6B	
INFL PUMP 4 VFD	0.48	STANDBY	Standby	4.19	2.8	Level C	0.07	8.375	B-52-6C	
INFL PUMP 3 VFD	0.48	BASE	Normal	4.3	2.8	Level C	0.07	13.917	B-52-2C	15%
INFL PUMP 5 VFD	0.48	BASE	Normal	4.3	2.8	Level C	0.07	13.917	B-52-2D	15%
INFL PUMP 6 VFD PRI	0.48	BASE	Normal	4.83	3	Level C	0.07	15.676	B-52-6D	
INFL PUMP 2 VFD PRI	0.48	BASE	Normal	4.88	3	Level C	0.07	15.832	B-52-6B	
INFL PUMP 4 VFD PRI	0.48	BASE	Normal	4.94	3	Level C	0.07	15.991	B-52-6C	
TRANSF TC SEC	0.48	BASE	Normal	48.45	9.5	Level F	2	6.577	F TRANSF TC	
TRANSF TD SEC	0.48	BASE	Normal	49.15	9.6	Level F	2	6.727	F TRANSF TD	
MCC-HW BUS B PRI	0.48	BASE	Normal	5.09	3.1	Level C	0.07	16.408	B-52-5C	
INFL PUMP 1 VFD PRI	0.48	BASE	Normal	5.13	3.1	Level C	0.07	16.372	B-52-2B	
INFL PUMP 3 VFD PRI	0.48	BASE	Normal	5.13	3.1	Level C	0.07	16.373	B-52-2C	
INFL PUMP 5 VFD PRI	0.48	BASE	Normal	5.13	3.1	Level C	0.07	16.373	B-52-2D	
MCC-HW BUS A PRI	0.48	BASE	Normal	5.16	3.1	Level C	0.07	16.468	B-52-3C	
TRANSF TD PRI	2.4	MinUtility	Normal	5.45	3.2	Level C	0.666	3.674	F TRANSF TD	
MCC-HW BUS A	0.48	STANDBY	Standby	5.84	3.9	Level C	0.158	7.672	B-MCC-HW BUS A MAIN	
MCC-HW BUS B	0.48	STANDBY	Standby	5.84	3.9	Level C	0.158	7.672	B-MCC-HW BUS B MAIN	
MCC-SH BUS A	0.48	STANDBY	Standby	5.94	4	Level C	0.34	5.231	B-MCC-SH BUS A	
MS-HW BUS A	0.48	MinUtility	Normal	58.08	27.8	Level F	2	13.426	B-MS-HW 52-A	
MS-HW BUS B	0.48	MinUtility	Normal	58.14	27.9	Level F	2	13.463	B-MS-HW 52-B	
MCC-SH BUS A PRI	0.48	STANDBY	Standby	6.9	3.6	Level C	0.34	5.612	B-MCC-SH BUS A	
MCC-SH BUS B PRI	0.48	STANDBY	Standby	6.98	3.6	Level C	0.34	5.767	B-MCC-SH BUS B	

PNL DP2	0.48	BASE	Normal	7.48	6.9	Level C	0.34	10.19	B-FB4	
MCC-NA BUS B	2.4	STANDBY	Standby	7.94	10.5	Level C	2	1.666	F TRANSF TD	
MCC-NA BUS B PRI	2.4	STANDBY	Standby	7.94	10.5	Level C	2	1.666	F TRANSF TD	
MCC-DP4A	0.48	MinUtility	Normal	8.23	4.8	Level D	2	1.449	B-FB3	
TRANSF TB SEC	2.4	STANDBY	Standby	8.42	4	Level D	2	1.646	F TRANSF TD	
SR-DAF	0.48	STANDBY	Standby	9.15	4.1	Level D	0.34	7.281	B-SR-DAF	
SR-DAF PRI	0.48	STANDBY	Standby	9.15	4.1	Level D	0.34	7.281	B-SR-DAF	
MCC-GE	0.48	BASE	Normal	9.45	5.3	Level D	0.34	8.243	B-FB5-MCC-GE	
MCC-NG BUS A PRI	0.48	STANDBY	Standby	9.96	4.3	Level D	0.34	7.777	B-MCC-NG BUS A	
MCC-NG BUS B PRI	0.48	STANDBY	Standby	9.96	4.3	Level D	0.34	7.778	B-MCC-NG BUS B	
COGEN TIE BUS	0.48	MinUtility	Normal	96.39	39.3	Level F	2	21.271	B-GEN TIE A3	
MAIN SWGR "SLUDGE"	0.48	MinUtility	Normal	96.39	39.3	Level F	2	21.271	B-GEN TIE A3	

APPENDIX E – PROTECTION SETTINGS

Protective Device Settings

OCR: OCR-3 ATS #10

MFR: GE Multilin
Tag #:
Model: IFCV

	CT	Base kV	If (kA)
CT Input:	400/5		

OC Level: OC1

		Range	Setting
Phase TOC	Inverse (51) (0%)		
	Pickup (Tap)	2 - 16 Sec - 5A	6.000
	Time Dial		1.000

OCR: OCR3 ATS#11

MFR: GE Multilin
Tag #:
Model: IFCV

	CT	Base kV	If (kA)
CT Input:	400/5		

OC Level: OC1

		Range	Setting
Phase TOC	Inverse (51) (0%)		
	Pickup (Tap)	2 - 16 Sec - 5A	6.000
	Time Dial		1.000

Fuse: F B20100.00

MFR:	Westinghouse	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	CLS-12	kV:	5.080	LG kA:	0.00	Asym. (Calc.)
Speed:	Other	Int. kA:	50.000	Base kV:	0.000	(Calc.)
Size:	6R	Cont. Amp:	170.000			

Fuse: F B20200.00

MFR:	Westinghouse	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	CLS-12	kV:	5.080	LG kA:	0.00	Asym. (Calc.)
Speed:	Other	Int. kA:	50.000	Base kV:	0.000	(Calc.)
Size:	6R	Cont. Amp:	170.000			

Fuse: F B20300.00

MFR:	Westinghouse	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	CLS-12	kV:	5.080	LG kA:	0.00	Asym. (Calc.)
Speed:	Other	Int. kA:	50.000	Base kV:	0.000	(Calc.)
Size:	6R	Cont. Amp:	170.000			

Fuse: F B20400.00

MFR:	Westinghouse	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	CLS-12	kV:	5.080	LG kA:	0.00	Asym. (Calc.)
Speed:	Other	Int. kA:	50.000	Base kV:	0.000	(Calc.)
Size:	6R	Cont. Amp:	170.000			

Protective Device Settings

Fuse:	F B20500.00					
MFR:	Westinghouse	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	CLS-12	kV:	5.080	LG kA:	0.00	Asym. (Calc.)
Speed:	Other	Int. kA:	50.000	Base kV:	0.000	(Calc.)
Size:	6R	Cont. Amp:	170.000			

Fuse:	F MCC-NA BUS A					
MFR:	S&C	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	SMU-40	kV:	5.500	LG kA:	0.00	Asym. (Calc.)
Speed:	Slow	Int. kA:	25.000	Base kV:	0.000	(Calc.)
Size:	2-300E	Cont. Amp:	540.000			

Fuse:	F MCC-NA BUS B					
MFR:	S&C	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	SMU-40	kV:	5.500	LG kA:	0.00	Asym. (Calc.)
Speed:	Slow	Int. kA:	25.000	Base kV:	0.000	(Calc.)
Size:	2-300E	Cont. Amp:	540.000			

Fuse:	F TRANSF TC					
MFR:	S&C	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	SMU-40	kV:	5.500	LG kA:	0.00	Asym. (Calc.)
Speed:	Slow	Int. kA:	25.000	Base kV:	0.000	(Calc.)
Size:	400E	Cont. Amp:	400.000			

Fuse:	F TRANSF TD					
MFR:	S&C	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	SMU-40	kV:	5.500	LG kA:	0.00	Asym. (Calc.)
Speed:	Slow	Int. kA:	25.000	Base kV:	0.000	(Calc.)
Size:	400E	Cont. Amp:	400.000			

Fuse:	F-EFF PUMP NO. 2 VFD					
MFR:	Bussmann	Tag #:		3-Phase kA:	22.94	Asym. (Calc.)
Model:	LPJ_SP	kV:	0.600	LG kA:	22.64	Asym. (Calc.)
Speed:	Time Delay	Int. kA:	300.000	Base kV:	0.480	(Calc.)
Size:	600A	Cont. Amp:	600.000			

Fuse:	F-EFF PUMP NO. 4 VFD					
MFR:	Bussmann	Tag #:		3-Phase kA:	22.91	Asym. (Calc.)
Model:	LPJ_SP	kV:	0.600	LG kA:	22.61	Asym. (Calc.)
Speed:	Time Delay	Int. kA:	300.000	Base kV:	0.480	(Calc.)
Size:	600A	Cont. Amp:	600.000			

Fuse:	F-HVAC56100.00					
MFR:	S&C*	Tag #:		3-Phase kA:	6.13	Asym. (Calc.)
Model:	SMU-20	kV:	0.480	LG kA:	3.65	Asym. (Calc.)
Speed:	Standard	Int. kA:	14.000	Base kV:	0.480	(Calc.)
Size:	30E	Cont. Amp:	30.000			

* Retrieved library data is modified by user.

Protective Device Settings

Fuse: F-HVAC56110.00

MFR:	S&C*	Tag #:		3-Phase kA:	2.54	Asym. (Calc.)
Model:	SMU-20	kV:	0.480	LG kA:	1.49	Asym. (Calc.)
Speed:	Standard	Int. kA:	14.000	Base kV:	0.480	(Calc.)
Size:	20E	Cont. Amp:	20.000			

* Retrieved library data is modified by user.

Fuse: F-MCC-DP4B

MFR:	Mersen	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HSJ	kV:	0.600	LG kA:	0.00	Asym. (Calc.)
Speed:	High	Int. kA:	200.000	Base kV:	0.000	(Calc.)
Size:	600A	Cont. Amp:	600.000			

Fuse: F-P4023.00

MFR:	Mersen	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HSJ	kV:	0.600	LG kA:	0.00	Asym. (Calc.)
Speed:	High	Int. kA:	200.000	Base kV:	0.000	(Calc.)
Size:	400A	Cont. Amp:	400.000			

CB: B- PANEL DPC5

MFR:	Westinghouse	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	BA	Rating:	10 kA, 0.24 kV	LG kA:	0.00	Asym. (Calc.)
Size:	30	Cont. Amp:	30.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	Quicklag (2P)	Magnetic Trip:	FIXED
ID:	30		

CB: B- PNL DPC6

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	BAB	Rating:	10 kA, 0.24 kV	LG kA:	0.00	Asym. (Calc.)
Size:	50	Cont. Amp:	50.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	Quicklag (3P)	Magnetic Trip:	FIXED
ID:	50		

CB: B- Polymer

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HFD	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	20	Cont. Amp:	20.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFD (2,3,4P)	Magnetic Trip:	FIXED
ID:	20		

Protective Device Settings

CB: B- Praestemat

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HFD	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	20	Cont. Amp:	20.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFD (2,3,4P)	Magnetic Trip:	FIXED
ID:	20		

CB: B SUMP PUMP CONTROL PANEL

MFR:	Allen-Bradley	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	140U-I6C3	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Allen Bradley	Thermal Trip:	Fixed
Model:	140U-I6C3	Magnetic Trip:	FIXED
ID:	15		

CB: B0P4021.00

MFR:	Westinghouse*	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	LA-400 (125-400A)	Rating:	200 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	400	Cont. Amp:	400.000	Base kV:	0.000	(Calc.)

* The retrieved library data is modified by user.

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	LA-400	Magnetic Trip:	High
ID:	400		

CB: B2-MCC-DP4B

MFR:	Westinghouse	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	LCL	Rating:	200 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	400	Cont. Amp:	400.000	Base kV:	0.000	(Calc.)

LV Solid State Trip Device

MFR:	Westinghouse
Model:	Seltronic LCL (Fixed)
Sensor:	400
Rating Plug:	250.00

		Phase Setting		Ground Setting	
Long-Time	LT Pickup	Fixed		Ground Pickup	0.650
	LT Band	Fixed		Ground Band	0.060
Short-Time	ST Pickup	8			
	ST Band	Fixed	I^xt=IN		
INST	Inst. Pickup	Fixed			

Protective Device Settings

CB: B-400 KW GENERATOR

MFR:	Merlin Gerin*	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	NSJ600N	Rating:	35 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	600	Cont. Amp:	240.000	Base kV:	0.000	(Calc.)

* The retrieved library data is modified by user.

LV Solid State Trip Device

MFR: Merlin Gerin
Model: STR23SP
Sensor: 600
Rating Plug: 300.00

		Phase Setting
Long-Time	LT Pickup	1.0
	LT Band	Fixed
Short-Time	ST Pickup	6
	ST Band	Fixed

CB: B-4911.00

MFR:	General Electric	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	TBC4	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	400	Cont. Amp:	400.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: General Electric
Model: TBC
ID: 400
Pick up: HI

CB: B-50A RECEPT

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HFB	Rating:	25 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	50	Cont. Amp:	50.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFB (2,3P)	Magnetic Trip:	FIXED
ID:	50		

Protective Device Settings

CB: B-52-2B

MFR:	Siemens*	Tag #:		3-Phase kA:	54.93	Asym. (Calc.)
Model:	WL-L-800	Rating:	100 kA, 0.508 kV	LG kA:	50.77	Asym. (Calc.)
Size:	800	Cont. Amp:	600.000	Base kV:	0.480	(Calc.)

* The retrieved library data is modified by user.

LV Solid State Trip Device

MFR: Siemens

Model: ETU745 (I^2t)

Sensor: Frame Size II - 800

Rating Plug: 600.00

		Phase Setting		Ground Setting		
Long-Time	LT Pickup	1		Ground Pickup	B	
	LT Band	5.5		Ground Band	0.1	I^xt=OUT
Short-Time	ST Pickup	2.5				
	ST Band	0.3	I^xt=IN			
INST	Inst. Pickup	6				

CB: B-52-2C

MFR:	Siemens*	Tag #:		3-Phase kA:	54.93	Asym. (Calc.)
Model:	WL-L-800	Rating:	100 kA, 0.508 kV	LG kA:	50.77	Asym. (Calc.)
Size:	800	Cont. Amp:	600.000	Base kV:	0.480	(Calc.)

* The retrieved library data is modified by user.

LV Solid State Trip Device

MFR: Siemens

Model: ETU745 (I^2t)

Sensor: Frame Size II - 800

Rating Plug: 600.00

		Phase Setting		Ground Setting		
Long-Time	LT Pickup	1		Ground Pickup	B	
	LT Band	5.5		Ground Band	0.1	I^xt=OUT
Short-Time	ST Pickup	2.5				
	ST Band	0.3	I^xt=IN			
INST	Inst. Pickup	6				

Protective Device Settings

CB: B-52-2D

MFR:	Siemens*	Tag #:		3-Phase kA:	54.93 Asym. (Calc.)
Model:	WL-L-800	Rating:	100 kA, 0.508 kV	LG kA:	50.77 Asym. (Calc.)
Size:	800	Cont. Amp:	600.000	Base kV:	0.480 (Calc.)

* The retrieved library data is modified by user.

LV Solid State Trip Device

MFR: Siemens

Model: ETU745 (I^2t)

Sensor: Frame Size II - 800

Rating Plug: 600.00

	Phase Setting			Ground Setting		
Long-Time	LT Pickup	1		Ground Pickup	B	
	LT Band	5.5		Ground Band	0.1	I^xt=OUT
Short-Time	ST Pickup	2.5				
	ST Band	0.3	I^xt=IN			
INST	Inst. Pickup	6				

CB: B-52-3C

MFR:	Siemens	Tag #:		3-Phase kA:	54.93 Asym. (Calc.)
Model:	WL-L-1600	Rating:	100 kA, 0.508 kV	LG kA:	50.77 Asym. (Calc.)
Size:	1600	Cont. Amp:	1600.000	Base kV:	0.480 (Calc.)

LV Solid State Trip Device

MFR: Siemens

Model: ETU745 (I^2t)

Sensor: Frame Size II - 1600

Rating Plug: 1000.00

	Phase Setting			Ground Setting		
Long-Time	LT Pickup	1		Ground Pickup	C	
	LT Band	10		Ground Band	0.2	I^xt=IN
Short-Time	ST Pickup	2.5				
	ST Band	0.1	I^xt=IN			
INST	Inst. Pickup	10				

Protective Device Settings

CB: B-52-5C

MFR:	Siemens	Tag #:		3-Phase kA:	54.93	Asym. (Calc.)
Model:	WL-L-1600	Rating:	100 kA, 0.508 kV	LG kA:	50.77	Asym. (Calc.)
Size:	1600	Cont. Amp:	1600.000	Base kV:	0.480	(Calc.)

LV Solid State Trip Device

MFR: Siemens

Model: ETU745 (I^2t)

Sensor: Frame Size II - 1600

Rating Plug: 1000.00

		Phase Setting		Ground Setting		
Long-Time	LT Pickup	1		Ground Pickup	C	
	LT Band	10		Ground Band	0.2	I^xt=IN
Short-Time	ST Pickup	2.5				
	ST Band	0.1	I^xt=IN			
INST	Inst. Pickup	10				

CB: B-52-6B

MFR:	Siemens*	Tag #:		3-Phase kA:	54.93	Asym. (Calc.)
Model:	WL-L-800	Rating:	100 kA, 0.508 kV	LG kA:	50.77	Asym. (Calc.)
Size:	800	Cont. Amp:	600.000	Base kV:	0.480	(Calc.)

* The retrieved library data is modified by user.

LV Solid State Trip Device

MFR: Siemens

Model: ETU745 (I^2t)

Sensor: Frame Size II - 800

Rating Plug: 600.00

		Phase Setting		Ground Setting		
Long-Time	LT Pickup	1		Ground Pickup	A	
	LT Band	5.5		Ground Band	0.1	I^xt=OUT
Short-Time	ST Pickup	2.5				
	ST Band	0.3	I^xt=IN			
INST	Inst. Pickup	6				

Protective Device Settings

CB: B-52-6C

MFR:	Siemens*	Tag #:		3-Phase kA:	54.93	Asym. (Calc.)
Model:	WL-L-800	Rating:	100 kA, 0.508 kV	LG kA:	50.77	Asym. (Calc.)
Size:	800	Cont. Amp:	600.000	Base kV:	0.480	(Calc.)

* The retrieved library data is modified by user.

LV Solid State Trip Device

MFR: Siemens
Model: ETU745 (I^2t)
Sensor: Frame Size II - 800
Rating Plug: 600.00

	Phase Setting			Ground Setting		
Long-Time	LT Pickup	1		Ground Pickup	A	
	LT Band	5.5		Ground Band	0.1	I^xt=OUT
Short-Time	ST Pickup	2.5				
	ST Band	0.3	I^xt=IN			
INST	Inst. Pickup	6				

CB: B-52-6D

MFR:	Siemens*	Tag #:		3-Phase kA:	54.93	Asym. (Calc.)
Model:	WL-L-800	Rating:	100 kA, 0.508 kV	LG kA:	50.77	Asym. (Calc.)
Size:	800	Cont. Amp:	600.000	Base kV:	0.480	(Calc.)

* The retrieved library data is modified by user.

LV Solid State Trip Device

MFR: Siemens
Model: ETU745 (I^2t)
Sensor: Frame Size II - 800
Rating Plug: 600.00

	Phase Setting			Ground Setting		
Long-Time	LT Pickup	1		Ground Pickup	A	
	LT Band	5.5		Ground Band	0.1	I^xt=OUT
Short-Time	ST Pickup	2.5				
	ST Band	0.3	I^xt=IN			
INST	Inst. Pickup	6				

Protective Device Settings

CB: B-52-GA

MFR:	Siemens*	Tag #:		3-Phase kA:	54.93	Asym. (Calc.)
Model:	WL-L-3200	Rating:	100 kA, 0.508 kV	LG kA:	50.77	Asym. (Calc.)
Size:	3200	Cont. Amp:	2000.000	Base kV:	0.480	(Calc.)

* The retrieved library data is modified by user.

LV Solid State Trip Device

MFR: Siemens
Model: ETU745 (I^2t)
Sensor: Frame Size II - 3200
Rating Plug: 2000.00

		Phase Setting		Ground Setting		
Long-Time	LT Pickup	1		Ground Pickup	D	
	LT Band	5.5		Ground Band	0.4	I^xt=IN
Short-Time	ST Pickup	4				
	ST Band	0.2	I^xt=IN			
INST	Inst. Pickup	12				

CB: B-52-GB

MFR:	Siemens*	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	WL-L-3200	Rating:	100 kA, 0.508 kV	LG kA:	0.00	Asym. (Calc.)
Size:	3200	Cont. Amp:	2000.000	Base kV:	0.000	(Calc.)

* The retrieved library data is modified by user.

LV Solid State Trip Device

MFR: Siemens
Model: ETU745 (I^2t)
Sensor: Frame Size II - 3200
Rating Plug: 2000.00

		Phase Setting		Ground Setting		
Long-Time	LT Pickup	1		Ground Pickup	D	
	LT Band	5.5		Ground Band	0.4	I^xt=IN
Short-Time	ST Pickup	4				
	ST Band	0.2	I^xt=IN			
INST	Inst. Pickup	12				

CB: B-6511.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	150	Cont. Amp:	150.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 150T4
Pick up: E

Protective Device Settings

CB: B-6512.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	150	Cont. Amp:	150.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 150T4
Pick up: H

CB: B-AC-1

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HFD	Rating:	100 kA, 0.24 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFD (2,3,4P)	Magnetic Trip:	FIXED
ID:	15		

CB: B-ATS-C BUS A

MFR:	Allen-Bradley	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	140U-I6C3	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	70	Cont. Amp:	70.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Allen Bradley	Thermal Trip:	Fixed
Model:	140U-I6C3	Magnetic Trip:	FIXED
ID:	70		

CB: B-ATS-C BUS B

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	FDB	Rating:	18 kA, 0.24 kV	LG kA:	0.00	Asym. (Calc.)
Size:	70	Cont. Amp:	70.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	FDB	Magnetic Trip:	FIXED
ID:	70		

CB: B-ATS-L BUS A

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	48.82	Asym. (Calc.)
Model:	FDB	Rating:	14 kA, 0.48 kV	LG kA:	42.55	Asym. (Calc.)
Size:	100	Cont. Amp:	100.000	Base kV:	0.480	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	FDB	Magnetic Trip:	FIXED
ID:	100		

Protective Device Settings

CB: B-ATS-L BUS B

MFR:	Cutler-Hammer*	Tag #:		3-Phase kA:	48.69	Asym. (Calc.)
Model:	FDB	Rating:	18 kA, 0.48 kV	LG kA:	42.49	Asym. (Calc.)
Size:	100	Cont. Amp:	100.000	Base kV:	0.480	(Calc.)

* The retrieved library data is modified by user.

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	FDB	Magnetic Trip:	FIXED
ID:	100		

CB: B-B27400.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	150	Cont. Amp:	150.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 150T4
Pick up: F

CB: B-B36040.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	50	Cont. Amp:	50.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 050K2
Pick up: G

CB: B-B36045.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	50	Cont. Amp:	50.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 050K2
Pick up: G

Protective Device Settings

CB: B-B4121.00

MFR:	Westinghouse	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	MCP	Rating:	0 kA, 0 kV	LG kA:	0.00	Asym. (Calc.)
Size:	30	Cont. Amp:	30.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Westinghouse
Model: MCP
ID: 13300R
Pick up: 195.000 (100 - 300)

CB: B-B4122.00

MFR:	Westinghouse	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	MCP	Rating:	0 kA, 0 kV	LG kA:	0.00	Asym. (Calc.)
Size:	30	Cont. Amp:	30.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Westinghouse
Model: MCP
ID: 13300R
Pick up: 150.000 (100 - 300)

CB: B-B4123.00

MFR:	Westinghouse	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	MCP	Rating:	0 kA, 0 kV	LG kA:	0.00	Asym. (Calc.)
Size:	30	Cont. Amp:	30.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Westinghouse
Model: MCP
ID: 13300R
Pick up: 150.000 (100 - 300)

CB: B-B4124.00

MFR:	Westinghouse	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	MCP	Rating:	0 kA, 0 kV	LG kA:	0.00	Asym. (Calc.)
Size:	30	Cont. Amp:	30.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Westinghouse
Model: MCP
ID: 13300R
Pick up: 150.000 (100 - 300)

Protective Device Settings

CB: B-B4221.00

MFR:	Westinghouse	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	MCP	Rating:	0 kA, 0 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Westinghouse
Model: MCP
ID: 03150R
Pick up: 75.000 (50 - 150)

CB: B-B4222.00

MFR:	Westinghouse	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	MCP	Rating:	0 kA, 0 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Westinghouse
Model: MCP
ID: 03150R
Pick up: 100.000 (100 - 300)

CB: B-B4223.00

MFR:	Westinghouse	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	MCP	Rating:	0 kA, 0 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Westinghouse
Model: MCP
ID: 03150R
Pick up: 75.000 (50 - 150)

CB: B-B4224.00

MFR:	Westinghouse	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	MCP	Rating:	0 kA, 0 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Westinghouse
Model: MCP
ID: 03150R
Pick up: 100.000 (100 - 300)

Protective Device Settings

CB:	B-B52180.00					
MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	48.82	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	42.55	Asym. (Calc.)
Size:	100	Cont. Amp:	100.000	Base kV:	0.480	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 100R3
Pick up: C

CB:	B-B52190.00					
MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	48.69	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	42.49	Asym. (Calc.)
Size:	100	Cont. Amp:	100.000	Base kV:	0.480	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 100R3
Pick up: E

CB:	B-B52210.00					
MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	48.69	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	42.49	Asym. (Calc.)
Size:	50	Cont. Amp:	50.000	Base kV:	0.480	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 050K2
Pick up: D

CB:	B-B52220.00					
MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	48.82	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	42.55	Asym. (Calc.)
Size:	50	Cont. Amp:	50.000	Base kV:	0.480	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 050K2
Pick up: D

Protective Device Settings

CB: B-B6513.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	150	Cont. Amp:	150.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 150U4
Pick up: H

CB: B-B6556.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	7	Cont. Amp:	7.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 007C0
Pick up: H

CB: B-BATTERY CHARGER XFMR

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	15		

CB: B-BLOWER #1 BYPASSS VALVE

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	15		

CB: B-BLOWER #1 DISCH VALVE

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	15		

CB: B-BLOWER #1 GUIDE VALVE

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	15		

CB: B-BLOWER #2 BYPASS VALVE

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	15		

CB: B-BLOWER #2 DISCH VALVE

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	15		

CB: B-BLOWER #2 GUIDE VANES

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	15		

CB: B-BLOWER #3 BYPASS VALVE

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	15		

Protective Device Settings

CB: B-BLOWER #3 DISCH VALVE

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	15		

CB: B-BLOWER #3 GUIDE VANES

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	15		

CB: B-BLOWER #4 BYPASS VALVE

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	20	Cont. Amp:	20.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	20		

CB: B-BLOWER #4 DISCHA VALVE

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	20	Cont. Amp:	20.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	20		

CB: B-BLOWER #4 GUIDE VALVE

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	20	Cont. Amp:	20.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	20		

CB: B-BLOWER #5 BYPASS VALVE

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	20	Cont. Amp:	20.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	20		

CB: B-BLOWER #5 DISCHAR VALVE

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	20	Cont. Amp:	20.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	20		

CB: B-BLOWER #5 GUIDE VALVE

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	20	Cont. Amp:	20.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	20		

CB: B-BLRW BLDG TROLLEY

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	48.82	Asym. (Calc.)
Model:	HFD	Rating:	65 kA, 0.48 kV	LG kA:	42.55	Asym. (Calc.)
Size:	20	Cont. Amp:	20.000	Base kV:	0.480	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFD (2,3,4P)	Magnetic Trip:	FIXED
ID:	20		

CB: B-BSN51240.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	48.82	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	42.55	Asym. (Calc.)
Size:	3	Cont. Amp:	3.000	Base kV:	0.480	(Calc.)

Motor Circuit Protector Trip Device

MFR:	Cutler-Hammer
Model:	HMCP
ID:	003A0
Pick up:	B

Protective Device Settings

CB: B-BSN51250.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	48.69 Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	42.49 Asym. (Calc.)
Size:	3	Cont. Amp:	3.000	Base kV:	0.480 (Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 003A0
Pick up: A

CB: B-BSN51260.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	48.82 Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	42.55 Asym. (Calc.)
Size:	3	Cont. Amp:	3.000	Base kV:	0.480 (Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 003A0
Pick up: A

CB: B-BSN51270.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	48.69 Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	42.49 Asym. (Calc.)
Size:	3	Cont. Amp:	3.000	Base kV:	0.480 (Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 003A0
Pick up: A

CB: B-BUS A MCC-NG

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00 Asym. (Calc.)
Model:	HKD	Rating:	65 kA, 0.48 kV	LG kA:	0.00 Asym. (Calc.)
Size:	400	Cont. Amp:	400.000	Base kV:	0.000 (Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HKD	Magnetic Trip:	5
ID:	400		

CB: B-BUS-B MCC-NG

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00 Asym. (Calc.)
Model:	HKD	Rating:	65 kA, 0.48 kV	LG kA:	0.00 Asym. (Calc.)
Size:	400	Cont. Amp:	400.000	Base kV:	0.000 (Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HKD	Magnetic Trip:	5.000
ID:	400		

Protective Device Settings

CB: B-COM53030.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	48.82	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	42.55	Asym. (Calc.)
Size:	7	Cont. Amp:	7.000	Base kV:	0.480	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 007C0
Pick up: A

CB: B-COM53040.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	48.69	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	42.49	Asym. (Calc.)
Size:	7	Cont. Amp:	7.000	Base kV:	0.480	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 007C0
Pick up: D

CB: B-COMPRESSOR

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HFB	Rating:	25 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	30	Cont. Amp:	30.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFB (2,3P)	Magnetic Trip:	FIXED
ID:	30		

CB: B-CON 330040.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 015E0
Pick up: A

Protective Device Settings

CB: B-CON 33010.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 015E0
Pick up: B

CB: B-CON 33020.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 015E0
Pick up: B

CB: B-CON 33030.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 015E0
Pick up: C

CB: B-CON51300.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	48.82	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	42.55	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.480	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 015E0
Pick up: C

Protective Device Settings

CB: B-CON51320.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	48.82	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	42.55	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.480	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 015E0
Pick up: D

CB: B-CON53020.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	48.69	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	42.49	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.480	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 015E0
Pick up: A

CB: B-CON53030.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	48.69	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	42.49	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.480	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 015E0
Pick up: B

CB: B-CP 7561

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	50	Cont. Amp:	50.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 050K2
Pick up: G

Protective Device Settings

CB: B-CP7562.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	50	Cont. Amp:	50.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR:	Cutler-Hammer
Model:	HMCP
ID:	050K2
Pick up:	G

CB: B-CRANE (MME-1)

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HFB	Rating:	25 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFB (2,3P)	Magnetic Trip:	FIXED
ID:	15		

CB: B-DPC3

MFR:	Westinghouse	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	BAB	Rating:	10 kA, 0.24 kV	LG kA:	0.00	Asym. (Calc.)
Size:	60	Cont. Amp:	60.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	Quicklag (3P)	Magnetic Trip:	FIXED
ID:	60		

CB: B-DPC7

MFR:	Westinghouse	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	BA	Rating:	10 kA, 0.24 kV	LG kA:	0.00	Asym. (Calc.)
Size:	50	Cont. Amp:	50.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	Quicklag (3P)	Magnetic Trip:	FIXED
ID:	50		

CB: B-DPL2

MFR:	Westinghouse	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	BAB	Rating:	10 kA, 0.24 kV	LG kA:	0.00	Asym. (Calc.)
Size:	100	Cont. Amp:	100.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	Quicklag (3P)	Magnetic Trip:	FIXED
ID:	100		

Protective Device Settings

CB:	B-DPL7					
MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HJD	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	250	Cont. Amp:	250.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HJD	Magnetic Trip:	10
ID:	250		

CB:	B-DPL7A					
MFR:	Westinghouse	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	BA	Rating:	10 kA, 0.24 kV	LG kA:	0.00	Asym. (Calc.)
Size:	100	Cont. Amp:	100.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	Quicklag (3P)	Magnetic Trip:	FIXED
ID:	100		

CB:	B-DPL7A2 MAIN					
MFR:	Westinghouse	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	BA	Rating:	10 kA, 0.24 kV	LG kA:	0.00	Asym. (Calc.)
Size:	100	Cont. Amp:	100.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	Quicklag (3P)	Magnetic Trip:	FIXED
ID:	100		

CB:	B-DPM1					
MFR:	Westinghouse	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	CA	Rating:	10 kA, 0.24 kV	LG kA:	0.00	Asym. (Calc.)
Size:	125	Cont. Amp:	125.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	CA	Magnetic Trip:	FIXED
ID:	125		

CB:	B-DPM2					
MFR:	Westinghouse	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	CA	Rating:	10 kA, 0.24 kV	LG kA:	0.00	Asym. (Calc.)
Size:	125	Cont. Amp:	125.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	CA	Magnetic Trip:	FIXED
ID:	125		

CB: B-DPP8

MFR:	Cutler-Hammer*	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HKD	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	250	Cont. Amp:	225.000	Base kV:	0.000	(Calc.)

* The retrieved library data is modified by user.

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HKD	Magnetic Trip:	5
ID:	250		

CB: B-DPP8 MAIN

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	JD	Rating:	35 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	250	Cont. Amp:	250.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	JD	Magnetic Trip:	5.000
ID:	250		

CB: B-EFF PS SWGR BUS A

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	24.46	Asym. (Calc.)
Model:	DSII-616	Rating:	65 kA, 0.48 kV	LG kA:	25.61	Asym. (Calc.)
Size:	1600	Cont. Amp:	1600.000	Base kV:	0.480	(Calc.)

LV Solid State Trip Device

MFR:	Westinghouse
Model:	RMS 510 Series DS
Sensor:	1600
Rating Plug:	1600.00

Phase Setting

Long-Time	LT Pickup	1	
	LT Band	15	
Short-Time	ST Pickup	2.5	
	ST Band	.1	I^xt=IN
INST	Inst. Pickup	2	

Ground Setting

Ground Pickup	E	
Ground Band	.3	I^xt=IN

Protective Device Settings

CB: B-EFF PS SWGR BUS B

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	24.50	Asym. (Calc.)
Model:	DSII-616	Rating:	65 kA, 0.48 kV	LG kA:	25.65	Asym. (Calc.)
Size:	1600	Cont. Amp:	1600.000	Base kV:	0.480	(Calc.)

LV Solid State Trip Device

MFR: Westinghouse

Model: RMS 510 Series DS

Sensor: 1600

Rating Plug: 1600.00

	Phase Setting			Ground Setting		
Long-Time	LT Pickup	1		Ground Pickup	E	
	LT Band	15		Ground Band	.1	I^xt=IN
Short-Time	ST Pickup	2.5				
	ST Band	.5	I^xt=IN			
INST	Inst. Pickup	2				

CB: B-EFF PS SWGR TIE

MFR:	Cutler-Hammer*	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	DSII-616	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	1600	Cont. Amp:	1200.000	Base kV:	0.000	(Calc.)

* The retrieved library data is modified by user.

LV Solid State Trip Device

MFR: Cutler-Hammer

Model: RMS 510 Series DS

Sensor: 1200

Rating Plug: 1000.00

	Phase Setting			Ground Setting		
Long-Time	LT Pickup	1		Ground Pickup	E	
	LT Band	15		Ground Band	.3	I^xt=IN
Short-Time	ST Pickup	2.5				
	ST Band	.3	I^xt=IN			
INST	Inst. Pickup	2				

CB: B-EFF PUMP NO. 2 VFD

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	24.50	Asym. (Calc.)
Model:	DSII-616	Rating:	65 kA, 0.48 kV	LG kA:	25.65	Asym. (Calc.)
Size:	1600	Cont. Amp:	1600.000	Base kV:	0.480	(Calc.)

LV Solid State Trip Device

MFR: Westinghouse
Model: RMS 510 Series DS
Sensor: 1600
Rating Plug: 1000.00

		Phase Setting		Ground Setting		
Long-Time	LT Pickup	.6		Ground Pickup	A	
	LT Band	20		Ground Band	.1	I^xt=IN
Short-Time	ST Pickup	4				
	ST Band	.5	I^xt=IN			
INST	Inst. Pickup	2				

CB: B-EFF PUMP NO. 4 VFD

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	24.46	Asym. (Calc.)
Model:	DSII-616	Rating:	65 kA, 0.48 kV	LG kA:	25.61	Asym. (Calc.)
Size:	1600	Cont. Amp:	1600.000	Base kV:	0.480	(Calc.)

LV Solid State Trip Device

MFR: Westinghouse
Model: RMS 510 Series DS
Sensor: 1600
Rating Plug: 1000.00

		Phase Setting		Ground Setting		
Long-Time	LT Pickup	1		Ground Pickup	A	
	LT Band	20		Ground Band	.1	I^xt=IN
Short-Time	ST Pickup	4				
	ST Band	.1	I^xt=IN			
INST	Inst. Pickup	2				

CB: B-ELP5

MFR:	Westinghouse	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	BA	Rating:	10 kA, 0.24 kV	LG kA:	0.00	Asym. (Calc.)
Size:	50	Cont. Amp:	50.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	Quicklag (3P)	Magnetic Trip:	FIXED
ID:	50		

CB: B-EMD GEN #4

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HFD	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	100	Cont. Amp:	100.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFD (2,3,4P)	Magnetic Trip:	FIXED
ID:	100		

CB: B-EMD GEN #5

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HFD	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	100	Cont. Amp:	100.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFD (2,3,4P)	Magnetic Trip:	FIXED
ID:	100		

CB: B-EXHAUST FAN #1

MFR:	Cutler-Hammer*	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	FD	Rating:	25 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

* The retrieved library data is modified by user.

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	FD (2,3,4P)	Magnetic Trip:	FIXED
ID:	15		

CB: B-F21159.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	3	Cont. Amp:	3.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR:	Cutler-Hammer
Model:	HMCP
ID:	003A0
Pick up:	G

CB: B-F21160.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	3	Cont. Amp:	3.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR:	Cutler-Hammer
Model:	HMCP
ID:	003A0
Pick up:	G

Protective Device Settings

CB: B-F27505.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	7	Cont. Amp:	7.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 007C0
Pick up: F

CB: B-F27506.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	7	Cont. Amp:	7.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 007C0
Pick up: F

CB: B-F36030.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	30	Cont. Amp:	30.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 030H1
Pick up: E

CB: B-F36035.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	30	Cont. Amp:	30.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 030H1
Pick up: E

Protective Device Settings

CB: B-F36037.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 015E0
Pick up: G

CB: B-F37010.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	3	Cont. Amp:	3.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 003A0
Pick up: H

CB: B-F37013.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	3	Cont. Amp:	3.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 003A0
Pick up: H

CB: B-F37015.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	3	Cont. Amp:	3.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 003A0
Pick up: C

Protective Device Settings

CB: B-F37017.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	3	Cont. Amp:	3.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 003A0
Pick up: G

CB: B-F37020.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	3	Cont. Amp:	3.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 003A0
Pick up: C

CB: B-F37023.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	3	Cont. Amp:	3.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 003A0
Pick up: C

CB: B-F37030

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	3	Cont. Amp:	3.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 003A0
Pick up: F

Protective Device Settings

CB: B-F37033.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	3	Cont. Amp:	3.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 003A0
Pick up: G

CB: B-F52410.00

MFR:	Siemens*	Tag #:		3-Phase kA:	17.39	Asym. (Calc.)
Model:	HED4	Rating:	18 kA, 0.48 kV	LG kA:	11.53	Asym. (Calc.)
Size:	20	Cont. Amp:	20.000	Base kV:	0.480	(Calc.)

* The retrieved library data is modified by user.

Thermal Magnetic Trip Device

MFR:	Siemens	Thermal Trip:	Fixed
Model:	HED4	Magnetic Trip:	FIXED
ID:	20 (0.48kV)		

CB: B-F52420.00

MFR:	Siemens*	Tag #:		3-Phase kA:	17.39	Asym. (Calc.)
Model:	HED4	Rating:	18 kA, 0.48 kV	LG kA:	11.53	Asym. (Calc.)
Size:	20	Cont. Amp:	20.000	Base kV:	0.480	(Calc.)

* The retrieved library data is modified by user.

Thermal Magnetic Trip Device

MFR:	Siemens	Thermal Trip:	Fixed
Model:	HED4	Magnetic Trip:	FIXED
ID:	20 (0.24kV)		

CB: B-F54330.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	48.69	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	42.49	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.480	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 015E0
Pick up: C

Protective Device Settings

CB: B-F7943.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	7	Cont. Amp:	7.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 007C0
Pick up: F

CB: B-FA1

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	73.20	Asym. (Calc.)
Model:	SPB-100 (3000)	Rating:	100 kA, 0.48 kV	LG kA:	77.93	Asym. (Calc.)
Size:	3000	Cont. Amp:	3000.000	Base kV:	0.480	(Calc.)

LV Solid State Trip Device

MFR: Cutler-Hammer
Model: RMS 500 Series SPB
Sensor: 3000
Rating Plug: 3000.00

	Phase Setting			Ground Setting		
Long-Time	LT Pickup	1		Ground Pickup	A	
	LT Band	7		Ground Band	.3	I^xt=OUT
Short-Time	ST Pickup	5				
	ST Band	.2	I^xt=OUT			

CB: B-FA2-MCC-HCC

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	73.20	Asym. (Calc.)
Model:	SPB-100 (1600)	Rating:	100 kA, 0.48 kV	LG kA:	77.93	Asym. (Calc.)
Size:	1600	Cont. Amp:	1600.000	Base kV:	0.480	(Calc.)

LV Solid State Trip Device

MFR: Westinghouse
Model: RMS 500 Series SPB
Sensor: 1600
Rating Plug: 800.00

	Phase Setting			Ground Setting		
Long-Time	LT Pickup	1		Ground Pickup	F	
	LT Band	24		Ground Band	.1	I^xt=OUT
Short-Time	ST Pickup	5				
	ST Band	.3	I^xt=IN			

Protective Device Settings

CB: B-FA3-PNL DP3

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	73.20	Asym. (Calc.)
Model:	SPB-100 (1600)	Rating:	100 kA, 0.48 kV	LG kA:	77.93	Asym. (Calc.)
Size:	1600	Cont. Amp:	1600.000	Base kV:	0.480	(Calc.)

LV Solid State Trip Device

MFR: Cutler-Hammer
Model: RMS 500 Series SPB
Sensor: 1600
Rating Plug: 1200.00

		Phase Setting		Ground Setting		
Long-Time	LT Pickup	1		Ground Pickup	E	
	LT Band	16		Ground Band	.1	I^xt=OUT
Short-Time	ST Pickup	5				
	ST Band	.3	I^xt=IN			

CB: B-FA4-MCC-GD

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	73.20	Asym. (Calc.)
Model:	SPB-100 (800)	Rating:	100 kA, 0.48 kV	LG kA:	77.93	Asym. (Calc.)
Size:	800	Cont. Amp:	800.000	Base kV:	0.480	(Calc.)

LV Solid State Trip Device

MFR: Westinghouse
Model: RMS 500 Series SPB
Sensor: 800
Rating Plug: 400.00

		Phase Setting		Ground Setting		
Long-Time	LT Pickup	1		Ground Pickup	E	
	LT Band	24		Ground Band	.1	I^xt=OUT
Short-Time	ST Pickup	5				
	ST Band	.3	I^xt=IN			

CB: B-FA5-MCC-GB

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	73.20	Asym. (Calc.)
Model:	SPB-100 (800)	Rating:	100 kA, 0.48 kV	LG kA:	77.93	Asym. (Calc.)
Size:	800	Cont. Amp:	800.000	Base kV:	0.480	(Calc.)

LV Solid State Trip Device

MFR: Westinghouse
Model: RMS 500 Series SPB
Sensor: 800
Rating Plug: 400.00

		Phase Setting		Ground Setting		
Long-Time	LT Pickup	1		Ground Pickup	E	
	LT Band	24		Ground Band	.3	I^xt=OUT
Short-Time	ST Pickup	S1(7)				
	ST Band	.3	I^xt=IN			

Protective Device Settings

CB: B-FA6-MCC-GF

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	73.20 Asym. (Calc.)
Model:	SPB-100 (400)	Rating:	100 kA, 0.48 kV	LG kA:	77.93 Asym. (Calc.)
Size:	400	Cont. Amp:	400.000	Base kV:	0.480 (Calc.)

LV Solid State Trip Device

MFR: Cutler-Hammer
Model: RMS 500 Series SPB
Sensor: 400
Rating Plug: 300.00

	Phase Setting			Ground Setting		
Long-Time	LT Pickup	1		Ground Pickup	E	
	LT Band	24		Ground Band	.1	I^xt=OUT
Short-Time	ST Pickup	S2(8)				
	ST Band	.2	I^xt=OUT			

CB: B-FA7-MCC-GH

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	73.20 Asym. (Calc.)
Model:	SPB-100 (800)	Rating:	100 kA, 0.48 kV	LG kA:	77.93 Asym. (Calc.)
Size:	800	Cont. Amp:	800.000	Base kV:	0.480 (Calc.)

LV Solid State Trip Device

MFR: Cutler-Hammer
Model: RMS 500 Series SPB
Sensor: 800
Rating Plug: 400.00

	Phase Setting			Ground Setting		
Long-Time	LT Pickup	1		Ground Pickup	E	
	LT Band	20		Ground Band	.1	I^xt=OUT
Short-Time	ST Pickup	6				
	ST Band	.3	I^xt=IN			

CB: B-FB1

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	87.95 Asym. (Calc.)
Model:	SPB-100 (3000)	Rating:	100 kA, 0.48 kV	LG kA:	91.71 Asym. (Calc.)
Size:	3000	Cont. Amp:	3000.000	Base kV:	0.480 (Calc.)

LV Solid State Trip Device

MFR: Westinghouse
Model: RMS 500 Series SPB
Sensor: 3000
Rating Plug: 3000.00

	Phase Setting			Ground Setting		
Long-Time	LT Pickup	.7		Ground Pickup	A	
	LT Band	7		Ground Band	.3	I^xt=IN
Short-Time	ST Pickup	3				
	ST Band	.3	I^xt=IN			

Protective Device Settings

CB: B-FB2-MCC-HC

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	87.95 Asym. (Calc.)
Model:	SPB-100 (1600)	Rating:	100 kA, 0.48 kV	LG kA:	91.71 Asym. (Calc.)
Size:	1600	Cont. Amp:	1600.000	Base kV:	0.480 (Calc.)

LV Solid State Trip Device

MFR: Cutler-Hammer
Model: RMS 500 Series SPB
Sensor: 1600
Rating Plug: 1200.00

		Phase Setting		Ground Setting		
Long-Time	LT Pickup	1		Ground Pickup	F	
	LT Band	24		Ground Band	.1	I^xt=IN
Short-Time	ST Pickup	S1(7)				
	ST Band	.3	I^xt=IN			

CB: B-FB3

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	87.95 Asym. (Calc.)
Model:	SPB-100 (800)	Rating:	100 kA, 0.48 kV	LG kA:	91.71 Asym. (Calc.)
Size:	800	Cont. Amp:	800.000	Base kV:	0.480 (Calc.)

LV Solid State Trip Device

MFR: Cutler-Hammer
Model: RMS 500 Series SPB
Sensor: 800
Rating Plug: 400.00

		Phase Setting		Ground Setting		
Long-Time	LT Pickup	1		Ground Pickup	E	
	LT Band	24		Ground Band	.1	I^xt=IN
Short-Time	ST Pickup	S1(7)				
	ST Band	.3	I^xt=IN			

CB: B-FB4

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	87.95 Asym. (Calc.)
Model:	SPB-100 (800)	Rating:	100 kA, 0.48 kV	LG kA:	91.71 Asym. (Calc.)
Size:	800	Cont. Amp:	800.000	Base kV:	0.480 (Calc.)

LV Solid State Trip Device

MFR: Cutler-Hammer
Model: RMS 500 Series SPB
Sensor: 800
Rating Plug: 400.00

		Phase Setting		Ground Setting		
Long-Time	LT Pickup	.9		Ground Pickup	F	
	LT Band	20		Ground Band	.1	I^xt=IN
Short-Time	ST Pickup	6				
	ST Band	.3	I^xt=IN			

Protective Device Settings

CB: B-FB5-MCC-GE

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	87.95 Asym. (Calc.)
Model:	SPB-100 (800)	Rating:	100 kA, 0.48 kV	LG kA:	91.71 Asym. (Calc.)
Size:	800	Cont. Amp:	800.000	Base kV:	0.480 (Calc.)

LV Solid State Trip Device

MFR: Cutler-Hammer
Model: RMS 500 Series SPB
Sensor: 800
Rating Plug: 600.00

		Phase Setting		Ground Setting		
Long-Time	LT Pickup	1		Ground Pickup	F	
	LT Band	20		Ground Band	.1	I^xt=IN
Short-Time	ST Pickup	6				
	ST Band	.3	I^xt=IN			

CB: B-FB6-MCC-GC

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	87.95 Asym. (Calc.)
Model:	SPB-100 (800)	Rating:	100 kA, 0.48 kV	LG kA:	91.71 Asym. (Calc.)
Size:	800	Cont. Amp:	800.000	Base kV:	0.480 (Calc.)

LV Solid State Trip Device

MFR: Cutler-Hammer
Model: RMS 500 Series SPB
Sensor: 800
Rating Plug: 400.00

		Phase Setting		Ground Setting		
Long-Time	LT Pickup	1		Ground Pickup	F	
	LT Band	24		Ground Band	.1	I^xt=IN
Short-Time	ST Pickup	S1(7)				
	ST Band	.3	I^xt=IN			

CB: B-FB7-MCC-GA

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	87.95 Asym. (Calc.)
Model:	SPB-100 (800)	Rating:	100 kA, 0.48 kV	LG kA:	91.71 Asym. (Calc.)
Size:	800	Cont. Amp:	800.000	Base kV:	0.480 (Calc.)

LV Solid State Trip Device

MFR: Westinghouse
Model: RMS 500 Series SPB
Sensor: 800
Rating Plug: 400.00

		Phase Setting		Ground Setting		
Long-Time	LT Pickup	1		Ground Pickup	F	
	LT Band	24		Ground Band	.1	I^xt=IN
Short-Time	ST Pickup	S1(7)				
	ST Band	.3	I^xt=IN			

Protective Device Settings

CB: B-FB8-ATS-8

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	87.95 Asym. (Calc.)
Model:	SPB-100 (800)	Rating:	100 kA, 0.48 kV	LG kA:	91.71 Asym. (Calc.)
Size:	800	Cont. Amp:	800.000	Base kV:	0.480 (Calc.)

LV Solid State Trip Device

MFR: Cutler-Hammer
Model: RMS 500 Series SPB
Sensor: 800
Rating Plug: 600.00

	Phase Setting			Ground Setting		
Long-Time	LT Pickup	1		Ground Pickup	E	
	LT Band	20		Ground Band	.1	I^xt=IN
Short-Time	ST Pickup	6				
	ST Band	.1	I^xt=IN			

CB: B-FC-1

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00 Asym. (Calc.)
Model:	HFD	Rating:	100 kA, 0.24 kV	LG kA:	0.00 Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000 (Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFD (2,3,4P)	Magnetic Trip:	FIXED
ID:	15		

CB: B-GAS BOOSTER BLOWER VFD

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00 Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00 Asym. (Calc.)
Size:	50	Cont. Amp:	50.000	Base kV:	0.000 (Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 050K2
Pick up: F

CB: B-GAS COMPRESSOR #6

MFR:	Siemens	Tag #:		3-Phase kA:	0.00 Asym. (Calc.)
Model:	FD6-A	Rating:	35 kA, 0.48 kV	LG kA:	0.00 Asym. (Calc.)
Size:	250	Cont. Amp:	250.000	Base kV:	0.000 (Calc.)

Thermal Magnetic Trip Device

MFR:	Siemens	Thermal Trip:	Fixed
Model:	FD6-A	Magnetic Trip:	4
ID:	250 (0.48kV)		

Protective Device Settings

CB: B-GAS COMPRESSOR #7

MFR:	Siemens	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	FD6-A	Rating:	35 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	250	Cont. Amp:	250.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Siemens	Thermal Trip:	Fixed
Model:	FD6-A	Magnetic Trip:	5
ID:	250 (0.48kV)		

CB: B-GEN 175KW

MFR:	Westinghouse	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	LC	Rating:	30 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	400	Cont. Amp:	400.000	Base kV:	0.000	(Calc.)

LV Solid State Trip Device

MFR: Westinghouse

Model: Seltronic LC (Adj)

Sensor: 400

Rating Plug: 300.00

		Phase Setting		Ground Setting	
Long-Time	LT Pickup	1.000		Ground Pickup	0.650
	LT Band	Fixed		Ground Band	0.060
Short-Time	ST Pickup	4			
	ST Band	Fixed	I^xt=IN		

CB: B-GEN G6

MFR:	Square-D	Tag #:		3-Phase kA:	46.31	Asym. (Calc.)
Model:	RGF	Rating:	35 kA, 0.48 kV	LG kA:	49.42	Asym. (Calc.)
Size:	2000	Cont. Amp:	2000.000	Base kV:	0.480	(Calc.)

LV Solid State Trip Device

MFR: Square-D

Model: ET1.0I (RG)

Sensor: 2000

		Phase Setting		
Long-Time	LT Pickup	fixed	LT Band	Fixed
INST	Inst. Pickup	12		

Protective Device Settings

CB: B-GEN NO. 1

MFR:	Siemens-Allis	Tag #:		3-Phase kA:	64.89	Asym. (Calc.)
Model:	LA-1600A	Rating:	50 kA, 0.48 kV	LG kA:	66.24	Asym. (Calc.)
Size:	1600	Cont. Amp:	1600.000	Base kV:	0.480	(Calc.)

LV Solid State Trip Device

MFR: Siemens

Model: Static Trip II

Sensor: 1600

		Phase Setting		Ground Setting
Long-Time	LT Pickup	B	Ground Pickup	0.15
	LT Band	Band 6	Ground Band	Minimum
Short-Time	ST Pickup	12		
	ST Band	Minimum		
INST	Inst. Pickup	12		

CB: B-GEN NO. 2

MFR:	Siemens-Allis	Tag #:	7713.00	3-Phase kA:	64.14	Asym. (Calc.)
Model:	LA-1600A	Rating:	50 kA, 0.48 kV	LG kA:	62.04	Asym. (Calc.)
Size:	1600	Cont. Amp:	1600.000	Base kV:	0.480	(Calc.)

LV Solid State Trip Device

MFR: Siemens

Model: Static Trip II

Sensor: 1600

		Phase Setting		Ground Setting
Long-Time	LT Pickup	D	Ground Pickup	0.5
	LT Band	Band 4	Ground Band	Intermediate
Short-Time	ST Pickup	3		
	ST Band	Intermediate		

CB: B-GEN NO. 3

MFR:	Siemens-Allis	Tag #:		3-Phase kA:	64.14	Asym. (Calc.)
Model:	LA-1600A	Rating:	50 kA, 0.48 kV	LG kA:	62.04	Asym. (Calc.)
Size:	1600	Cont. Amp:	1600.000	Base kV:	0.480	(Calc.)

LV Solid State Trip Device

MFR: Siemens

Model: Static Trip II

Sensor: 1600

		Phase Setting		Ground Setting
Long-Time	LT Pickup	B	Ground Pickup	0.15
	LT Band	Band 6	Ground Band	Minimum
Short-Time	ST Pickup	12		
	ST Band	Minimum		
INST	Inst. Pickup	12		

Protective Device Settings

CB: B-GEN TIE A3

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	64.14 Asym. (Calc.)
Model:	SPB-100 (3000)	Rating:	100 kA, 0.48 kV	LG kA:	62.04 Asym. (Calc.)
Size:	3000	Cont. Amp:	3000.000	Base kV:	0.480 (Calc.)

LV Solid State Trip Device

MFR: Cutler-Hammer

Model: RMS 500 Series SPB

Sensor: 3000

Rating Plug: 1600.00

		Phase Setting		Ground Setting		
Long-Time	LT Pickup	1		Ground Pickup	A	
	LT Band	12		Ground Band	.3	I^xt=OUT
Short-Time	ST Pickup	4				
	ST Band	.5	I^xt=OUT			

CB: B-Grinder

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00 Asym. (Calc.)
Model:	HFD	Rating:	65 kA, 0.48 kV	LG kA:	0.00 Asym. (Calc.)
Size:	30	Cont. Amp:	30.000	Base kV:	0.000 (Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFD (2,3,4P)	Magnetic Trip:	FIXED
ID:	30		

CB: B-GRIT SCR TROLLEY

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	48.82 Asym. (Calc.)
Model:	HFD	Rating:	65 kA, 0.48 kV	LG kA:	42.55 Asym. (Calc.)
Size:	20	Cont. Amp:	20.000	Base kV:	0.480 (Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFD (2,3,4P)	Magnetic Trip:	FIXED
ID:	20		

CB: B-HOIST TROLLY

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00 Asym. (Calc.)
Model:	HFB	Rating:	25 kA, 0.48 kV	LG kA:	0.00 Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000 (Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFB (2,3P)	Magnetic Trip:	FIXED
ID:	15		

Protective Device Settings

CB: B-HVAC 10001

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	GHB	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	30	Cont. Amp:	30.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	GHB (2,3P)	Magnetic Trip:	FIXED
ID:	30		

CB: B-HVAC56100.00

MFR:	Siemens*	Tag #:		3-Phase kA:	17.39	Asym. (Calc.)
Model:	HED4	Rating:	18 kA, 0.48 kV	LG kA:	11.53	Asym. (Calc.)
Size:	30	Cont. Amp:	30.000	Base kV:	0.480	(Calc.)

* The retrieved library data is modified by user.

Thermal Magnetic Trip Device

MFR:	Siemens	Thermal Trip:	Fixed
Model:	HED4	Magnetic Trip:	FIXED
ID:	30 (0.48kV)		

CB: B-HVAC56110.00

MFR:	Siemens*	Tag #:		3-Phase kA:	17.39	Asym. (Calc.)
Model:	HED4	Rating:	18 kA, 0.48 kV	LG kA:	11.53	Asym. (Calc.)
Size:	20	Cont. Amp:	20.000	Base kV:	0.480	(Calc.)

* The retrieved library data is modified by user.

Thermal Magnetic Trip Device

MFR:	Siemens	Thermal Trip:	Fixed
Model:	HED4	Magnetic Trip:	FIXED
ID:	20 (0.48kV)		

CB: B-HVC-1750

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	60	Cont. Amp:	60.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	60		

CB: B-HVC-1760

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	20	Cont. Amp:	20.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	20		

Protective Device Settings

CB: B-HW ELEVATOR

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	48.82	Asym. (Calc.)
Model:	HFD	Rating:	65 kA, 0.48 kV	LG kA:	42.55	Asym. (Calc.)
Size:	50	Cont. Amp:	50.000	Base kV:	0.480	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFD (2,3,4P)	Magnetic Trip:	FIXED
ID:	50		

CB: B-HW GATES

MFR:	Siemens*	Tag #:		3-Phase kA:	17.39	Asym. (Calc.)
Model:	HED4	Rating:	18 kA, 0.48 kV	LG kA:	11.53	Asym. (Calc.)
Size:	20	Cont. Amp:	20.000	Base kV:	0.480	(Calc.)

* The retrieved library data is modified by user.

Thermal Magnetic Trip Device

MFR:	Siemens	Thermal Trip:	Fixed
Model:	HED4	Magnetic Trip:	FIXED
ID:	20 (0.48kV)		

CB: B-HWH

MFR:	Cutler-Hammer*	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HFD	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	30	Cont. Amp:	30.000	Base kV:	0.000	(Calc.)

* The retrieved library data is modified by user.

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFD (2,3,4P)	Magnetic Trip:	FIXED
ID:	30		

CB: B-HYDRALIC PRESS

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HFB	Rating:	25 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	30	Cont. Amp:	30.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFB (2,3P)	Magnetic Trip:	FIXED
ID:	30		

Protective Device Settings

CB: B-INFL PUMP 1

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	48.58 Asym. (Calc.)
Model:	HND	Rating:	65 kA, 0.48 kV	LG kA:	41.99 Asym. (Calc.)
Size:	800	Cont. Amp:	800.000	Base kV:	0.480 (Calc.)

LV Solid State Trip Device

MFR: Cutler-Hammer
Model: RMS 310 N (LSG)
Sensor: 800
Rating Plug: 800.00

		Phase Setting	
Short-Time	ST Pickup	4X	
	ST Band	Fixed	I^xt=IN

CB: B-INFL PUMP 2

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	45.48 Asym. (Calc.)
Model:	MDL	Rating:	50 kA, 0.48 kV	LG kA:	38.13 Asym. (Calc.)
Size:	800	Cont. Amp:	800.000	Base kV:	0.480 (Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	MDL	Magnetic Trip:	4
ID:	800		

CB: B-INFL PUMP 2 VFD MAIN

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	45.48 Asym. (Calc.)
Model:	HND	Rating:	65 kA, 0.48 kV	LG kA:	38.13 Asym. (Calc.)
Size:	800	Cont. Amp:	800.000	Base kV:	0.480 (Calc.)

LV Solid State Trip Device

MFR: Cutler-Hammer
Model: RMS 310 N (LSG)
Sensor: 800
Rating Plug: 800.00

		Phase Setting	
Short-Time	ST Pickup	4X	
	ST Band	Fixed	I^xt=IN

CB: B-INFL PUMP 3

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	48.57 Asym. (Calc.)
Model:	MDL	Rating:	50 kA, 0.48 kV	LG kA:	41.98 Asym. (Calc.)
Size:	800	Cont. Amp:	800.000	Base kV:	0.480 (Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	MDL	Magnetic Trip:	4.000
ID:	800		

Protective Device Settings

CB: B-INFL PUMP 3 VFD MAIN

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	48.57	Asym. (Calc.)
Model:	HND	Rating:	65 kA, 0.48 kV	LG kA:	41.98	Asym. (Calc.)
Size:	800	Cont. Amp:	800.000	Base kV:	0.480	(Calc.)

LV Solid State Trip Device

MFR: Cutler-Hammer
Model: RMS 310 N (LSG)
Sensor: 800
Rating Plug: 800.00

		Phase Setting	
Short-Time	ST Pickup	4X	
	ST Band	Fixed	I^xt=IN

CB: B-INFL PUMP 4

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	46.46	Asym. (Calc.)
Model:	MDL	Rating:	50 kA, 0.48 kV	LG kA:	39.32	Asym. (Calc.)
Size:	800	Cont. Amp:	800.000	Base kV:	0.480	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	MDL	Magnetic Trip:	4
ID:	800		

CB: B-INFL PUMP 4 VFD MAIN

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	46.46	Asym. (Calc.)
Model:	HND	Rating:	65 kA, 0.48 kV	LG kA:	39.32	Asym. (Calc.)
Size:	800	Cont. Amp:	800.000	Base kV:	0.480	(Calc.)

LV Solid State Trip Device

MFR: Cutler-Hammer
Model: RMS 310 N (LSG)
Sensor: 800
Rating Plug: 800.00

		Phase Setting		Ground Setting	
Short-Time	ST Pickup	4X		Ground Pickup	1
	ST Band	Fixed	I^xt=IN	Ground Band	INST

CB: B-INFL PUMP 5

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	48.57	Asym. (Calc.)
Model:	MDL	Rating:	50 kA, 0.48 kV	LG kA:	41.98	Asym. (Calc.)
Size:	800	Cont. Amp:	800.000	Base kV:	0.480	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	MDL	Magnetic Trip:	4
ID:	800		

Protective Device Settings

CB: B-INFL PUMP 5 VFD MAIN

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	48.57 Asym. (Calc.)
Model:	HND	Rating:	65 kA, 0.48 kV	LG kA:	41.98 Asym. (Calc.)
Size:	800	Cont. Amp:	800.000	Base kV:	0.480 (Calc.)

LV Solid State Trip Device

MFR: Cutler-Hammer
Model: RMS 310 N (LSG)
Sensor: 800
Rating Plug: 800.00

		Phase Setting	
Short-Time	ST Pickup	2X	
	ST Band	Fixed	I^xt=IN

CB: B-INFL PUMP 6

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	44.56 Asym. (Calc.)
Model:	HND	Rating:	65 kA, 0.48 kV	LG kA:	37.02 Asym. (Calc.)
Size:	800	Cont. Amp:	800.000	Base kV:	0.480 (Calc.)

LV Solid State Trip Device

MFR: Cutler-Hammer
Model: RMS 310 N (LSG)
Sensor: 800
Rating Plug: 800.00

		Phase Setting	
Short-Time	ST Pickup	4X	
	ST Band	Fixed	I^xt=IN

CB: B-LATCH

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00 Asym. (Calc.)
Model:	HFB	Rating:	25 kA, 0.48 kV	LG kA:	0.00 Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000 (Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFB (2,3P)	Magnetic Trip:	FIXED
ID:	15		

CB: B-LCP-BFP1

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00 Asym. (Calc.)
Model:	HFD	Rating:	65 kA, 0.48 kV	LG kA:	0.00 Asym. (Calc.)
Size:	30	Cont. Amp:	30.000	Base kV:	0.000 (Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFD (2,3,4P)	Magnetic Trip:	FIXED
ID:	30		

Protective Device Settings

CB: B-LCP-BFP2

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HFD	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	30	Cont. Amp:	30.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFD (2,3,4P)	Magnetic Trip:	FIXED
ID:	30		

CB: B-LCP-BFP3

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HFD	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	30	Cont. Amp:	30.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFD (2,3,4P)	Magnetic Trip:	FIXED
ID:	30		

CB: B-LCP-BFP4

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HFD	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	30	Cont. Amp:	30.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFD (2,3,4P)	Magnetic Trip:	FIXED
ID:	30		

CB: B-LCP-HWOCS

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	48.82	Asym. (Calc.)
Model:	HFD	Rating:	65 kA, 0.48 kV	LG kA:	42.55	Asym. (Calc.)
Size:	150	Cont. Amp:	150.000	Base kV:	0.480	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFD (2,3,4P)	Magnetic Trip:	FIXED
ID:	150		

CB: B-LCP-PD

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HFD	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	60	Cont. Amp:	60.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFD (2,3,4P)	Magnetic Trip:	FIXED
ID:	60		

Protective Device Settings

CB: B-LP-GD

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	BAB	Rating:	10 kA, 0.24 kV	LG kA:	0.00	Asym. (Calc.)
Size:	50	Cont. Amp:	50.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	Quicklag (3P)	Magnetic Trip:	FIXED
ID:	50		

CB: B-LP-VFD

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	100	Cont. Amp:	100.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	100		

CB: B-LTG PNL LPE

MFR:	General Electric	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	TQD	Rating:	10 kA, 0.24 kV	LG kA:	0.00	Asym. (Calc.)
Size:	150	Cont. Amp:	150.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	General Electric	Thermal Trip:	Fixed
Model:	TQD	Magnetic Trip:	FIXED
ID:	150		

CB: B-M25011.10

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	7	Cont. Amp:	7.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR:	Cutler-Hammer
Model:	HMCP
ID:	007C0
Pick up:	A

CB: B-M25031.10

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	7	Cont. Amp:	7.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR:	Cutler-Hammer
Model:	HMCP
ID:	007C0
Pick up:	F

Protective Device Settings

CB: B-M25051.10

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	7	Cont. Amp:	7.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 007C0
Pick up: A

CB: B-M25071.10

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	7	Cont. Amp:	7.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 007C0
Pick up: A

CB: B-M25091.10

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	7	Cont. Amp:	7.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 007C0
Pick up: B

CB: B-M25111.10

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	7	Cont. Amp:	7.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 007C0
Pick up: A

Protective Device Settings

CB: B-M25131.10

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	7	Cont. Amp:	7.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer

Model: HMCP

ID: 007C0

Pick up: B

CB: B-M25151.10

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	7	Cont. Amp:	7.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer

Model: HMCP

ID: 007C0

Pick up: A

CB: B-M25171.10

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	7	Cont. Amp:	7.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer

Model: HMCP

ID: 007C0

Pick up: A

CB: B-MAIN SWGR A1

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	73.20	Asym. (Calc.)
Model:	SPB-100M (4000)	Rating:	100 kA, 0.48 kV	LG kA:	77.93	Asym. (Calc.)
Size:	4000	Cont. Amp:	4000.000	Base kV:	0.480	(Calc.)

LV Solid State Trip Device

MFR: Westinghouse

Model: RMS 510 Series SPB

Sensor: 4000 (100M, 150)

Rating Plug: 4000.00

	Phase Setting			Ground Setting		
Long-Time	LT Pickup	1		Ground Pickup	B	
	LT Band	20		Ground Band	.5	I^xt=OUT
Short-Time	ST Pickup	3				
	ST Band	.5	I^xt=OUT			

Protective Device Settings

CB: B-MAIN SWGR A2

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	82.68	Asym. (Calc.)
Model:	SPB-100 (3000)	Rating:	100 kA, 0.48 kV	LG kA:	89.29	Asym. (Calc.)
Size:	3000	Cont. Amp:	3000.000	Base kV:	0.480	(Calc.)

LV Solid State Trip Device

MFR: Westinghouse
Model: RMS 500 Series SPB
Sensor: 3000
Rating Plug: 3000.00

		Phase Setting		Ground Setting		
Long-Time	LT Pickup	1		Ground Pickup	A	
	LT Band	12		Ground Band	.3	I^xt=OUT
Short-Time	ST Pickup	4				
	ST Band	.5	I^xt=IN			

CB: B-MAIN SWGR B1

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	87.95	Asym. (Calc.)
Model:	SPB-100 (4000)	Rating:	100 kA, 0.48 kV	LG kA:	91.71	Asym. (Calc.)
Size:	4000	Cont. Amp:	4000.000	Base kV:	0.480	(Calc.)

LV Solid State Trip Device

MFR: Cutler-Hammer
Model: RMS 500 Series SPB
Sensor: 4000
Rating Plug: 2000.00

		Phase Setting		Ground Setting		
Long-Time	LT Pickup	.5		Ground Pickup	B	
	LT Band	20		Ground Band	.5	I^xt=OUT
Short-Time	ST Pickup	3				
	ST Band	.5	I^xt=OUT			

CB: B-MAIN SWGR B2

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	87.95	Asym. (Calc.)
Model:	SPB-100 (3000)	Rating:	100 kA, 0.48 kV	LG kA:	91.71	Asym. (Calc.)
Size:	3000	Cont. Amp:	3000.000	Base kV:	0.480	(Calc.)

LV Solid State Trip Device

MFR: Cutler-Hammer
Model: RMS 500 Series SPB
Sensor: 3000
Rating Plug: 3000.00

		Phase Setting		Ground Setting		
Long-Time	LT Pickup	1		Ground Pickup	A	
	LT Band	12		Ground Band	.3	I^xt=IN
Short-Time	ST Pickup	4				
	ST Band	.5	I^xt=IN			

Protective Device Settings

CB: B-MAIN SWGR TIE A1-B1

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	SPB-100 (4000)	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	4000	Cont. Amp:	4000.000	Base kV:	0.000	(Calc.)

LV Solid State Trip Device

MFR: Cutler-Hammer
Model: RMS 500 Series SPB
Sensor: 4000
Rating Plug: 4000.00

	Phase Setting			Ground Setting		
Long-Time	LT Pickup	.9		Ground Pickup	A	
	LT Band	10		Ground Band	.3	I^xt=OUT
Short-Time	ST Pickup	3				
	ST Band	.5	I^xt=IN			

CB: B-MAINT

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HFB	Rating:	25 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	30	Cont. Amp:	30.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFB (2,3P)	Magnetic Trip:	FIXED
ID:	30		

CB: B-MCC-DP1A

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	100	Cont. Amp:	100.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	100		

CB: B-MCC-DP1B

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	KD	Rating:	35 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	400	Cont. Amp:	400.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	KD	Magnetic Trip:	5
ID:	400		

CB: B-MCC-DP2C

MFR:	Federal Pacific	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	NJL	Rating:	30 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	100	Cont. Amp:	100.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Federal Pacific	Thermal Trip:	Fixed
Model:	JL	Magnetic Trip:	4.000
ID:	100		

CB: B-MCC-DP2D

MFR:	Cutler-Hammer*	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	FD	Rating:	25 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	100	Cont. Amp:	100.000	Base kV:	0.000	(Calc.)

* The retrieved library data is modified by user.

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	FD (2,3,4P)	Magnetic Trip:	FIXED
ID:	100		

CB: B-MCC-DP3A

MFR:	Cutler-Hammer*	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HKD	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	400	Cont. Amp:	350.000	Base kV:	0.000	(Calc.)

* The retrieved library data is modified by user.

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HKD	Magnetic Trip:	5.000
ID:	400		

CB: B-MCC-DP3B

MFR:	Westinghouse	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	LCL	Rating:	200 kA, 0.24 kV	LG kA:	0.00	Asym. (Calc.)
Size:	400	Cont. Amp:	400.000	Base kV:	0.000	(Calc.)

LV Solid State Trip Device

MFR:	Westinghouse
Model:	Seltronic LCL (Adj)
Sensor:	400
Rating Plug:	350.00

		Phase Setting		Ground Setting	
Short-Time	ST Pickup	8		Ground Pickup	0.200
	ST Band	Fixed	I^xt=IN	Ground Band	0.060

Protective Device Settings

CB: B-MCC-DP3C

MFR: Cutler-Hammer*	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model: HKD	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size: 400	Cont. Amp:	350.000	Base kV:	0.000	(Calc.)

* The retrieved library data is modified by user.

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HKD	Magnetic Trip:	5
ID:	400		

CB: B-MCC-DP3D

MFR: Cutler-Hammer*	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model: HKD	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size: 250	Cont. Amp:	225.000	Base kV:	0.000	(Calc.)

* The retrieved library data is modified by user.

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HKD	Magnetic Trip:	5
ID:	250		

CB: B-MCC-DP4A

MFR: Federal Pacific*	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model: XF	Rating:	14 kA, 0.6 kV	LG kA:	0.00	Asym. (Calc.)
Size: 70	Cont. Amp:	70.000	Base kV:	0.000	(Calc.)

* The retrieved library data is modified by user.

Thermal Magnetic Trip Device

MFR:	Federal Pacific	Thermal Trip:	Fixed
Model:	XF	Magnetic Trip:	FIXED
ID:	70		

CB: B-MCC-DP4B

MFR: Federal Pacific	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model: XJL	Rating:	200 kA, 0.6 kV	LG kA:	0.00	Asym. (Calc.)
Size: 400	Cont. Amp:	400.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Federal Pacific	Thermal Trip:	Fixed
Model:	XJL	Magnetic Trip:	3.000
ID:	400		

CB: B-MCC-EDP1A

MFR: General Electric	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model: TED	Rating:	18 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size: 100	Cont. Amp:	100.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	General Electric	Thermal Trip:	Fixed
Model:	TED (E 100)	Magnetic Trip:	FIXED
ID:	100		

Protective Device Settings

CB: B-MCC-EDP1B

MFR:	General Electric*	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	TED	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	70	Cont. Amp:	70.000	Base kV:	0.000	(Calc.)

* The retrieved library data is modified by user.

Thermal Magnetic Trip Device

MFR:	General Electric	Thermal Trip:	Fixed
Model:	TED (E 100)	Magnetic Trip:	FIXED
ID:	70		

CB: B-MCC-EDP1B-1

MFR:	Cutler-Hammer*	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	FD	Rating:	200 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	150	Cont. Amp:	150.000	Base kV:	0.000	(Calc.)

* The retrieved library data is modified by user.

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	FD (2,3,4P)	Magnetic Trip:	FIXED
ID:	150		

CB: B-MCC-EDP1C

MFR:	General Electric*	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	TED	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	100	Cont. Amp:	100.000	Base kV:	0.000	(Calc.)

* The retrieved library data is modified by user.

Thermal Magnetic Trip Device

MFR:	General Electric	Thermal Trip:	Fixed
Model:	TED (E 100)	Magnetic Trip:	FIXED
ID:	100		

CB: B-MCC-EDP1D

MFR:	General Electric	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	TED	Rating:	18 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	70	Cont. Amp:	70.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	General Electric	Thermal Trip:	Fixed
Model:	TED (E 100)	Magnetic Trip:	FIXED
ID:	70		

CB: B-MCC-EDP1E

MFR:	General Electric	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	TED	Rating:	18 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	50	Cont. Amp:	50.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	General Electric	Thermal Trip:	Fixed
Model:	TED (E 100)	Magnetic Trip:	FIXED
ID:	50		

Protective Device Settings

CB: B-MCC-GB

MFR:	Westinghouse	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	LCL	Rating:	200 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	400	Cont. Amp:	400.000	Base kV:	0.000	(Calc.)

LV Solid State Trip Device

MFR: Westinghouse
Model: Seltronic LCL (Adj)
Sensor: 400
Rating Plug: 300.00

	Phase Setting			Ground Setting	
Long-Time	LT Pickup	1.000		Ground Pickup	0.650
	LT Band	Fixed		Ground Band	0.060
Short-Time	ST Pickup	8			
	ST Band	Fixed	I^xt=IN		
INST	Inst. Pickup	Fixed			

CB: B-MCC-GD

MFR:	Allen-Bradley	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	140U-JD0	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	100	Cont. Amp:	100.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Allen Bradley	Thermal Trip:	Fixed
Model:	140U-JD0	Magnetic Trip:	5x
ID:	100 (0.48kV)		

CB: B-MCC-GD MAIN

MFR:	Allen-Bradley	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	140U-JD6	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	100	Cont. Amp:	100.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Allen Bradley	Thermal Trip:	Fixed
Model:	140U-JD3	Magnetic Trip:	10x
ID:	100		

CB: B-MCC-GD_EASTERN TRUNK

MFR:	Cutler-Hammer*	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	FD	Rating:	25 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	150	Cont. Amp:	150.000	Base kV:	0.000	(Calc.)

* The retrieved library data is modified by user.

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	FD (2,3,4P)	Magnetic Trip:	FIXED
ID:	150		

CB: B-MCC-HW BUS A MAIN

MFR:	Cutler-Hammer*	Tag #:		3-Phase kA:	48.82	Asym. (Calc.)
Model:	CHND	Rating:	65 kA, 0.48 kV	LG kA:	42.55	Asym. (Calc.)
Size:	1200	Cont. Amp:	1000.000	Base kV:	0.480	(Calc.)

* The retrieved library data is modified by user.

LV Solid State Trip Device

MFR: Cutler-Hammer

Model: RMS 310 N (LSG)

Sensor: 1250

Rating Plug: 1000.00

		Phase Setting	
Long-Time	LT Pickup	Fixed	
	LT Band	Fixed	
Short-Time	ST Pickup	3X	
	ST Band	Fixed	I^xt=IN

CB: B-MCC-HW BUS B MAIN

MFR:	Cutler-Hammer*	Tag #:		3-Phase kA:	48.69	Asym. (Calc.)
Model:	HND	Rating:	65 kA, 0.48 kV	LG kA:	42.49	Asym. (Calc.)
Size:	1200	Cont. Amp:	1000.000	Base kV:	0.480	(Calc.)

* The retrieved library data is modified by user.

LV Solid State Trip Device

MFR: Cutler-Hammer

Model: RMS 310 N (LSG)

Sensor: 1250

Rating Plug: 1000.00

		Phase Setting	
Long-Time	LT Pickup	Fixed	
	LT Band	Fixed	
Short-Time	ST Pickup	3X	
	ST Band	Fixed	I^xt=IN

CB: B-MCC-HW TIE

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMDLB	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	600	Cont. Amp:	600.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HMDLB	Magnetic Trip:	5
ID:	600		

Protective Device Settings

CB: B-MCC-NC

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	SPB-65 (1600)	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	1600	Cont. Amp:	1600.000	Base kV:	0.000	(Calc.)

LV Solid State Trip Device

MFR: Westinghouse
Model: RMS 500 Series SPB
Sensor: 1600
Rating Plug: 1000.00

	Phase Setting				Ground Setting	
Long-Time	LT Pickup	1		Ground Pickup	E	
	LT Band	7		Ground Band	.1	I^xt=IN
Short-Time	ST Pickup	3				
	ST Band	.3	I^xt=IN			

CB: B-MCC-ND

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	SPB-65 (1600)	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	1600	Cont. Amp:	1600.000	Base kV:	0.000	(Calc.)

LV Solid State Trip Device

MFR: Cutler-Hammer
Model: OPTIM 750/1050 SPB (I2t)
Sensor: 1600
Rating Plug: 1000.00

	Phase Setting				Ground Setting	
Long-Time	LT Pickup	1.000		Ground Pickup	0.650	
	LT Band	7.000	Range=(2 - 24)	Ground Band	0.1	I^xt=IN
Short-Time	ST Pickup	3.000				
	ST Band	0.3	I^xt=IN			

CB: B-MCC-NE

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	SPB-50 (400)	Rating:	50 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	400	Cont. Amp:	400.000	Base kV:	0.000	(Calc.)

LV Solid State Trip Device

MFR: Cutler-Hammer
Model: RMS 500 Series SPB
Sensor: 400
Rating Plug: 300.00

	Phase Setting				Ground Setting	
Long-Time	LT Pickup	1		Ground Pickup	E	
	LT Band	24		Ground Band	.1	I^xt=IN
Short-Time	ST Pickup	S2(8)				
	ST Band	.3	I^xt=IN			

CB: B-MCC-NF

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	SPB-50 (400)	Rating:	50 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	400	Cont. Amp:	400.000	Base kV:	0.000	(Calc.)

LV Solid State Trip Device

MFR: Cutler-Hammer
Model: RMS 500 Series SPB
Sensor: 400
Rating Plug: 200.00

		Phase Setting			Ground Setting	
Long-Time	LT Pickup	1		Ground Pickup	E	
	LT Band	24		Ground Band	.1	I^xt=IN
Short-Time	ST Pickup	S2(8)				
	ST Band	.3	I^xt=IN			

CB: B-MCC-NG BUS A

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	SPB-50 (400)	Rating:	50 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	400	Cont. Amp:	400.000	Base kV:	0.000	(Calc.)

LV Solid State Trip Device

MFR: Westinghouse
Model: RMS 500 Series SPB
Sensor: 400
Rating Plug: 250.00

		Phase Setting			Ground Setting	
Long-Time	LT Pickup	1		Ground Pickup	E	
	LT Band	24		Ground Band	.1	I^xt=IN
Short-Time	ST Pickup	S2(8)				
	ST Band	.3	I^xt=IN			

CB: B-MCC-NG BUS B

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	SPB-50 (400)	Rating:	50 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	400	Cont. Amp:	400.000	Base kV:	0.000	(Calc.)

LV Solid State Trip Device

MFR: Westinghouse
Model: RMS 500 Series SPB
Sensor: 400
Rating Plug: 250.00

		Phase Setting			Ground Setting	
Long-Time	LT Pickup	1		Ground Pickup	E	
	LT Band	24		Ground Band	.1	I^xt=IN
Short-Time	ST Pickup	S2(8)				
	ST Band	.3	I^xt=IN			

Protective Device Settings

CB: B-MCC-SH BUS A

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	SPB-50 (400)	Rating:	50 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	400	Cont. Amp:	400.000	Base kV:	0.000	(Calc.)

LV Solid State Trip Device

MFR: Westinghouse
Model: RMS 500 Series SPB
Sensor: 400
Rating Plug: 300.00

		Phase Setting		Ground Setting		
Long-Time	LT Pickup	1		Ground Pickup	E	
	LT Band	24		Ground Band	.1	I^xt=IN
Short-Time	ST Pickup	S2(8)				
	ST Band	.3	I^xt=IN			

CB: B-MCC-SH BUS A MAIN

MFR:	Westinghouse	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	LC	Rating:	30 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	600	Cont. Amp:	600.000	Base kV:	0.000	(Calc.)

LV Solid State Trip Device

MFR: Westinghouse
Model: Seltronic LC (Fixed)
Sensor: 600
Rating Plug: 600.00

		Phase Setting	
Long-Time	LT Pickup	Fixed	
	LT Band	Fixed	
Short-Time	ST Pickup	10	
	ST Band	Fixed	I^xt=IN

CB: B-MCC-SH BUS B

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	SPB-50 (400)	Rating:	50 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	400	Cont. Amp:	400.000	Base kV:	0.000	(Calc.)

LV Solid State Trip Device

MFR: Westinghouse
Model: RMS 500 Series SPB
Sensor: 400
Rating Plug: 250.00

		Phase Setting		Ground Setting		
Long-Time	LT Pickup	1		Ground Pickup	E	
	LT Band	24		Ground Band	.1	I^xt=IN
Short-Time	ST Pickup	S2(8)				
	ST Band	.3	I^xt=IN			

CB: B-MCC-SH BUS B MAIN

MFR:	Westinghouse	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	LC	Rating:	30 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	600	Cont. Amp:	600.000	Base kV:	0.000	(Calc.)

LV Solid State Trip Device

MFR: Westinghouse
Model: Seltronic LC (Fixed)
Sensor: 600
Rating Plug: 600.00

		Phase Setting	
Long-Time	LT Pickup	Fixed	
	LT Band	Fixed	
Short-Time	ST Pickup	10	
	ST Band	Fixed	I^xt=IN

CB: B-MCC-SH TIE

MFR:	Westinghouse	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	LC	Rating:	30 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	600	Cont. Amp:	600.000	Base kV:	0.000	(Calc.)

LV Solid State Trip Device

MFR: Westinghouse
Model: Seltronic LC (Fixed)
Sensor: 600
Rating Plug: 300.00

		Phase Setting	
Short-Time	ST Pickup	10	
	ST Band	Fixed	I^xt=IN

CB: B-MME-1

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HFB	Rating:	25 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFB (2,3P)	Magnetic Trip:	FIXED
ID:	15		

CB: B-MME-13

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HFB	Rating:	25 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	30	Cont. Amp:	30.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFB (2,3P)	Magnetic Trip:	FIXED
ID:	30		

Protective Device Settings

CB: B-MME15

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HFB	Rating:	25 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFB (2,3P)	Magnetic Trip:	FIXED
ID:	15		

CB: B-MME-4

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HFB	Rating:	25 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFB (2,3P)	Magnetic Trip:	FIXED
ID:	15		

CB: B-MME-6

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HFB	Rating:	25 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFB (2,3P)	Magnetic Trip:	FIXED
ID:	15		

CB: B-MME-7

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HFB	Rating:	25 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	125	Cont. Amp:	125.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFB (2,3P)	Magnetic Trip:	FIXED
ID:	125		

CB: B-MME-9

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HFB	Rating:	25 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFB (2,3P)	Magnetic Trip:	FIXED
ID:	15		

Protective Device Settings

CB: B-MONORAIL HOSIT

MFR:	Cutler-Hammer*	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	FD	Rating:	25 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

* The retrieved library data is modified by user.

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	FD (2,3,4P)	Magnetic Trip:	FIXED
ID:	15		

CB: B-MPV 30021.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	SPB-50 (400)	Rating:	50 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	400	Cont. Amp:	400.000	Base kV:	0.000	(Calc.)

LV Solid State Trip Device

MFR: Westinghouse

Model: OPTIM 750/1050 SPB (I2t)

Sensor: 400

Rating Plug: 250.00

	Phase Setting			Ground Setting		
Long-Time	LT Pickup	1.000		Ground Pickup	0.650	
	LT Band	24.000	Range=(2 - 24)	Ground Band	0.1	I^xt=IN
Short-Time	ST Pickup	8.000				
	ST Band	0.3	I^xt=IN			

CB: B-MS-HW 52-A

MFR:	Siemens	Tag #:		3-Phase kA:	43.35	Asym. (Calc.)
Model:	WL-L-3200	Rating:	100 kA, 0.508 kV	LG kA:	43.60	Asym. (Calc.)
Size:	3200	Cont. Amp:	3200.000	Base kV:	0.480	(Calc.)

LV Solid State Trip Device

MFR: Siemens

Model: ETU745 (I^2t)

Sensor: Frame Size II - 3200

Rating Plug: 3000.00

	Phase Setting			Ground Setting		
Long-Time	LT Pickup	1		Ground Pickup	D	
	LT Band	3.5		Ground Band	0.5	I^xt=IN
Short-Time	ST Pickup	2.5				
	ST Band	0.2	I^xt=IN			
INST	Inst. Pickup	10				

Protective Device Settings

CB: B-MS-HW 52-B

MFR:	Siemens	Tag #:		3-Phase kA:	54.93 Asym. (Calc.)
Model:	WL-L-3200	Rating:	100 kA, 0.508 kV	LG kA:	50.77 Asym. (Calc.)
Size:	3200	Cont. Amp:	3200.000	Base kV:	0.480 (Calc.)

LV Solid State Trip Device

MFR: Siemens

Model: ETU745 (I^2t)

Sensor: Frame Size II - 3200

Rating Plug: 3000.00

		Phase Setting		Ground Setting		
Long-Time	LT Pickup	1		Ground Pickup	D	
	LT Band	3.5		Ground Band	0.5	I^xt=IN
Short-Time	ST Pickup	2.5				
	ST Band	0.2	I^xt=IN			
INST	Inst. Pickup	10				

CB: B-MS-HW TIE

MFR:	Siemens	Tag #:		3-Phase kA:	54.93 Asym. (Calc.)
Model:	WL-L-3200	Rating:	100 kA, 0.508 kV	LG kA:	50.77 Asym. (Calc.)
Size:	3200	Cont. Amp:	3200.000	Base kV:	0.480 (Calc.)

LV Solid State Trip Device

MFR: Siemens

Model: ETU745 (I^2t)

Sensor: Frame Size II - 3200

Rating Plug: 2000.00

		Phase Setting		Ground Setting		
Long-Time	LT Pickup	1		Ground Pickup	C	
	LT Band	2		Ground Band	0.3	I^xt=IN
Short-Time	ST Pickup	1.5				
	ST Band	0.1	I^xt=IN			
INST	Inst. Pickup	8				

CB: B-NEW INTERSTAGE BLDG

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00 Asym. (Calc.)
Model:	HFD	Rating:	65 kA, 0.48 kV	LG kA:	0.00 Asym. (Calc.)
Size:	50	Cont. Amp:	50.000	Base kV:	0.000 (Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFD (2,3,4P)	Magnetic Trip:	FIXED
ID:	50		

Protective Device Settings

CB: B-ORS Sprayer

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	FD	Rating:	35 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	FD (2,3,4P)	Magnetic Trip:	FIXED
ID:	15		

CB: B-P20100.20

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	7	Cont. Amp:	7.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR:	Cutler-Hammer
Model:	HMCP
ID:	007C0
Pick up:	E

CB: B-P20200.20

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	7	Cont. Amp:	7.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR:	Cutler-Hammer
Model:	HMCP
ID:	007C0
Pick up:	G

CB: B-P20300.20

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	7	Cont. Amp:	7.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR:	Cutler-Hammer
Model:	HMCP
ID:	007C0
Pick up:	E

Protective Device Settings

CB: B-P20400.20

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	7	Cont. Amp:	7.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 007C0
Pick up: F

CB: B-P20500.20

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	7	Cont. Amp:	7.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 007C0
Pick up: G

CB: B-P26010.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	100	Cont. Amp:	100.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 100R3
Pick up: F

CB: B-P26020.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	100	Cont. Amp:	100.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 100R3
Pick up: G

CB: B-P26025.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	7	Cont. Amp:	7.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR:	Cutler-Hammer
Model:	HMCP
ID:	007C0
Pick up:	D

CB: B-P26057.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR:	Cutler-Hammer
Model:	HMCP
ID:	015E0
Pick up:	G

CB: B-P26058.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR:	Cutler-Hammer
Model:	HMCP
ID:	015E0
Pick up:	G

CB: B-P26059.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	7	Cont. Amp:	7.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR:	Cutler-Hammer
Model:	HMCP
ID:	007C0
Pick up:	E

Protective Device Settings

CB: B-P26060.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	7	Cont. Amp:	7.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 007C0
Pick up: E

CB: B-P27010.00 (Bypass)

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-J	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	250	Cont. Amp:	250.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 250W5
Pick up: A

CB: B-P27020.00 (Bypass)

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-J	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	250	Cont. Amp:	250.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 250W5
Pick up: A

CB: B-P27030.00 (Bypass)

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-J	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	250	Cont. Amp:	250.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 250W5
Pick up: A

Protective Device Settings

CB: B-P27040.00 (Bypass)

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-J	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	250	Cont. Amp:	250.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 250W5
Pick up: A

CB: B-P27110.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	50	Cont. Amp:	50.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 050K2
Pick up: D

CB: B-P27120.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	50	Cont. Amp:	50.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 050K2
Pick up: D

CB: B-P27130.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	50	Cont. Amp:	50.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 050K2
Pick up: D

Protective Device Settings

CB: B-P27230.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	70	Cont. Amp:	70.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 070M2
Pick up: G

CB: B-P27310.00 (Bypass)

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-J	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	250	Cont. Amp:	250.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 250W5
Pick up: A

CB: B-P27320.00 (Bypass)

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-J	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	250	Cont. Amp:	250.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 250W5
Pick up: A

CB: B-P27330.00 (Bypass)

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-J	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	250	Cont. Amp:	250.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 250W5
Pick up: A

Protective Device Settings

CB: B-P27720.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	50	Cont. Amp:	50.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 050K2
Pick up: F

CB: B-P28010.00 (Bypass)

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-J	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	250	Cont. Amp:	250.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 250W5
Pick up: A

CB: B-P28020.00 (Bypass)

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-J	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	250	Cont. Amp:	250.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 250W5
Pick up: A

CB: B-P28030.00 (Bypass)

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-J	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	250	Cont. Amp:	250.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 250W5
Pick up: A

Protective Device Settings

CB: B-P32011.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	30	Cont. Amp:	30.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 030H1
Pick up: C

CB: B-P32013.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	30	Cont. Amp:	30.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 030H1
Pick up: C

CB: B-P32021.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	30	Cont. Amp:	30.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 030H1
Pick up: B

CB: B-P32023.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	30	Cont. Amp:	30.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 030H1
Pick up: F

CB: B-P32031.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	30	Cont. Amp:	30.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 030H1
Pick up: C

CB: B-P32033.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	30	Cont. Amp:	30.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 030H1
Pick up: G

CB: B-P32041.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	30	Cont. Amp:	30.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 030H1
Pick up: B

CB: B-P32043.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	30	Cont. Amp:	30.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 030H1
Pick up: C

Protective Device Settings

CB: B-P4011.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	LD	Rating:	35 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	400	Cont. Amp:	400.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	LD	Magnetic Trip:	6.25
ID:	400		

CB: B-P4012.00

MFR:	Federal Pacific	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	XJL	Rating:	200 kA, 0.6 kV	LG kA:	0.00	Asym. (Calc.)
Size:	400	Cont. Amp:	400.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Federal Pacific	Thermal Trip:	Fixed
Model:	XJL	Magnetic Trip:	3.000
ID:	400		

CB: B-P4013.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	LDC	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	400	Cont. Amp:	400.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	LDC	Magnetic Trip:	7.5
ID:	400 (0.48kV)		

CB: B-P4014.00

MFR:	Federal Pacific	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	XJL	Rating:	200 kA, 0.6 kV	LG kA:	0.00	Asym. (Calc.)
Size:	400	Cont. Amp:	400.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Federal Pacific	Thermal Trip:	Fixed
Model:	XJL	Magnetic Trip:	3.000
ID:	400		

CB: B-P4023.00

MFR:	Federal Pacific	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	XJL	Rating:	200 kA, 0.6 kV	LG kA:	0.00	Asym. (Calc.)
Size:	400	Cont. Amp:	400.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Federal Pacific	Thermal Trip:	Fixed
Model:	XJL	Magnetic Trip:	3.000
ID:	400		

Protective Device Settings

CB: B-P4598

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	7	Cont. Amp:	7.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 007C0
Pick up: E

CB: B-P52100.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	48.82	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	42.55	Asym. (Calc.)
Size:	100	Cont. Amp:	100.000	Base kV:	0.480	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 100R3
Pick up: D

CB: B-P52110.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	48.69	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	42.49	Asym. (Calc.)
Size:	100	Cont. Amp:	100.000	Base kV:	0.480	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 100R3
Pick up: G

CB: B-P52120.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	48.82	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	42.55	Asym. (Calc.)
Size:	100	Cont. Amp:	100.000	Base kV:	0.480	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 100R3
Pick up: A

Protective Device Settings

CB: B-P52130.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	48.69	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	42.49	Asym. (Calc.)
Size:	100	Cont. Amp:	100.000	Base kV:	0.480	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 100R3
Pick up: A

CB: B-P52140.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	48.82	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	42.55	Asym. (Calc.)
Size:	100	Cont. Amp:	100.000	Base kV:	0.480	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 100R3
Pick up: D

CB: B-P52150.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	48.69	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	42.49	Asym. (Calc.)
Size:	100	Cont. Amp:	100.000	Base kV:	0.480	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 100R3
Pick up: D

CB: B-P52160.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	48.82	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	42.55	Asym. (Calc.)
Size:	100	Cont. Amp:	100.000	Base kV:	0.480	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 100R3
Pick up: G

Protective Device Settings

CB: B-P52170.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	48.69	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	42.49	Asym. (Calc.)
Size:	100	Cont. Amp:	100.000	Base kV:	0.480	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 100R3
Pick up: D

CB: B-P52220.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	48.82	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	42.55	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.480	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 015E0
Pick up: A

CB: B-P52230.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	48.82	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	42.55	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.480	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 015E0
Pick up: A

CB: B-P52240.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	48.69	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	42.49	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.480	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 015E0
Pick up: B

Protective Device Settings

CB: B-P52250.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	48.69	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	42.49	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.480	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 015E0
Pick up: A

CB: B-P54080.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	48.82	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	42.55	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.480	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 015E0
Pick up: A

CB: B-P54090.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	48.82	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	42.55	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.480	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 015E0
Pick up: A

CB: B-P6501.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	100	Cont. Amp:	100.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	100		

Protective Device Settings

CB: B-P6901.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	30	Cont. Amp:	30.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 030H1
Pick up: G

CB: B-P6902.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	30	Cont. Amp:	30.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 030H1
Pick up: E

CB: B-P6903.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	30	Cont. Amp:	30.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 030H1
Pick up: E

CB: B-P7541.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	30	Cont. Amp:	30.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 030H1
Pick up: H

CB: B-PANEL A

MFR:	Cutler-Hammer*	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	FD	Rating:	25 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	30	Cont. Amp:	30.000	Base kV:	0.000	(Calc.)

* The retrieved library data is modified by user.

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	FD (2,3,4P)	Magnetic Trip:	FIXED
ID:	30		

CB: B-PANEL DB

MFR:	Westinghouse*	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	LA-400 (125-400A)	Rating:	200 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	400	Cont. Amp:	400.000	Base kV:	0.000	(Calc.)

* The retrieved library data is modified by user.

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	LA-400	Magnetic Trip:	High
ID:	400		

CB: B-PNL DDP6 MAIN

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	100	Cont. Amp:	100.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	100		

CB: B-PNL DP1

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	73.20	Asym. (Calc.)
Model:	SPB-100 (400)	Rating:	100 kA, 0.48 kV	LG kA:	77.93	Asym. (Calc.)
Size:	400	Cont. Amp:	400.000	Base kV:	0.480	(Calc.)

LV Solid State Trip Device

MFR:	Cutler-Hammer
Model:	RMS 500 Series SPB
Sensor:	400
Rating Plug:	300.00

	Phase Setting			Ground Setting		
Long-Time	LT Pickup	1		Ground Pickup	E	
	LT Band	20		Ground Band	.1	I^xt=OUT
Short-Time	ST Pickup	5				
	ST Band	.3	I^xt=OUT			

Protective Device Settings

CB: B-PNL DP3

MFR:	Westinghouse	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	LCL	Rating:	200 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	400	Cont. Amp:	400.000	Base kV:	0.000	(Calc.)

LV Solid State Trip Device

MFR: Westinghouse

Model: Seltronic LCL (Adj)

Sensor: 400

Rating Plug: 300.00

		Phase Setting		Ground Setting	
Long-Time	LT Pickup	1.000		Ground Pickup	0.650
	LT Band	Fixed		Ground Band	0.060
Short-Time	ST Pickup	8			
	ST Band	Fixed	I^xt=IN		
INST	Inst. Pickup	Fixed			

CB: B-PNL DPC-2

MFR:	Siemens	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	BL	Rating:	10 kA, 0.24 kV	LG kA:	0.00	Asym. (Calc.)
Size:	100	Cont. Amp:	100.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Siemens	Thermal Trip:	Fixed
Model:	BL (2,3P)	Magnetic Trip:	FIXED
ID:	100		

CB: B-PNL DPL4

MFR:	Westinghouse	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	CA	Rating:	10 kA, 0.24 kV	LG kA:	0.00	Asym. (Calc.)
Size:	150	Cont. Amp:	150.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	CA	Magnetic Trip:	FIXED
ID:	150		

CB: B-PNL DPL5

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	BAB	Rating:	10 kA, 0.24 kV	LG kA:	0.00	Asym. (Calc.)
Size:	100	Cont. Amp:	100.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	Quicklag (3P)	Magnetic Trip:	FIXED
ID:	100		

Protective Device Settings

CB: B-PNL DPLC-1

MFR:	Siemens	Tag #:		3-Phase kA:	2.01	Asym. (Calc.)
Model:	ED4	Rating:	65 kA, 0.24 kV	LG kA:	2.04	Asym. (Calc.)
Size:	100	Cont. Amp:	100.000	Base kV:	0.208	(Calc.)

Thermal Magnetic Trip Device

MFR:	Siemens	Thermal Trip:	Fixed
Model:	ED4	Magnetic Trip:	FIXED
ID:	100 (0.24kV)		

CB: B-PNL DPLC-2 MAIN

MFR:	Siemens	Tag #:		3-Phase kA:	1.57	Asym. (Calc.)
Model:	ED6	Rating:	65 kA, 0.24 kV	LG kA:	1.67	Asym. (Calc.)
Size:	90	Cont. Amp:	90.000	Base kV:	0.208	(Calc.)

Thermal Magnetic Trip Device

MFR:	Siemens	Thermal Trip:	Fixed
Model:	ED6	Magnetic Trip:	FIXED
ID:	90 (0.6kV)		

CB: B-PNL DPLC-3

MFR:	Siemens	Tag #:		3-Phase kA:	2.01	Asym. (Calc.)
Model:	BL	Rating:	10 kA, 0.24 kV	LG kA:	2.04	Asym. (Calc.)
Size:	60	Cont. Amp:	60.000	Base kV:	0.208	(Calc.)

Thermal Magnetic Trip Device

MFR:	Siemens	Thermal Trip:	Fixed
Model:	BL (2,3P)	Magnetic Trip:	FIXED
ID:	60		

CB: B-PNL DPLC-3 MAIN

MFR:	Westinghouse	Tag #:		3-Phase kA:	1.89	Asym. (Calc.)
Model:	BAB	Rating:	10 kA, 0.24 kV	LG kA:	1.84	Asym. (Calc.)
Size:	60	Cont. Amp:	60.000	Base kV:	0.208	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	Quicklag (3P)	Magnetic Trip:	FIXED
ID:	60		

CB: B-PNL DPLC-4 MAIN

MFR:	Siemens	Tag #:		3-Phase kA:	0.88	Asym. (Calc.)
Model:	BL	Rating:	10 kA, 0.24 kV	LG kA:	0.88	Asym. (Calc.)
Size:	100	Cont. Amp:	100.000	Base kV:	0.208	(Calc.)

Thermal Magnetic Trip Device

MFR:	Siemens	Thermal Trip:	Fixed
Model:	BL (2,3P)	Magnetic Trip:	FIXED
ID:	100		

Protective Device Settings

CB: B-PNL DPMB

MFR:	Cutler-Hammer*	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HKD	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	400	Cont. Amp:	350.000	Base kV:	0.000	(Calc.)

* The retrieved library data is modified by user.

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HKD	Magnetic Trip:	5
ID:	400		

CB: B-PNL DPP1

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	48.82	Asym. (Calc.)
Model:	HFD	Rating:	65 kA, 0.48 kV	LG kA:	42.55	Asym. (Calc.)
Size:	100	Cont. Amp:	100.000	Base kV:	0.480	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFD (2,3,4P)	Magnetic Trip:	FIXED
ID:	100		

CB: B-PNL DPP1 BLOWER GALLERY

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HFD	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	100	Cont. Amp:	100.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFD (2,3,4P)	Magnetic Trip:	FIXED
ID:	100		

CB: B-PNL DPP1 MAIN

MFR:	Siemens	Tag #:		3-Phase kA:	17.39	Asym. (Calc.)
Model:	HED4	Rating:	42 kA, 0.48 kV	LG kA:	11.53	Asym. (Calc.)
Size:	100	Cont. Amp:	100.000	Base kV:	0.480	(Calc.)

Thermal Magnetic Trip Device

MFR:	Siemens	Thermal Trip:	Fixed
Model:	HED4	Magnetic Trip:	FIXED
ID:	100 (0.48kV)		

CB: B-PNL DPP1-MAIN

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	100	Cont. Amp:	100.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	100		

CB: B-PNL DPP3 MAIN

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	100	Cont. Amp:	100.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	100		

CB: B-PNL DPP3_BLOWER GALLERY

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HFD	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	100	Cont. Amp:	100.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFD (2,3,4P)	Magnetic Trip:	FIXED
ID:	100		

CB: B-PNL DPP4

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HFD	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	100	Cont. Amp:	100.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFD (2,3,4P)	Magnetic Trip:	FIXED
ID:	100		

CB: B-PNL DPP4 MAIN

MFR:	Westinghouse	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	FCL	Rating:	150 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	100	Cont. Amp:	100.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	FCL	Magnetic Trip:	FIXED
ID:	100 (0.24kV)		

CB: B-PNL DPP5

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HFD	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	100	Cont. Amp:	100.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFD (2,3,4P)	Magnetic Trip:	FIXED
ID:	100		

Protective Device Settings

CB: B-PNL DPP5 MAIN

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	100	Cont. Amp:	100.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	100		

CB: B-PNL DPP6_BLOWER GALLERY

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HFD	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	100	Cont. Amp:	100.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFD (2,3,4P)	Magnetic Trip:	FIXED
ID:	100		

CB: B-PNL DPP7 BLOWER GALLERY

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HFD	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	100	Cont. Amp:	100.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFD (2,3,4P)	Magnetic Trip:	FIXED
ID:	100		

CB: B-PNL DPP7 MAIN

MFR:	Westinghouse	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	FCL	Rating:	150 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	100	Cont. Amp:	100.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	FCL	Magnetic Trip:	FIXED
ID:	100 (0.24kV)		

CB: B-PNL-DPC1

MFR:	Westinghouse	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	BA	Rating:	10 kA, 0.24 kV	LG kA:	0.00	Asym. (Calc.)
Size:	50	Cont. Amp:	50.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	Quicklag (3P)	Magnetic Trip:	FIXED
ID:	50		

Protective Device Settings

CB: B-PNL-DPL

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HFD	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	30	Cont. Amp:	30.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFD (2,3,4P)	Magnetic Trip:	FIXED
ID:	30		

CB: B-PNL-DPL1

MFR:	Westinghouse	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	BA	Rating:	10 kA, 0.24 kV	LG kA:	0.00	Asym. (Calc.)
Size:	80	Cont. Amp:	80.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	Quicklag (3P)	Magnetic Trip:	FIXED
ID:	80		

CB: B-PNL-DPL6

MFR:	Westinghouse	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	BA	Rating:	10 kA, 0.24 kV	LG kA:	0.00	Asym. (Calc.)
Size:	50	Cont. Amp:	50.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	Quicklag (3P)	Magnetic Trip:	FIXED
ID:	50		

CB: B-PNL-DPP2

MFR:	Westinghouse	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	BA	Rating:	10 kA, 0.24 kV	LG kA:	0.00	Asym. (Calc.)
Size:	80	Cont. Amp:	80.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	Quicklag (3P)	Magnetic Trip:	FIXED
ID:	80		

CB: B-Polymer PNL

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HFD	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFD (2,3,4P)	Magnetic Trip:	FIXED
ID:	15		

Protective Device Settings

CB: B-PP VFD PNL

MFR:	Cutler-Hammer*	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	FD	Rating:	25 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	50	Cont. Amp:	50.000	Base kV:	0.000	(Calc.)

* The retrieved library data is modified by user.

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	FD (2,3,4P)	Magnetic Trip:	FIXED
ID:	50		

CB: B-PURGING COMPROSSER

MFR:	Siemens	Tag #:		3-Phase kA:	2.01	Asym. (Calc.)
Model:	BL	Rating:	10 kA, 0.24 kV	LG kA:	2.04	Asym. (Calc.)
Size:	20	Cont. Amp:	20.000	Base kV:	0.208	(Calc.)

Thermal Magnetic Trip Device

MFR:	Siemens	Thermal Trip:	Fixed
Model:	BL (2,3P)	Magnetic Trip:	FIXED
ID:	20		

CB: B-ROOF A/C BREAKER

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HFD	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	30	Cont. Amp:	30.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFD (2,3,4P)	Magnetic Trip:	FIXED
ID:	30		

CB: B-RSS 30010.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	3	Cont. Amp:	3.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR:	Cutler-Hammer
Model:	HMCP
ID:	003A0
Pick up:	F

CB: B-RSS30020.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	3	Cont. Amp:	3.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR:	Cutler-Hammer
Model:	HMCP
ID:	003A0
Pick up:	G

CB: B-SCR BLDG N OH DOOR

MFR:	Siemens*	Tag #:		3-Phase kA:	17.39	Asym. (Calc.)
Model:	HED4	Rating:	18 kA, 0.48 kV	LG kA:	11.53	Asym. (Calc.)
Size:	20	Cont. Amp:	20.000	Base kV:	0.480	(Calc.)

* The retrieved library data is modified by user.

Thermal Magnetic Trip Device

MFR:	Siemens	Thermal Trip:	Fixed
Model:	HED4	Magnetic Trip:	FIXED
ID:	20 (0.48kV)		

CB: B-SCR BLDG S OH DOOR

MFR:	Siemens*	Tag #:		3-Phase kA:	17.39	Asym. (Calc.)
Model:	HED4	Rating:	18 kA, 0.48 kV	LG kA:	11.53	Asym. (Calc.)
Size:	20	Cont. Amp:	20.000	Base kV:	0.480	(Calc.)

* The retrieved library data is modified by user.

Thermal Magnetic Trip Device

MFR:	Siemens	Thermal Trip:	Fixed
Model:	HED4	Magnetic Trip:	FIXED
ID:	20 (0.48kV)		

CB: B-SCRUBBER CHEM HANDLING

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HFD	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	60	Cont. Amp:	60.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFD (2,3,4P)	Magnetic Trip:	FIXED
ID:	60		

CB: B-SEP53000.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	48.82	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	42.55	Asym. (Calc.)
Size:	7	Cont. Amp:	7.000	Base kV:	0.480	(Calc.)

Motor Circuit Protector Trip Device

MFR:	Cutler-Hammer
Model:	HMCP
ID:	007C0
Pick up:	C

Protective Device Settings

CB: B-SEP53010.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	48.69 Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	42.49 Asym. (Calc.)
Size:	7	Cont. Amp:	7.000	Base kV:	0.480 (Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 007C0
Pick up: A

CB: B-SEP53020.00

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	48.69 Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	42.49 Asym. (Calc.)
Size:	7	Cont. Amp:	7.000	Base kV:	0.480 (Calc.)

Motor Circuit Protector Trip Device

MFR: Cutler-Hammer
Model: HMCP
ID: 007C0
Pick up: C

CB: B-SKIMMER ACTUATOR #1

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00 Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00 Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000 (Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	15		

CB: B-SKIMMER ACTUATOR #10

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00 Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00 Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000 (Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	15		

CB: B-SKIMMER ACTUATOR #11

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00 Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00 Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000 (Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	15		

Protective Device Settings

CB: B-SKIMMER ACTUATOR #12

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	15		

CB: B-SKIMMER ACTUATOR #13

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	15		

CB: B-SKIMMER ACTUATOR #14

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	15		

CB: B-SKIMMER ACTUATOR #15

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	15		

CB: B-SKIMMER ACTUATOR #16

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	15		

CB: B-SKIMMER ACTUATOR #17

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	15		

CB: B-SKIMMER ACTUATOR #18

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	15		

CB: B-SKIMMER ACTUATOR #19

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	15		

CB: B-SKIMMER ACTUATOR #2

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	15		

CB: B-SKIMMER ACTUATOR #20

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	15		

Protective Device Settings

CB: B-SKIMMER ACTUATOR #21

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	15		

CB: B-SKIMMER ACTUATOR #3

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	15		

CB: B-SKIMMER ACTUATOR #4

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	15		

CB: B-SKIMMER ACTUATOR #5

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	15		

CB: B-SKIMMER ACTUATOR #6

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	15		

Protective Device Settings

CB: B-SKIMMER ACTUATOR #7

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	15		

CB: B-SKIMMER ACTUATOR #8

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	15		

CB: B-SKIMMER ACTUATOR #9

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	15		

CB: B-SKIMMINGS VALVES ACT#1

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	20	Cont. Amp:	20.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	20		

CB: B-SKIMMINGS VALVES ACT#2

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	15		

Protective Device Settings

CB: B-SKIMMINGS VALVES ACT#3

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	15		

CB: B-SNAIL BOOSTER PUMP

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	20	Cont. Amp:	20.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	20		

CB: B-SP2

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HMCP-F	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	50	Cont. Amp:	50.000	Base kV:	0.000	(Calc.)

Motor Circuit Protector Trip Device

MFR:	Cutler-Hammer
Model:	HMCP
ID:	050K2
Pick up:	A

CB: B-SR-DAF

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	SPB-50 (400)	Rating:	50 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	400	Cont. Amp:	400.000	Base kV:	0.000	(Calc.)

LV Solid State Trip Device

MFR:	Cutler-Hammer
Model:	RMS 500 Series SPB
Sensor:	400
Rating Plug:	300.00

		Phase Setting		Ground Setting		
Long-Time	LT Pickup	1		Ground Pickup	E	
	LT Band	2		Ground Band	.1	I^xt=IN
Short-Time	ST Pickup	S2(8)				
	ST Band	.3	I^xt=IN			

Protective Device Settings

CB: B-STANDBY GEN PNL

MFR:	Siemens	Tag #:		3-Phase kA:	2.01	Asym. (Calc.)
Model:	BL	Rating:	10 kA, 0.24 kV	LG kA:	2.04	Asym. (Calc.)
Size:	70	Cont. Amp:	70.000	Base kV:	0.208	(Calc.)

Thermal Magnetic Trip Device

MFR:	Siemens	Thermal Trip:	Fixed
Model:	BL (2,3P)	Magnetic Trip:	FIXED
ID:	70		

CB: B-SUMP PUMP

MFR:	Westinghouse	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	BA	Rating:	10 kA, 0.24 kV	LG kA:	0.00	Asym. (Calc.)
Size:	45	Cont. Amp:	45.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	Quicklag (3P)	Magnetic Trip:	FIXED
ID:	45		

CB: B-SUPPLY FAN 1

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	15		

CB: B-SWBD-NB BUS A MAIN

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	SPB-65 (1600)	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	1600	Cont. Amp:	1600.000	Base kV:	0.000	(Calc.)

LV Solid State Trip Device

MFR:	Westinghouse
Model:	RMS 500 Series SPB (LS)
Sensor:	1600
Rating Plug:	1600.00

	Phase Setting				Ground Setting		
Long-Time	LT Pickup	1			Ground Pickup	E	
	LT Band	16			Ground Band	.5	I^xt=IN
Short-Time	ST Pickup	4					
	ST Band	.5	I^xt=IN				

Protective Device Settings

CB: B-SWBD-NB BUS B MAIN

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	SPB-65 (1600)	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	1600	Cont. Amp:	1600.000	Base kV:	0.000	(Calc.)

LV Solid State Trip Device

MFR: Westinghouse
Model: RMS 500 Series SPB (LS)
Sensor: 1600
Rating Plug: 1600.00

	Phase Setting			Ground Setting		
Long-Time	LT Pickup	1		Ground Pickup	E	
	LT Band	16		Ground Band	.5	I^xt=IN
Short-Time	ST Pickup	4				
	ST Band	.5	I^xt=IN			

CB: B-SWBD-NB TIE

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	SPB-65 (1600)	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	1600	Cont. Amp:	1600.000	Base kV:	0.000	(Calc.)

LV Solid State Trip Device

MFR: Cutler-Hammer
Model: RMS 500 Series SPB (LS)
Sensor: 1600
Rating Plug: 1600.00

	Phase Setting			Ground Setting		
Long-Time	LT Pickup	.9		Ground Pickup	E	
	LT Band	10		Ground Band	.5	I^xt=IN
Short-Time	ST Pickup	3				
	ST Band	.5	I^xt=IN			

CB: B-TIE ACB MCC-NG

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HJD	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	250	Cont. Amp:	250.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HJD	Magnetic Trip:	10
ID:	250		

Protective Device Settings

CB: B-TSDF XFMR

MFR:	Cutler-Hammer*	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	FD	Rating:	25 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	30	Cont. Amp:	30.000	Base kV:	0.000	(Calc.)

* The retrieved library data is modified by user.

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	FD (2,3,4P)	Magnetic Trip:	FIXED
ID:	30		

CB: B-WELDER RECPT NEW ROLL U

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HFB	Rating:	25 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	50	Cont. Amp:	50.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFB (2,3P)	Magnetic Trip:	FIXED
ID:	50		

CB: B-XFMR T-C4

MFR:	Siemens*	Tag #:		3-Phase kA:	17.39	Asym. (Calc.)
Model:	HED4	Rating:	18 kA, 0.48 kV	LG kA:	11.53	Asym. (Calc.)
Size:	25	Cont. Amp:	25.000	Base kV:	0.480	(Calc.)

* The retrieved library data is modified by user.

Thermal Magnetic Trip Device

MFR:	Siemens	Thermal Trip:	Fixed
Model:	HED4	Magnetic Trip:	FIXED
ID:	25 (0.48kV)		

CB: B-XFMR T-LC2

MFR:	Siemens*	Tag #:		3-Phase kA:	17.39	Asym. (Calc.)
Model:	HED4	Rating:	18 kA, 0.48 kV	LG kA:	11.53	Asym. (Calc.)
Size:	50	Cont. Amp:	50.000	Base kV:	0.480	(Calc.)

* The retrieved library data is modified by user.

Thermal Magnetic Trip Device

MFR:	Siemens	Thermal Trip:	Fixed
Model:	HED4	Magnetic Trip:	FIXED
ID:	45 (0.48kV)		

CB: B-XFMR-DPL4-PRI

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHD	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	60	Cont. Amp:	60.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHD (2,3,4P)	Magnetic Trip:	FIXED
ID:	60		

CB: B-XFMR-LPG-PRI

MFR:	Westinghouse	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHB	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	30	Cont. Amp:	30.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHB (2,3P)	Magnetic Trip:	FIXED
ID:	30		

CB: B-XFMR-LPJ-PRI

MFR:	Westinghouse	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	EHB	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	30	Cont. Amp:	30.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	EHB (2,3P)	Magnetic Trip:	FIXED
ID:	30		

CB: B-XFMR-T1-LPM-PRI

MFR:	General Electric	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	TQD	Rating:	10 kA, 0.24 kV	LG kA:	0.00	Asym. (Calc.)
Size:	150	Cont. Amp:	150.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	General Electric	Thermal Trip:	Fixed
Model:	TQD	Magnetic Trip:	FIXED
ID:	150		

CB: B-XFMR-T-DPC1-PRI

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HFD	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	30	Cont. Amp:	30.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFD (2,3,4P)	Magnetic Trip:	FIXED
ID:	30		

CB: B-XFMR-T-DPC3-PRI

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HFD	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	30	Cont. Amp:	30.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFD (2,3,4P)	Magnetic Trip:	FIXED
ID:	30		

Protective Device Settings

CB: B-XFMR-T-DPC6-PRI

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HFD	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	30	Cont. Amp:	30.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFD (2,3,4P)	Magnetic Trip:	FIXED
ID:	30		

CB: B-XFMR-T-DPL2-PRI

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HFD	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	50	Cont. Amp:	50.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFD (2,3,4P)	Magnetic Trip:	FIXED
ID:	50		

CB: B-XFMR-T-DPL4-PRI

MFR:	Westinghouse	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	BA	Rating:	10 kA, 0.24 kV	LG kA:	0.00	Asym. (Calc.)
Size:	15	Cont. Amp:	15.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	Quicklag (3P)	Magnetic Trip:	FIXED
ID:	15		

CB: B-XFMR-T-DPL5-PRI

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HFD	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	50	Cont. Amp:	50.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFD (2,3,4P)	Magnetic Trip:	FIXED
ID:	50		

CB: B-XFMR-T-DPL7-PRI

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HFD	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	100	Cont. Amp:	100.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFD (2,3,4P)	Magnetic Trip:	FIXED
ID:	100		

Protective Device Settings

CB: B-XFMR-T-DPL-PRI

MFR:	Westinghouse	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	BA	Rating:	10 kA, 0.24 kV	LG kA:	0.00	Asym. (Calc.)
Size:	30	Cont. Amp:	30.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	Quicklag (3P)	Magnetic Trip:	FIXED
ID:	30		

CB: B-XFMR-T-DPM1-PRI

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HFD	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	70	Cont. Amp:	70.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFD (2,3,4P)	Magnetic Trip:	FIXED
ID:	70		

CB: B-XFMR-T-DPM2-PRI

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HFD	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	70	Cont. Amp:	70.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFD (2,3,4P)	Magnetic Trip:	FIXED
ID:	70		

CB: B-XFMR-T-DPP-PRI

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	GHB	Rating:	14 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	30	Cont. Amp:	30.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	GHB (2,3P)	Magnetic Trip:	FIXED
ID:	30		

CB: B-XFMR-T-GD-PRI

MFR:	Allen-Bradley	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	140U-I6C3	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	30	Cont. Amp:	30.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Allen Bradley	Thermal Trip:	Fixed
Model:	140U-I6C3	Magnetic Trip:	FIXED
ID:	30		

CB: B-XFRM-FEB-PRI

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HFD	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	50	Cont. Amp:	50.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFD (2,3,4P)	Magnetic Trip:	FIXED
ID:	50		

CB: B-XFRM-LP-VFD-PRI

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HFD	Rating:	100 kA, 0.24 kV	LG kA:	0.00	Asym. (Calc.)
Size:	50	Cont. Amp:	50.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFD (2,3,4P)	Magnetic Trip:	FIXED
ID:	50		

CB: B-XFRM-T-DPC7-PRI

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HFD	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	30	Cont. Amp:	30.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFD (2,3,4P)	Magnetic Trip:	FIXED
ID:	30		

CB: B-XFRM-T-DPL1-PRI

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HFD	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	60	Cont. Amp:	60.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFD (2,3,4P)	Magnetic Trip:	FIXED
ID:	60		

CB: B-XFRM-T-DPP2-PRI

MFR:	Cutler-Hammer	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HFD	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	30	Cont. Amp:	30.000	Base kV:	0.000	(Calc.)

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFD (2,3,4P)	Magnetic Trip:	FIXED
ID:	30		

Protective Device Settings

CB: B-XFRM-TRAN-LPA-PRI

MFR:	Cutler-Hammer*	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HFD	Rating:	25 kA, 0.24 kV	LG kA:	0.00	Asym. (Calc.)
Size:	70	Cont. Amp:	70.000	Base kV:	0.000	(Calc.)

* The retrieved library data is modified by user.

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFD (2,3,4P)	Magnetic Trip:	FIXED
ID:	70		

CB: B-XFRM-TRAN-PPA-PRI

MFR:	Cutler-Hammer*	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HFD	Rating:	25 kA, 0.24 kV	LG kA:	0.00	Asym. (Calc.)
Size:	70	Cont. Amp:	70.000	Base kV:	0.000	(Calc.)

* The retrieved library data is modified by user.

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFD (2,3,4P)	Magnetic Trip:	FIXED
ID:	70		

CB: B-XFRM-TRAN-PPB-PRI

MFR:	Cutler-Hammer*	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	HFD	Rating:	25 kA, 0.24 kV	LG kA:	0.00	Asym. (Calc.)
Size:	70	Cont. Amp:	70.000	Base kV:	0.000	(Calc.)

* The retrieved library data is modified by user.

Thermal Magnetic Trip Device

MFR:	Cutler-Hammer	Thermal Trip:	Fixed
Model:	HFD (2,3,4P)	Magnetic Trip:	FIXED
ID:	70		

APPENDIX F – EQUIPMENT DATA

Transformer Schedule

2-Winding Transformer

Transformer ID	Status	Rating						% Tap Setting	
		kVA	Prim. kV	Sec. kV	% Z	X/R	% Tol.	Pri.	Sec.
TRANSF A	Energized	2500	16.000	0.480	4.9	10.67	0.0	0.000	0.000
TRANSF B	Energized	2500	16.000	0.480	5.1	10.67	0.0	0.000	0.000
TRANSF TA	Energized	2000	0.480	2.400	5.8	7.10	0.0	0.000	0.000
TRANSF TB	Energized	2000	0.480	2.400	5.8	7.10	0.0	0.000	0.000
TRANSF TC	Energized	1000	2.400	0.480	5.6	5.79	0.0	0.000	0.000
TRANSF TD	Energized	1000	2.400	0.480	5.6	5.79	0.0	0.000	0.000
T-TSDF XFMR	De-energized	15.0	0.480	0.240	0.0	0.00	0.0	0.000	0.000
T-XFMR-T2	De-energized	7.5	0.480	0.120	2.3	1.13	0.0	0.000	0.000
XFMR LPF	De-energized	30.0	0.480	0.208	2.6	1.69	0.0	0.000	0.000
XFMR T-C2	Energized	25.0	0.480	0.240	5.2	1.13	0.0	0.000	0.000
XFMR T-C4	Energized	15.0	0.480	0.208	4.4	1.13	0.0	0.000	0.000
XFMR T-LC1	Energized	45.0	0.480	0.208	5.9	1.69	0.0	0.000	0.000
XFMR T-LC2	Energized	30.0	0.480	0.208	4.4	1.69	0.0	0.000	0.000
XFMR-DPL4	Energized	45.0	0.480	0.208	2.6	1.69	0.0	0.000	0.000
XFMR-ELP5	Energized	15.0	0.480	0.208	2.3	1.13	0.0	0.000	0.000
XFMR-EPH1	Energized	15.0	0.480	0.208	2.3	1.13	0.0	0.000	0.000
XFMR-LP4	Energized	9.0	0.480	0.208	2.3	1.13	0.0	0.000	0.000
XFMR-LP9	Energized	15.0	0.480	0.208	2.3	1.13	0.0	0.000	0.000
XFMR-LPA	Energized	45.0	0.480	0.208	2.6	1.69	0.0	0.000	0.000
XFMR-LPD	Energized	30.0	0.480	0.208	2.6	1.92	0.0	0.000	0.000
XFMR-LPG	Energized	15.0	0.408	0.208	2.3	1.13	0.0	0.000	0.000
XFMR-LPJ	Energized	30.0	0.480	0.208	2.6	1.69	0.0	0.000	0.000
XFMR-STORAGE-BLDG	De-energized	15.0	0.480	0.208	2.3	1.13	0.0	0.000	0.000
XFMR-T1-ELP11	Energized	15.0	0.480	0.208	2.3	1.13	0.0	0.000	0.000
XFMR-T1-LPK	Energized	30.0	0.480	0.208	2.6	1.69	0.0	0.000	0.000
XFMR-T1-LPL	Energized	15.0	0.480	0.208	2.3	1.13	0.0	0.000	0.000
XFMR-T1-LPM	Energized	45.0	0.480	0.208	2.6	1.69	0.0	0.000	0.000
XFMR-T2-ELP3	Energized	9.0	0.480	0.208	2.3	1.13	0.0	0.000	0.000
XFMR-T2-ELP7	Energized	15.0	0.480	0.208	2.3	1.13	0.0	0.000	0.000
XFMR-T2-LPB	Energized	30.0	0.480	0.208	2.6	1.69	0.0	0.000	0.000
XFMR-T2-LPC	Energized	75.0	0.480	0.208	2.6	1.92	0.0	0.000	0.000
XFMR-T2-LPE	Energized	45.0	0.480	0.208	2.6	1.69	0.0	0.000	0.000
XFMR-T3-ELP10	Energized	15.0	0.480	0.208	2.3	1.13	0.0	0.000	0.000
XFMR-T3-ELP8	Energized	30.0	0.480	0.208	2.3	1.13	0.0	0.000	0.000
XFMR-T3-LPN	Energized	15.0	0.480	0.208	2.3	1.13	0.0	0.000	0.000
XFMR-T4	De-energized	7.5	0.480	0.120	7.8	2.47	0.0	0.000	0.000
XFMR-T5-ELP1	Energized	30.0	0.480	0.208	2.6	1.69	0.0	0.000	0.000
XFMR-T-DPC1	Energized	15.0	0.480	0.208	2.3	1.13	0.0	0.000	0.000
XFMR-T-DPC3	Energized	15.0	0.480	0.208	2.3	1.13	0.0	0.000	0.000
XFMR-T-DPC6	Energized	15.0	0.480	0.208	2.3	1.13	0.0	0.000	0.000
XFMR-T-DPL	De-energized	15.0	0.480	0.208	2.3	1.13	0.0	0.000	0.000

Transformer Schedule

2-Winding Transformer

		Rating						% Tap Setting	
Transformer ID	Status	kVA	Prim. kV	Sec. kV	% Z	X/R	% Tol.	Pri.	Sec.
XFMR-T-DPL2	Energized	30.0	0.480	0.208	2.6	1.69	0.0	0.000	0.000
XFMR-T-DPL4	De-energized	9.0	0.480	0.208	2.3	1.13	0.0	0.000	0.000
XFMR-T-DPL5	Energized	30.0	0.480	0.208	7.8	2.47	0.0	0.000	0.000
XFMR-T-DPL7	Energized	75.0	0.480	0.208	2.6	1.92	0.0	0.000	0.000
XFMR-T-DPM1	Energized	25.0	0.480	0.240	2.3	1.13	0.0	0.000	0.000
XFMR-T-DPM2	Energized	25.0	0.480	0.240	2.3	1.13	0.0	0.000	0.000
XFMR-T-DPP	De-energized	15.0	0.480	0.208	2.3	1.13	0.0	0.000	0.000
XFMR-T-EPH2	Energized	30.0	0.480	0.208	2.6	1.69	0.0	0.000	0.000
XFMR-T-GD	Energized	15.0	0.480	0.208	2.3	1.13	0.0	0.000	0.000
XFRM-FEB	Energized	30.0	0.480	0.208	2.6	1.69	0.0	0.000	0.000
XFRM-LP-VFD	Energized	30.0	0.480	0.208	2.6	1.69	0.0	0.000	0.000
XFRM-T1-LP12	Energized	15.0	0.480	0.208	2.3	1.13	0.0	0.000	0.000
XFRM-T1-LP2	Energized	30.0	0.480	0.208	2.6	1.69	0.0	0.000	0.000
XFRM-T-DPC7	Energized	15.0	0.480	0.208	2.3	1.13	0.0	0.000	0.000
XFRM-T-DPL1	Energized	30.0	0.480	0.208	2.6	1.69	0.0	0.000	0.000
XFRM-T-DPP2	Energized	15.0	0.480	0.208	2.3	1.13	0.0	0.000	0.000
XFRM-TRAN-LPA	Energized	45.0	0.480	0.208	2.6	1.69	0.0	0.000	0.000
XFRM-TRAN-PPA	Energized	45.0	0.480	0.240	2.6	1.69	0.0	0.000	0.000
XFRM-TRAN-PPB	Energized	45.0	0.480	0.240	2.3	1.13	0.0	0.000	0.000

Cable Data Schedule

Cable ID	Library	Status	Size	Length	#/ph	T (C)	R	X	Y	Impedance Unit
B-XFMR-T1-LPL-PRI	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C TIE ACB MCC-NG	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4/0	5.000 ft	1	75	0.06300	0.05100	0	Ohms per 1,000 ft
C1-F27505.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	30.000 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C1-F27506.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	30.000 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C1-MCC-DP4B	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	500	5.000 ft	1	75	0.02900	0.04800	0	Ohms per 1,000 ft
C1-MCC-GF	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	30.000 ft	1	75	0.78000	0.06500	0	Ohms per 1,000 ft
C2-B52180.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	5.000 ft	1	75	0.31000	0.06000	0	Ohms per 1,000 ft
C2-B52190.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	5.000 ft	1	75	0.31000	0.06000	0	Ohms per 1,000 ft
C2-B52210.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	5.000 ft	1	75	0.78000	0.06500	0	Ohms per 1,000 ft
C2-B52220.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	5.000 ft	1	75	0.78000	0.06500	0	Ohms per 1,000 ft
C2-BSN51240.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	5.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C2-BSN51250.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	5.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C2-BSN51260.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	5.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C2-BSN51270.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	5.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C2-COM53030.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	5.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C2-COM53040.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	5.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C2-CON51300.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	5.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C2-CON51320.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	5.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C2-CON53020.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	5.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft

Cable Data Schedule

Cable ID	Library	Status	Size	Length	#/ph	T (C)	R	X	Y	Impedance Unit
C2-CON53030.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	5.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C2-F52410.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	12	15.000 ft	1	75	2.00000	0.06800	0	Ohms per 1,000 ft
C2-F52420.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	12	15.000 ft	1	75	2.00000	0.06800	0	Ohms per 1,000 ft
C2-F54330.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	5.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C2-HVAC56100.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	5.000 ft	1	75	0.78000	0.06500	0	Ohms per 1,000 ft
C2-HVAC56110.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	5.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C2-MCC-GH	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4/0	1.000 ft	2	75	0.06300	0.05100	0	Ohms per 1,000 ft
C2-P52100.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	2	5.000 ft	1	75	0.20000	0.05700	0	Ohms per 1,000 ft
C2-P52110.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	5.000 ft	1	75	0.31000	0.06000	0	Ohms per 1,000 ft
C2-P52120.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	2	5.000 ft	1	75	0.20000	0.05700	0	Ohms per 1,000 ft
C2-P52130.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	5.000 ft	1	75	0.31000	0.06000	0	Ohms per 1,000 ft
C2-P52140.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	2	5.000 ft	1	75	0.20000	0.05700	0	Ohms per 1,000 ft
C2-P52150.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	5.000 ft	1	75	0.31000	0.06000	0	Ohms per 1,000 ft
C2-P52160.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	5.000 ft	1	75	0.31000	0.06000	0	Ohms per 1,000 ft
C2-P52170.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	5.000 ft	1	75	0.31000	0.06000	0	Ohms per 1,000 ft
C2-P52220.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	5.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C2-P52230.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	5.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C2-P52240.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	5.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C2-P52250.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	5.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft

Cable Data Schedule

Cable ID	Library	Status	Size	Length	#/ph	T (C)	R	X	Y	Impedance Unit
C2-P54080.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	5.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C2-P54090.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	5.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C2-SCR BLDG N OH DOOR	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	5.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C2-SCR BLDG S OH DOOR	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	5.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C2-SEP53000.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	5.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C2-SEP53010.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	5.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C2-SEP53020.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	5.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-400KW GENERATOR	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	De-energized	350	30.000 ft	2	75	0.03900	0.05000	0	Ohms per 1,000 ft
C-4543.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	30.000 ft	1	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-4911.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	500	18.000 ft	1	75	0.02900	0.04800	0	Ohms per 1,000 ft
C-50A RECEPT.	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-AC-1	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-AHU1503.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	35.000 ft	1	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-AHU1505.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	12	40.000 ft	1	75	2.00000	0.06800	0	Ohms per 1,000 ft
C-AHU6591.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	12	35.000 ft	1	75	2.00000	0.06800	0	Ohms per 1,000 ft
C-AHU6592.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	35.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-ATS-8	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	350	870.00 ft	2	75	0.03900	0.05000	0	Ohms per 1,000 ft
C-ATS-C BUS A	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	6	3.000 ft	1	75	0.49000	0.06400	0	Ohms per 1,000 ft
C-ATS-C BUS B	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	6	10.000 ft	1	75	0.49000	0.06400	0	Ohms per 1,000 ft

Cable Data Schedule

Cable ID	Library	Status	Size	Length	#/ph	T (C)	R	X	Y	Impedance Unit
C-ATS-L BUS A	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	3.000 ft	1	75	0.31000	0.06000	0	Ohms per 1,000 ft
C-ATS-L BUS B	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	10.000 ft	1	75	0.31000	0.06000	0	Ohms per 1,000 ft
C-AUH-7930.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	31.000 ft	1	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-B20100.00	KERITE, EPR, 5.0, 100, Copper, 1/C, Magnetic, 90, 1000 ft,60, English, 20 90 90 35 90	Energized	1/0	230.00 ft	2	90	0.13400	0.12300	0	Ohms per 1,000 ft
C-B20200.00	KERITE, EPR, 5.0, 100, Copper, 1/C, Magnetic, 90, 1000 ft,60, English, 20 90 90 35 90	Energized	1/0	240.00 ft	2	90	0.13400	0.12300	0	Ohms per 1,000 ft
C-B20300.00	KERITE, EPR, 5.0, 100, Copper, 1/C, Magnetic, 90, 1000 ft,60, English, 20 90 90 35 90	Energized	1/0	250.00 ft	2	90	0.13400	0.12300	0	Ohms per 1,000 ft
C-B20400.00	KERITE, EPR, 5.0, 100, Copper, 1/C, Magnetic, 90, 1000 ft,60, English, 20 90 90 35 90	Energized	1/0	265.00 ft	2	90	0.13400	0.12300	0	Ohms per 1,000 ft
C-B20500.00	KERITE, EPR, 5.0, 100, Copper, 1/C, Magnetic, 90, 1000 ft,60, English, 20 90 90 35 90	Energized	1/0	280.00 ft	2	90	0.13400	0.12300	0	Ohms per 1,000 ft
C-B27400.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	80.000 ft	3	75	0.31000	0.06000	0	Ohms per 1,000 ft
C-B36040.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	70.000 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-B36045.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	60.000 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-B4121.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	340.00 ft	1	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-B4122.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	6	205.00 ft	1	75	0.49000	0.06400	0	Ohms per 1,000 ft
C-B4123.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	150.00 ft	1	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-B4124.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	6	300.00 ft	1	75	0.49000	0.06400	0	Ohms per 1,000 ft
C-B4221.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	150.00 ft	1	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-B4222.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	70.000 ft	1	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-B4223.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	180.00 ft	1	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-B4224.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	275.00 ft	1	75	0.78000	0.06500	0	Ohms per 1,000 ft

Cable Data Schedule

Cable ID	Library	Status	Size	Length	#/ph	T (C)	R	X	Y	Impedance Unit
C-B52180.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	2	215.00 ft	1	75	0.20000	0.05700	0	Ohms per 1,000 ft
C-B52190.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	200.00 ft	1	75	0.31000	0.06000	0	Ohms per 1,000 ft
C-B52210.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	225.00 ft	1	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-B52220.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	240.00 ft	1	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-B6511.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	2	100.00 ft	1	75	0.20000	0.05700	0	Ohms per 1,000 ft
C-B6512.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	2/0	95.000 ft	1	75	0.10000	0.05400	0	Ohms per 1,000 ft
C-B6513.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	2/0	100.00 ft	1	75	0.10000	0.05400	0	Ohms per 1,000 ft
C-B6555.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	12	30.000 ft	1	75	2.00000	0.06800	0	Ohms per 1,000 ft
C-B6556.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-BATTERY CHARGER XFMR	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	12	30.000 ft	1	75	2.00000	0.06800	0	Ohms per 1,000 ft
C-BLOWER #1 BYPASSS VALVE	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-BLOWER #1 DISCH VALVE	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-BLOWER #1 GUIDE VALVE	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-BLOWER #2 BYPASS VALVE	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-BLOWER #2 DISCH VALVE	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-BLOWER #2 GUIDE VANES	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-BLOWER #3 BYPASS VALVE	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-BLOWER #3 DISCH VALVE	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-BLOWER #3 GUIDE VANES	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft

Cable Data Schedule

Cable ID	Library	Status	Size	Length	#/ph	T (C)	R	X	Y	Impedance Unit
C-BLOWER #4 BYPASS VALVE	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-BLOWER #4 DISCHA VALVE	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-BLOWER #4 GUIDE VALVE	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-BLOWER #5 BYPASS VALVE	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-BLOWER #5 DISCHAR VALVE	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-BLOWER #5 GUIDE VALVE	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-BLRW BLDG TROLLEY	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	6	240.00 ft	2	75	0.49000	0.06400	0	Ohms per 1,000 ft
C-BSN51240.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	300.00 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-BSN51250.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	300.00 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-BSN51260.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	300.00 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-BSN51270.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	300.00 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-COM53030.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	290.00 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-COM53040.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	265.00 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-COMPRESSOR	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	12	30.000 ft	1	75	2.00000	0.06800	0	Ohms per 1,000 ft
C-CON 330040.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	30.000 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-CON 33010.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	30.000 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-CON 33020.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	30.000 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-CON 33030.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	30.000 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-CON51300.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	290.00 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft

Cable Data Schedule

Cable ID	Library	Status	Size	Length	#/ph	T (C)	R	X	Y	Impedance Unit
C-CON51320.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	290.00 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-CON53020.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	310.00 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-CON53030.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	310.00 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-CP 7561	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	31.000 ft	1	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-CP3112.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	105.00 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-CP3212.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	120.00 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-CP3312.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	75.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-CP3412.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	90.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-CP7521.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	6	36.000 ft	1	75	0.49000	0.06400	0	Ohms per 1,000 ft
C-CP7522.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	6	36.000 ft	1	75	0.49000	0.06400	0	Ohms per 1,000 ft
C-CP7562.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	31.000 ft	1	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-CRANE (MME-1)	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	12	30.000 ft	1	75	2.00000	0.06800	0	Ohms per 1,000 ft
C-DPL7A	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	2	30.000 ft	3	75	0.20000	0.05700	0	Ohms per 1,000 ft
C-DPP8	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	250	30.000 ft	1	75	0.05400	0.05200	0	Ohms per 1,000 ft
C-EFF PUMP NO. 2 VFD	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	350	40.000 ft	3	75	0.03900	0.05000	0	Ohms per 1,000 ft
C-EFF PUMP NO. 4 VFD	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	350	40.000 ft	3	75	0.03900	0.05000	0	Ohms per 1,000 ft
C-EMD #4	KERITE, EPR, 5.0, 100, Copper, 1/C, Non-Mag., 90, 1000 ft,60, English, 20 90 90 40 90	Energized	2/0	30.000 ft	1	90	0.10800	0.09500	0	Ohms per 1,000 ft
C-EMD #5	KERITE, EPR, 5.0, 100, Copper, 1/C, Magnetic, 90, 1000 ft,60, English, 20 90 90 40 90	Energized	2/0	30.000 ft	1	90	0.10800	0.11900	0	Ohms per 1,000 ft
C-EMD GEN#4	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	30.000 ft	1	75	0.78000	0.06500	0	Ohms per 1,000 ft

Cable Data Schedule

Cable ID	Library	Status	Size	Length	#/ph	T (C)	R	X	Y	Impedance Unit
C-EMD GEN#5	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	30.000 ft	1	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-EXHAUST FAN #1	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	De-energized	12	30.000 ft	1	75	2.00000	0.06800	0	Ohms per 1,000 ft
C-F1003.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	12	30.000 ft	1	75	2.00000	0.06800	0	Ohms per 1,000 ft
C-F1004.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	12	30.000 ft	1	75	2.00000	0.06800	0	Ohms per 1,000 ft
C-F1009.10	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	12	20.000 ft	1	75	2.00000	0.06800	0	Ohms per 1,000 ft
C-F1010.10	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	12	17.000 ft	1	75	2.00000	0.06800	0	Ohms per 1,000 ft
C-F1011.10	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	12	20.000 ft	1	75	2.00000	0.06800	0	Ohms per 1,000 ft
C-F21159.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	25.000 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-F21160.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	30.000 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-F2211.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-F27505.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	595.00 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-F27506.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	600.00 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-F36030.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	90.000 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-F36035.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	90.000 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-F36037.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	85.000 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-F37010.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	90.000 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-F37013.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	100.00 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-F37015.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	85.000 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-F37017.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	80.000 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft

Cable Data Schedule

Cable ID	Library	Status	Size	Length	#/ph	T (C)	R	X	Y	Impedance Unit
C-F37020.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	65.000 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-F37023.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	80.000 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-F37030	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	100.00 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-F37033.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	100.00 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-F3705.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	12	30.000 ft	1	75	2.00000	0.06800	0	Ohms per 1,000 ft
C-F3706.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	12	30.000 ft	1	75	2.00000	0.06800	0	Ohms per 1,000 ft
C-F5111.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	12	30.000 ft	1	75	2.00000	0.06800	0	Ohms per 1,000 ft
C-F5112.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	12	30.000 ft	1	75	2.00000	0.06800	0	Ohms per 1,000 ft
C-F5113.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	12	30.000 ft	1	75	2.00000	0.06800	0	Ohms per 1,000 ft
C-F5114.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	12	30.000 ft	1	75	2.00000	0.06800	0	Ohms per 1,000 ft
C-F5121.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	12	30.000 ft	1	75	2.00000	0.06800	0	Ohms per 1,000 ft
C-F5131.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	12	30.000 ft	1	75	2.00000	0.06800	0	Ohms per 1,000 ft
C-F5141.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	12	30.000 ft	1	75	2.00000	0.06800	0	Ohms per 1,000 ft
C-F52410.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	12	200.00 ft	1	75	2.00000	0.06800	0	Ohms per 1,000 ft
C-F52420.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	12	255.00 ft	1	75	2.00000	0.06800	0	Ohms per 1,000 ft
C-F54330.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	90.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-F55010.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	1	15.000 ft	1	75	0.16000	0.05700	0	Ohms per 1,000 ft
C-F7911.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	31.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-F7912.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	31.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft

Cable Data Schedule

Cable ID	Library	Status	Size	Length	#/ph	T (C)	R	X	Y	Impedance Unit
C-F7912.1	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	31.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-F-7941.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	30.000 ft	1	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-F7942.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	30.000 ft	1	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-F79420.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	30.000 ft	1	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-F7943.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	30.000 ft	1	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-F7944.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	6	30.000 ft	1	75	0.49000	0.06400	0	Ohms per 1,000 ft
C-FC-1	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-GAS BOOSTER BLOWER VFD	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	6	30.000 ft	1	75	0.49000	0.06400	0	Ohms per 1,000 ft
C-GAS COMPRESSOR #6	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	2	100.00 ft	2	75	0.20000	0.05700	0	Ohms per 1,000 ft
C-GAS COMPRESSOR #7	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	2	100.00 ft	2	75	0.20000	0.05700	0	Ohms per 1,000 ft
C-GEN 175KW	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	De-energized	3/0	30.000 ft	2	75	0.07900	0.05200	0	Ohms per 1,000 ft
C-GEN G6	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	De-energized	600	285.00 ft	6	75	0.02500	0.04800	0	Ohms per 1,000 ft
C-GEN NO. 1	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	De-energized	500	100.00 ft	3	75	0.02900	0.04800	0	Ohms per 1,000 ft
C-GEN NO. 2	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	500	85.000 ft	3	75	0.02900	0.04800	0	Ohms per 1,000 ft
C-GEN NO. 3	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	500	70.000 ft	3	75	0.02900	0.04800	0	Ohms per 1,000 ft
C-Grinder	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	85.000 ft	3	75	0.31000	0.06000	0	Ohms per 1,000 ft
C-GRIT SCR TROLLEY	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	310.00 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-HAVC 10001	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-HOIST TROLLY	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	12	30.000 ft	1	75	2.00000	0.06800	0	Ohms per 1,000 ft

Cable Data Schedule

Cable ID	Library	Status	Size	Length	#/ph	T (C)	R	X	Y	Impedance Unit
C-HTR 7535.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	2	28.000 ft	1	75	0.20000	0.05700	0	Ohms per 1,000 ft
C-HTR 7536.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	2	28.000 ft	1	75	0.20000	0.05700	0	Ohms per 1,000 ft
C-HVAC56100.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	40.000 ft	1	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-HVAC56110.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	80.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-HVC-1750	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-HVC-1760	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-HW ELEVATOR	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	90.000 ft	1	75	0.31000	0.06000	0	Ohms per 1,000 ft
C-HW GATES	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	12	325.00 ft	1	75	2.00000	0.06800	0	Ohms per 1,000 ft
C-HWH	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	30.000 ft	3	75	0.31000	0.06000	0	Ohms per 1,000 ft
C-HYDRAULIC PRESS	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-INFL PUMP 1	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	500	120.00 ft	2	75	0.02900	0.04800	0	Ohms per 1,000 ft
C-INFL PUMP 1 VFD	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	500	25.000 ft	2	75	0.02900	0.04800	0	Ohms per 1,000 ft
C-INFL PUMP 2	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4/0	120.00 ft	2	75	0.06300	0.05100	0	Ohms per 1,000 ft
C-INFL PUMP 2 VFD	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	500	40.000 ft	2	75	0.02900	0.04800	0	Ohms per 1,000 ft
C-INFL PUMP 3	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4/0	120.00 ft	2	75	0.06300	0.05100	0	Ohms per 1,000 ft
C-INFL PUMP 3 VFD	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	500	25.000 ft	2	75	0.02900	0.04800	0	Ohms per 1,000 ft
C-INFL PUMP 4	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4/0	120.00 ft	2	75	0.06300	0.05100	0	Ohms per 1,000 ft
C-INFL PUMP 4 VFD	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	500	35.000 ft	2	75	0.02900	0.04800	0	Ohms per 1,000 ft
C-INFL PUMP 5	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4/0	120.00 ft	2	75	0.06300	0.05100	0	Ohms per 1,000 ft

Cable Data Schedule

Cable ID	Library	Status	Size	Length	#/ph	T (C)	R	X	Y	Impedance Unit
C-INFL PUMP 5 VFD	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	500	25.000 ft	2	75	0.02900	0.04800	0	Ohms per 1,000 ft
C-INFL PUMP 6	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	500	120.00 ft	2	75	0.02900	0.04800	0	Ohms per 1,000 ft
C-INFL PUMP 6 VFD	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	500	45.000 ft	2	75	0.02900	0.04800	0	Ohms per 1,000 ft
C-INTERSTAGE ACTUATOR VAL	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	12	125.00 ft	1	75	2.00000	0.06800	0	Ohms per 1,000 ft
C-LATCH	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	12	30.000 ft	1	75	2.00000	0.06800	0	Ohms per 1,000 ft
C-LCP-BFP1	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	30.000 ft	3	75	0.31000	0.06000	0	Ohms per 1,000 ft
C-LCP-BFP2	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	30.000 ft	3	75	0.31000	0.06000	0	Ohms per 1,000 ft
C-LCP-BFP3	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	30.000 ft	3	75	0.31000	0.06000	0	Ohms per 1,000 ft
C-LCP-BFP4	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	30.000 ft	3	75	0.31000	0.06000	0	Ohms per 1,000 ft
C-LCP-HWOCS	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	6	260.00 ft	2	75	0.49000	0.06400	0	Ohms per 1,000 ft
C-LCP-PD	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	De-energized	6	30.000 ft	1	75	0.49000	0.06400	0	Ohms per 1,000 ft
C-LTG PNL ELP6	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	30.000 ft	1	75	0.31000	0.06000	0	Ohms per 1,000 ft
C-M25011.10	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	180.00 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-M25031.10	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	220.00 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-M25051.10	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	260.00 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-M25071.10	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	300.00 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-M25091.10	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	345.00 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-M25111.10	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	385.00 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-M25131.10	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	430.00 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft

Cable Data Schedule

Cable ID	Library	Status	Size	Length	#/ph	T (C)	R	X	Y	Impedance Unit
C-M25151.10	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	470.00 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-M25171.10	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	515.00 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-MAINT	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	30.000 ft	1	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-MCC-DP1A	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	3/0	260.00 ft	1	75	0.07900	0.05200	0	Ohms per 1,000 ft
C-MCC-DP1B	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	500	265.00 ft	1	75	0.02900	0.04800	0	Ohms per 1,000 ft
C-MCC-DP2B	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	250	30.000 ft	1	75	0.05400	0.05200	0	Ohms per 1,000 ft
C-MCC-DP2C	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	500	140.00 ft	2	75	0.02900	0.04800	0	Ohms per 1,000 ft
C-MCC-DP2D	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	30.000 ft	1	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-MCC-DP3A	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	500	30.000 ft	1	75	0.02900	0.04800	0	Ohms per 1,000 ft
C-MCC-DP3B	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4/0	30.000 ft	2	75	0.06300	0.05100	0	Ohms per 1,000 ft
C-MCC-DP3C	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	3/0	30.000 ft	2	75	0.07900	0.05200	0	Ohms per 1,000 ft
C-MCC-DP3D	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4/0	30.000 ft	1	75	0.06300	0.05100	0	Ohms per 1,000 ft
C-MCC-DP4A	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	6	325.00 ft	1	75	0.49000	0.06400	0	Ohms per 1,000 ft
C-MCC-DP4B	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	600	5.000 ft	1	75	0.02500	0.04800	0	Ohms per 1,000 ft
C-MCC-EDP1A	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	1/0	260.00 ft	1	75	0.12000	0.05500	0	Ohms per 1,000 ft
C-MCC-EDP1B-1	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	2	30.000 ft	1	75	0.20000	0.05700	0	Ohms per 1,000 ft
C-MCC-EDP1C	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4/0	365.00 ft	1	75	0.06300	0.05100	0	Ohms per 1,000 ft
C-MCC-EDP1D	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	1/0	580.00 ft	1	75	0.12000	0.05500	0	Ohms per 1,000 ft
C-MCC-EDP1E	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	6	560.00 ft	1	75	0.49000	0.06400	0	Ohms per 1,000 ft

Cable Data Schedule

Cable ID	Library	Status	Size	Length	#/ph	T (C)	R	X	Y	Impedance Unit
C-MCC-EDP1PB	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	1/0	100.00 ft	1	75	0.12000	0.05500	0	Ohms per 1,000 ft
C-MCC-GA	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	500	240.00 ft	2	75	0.02900	0.04800	0	Ohms per 1,000 ft
C-MCC-GB	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	500	42.000 ft	1	75	0.02900	0.04800	0	Ohms per 1,000 ft
C-MCC-GC	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	250	36.000 ft	2	75	0.05400	0.05200	0	Ohms per 1,000 ft
C-MCC-GD	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	3/0	50.000 ft	1	75	0.07900	0.05200	0	Ohms per 1,000 ft
C-MCC-GD_EASTERN TRUNK	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	3/0	25.000 ft	1	75	0.07900	0.05200	0	Ohms per 1,000 ft
C-MCC-GE	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	350	65.000 ft	2	75	0.03900	0.05000	0	Ohms per 1,000 ft
C-MCC-GF	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4/0	980.00 ft	1	75	0.06300	0.05100	0	Ohms per 1,000 ft
C-MCC-GH	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4/0	980.00 ft	2	75	0.06300	0.05100	0	Ohms per 1,000 ft
C-MCC-HC	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	750	950.00 ft	2	75	0.02100	0.04800	0	Ohms per 1,000 ft
C-MCC-HCC	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	750	955.00 ft	2	75	0.02100	0.04800	0	Ohms per 1,000 ft
C-MCC-HW BUS A	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	400	30.000 ft	3	75	0.03500	0.04900	0	Ohms per 1,000 ft
C-MCC-HW BUS B	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	400	30.000 ft	3	75	0.03500	0.04900	0	Ohms per 1,000 ft
C-MCC-NA BUS A	KERITE, EPR, 5.0, 100, Copper, 1/C, Magnetic, 90, 1000 ft,60, English, 20 90 90 35 90	Energized	350	850.00 ft	2	90	0.04600	0.10400	0	Ohms per 1,000 ft
C-MCC-NA BUS B	KERITE, EPR, 5.0, 100, Copper, 1/C, Magnetic, 90, 1000 ft,60, English, 20 90 90 35 90	Energized	350	850.00 ft	2	90	0.04600	0.10400	0	Ohms per 1,000 ft
C-MCC-NC	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	500	20.000 ft	4	75	0.02900	0.04800	0	Ohms per 1,000 ft
C-MCC-ND	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	400	15.000 ft	3	75	0.03500	0.04900	0	Ohms per 1,000 ft
C-MCC-NE	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	350	25.000 ft	1	75	0.03900	0.05000	0	Ohms per 1,000 ft
C-MCC-NF	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	350	25.000 ft	1	75	0.03900	0.05000	0	Ohms per 1,000 ft

Cable Data Schedule

Cable ID	Library	Status	Size	Length	#/ph	T (C)	R	X	Y	Impedance Unit
C-MCC-NG BUS A	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	350	275.00 ft	1	75	0.03900	0.05000	0	Ohms per 1,000 ft
C-MCC-NG BUS B	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	350	275.00 ft	1	75	0.03900	0.05000	0	Ohms per 1,000 ft
C-MCC-SH BUS A	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	350	625.00 ft	2	75	0.03900	0.05000	0	Ohms per 1,000 ft
C-MCC-SH BUS B	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	350	600.00 ft	2	75	0.03900	0.05000	0	Ohms per 1,000 ft
C-MCC-SH TIE BKR1	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	350	5.000 ft	1	75	0.03900	0.05000	0	Ohms per 1,000 ft
C-MME-1	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	12	30.000 ft	1	75	2.00000	0.06800	0	Ohms per 1,000 ft
C-MME-13	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	12	30.000 ft	1	75	2.00000	0.06800	0	Ohms per 1,000 ft
C-MME-15	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	12	30.000 ft	1	75	2.00000	0.06800	0	Ohms per 1,000 ft
C-MME-4	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	12	30.000 ft	1	75	2.00000	0.06800	0	Ohms per 1,000 ft
C-MME-6	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	12	30.000 ft	1	75	2.00000	0.06800	0	Ohms per 1,000 ft
C-MME6211.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	12	30.000 ft	1	75	2.00000	0.06800	0	Ohms per 1,000 ft
C-MME-7	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	1	30.000 ft	1	75	0.16000	0.05700	0	Ohms per 1,000 ft
C-MME-9	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	12	30.000 ft	1	75	2.00000	0.06800	0	Ohms per 1,000 ft
C-MONORAIL HOSIT	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	De-energized	12	30.000 ft	1	75	2.00000	0.06800	0	Ohms per 1,000 ft
C-MPV 30021.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	30.000 ft	3	75	0.31000	0.06000	0	Ohms per 1,000 ft
C-NEW INTERSTAGE BLDG	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	6	30.000 ft	1	75	0.49000	0.06400	0	Ohms per 1,000 ft
C-ORS Sprayer	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	30.000 ft	3	75	0.31000	0.06000	0	Ohms per 1,000 ft
C-P0103.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-P20100.20	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	40.000 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft

Cable Data Schedule

Cable ID	Library	Status	Size	Length	#/ph	T (C)	R	X	Y	Impedance Unit
C-P20200.20	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	30.000 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-P20300.20	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	25.000 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-P20400.20	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	35.000 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-P20500.20	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	50.000 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-P2201.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-P26010.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	75.000 ft	3	75	0.31000	0.06000	0	Ohms per 1,000 ft
C-P26020.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	70.000 ft	3	75	0.31000	0.06000	0	Ohms per 1,000 ft
C-P26025.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	65.000 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-P26057.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	30.000 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-P26058.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	30.000 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-P26059.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	48.000 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-P26060.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	45.000 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-P27010.00 (Bypass)	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	2/0	400.00 ft	3	75	0.10000	0.05400	0	Ohms per 1,000 ft
C-P27020.00 (Bypass)	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	2/0	410.00 ft	3	75	0.10000	0.05400	0	Ohms per 1,000 ft
C-P27030.00 (Bypass)	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	2/0	400.00 ft	3	75	0.10000	0.05400	0	Ohms per 1,000 ft
C-P27040.00 (Bypass)	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	2/0	410.00 ft	3	75	0.10000	0.05400	0	Ohms per 1,000 ft
C-P27110.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	2/0	400.00 ft	3	75	0.10000	0.05400	0	Ohms per 1,000 ft
C-P27120.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	405.00 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-P27130.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	410.00 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft

Cable Data Schedule

Cable ID	Library	Status	Size	Length	#/ph	T (C)	R	X	Y	Impedance Unit
C-P27230.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	30.000 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-P27310.00 (Bypass)	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	2/0	115.00 ft	3	75	0.10000	0.05400	0	Ohms per 1,000 ft
C-P27320.00 (Bypass)	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	2/0	125.00 ft	3	75	0.10000	0.05400	0	Ohms per 1,000 ft
C-P27330.00 (Bypass)	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	2/0	115.00 ft	3	75	0.10000	0.05400	0	Ohms per 1,000 ft
C-P27720.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	6	125.00 ft	3	75	0.49000	0.06400	0	Ohms per 1,000 ft
C-P28010.00 (Bypass)	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	2/0	150.00 ft	3	75	0.10000	0.05400	0	Ohms per 1,000 ft
C-P28020.00 (Bypass)	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	2/0	160.00 ft	3	75	0.10000	0.05400	0	Ohms per 1,000 ft
C-P28030.00 (Bypass)	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	2/0	150.00 ft	3	75	0.10000	0.05400	0	Ohms per 1,000 ft
C-P32011.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	75.000 ft	3	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-P32013.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	30.000 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-P32021.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	70.000 ft	3	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-P32023.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	30.000 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-P32031.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	65.000 ft	3	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-P32033.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	30.000 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-P32041.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	60.000 ft	3	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-P32043.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	30.000 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-P4011.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	350	120.00 ft	2	75	0.03900	0.05000	0	Ohms per 1,000 ft
C-P4012.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	300	120.00 ft	2	75	0.04500	0.05100	0	Ohms per 1,000 ft
C-P4013.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	350	105.00 ft	2	75	0.03900	0.05000	0	Ohms per 1,000 ft

Cable Data Schedule

Cable ID	Library	Status	Size	Length	#/ph	T (C)	R	X	Y	Impedance Unit
C-P4014.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	350	105.00 ft	2	75	0.03900	0.05000	0	Ohms per 1,000 ft
C-P4021.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	250	105.00 ft	2	75	0.05400	0.05200	0	Ohms per 1,000 ft
C-P4023.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	250	88.000 ft	2	75	0.05400	0.05200	0	Ohms per 1,000 ft
C-P4531.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	30.000 ft	1	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-P4598	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	30.000 ft	1	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-P5091.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	12	30.000 ft	1	75	2.00000	0.06800	0	Ohms per 1,000 ft
C-P5092.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	12	30.000 ft	1	75	2.00000	0.06800	0	Ohms per 1,000 ft
C-P52100.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	2	320.00 ft	1	75	0.20000	0.05700	0	Ohms per 1,000 ft
C-P52110.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	310.00 ft	1	75	0.31000	0.06000	0	Ohms per 1,000 ft
C-P52120.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	2	300.00 ft	1	75	0.20000	0.05700	0	Ohms per 1,000 ft
C-P52130.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	290.00 ft	1	75	0.31000	0.06000	0	Ohms per 1,000 ft
C-P52140.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	2	250.00 ft	1	75	0.20000	0.05700	0	Ohms per 1,000 ft
C-P52150.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	240.00 ft	1	75	0.31000	0.06000	0	Ohms per 1,000 ft
C-P52160.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	230.00 ft	1	75	0.31000	0.06000	0	Ohms per 1,000 ft
C-P52170.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	215.00 ft	1	75	0.31000	0.06000	0	Ohms per 1,000 ft
C-P52220.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	335.00 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-P52230.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	335.00 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-P52240.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	265.00 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-P52250.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	265.00 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft

Cable Data Schedule

Cable ID	Library	Status	Size	Length	#/ph	T (C)	R	X	Y	Impedance Unit
C-P54080.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	160.00 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-P54090.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	160.00 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-P55020.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	15.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-P55030.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	15.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-P6501.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	30.000 ft	1	75	0.31000	0.06000	0	Ohms per 1,000 ft
C-P6503.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	12	30.000 ft	1	75	2.00000	0.06800	0	Ohms per 1,000 ft
C-P6561.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	12	30.000 ft	1	75	2.00000	0.06800	0	Ohms per 1,000 ft
C-P6601.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	30.000 ft	1	75	0.31000	0.06000	0	Ohms per 1,000 ft
C-P6701.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	30.000 ft	1	75	0.31000	0.06000	0	Ohms per 1,000 ft
C-P6901.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	90.000 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-P6902.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	90.000 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-P6903.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	90.000 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-P7531.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	2	36.000 ft	1	75	0.20000	0.05700	0	Ohms per 1,000 ft
C-P7532.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	2	36.000 ft	1	75	0.20000	0.05700	0	Ohms per 1,000 ft
C-P7538.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	6	34.000 ft	1	75	0.49000	0.06400	0	Ohms per 1,000 ft
C-P7541.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	6	34.000 ft	1	75	0.49000	0.06400	0	Ohms per 1,000 ft
C-P7542.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	6	30.000 ft	1	75	0.49000	0.06400	0	Ohms per 1,000 ft
C-P7554.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	6	31.000 ft	1	75	0.49000	0.06400	0	Ohms per 1,000 ft
C-PANEL A	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	10.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft

Cable Data Schedule

Cable ID	Library	Status	Size	Length	#/ph	T (C)	R	X	Y	Impedance Unit
C-PANEL DPC5	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	5.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-PNL DP1	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	350	1020 ft	1	75	0.03900	0.05000	0	Ohms per 1,000 ft
C-PNL DP2	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	500	380.00 ft	2	75	0.02900	0.04800	0	Ohms per 1,000 ft
C-PNL DP3	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	350	235.00 ft	4	75	0.03900	0.05000	0	Ohms per 1,000 ft
C-PNL DP4	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	350	15.000 ft	2	75	0.03900	0.05000	0	Ohms per 1,000 ft
C-PNL DPC-2	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	1	8.000 ft	1	75	0.16000	0.05700	0	Ohms per 1,000 ft
C-PNL DPLC-1	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	2/0	6.000 ft	1	75	0.10000	0.05400	0	Ohms per 1,000 ft
C-PNL DPLC-2	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	3	1.000 ft	1	75	0.25000	0.05900	0	Ohms per 1,000 ft
C-PNL DPLC-3	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	6	10.000 ft	1	75	0.49000	0.06400	0	Ohms per 1,000 ft
C-PNL DPLC-4	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	6	10.000 ft	1	75	0.49000	0.06400	0	Ohms per 1,000 ft
C-PNL DPMB	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	500	30.000 ft	1	75	0.02900	0.04800	0	Ohms per 1,000 ft
C-PNL DPP1	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	2	55.000 ft	1	75	0.20000	0.05700	0	Ohms per 1,000 ft
C-PNL DPP1 BLOWER GALLERY	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	90.000 ft	3	75	0.31000	0.06000	0	Ohms per 1,000 ft
C-PNL DPP3_BLOWER GALLERY	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	90.000 ft	3	75	0.31000	0.06000	0	Ohms per 1,000 ft
C-PNL DPP4	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	2	30.000 ft	3	75	0.20000	0.05700	0	Ohms per 1,000 ft
C-PNL DPP5	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	2	365.00 ft	3	75	0.20000	0.05700	0	Ohms per 1,000 ft
C-PNL DPP6_BLOWER GALLERY	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	90.000 ft	3	75	0.31000	0.06000	0	Ohms per 1,000 ft
C-PNL DPP7 BLOWER GALLERY	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	50.000 ft	3	75	0.31000	0.06000	0	Ohms per 1,000 ft
C-PNL-DPL	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	De-energized	6	100.00 ft	1	75	0.49000	0.06400	0	Ohms per 1,000 ft

Cable Data Schedule

Cable ID	Library	Status	Size	Length	#/ph	T (C)	R	X	Y	Impedance Unit
C-Polymer	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	30.000 ft	3	75	0.31000	0.06000	0	Ohms per 1,000 ft
C-Polymer PNL	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	30.000 ft	3	75	0.31000	0.06000	0	Ohms per 1,000 ft
C-PP VFD PNL	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	30.000 ft	1	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-Praestemat	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	30.000 ft	3	75	0.31000	0.06000	0	Ohms per 1,000 ft
C-PURGING COMPROSSER	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	12	30.000 ft	1	75	2.00000	0.06800	0	Ohms per 1,000 ft
C-ROOF A/C BREAKER	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	31.000 ft	1	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-RSS 30010.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	125.00 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-RSS30020.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	130.00 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-SCR BLDG N OH DOOR	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	175.00 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-SCR BLDG S OH DOOR	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	160.00 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-SCRUBBER CHEM HANDLING	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	6	30.000 ft	1	75	0.49000	0.06400	0	Ohms per 1,000 ft
C-SEP53000.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	310.00 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-SEP53010.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	310.00 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-SEP53020.00	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	320.00 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-SKIMMER ACTUATOR #1	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-SKIMMER ACTUATOR #10	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-SKIMMER ACTUATOR #11	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-SKIMMER ACTUATOR #12	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-SKIMMER ACTUATOR #13	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft

Cable Data Schedule

Cable ID	Library	Status	Size	Length	#/ph	T (C)	R	X	Y	Impedance Unit
C-SKIMMER ACTUATOR #14	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-SKIMMER ACTUATOR #15	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-SKIMMER ACTUATOR #16	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-SKIMMER ACTUATOR #17	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-SKIMMER ACTUATOR #18	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-SKIMMER ACTUATOR #19	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-SKIMMER ACTUATOR #2	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-SKIMMER ACTUATOR #20	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-SKIMMER ACTUATOR #21	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-SKIMMER ACTUATOR #3	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-SKIMMER ACTUATOR #4	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-SKIMMER ACTUATOR #5	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-SKIMMER ACTUATOR #6	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-SKIMMER ACTUATOR #7	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-SKIMMER ACTUATOR #8	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-SKIMMER ACTUATOR #9	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-SKIMMINGS VALVES ACT#1	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	12	30.000 ft	1	75	2.00000	0.06800	0	Ohms per 1,000 ft
C-SKIMMINGS VALVES ACT#2	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-SKIMMINGS VALVES ACT#3	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft

Cable Data Schedule

Cable ID	Library	Status	Size	Length	#/ph	T (C)	R	X	Y	Impedance Unit
C-SNAIL BOOSTER PUMP	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	12	30.000 ft	1	75	2.00000	0.06800	0	Ohms per 1,000 ft
C-SP2	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	30.000 ft	3	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-SR-DAF	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	400	175.00 ft	1	75	0.03500	0.04900	0	Ohms per 1,000 ft
C-STANDBY GEN PNL	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	6	30.000 ft	1	75	0.49000	0.06400	0	Ohms per 1,000 ft
C-SUMP PUMP	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	30.000 ft	1	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-SUPPLY FAN 1	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	12	30.000 ft	1	75	2.00000	0.06800	0	Ohms per 1,000 ft
C-SWBD GDP	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	500	320.00 ft	12	75	0.02900	0.04800	0	Ohms per 1,000 ft
C-SWBD-NB BUS A	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	500	40.000 ft	4	75	0.02900	0.04800	0	Ohms per 1,000 ft
C-SWBD-NB BUS B	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	500	40.000 ft	4	75	0.02900	0.04800	0	Ohms per 1,000 ft
C-TRANSF TC	KERITE, EPR, 5.0, 100, Copper, 1/C, Magnetic, 90, 1000 ft,60, English, 20 90 90 35 90	Energized	3/0	20.000 ft	1	90	0.08700	0.11500	0	Ohms per 1,000 ft
C-TRANSF TD	KERITE, EPR, 5.0, 100, Copper, 1/C, Magnetic, 90, 1000 ft,60, English, 20 90 90 35 90	Energized	3/0	20.000 ft	1	90	0.08700	0.11500	0	Ohms per 1,000 ft
C-TSDF XFMR	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	30.000 ft	1	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-WELDER RECPT NEW ROLL U	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	6	30.000 ft	1	75	0.49000	0.06400	0	Ohms per 1,000 ft
C-XFMR T-C2	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	6	40.000 ft	1	75	0.49000	0.06400	0	Ohms per 1,000 ft
C-XFMR T-C4	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	15.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-XFMR T-LC1	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	55.000 ft	1	75	0.31000	0.06000	0	Ohms per 1,000 ft
C-XFMR T-LC2	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	6	160.00 ft	1	75	0.49000	0.06400	0	Ohms per 1,000 ft
C-XFMR-DPL4-PRI	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	30.000 ft	1	75	0.31000	0.06000	0	Ohms per 1,000 ft
C-XFMR-DPL4-SEC	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	1	30.000 ft	1	75	0.16000	0.05700	0	Ohms per 1,000 ft

Cable Data Schedule

Cable ID	Library	Status	Size	Length	#/ph	T (C)	R	X	Y	Impedance Unit
C-XFMR-ELP5-PRI	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-XFMR-ELP5-SEC	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	6	30.000 ft	1	75	0.49000	0.06400	0	Ohms per 1,000 ft
C-XFMR-EPH1-PRI	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-XFMR-LP4-PRI	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	12	30.000 ft	1	75	2.00000	0.06800	0	Ohms per 1,000 ft
C-XFMR-LP9-PRI	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-XFMR-LPA-PRI	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	73.000 ft	1	75	0.31000	0.06000	0	Ohms per 1,000 ft
C-XFMR-LPA-SEC	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	2/0	30.000 ft	1	75	0.10000	0.05400	0	Ohms per 1,000 ft
C-XFMR-LPD-PRI	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	6	16.000 ft	1	75	0.49000	0.06400	0	Ohms per 1,000 ft
C-XFMR-LPD-SEC	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	1	30.000 ft	1	75	0.16000	0.05700	0	Ohms per 1,000 ft
C-XFMR-LPF	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	30.000 ft	1	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-XFMR-LPG-PRI	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	12	30.000 ft	1	75	2.00000	0.06800	0	Ohms per 1,000 ft
C-XFMR-LPG-SEC	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	30.000 ft	1	75	0.31000	0.06000	0	Ohms per 1,000 ft
C-XFMR-LPJ-PRI	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	3	30.000 ft	1	75	0.25000	0.05900	0	Ohms per 1,000 ft
C-XFMR-STORAGE-BLDG-PRI	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	30.000 ft	1	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-XFMR-T1-LPK-PRI	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	30.000 ft	1	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-XFMR-T1-LPK-SEC	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	1	8.000 ft	1	75	0.16000	0.05700	0	Ohms per 1,000 ft
C-XFMR-T1-LPM-PRI	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	2/0	80.000 ft	1	75	0.10000	0.05400	0	Ohms per 1,000 ft
C-XFMR-T2	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	30.000 ft	1	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-XFMR-T2-ELP3-SEC	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	1	30.000 ft	1	75	0.16000	0.05700	0	Ohms per 1,000 ft

Cable Data Schedule

Cable ID	Library	Status	Size	Length	#/ph	T (C)	R	X	Y	Impedance Unit
C-XFMR-T2-ELP7-PRI	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-XFMR-T2-LPB-PRI	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	6	76.000 ft	1	75	0.49000	0.06400	0	Ohms per 1,000 ft
C-XFMR-T2-LPB-SEC	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	1	30.000 ft	1	75	0.16000	0.05700	0	Ohms per 1,000 ft
C-XFMR-T2-LPC-PRI	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	1	14.000 ft	1	75	0.16000	0.05700	0	Ohms per 1,000 ft
C-XFMR-T2-LPC-SEC	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	350	30.000 ft	1	75	0.03900	0.05000	0	Ohms per 1,000 ft
C-XFMR-T2-LPE-PRI	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	30.000 ft	1	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-XFMR-T2-LPE-SEC	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	2	30.000 ft	1	75	0.20000	0.05700	0	Ohms per 1,000 ft
C-XFMR-T3-ELP8-PRI	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	30.000 ft	1	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-XFMR-T3-ELP8-SEC	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	1	30.000 ft	1	75	0.16000	0.05700	0	Ohms per 1,000 ft
C-XFMR-T3-LPN-PRI	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	30.000 ft	1	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-XFMR-T3-LPN-SEC	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	6	15.000 ft	1	75	0.49000	0.06400	0	Ohms per 1,000 ft
C-XFMR-T4-PRI	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	12	30.000 ft	1	75	2.00000	0.06800	0	Ohms per 1,000 ft
C-XFMR-T5-ELP1-PRI	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	6	80.000 ft	1	75	0.49000	0.06400	0	Ohms per 1,000 ft
C-XFMR-T5-ELP1-SEC	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	1	30.000 ft	1	75	0.16000	0.05700	0	Ohms per 1,000 ft
C-XFMR-T-DPC1-PRI	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	95.000 ft	3	75	0.31000	0.06000	0	Ohms per 1,000 ft
C-XFMR-T-DPC1-SEC	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	6	30.000 ft	3	75	0.49000	0.06400	0	Ohms per 1,000 ft
C-XFMR-T-DPC3-PRI	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	53.000 ft	3	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-XFMR-T-DPC3-SEC	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	6	30.000 ft	3	75	0.49000	0.06400	0	Ohms per 1,000 ft
C-XFMR-T-DPC6-PRI	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft

Cable Data Schedule

Cable ID	Library	Status	Size	Length	#/ph	T (C)	R	X	Y	Impedance Unit
C-XFMR-T-DPC6-SEC	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	6	30.000 ft	1	75	0.49000	0.06400	0	Ohms per 1,000 ft
C-XFMR-T-DPL2-PRI	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	2	95.000 ft	3	75	0.20000	0.05700	0	Ohms per 1,000 ft
C-XFMR-T-DPL2-SEC	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	2	30.000 ft	3	75	0.20000	0.05700	0	Ohms per 1,000 ft
C-XFMR-T-DPL4-PRI	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	30.000 ft	1	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-XFMR-T-DPL5-PRI	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	6	30.000 ft	1	75	0.49000	0.06400	0	Ohms per 1,000 ft
C-XFMR-T-DPL5-SEC	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	1	30.000 ft	1	75	0.16000	0.05700	0	Ohms per 1,000 ft
C-XFMR-T-DPL7-PRI	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	95.000 ft	3	75	0.31000	0.06000	0	Ohms per 1,000 ft
C-XFMR-T-DPL7-SEC	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4/0	30.000 ft	3	75	0.06300	0.05100	0	Ohms per 1,000 ft
C-XFMR-T-DPL-PRI	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	30.000 ft	1	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-XFMR-T-DPM1-PRI	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	95.000 ft	3	75	0.31000	0.06000	0	Ohms per 1,000 ft
C-XFMR-T-DPM1-SEC	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	400	30.000 ft	3	75	0.03500	0.04900	0	Ohms per 1,000 ft
C-XFMR-T-DPM2-PRI	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	95.000 ft	3	75	0.31000	0.06000	0	Ohms per 1,000 ft
C-XFMR-T-DPM2-SEC	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	400	30.000 ft	3	75	0.03500	0.04900	0	Ohms per 1,000 ft
C-XFMR-T-DPP PRI	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	10	30.000 ft	1	75	1.20000	0.06300	0	Ohms per 1,000 ft
C-XFMR-T-GD-PRI	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	30.000 ft	1	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-XFMR-T-GD-SEC	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	6	30.000 ft	1	75	0.49000	0.06400	0	Ohms per 1,000 ft
C-XFRM-FEB-PRI	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	30.000 ft	3	75	0.31000	0.06000	0	Ohms per 1,000 ft
C-XFRM-LP-VFD-PRI	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	30.000 ft	1	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-XFRM-LP-VFD-SEC	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	30.000 ft	1	75	0.31000	0.06000	0	Ohms per 1,000 ft

Cable Data Schedule

Cable ID	Library	Status	Size	Length	#/ph	T (C)	R	X	Y	Impedance Unit
C-XFRM-T1-LP12-PRI	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	30.000 ft	1	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-XFRM-T1-LP12-SEC	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	6	15.000 ft	1	75	0.49000	0.06400	0	Ohms per 1,000 ft
C-XFRM-T1-LP2-PRI	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	8	30.000 ft	1	75	0.78000	0.06500	0	Ohms per 1,000 ft
C-XFRM-T1-LP2-SEC	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	1	30.000 ft	1	75	0.16000	0.05700	0	Ohms per 1,000 ft
C-XFRM-T-DPC7-PRI	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	95.000 ft	3	75	0.31000	0.06000	0	Ohms per 1,000 ft
C-XFRM-T-DPC7-SEC	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	400	30.000 ft	3	75	0.03500	0.04900	0	Ohms per 1,000 ft
C-XFRM-T-DPL1-PRI	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	95.000 ft	3	75	0.31000	0.06000	0	Ohms per 1,000 ft
C-XFRM-T-DPL1-SEC	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	30.000 ft	3	75	0.31000	0.06000	0	Ohms per 1,000 ft
C-XFRM-T-DPP2-PRI	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	95.000 ft	3	75	0.31000	0.06000	0	Ohms per 1,000 ft
C-XFRM-T-DPP2-SEC	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	10.000 ft	3	75	0.31000	0.06000	0	Ohms per 1,000 ft
C-XFRM-TRAN-LPA-PRI	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	30.000 ft	1	75	0.31000	0.06000	0	Ohms per 1,000 ft
C-XFRM-TRAN-LPA-SEC	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	2/0	30.000 ft	1	75	0.10000	0.05400	0	Ohms per 1,000 ft
C-XFRM-TRAN-PPA-PRI	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	30.000 ft	1	75	0.31000	0.06000	0	Ohms per 1,000 ft
C-XFRM-TRAN-PPA-SEC	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	2/0	30.000 ft	1	75	0.10000	0.05400	0	Ohms per 1,000 ft
C-XFRM-TRAN-PPB-PRI	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	4	30.000 ft	1	75	0.31000	0.06000	0	Ohms per 1,000 ft
C-XFRM-TRAN-PPB-SEC	NEC , XHHW, 0.6, 100, Copper, 1/C, Magnetic, 75, 1000 ft,60, English, 30 90 90 30 90	Energized	1/0	30.000 ft	1	75	0.12000	0.05500	0	Ohms per 1,000 ft

APPENDIX G – SUMMARY OF THE CONDITION ASSESSMENT

	A	B	O	P	Q	R
1	Equipment	Location	Manufacturer	Install Year	Condition	Reason
2	MCC-DP3A	Administration Bldg	Federal Pacific	1978	4	1, 2
3	MCC-EDP1E	Administration Bldg	Federal Pacific	1978	4	1, 2
4	MCC-NG Bus A	Blower Bldg	Westinghouse Series 2100	1989	3	
5	MCC-NG Bus B	Blower Bldg	Westinghouse Series 2100	1989	3	
6	COGEN SWBD	Cogen Bldg	Westinghouse Pow-R-Line	1989	4	1, 2
7	MCC-DP3B	Cogen Bldg	Federal Pacific	1978	5	
8	MCC-GA	Cogen Bldg	Federal Pacific	1978	5	1, 2
9	Panel DP3	Cogen Bldg	Federal Pacific	1978	5	1, 2
10	Panel DPP8	Collec. Sys. Maint Bldg				
11	MCC-DP1A	DAF Bldg	Federal Pacific	1978	5	1, 2, 3, 4, 11
12	MCC-DP1B	DAF Bldg	Federal Pacific	1978	5	1, 3, 4, 5, 11
13	MCC-EDP1A	DAF Bldg	Federal Pacific	1978	5	1, 2, 3, 4, 11
14	Panel DP1	DAF Bldg	Federal Pacific	1978	5	1, 3
15	SR-DAF	DAF Tank Area				
16	MCC-DP2C	Digester Control Bldg	Federal Pacific	1978	5	1, 2, 3
17	MCC-EDP1C	Digester Control Bldg	Federal Pacific	1978	5	1, 2, 3, 4, 5, 9
18	MCC-GF	Digester Control Bldg	Federal Pacific	1978	4	1, 2
19	MCC-GH	Digester Control Bldg	Federal Pacific	1978	4	1, 2
20	MCC-GD_AB	Eastern Trunk	Allen-Bradley Centerline 2100	2011	1	
21	Panel DB	Eastern Trunk	Westinghouse Pow-R-Line C	1989	5	1, 3
22	MCC-DP4A	Eff. Pump Station	Federal Pacific	1978	5	1, 2, 3, 5, 10
23	MCC-EDP1D	Eff. Pump Station	Federal Pacific	1978	5	1, 2, 3, 5, 10
24	Eff PS SWGR Bus A	Gym	C-H Westinghouse DS II	1997	2	
25	Eff PS SWGR Bus B	Gym	C-H Westinghouse DS II	1997	2	
26	IPS Pump No. 1	Headworks Elec. Bldg	Allen-Bradley 1336 Plus II	2007	2	
27	IPS Pump No. 2	Headworks Elec. Bldg	Allen-Bradley 1336 Plus II	2007	2	
28	IPS Pump No. 3	Headworks Elec. Bldg	Allen-Bradley 1336 Plus II	2007	2	
29	IPS Pump No. 4	Headworks Elec. Bldg	Allen-Bradley 1336 Plus II	2007	2	
30	IPS Pump No. 5	Headworks Elec. Bldg	Allen-Bradley 1336 Plus II	2007	2	
31	IPS Pump No. 6	Headworks Elec. Bldg	Allen-Bradley 1336 Plus II	2007	2	
32	MCC-HW Bus A	Headworks Elec. Bldg	Allen-Bradley Centerline	2007	2	
33	MCC-HW Bus B	Headworks Elec. Bldg	Allen-Bradley Centerline	2007	2	
34	Panel DPP1 (HW)	Headworks Elec. Bldg	Siemens	2007	2	
35	SWGR MS-HW Bus A	Headworks Elec. Bldg	Siemens Type WL LV SWGR	2007	2	
36	SWGR MS-HW Bus B	Headworks Elec. Bldg	Siemens Type WL LV SWGR	2007	2	
37	Main SWGR Bus A	Main Electrical Bldg	Westinghouse	1989	4	1, 2, 6, 8
38	Main SWGR Bus B	Main Electrical Bldg	Westinghouse	1989	4	1, 2, 6, 8
39	MCC-DP4B	Main Electrical Bldg	Federal Pacific	1978	5	1, 2, 5, 8
40	MCC-GB	Main Electrical Bldg	Federal Pacific	1978	4	1, 2, 5, 8
41	MCC-GC	Main Electrical Bldg	Federal Pacific	1978	4	1, 2, 5, 8
42	MCC-GD	Main Electrical Bldg	Federal Pacific	1978	4	1, 2, 5, 8
43	MCC-GE	Main Electrical Bldg	Federal Pacific	1978	4	1, 2, 5, 8
44	Panel DP4	Main Electrical Bldg	Federal Pacific	1978	5	1, 2, 7, 8
45	MCC-NA Bus A	N. Area Elec. Room	Westinghouse Ampguard MV MCC	1989	3	
46	MCC-NA Bus B	N. Area Elec. Room	Westinghouse Ampguard MV MCC	1989	3	
47	MCC-NC	N. Area Elec. Room	Westinghouse Series 2100	1989	3	
48	MCC-ND	N. Area Elec. Room	Westinghouse Series 2100	1989	3	
49	MCC-NE	N. Area Elec. Room	Westinghouse Series 2100	1989	3	
50	MCC-NF	N. Area Elec. Room	Westinghouse Series 2100	1989	3	
51	Panel DPP4	N. Area Elec. Room	Westinghouse Pow-R-Line C	1989	3	

	A	B	O	P	Q	R
52	SWBD-NB Bus A	N. Area Elec. Room	Westinghouse	1989	3	
53	SWBD-NB Bus B	N. Area Elec. Room	Westinghouse	1989	3	
54	MCC-DP2B	Old Blower Bldg	Federal Pacific	1978	5	1, 2, 3, 4, 9, 11
55	Panel DP2	Old Blower Bldg	Federal Pacific	1978	5	1, 3, 11
56	ATS PSS1	Old Headworks Bldg	Westinghouse Series 2100	1989	3	
57	MCC-DP2A-1	Old Headworks Bldg	Federal Pacific	1978	4	
58	MCC-EDP1B-1	Old Headworks Bldg	Federal Pacific	1978	4	1, 2
59	MCC-HCC	Old Headworks Bldg	Westinghouse Series 2100	1989	3	
60	ATS-8	Old Infl. Bldg	Federal Pacific	1978	5	1, 3
61	MCC-DP2A	Old Infl. Bldg	Federal Pacific	1978	5	1, 2, 3, 4, 11
62	MCC-EDP1B	Old Infl. Bldg	Federal Pacific	1978	5	1, 2, 3, 4, 5, 9, 11
63	Panel EDP-1	Old Infl. Bldg	Federal Pacific	1978	5	1, 2, 3, 4
64	MCC-DP2D	Plant Control Center	Federal Pacific	1978	5	1, 2, 3, 4, 5
65	Panel DPMB	Plant Maint Bldg	Sierra Switchboard Company	Unknown	5	3
66	MCC-SH Bus A	Solids Processing Bldg	Westinghouse Series 2100	1989	3	
67	MCC-SH Bus B	Solids Processing Bldg	Westinghouse Series 2100	1989	3	
68	Panel DPP7	South Gallery	Westinghouse Pow-R-Line C	1989	3	
69	Panel DPP1	South Pipe Gallery	Westinghouse Pow-R-Line C	1989	3	
70	Panel DPP2	South Pipe Gallery	Westinghouse Pow-R-Line C	1989	3	
71	Panel DPP3	South Pipe Gallery	Westinghouse Pow-R-Line C	1989	3	
72	Panel DPP6	South Pipe Gallery	Westinghouse Pow-R-Line C	1989	3	
73	MCC-DP3C	Thickeners	Federal Pacific	1978	5	1, 2
74	MCC-DP3D	Thickeners	Federal Pacific	1978	5	1, 2
75	Panel DPP5	West Pipe Gallery	Westinghouse Pow-R-Line C	1989	3	
76	Panel PP-VFD		Cutler-Hammer Pow-R-Line C	1999	3	3
77						
78	Condition Score					
79	1 = Equipment like new.					
80	2 = Equipment in good condition.					
81	3 = Equipment in adequate condition. Nearing end of useful life. Parts may be difficult/expensive to obtain.					
82	4 = Equipment in poor condition. Past useful life. Parts are difficult/expensive or impossible to obtain.					
83	5= Equipment in very poor condition. Past useful life. Parts are difficult/expensive or impossible to obtain.					
84						
85	Reasons for condition assessment					
86	1. Equipment is at or nearing end of life					
87	2. Replacement parts difficult to find or expensive.					
88	3. Very dusty and/or rusty.					
89	4. Uncovered holes in equipment.					
90	5. Broken/missing components					
91	6. Feeder circuit breaker to DP1 charging motor does not operate.					
92	Charging spring handle on the Tie breaker is broken. Relays have not been tested in a long time.					
93	7. Not fully rated for short circuit current.					
94	8. Building is in poor condition. The leaky roof presents dangerous conditions when there is rain.					
95	9. Exposed bus.					
96	10. Unconditioned room w/ engine driven pumps					
97	11. Unconditioned room.					

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City of Oxnard

Public Works Integrated Master Plan

WASTEWATER

PROJECT MEMORANDUM 3.9
CATHODIC PROTECTION ASSESSMENT

REVISED FINAL DRAFT
September 2017

Engineers...Working Wonders With Water™

2700 YGNACIO VALLEY ROAD • SUITE 300 • WALNUT CREEK, CALIFORNIA 94598 • (925) 932-1710 • FAX (925) 930-0208

PREFACE

The analysis and evaluations contained in these Project Memorandum (PM) are based on data and information available at the time of the original date of publication, December 2015. After development of the December 2015 Final Draft PMs, the City continued to move forward on two concurrent aspects: 1) advancing the facilities planning for the water, wastewater, recycled water, and stormwater facilities; and 2) developing Updated Cost of Service (COS) Studies (Carollo, 2017) for the wastewater/collection system and the water/distribution system. The updated 2017 COS studies contain the most recent near-term Capital Improvement Projects (CIP). **The complete updated CIP based on the near-term and long-term projects is contained in the Brief History and Overview of the City of Oxnard Public Works Department's Integrated Planning Efforts: May 2014 – August 2017 section.**

At the time of this Revised PWIMP, minor edits were also incorporated into the PMs. Minor edits included items such as table title changes and updating reports that were completed after the December 2015 original publication date.

City of Oxnard

Public Works Integrated Master Plan

WASTEWATER

PROJECT MEMORANDUM 3.9
CATHODIC PROTECTION ASSESSMENT

TABLE OF CONTENTS

Page No.

CATHODIC PROTECTION ASSESSMENT

1.0 INTRODUCTION

As part of the Public Works Integrated Master Plan (PWIMP), JDH Corrosion Consultants, Inc. (JDH) was contracted to conduct an asset corrosion assessment and CP evaluation survey for both the water and wastewater infrastructure within the City of Oxnard (City). Water transmission mains, water and wastewater treatment facilities, and other important City assets were included in this report. A survey was done to assess the existing level of cathodic protection and recommendations were made that outline needed improvements. The combined water and wastewater report (September 2014) can be found in Appendix A of Project Memorandum (PM) 2.7.

1.1 PMs Used for Reference

The findings outlined in the Cathodic Protection Assessment were made in concert with recommendations and analyses from other related PMs:

- PM 2.1 - Water System - Background Summary.
- PM 2.4 - Water System - Condition Assessment.
- PM 2.7 - Water System - Cathodic Protection Assessment.
- PM 3.1 - Wastewater System - Background Summary.
- PM 3.5 - Wastewater System - Condition Assessment.

2.0 FINDINGS

Below is a summary of the findings and recommendations for the City's wastewater infrastructure as it relates to cathodic protection:

- General Wastewater Treatment Plant: Most all piping tested did not meet NACE Criteria for protection. Thus a complete replacement of the entire cathodic protection system plant-wide is recommended immediately.
- Clarifiers and Digesters: Currently no cathodic protection exists at these facilities. It is recommended that cathodic protection be installed for the submerged surfaces of metallic components at these locations.

In addition to the projects recommended above, this PWIMP also recommends conducting an annual cathodic protection survey and report for all City facilities. A more detailed discussion of these findings and their associated costs can be found in Supplemental Report (August 2015) in Appendix B of PM 2.7.

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City of Oxnard

Public Works Integrated Master Plan

WASTEWATER

PROJECT MEMORANDUM 3.10
SCADA ASSESSMENT

REVISED FINAL DRAFT
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pw://Carollo/Documents/Client/CA/Oxnard/9587A00/Deliverables/Updated PM Deliverables/PM 03 Wastewater System/PM 3.10

PREFACE

The analysis and evaluations contained in these Project Memorandum (PM) are based on data and information available at the time of the original date of publication, December 2015. After development of the December 2015 Final Draft PMs, the City continued to move forward on two concurrent aspects: 1) advancing the facilities planning for the water, wastewater, recycled water, and stormwater facilities; and 2) developing Updated Cost of Service (COS) Studies (Carollo, 2017) for the wastewater/collection system and the water/distribution system. The updated 2017 COS studies contain the most recent near-term Capital Improvement Projects (CIP). **The complete updated CIP based on the near-term and long-term projects is contained in the Brief History and Overview of the City of Oxnard Public Works Department's Integrated Planning Efforts: May 2014 – August 2017 section.**

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City Of Oxnard

Public Works Integrated Master Plan

WASTEWATER

PROJECT MEMORANDUM 3.10
SCADA ASSESSMENT

TABLE OF CONTENTS

Page No.

LIST OF TABLES

SCADA ASSESSMENT

1.0 INTRODUCTION

The purpose of this Project Memo (PM) is to develop the list of projects to be included in the wastewater Capital Improvement Program (CIP) of the Public Works Integrated Master Plan (PWIMP) with associated project cost and drivers. The CIP is an estimate of the City's capital expenses over the next 25 years to address limitations, rehabilitation needs, and recommended improvements to the wastewater treatment plant. The CIP is intended to assist the City in planning future budgets and making financial decisions.

1.1 PMs Used for Reference

The recommendations outlined in this PM include recommendations from the following other PMs:

- PM 3.2 - Wastewater - Flow and Load Projections.
- PM 3.4 - Wastewater - Treatment Plant Performance and Capacity.
- PM 3.5 - Wastewater - Condition Assessment.
- PM 3.6 - Wastewater - Seismic Assessment.
- PM 3.9 - Wastewater - Arc Flash Assessment.
- PM 3.7 - Wastewater - Treatment Alternatives.

1.2 Other Reports Used for Reference

In developing this report, recommendations from other reports were incorporated to ensure a holistic and, un-biased approach. The followings reports are used in this PWIMP analysis:

- *Guide to Industrial Control Systems (ICS) Security,* National Institute of Standards and Technology, June 2011.

2.0 SUMMARY OF FINDINGS

2.1 Existing System

The City of Oxnard's Waste Water Treatment Plant SCADA System provides plant automation and operates on obsolete hardware and software. The Supervisory Control and Data Acquisition (SCADA) system is a computer system that monitors and controls the facility-based processes. The SCADA system consists of the following subsystems:

- SCADA-based Human Machine Interface (HMI), which is the apparatus that presents process data to the human operator; and through this the human operator monitors and controls the process.
- A SCADA computer system, acquiring and storing data on the process from the programmable logic controllers (PLCs) and controlling the process by sending commands to the PLC.
- Communication infrastructure connecting the SCADA system to the PLCs.

The Oxnard Waste Water Treatment Plant uses a Supervisory Control and Data Acquisition (SCADA) process control system to monitor and control processes at the facility. The automation hardware inside the WW facility was installed as an upgrade to the facility in approximately 1990. It consists primarily of SquareD SY/MAX PLCs interfaced over a RS422 Communication bus for Peer to Peer (PLC to PLC) and PLC to HMI communications. This uses a low bandwidth, ASCII based protocol. There is a Primary and a Secondary Kepware KEPServer that each function as an OPC bridge to provide data to the FactoryTalk View SE 6.0 HMI software platform.

The Lift Stations use an Allen Bradley CompactLogix L33E PLC with local I/O for control. These are interfaced into to the rest of the SCADA system through copper phone lines. The phone lines are operated and maintained by Verizon, the local phone provider. There were numerous discussions with plant personnel in regards to the copper lines being switched to fiber. Fiber optic cable provides would provide a much higher data bandwidth to the stations. However, this upgrade is being performed by Verizon and it is unclear when the upgrade would be performed.

2.2 Condition

The life cycle of the SquareD SY/MAX PLC platform ended in the mid-1990s and the last hardware components became obsolete in 2002. Replacement parts are not widely available and would need to be sourced through a 3rd party vendor. These PLCs control nearly the entire WW facility, a PLC hardware failure could mean that an entire section of the facility would have to be operated in manual, with little to no process visualization by which to make process decisions. The current programs were uploaded by Pacific Rim Automation, and are undocumented. This makes any modification of the original code very labor intensive.

The overall wiring condition of the SCADA systems are fair to poor, which is to be expected for the age of the system(s). In discussions with staff that maintains the equipment, many of the repairs to the wiring have gone undocumented, and visual inspection of cabinets verified these reports. Much of the downtime related to the SCADA system stems from loose or failing wire connections, and tracing wires to their source to troubleshoot an outage.

There are also reports of communication faults within the system due to Electro-Magnetic Interference (EMI) that happen during regular system events, such as large motors starting and stopping. This is likely due to poor cable, non-isolated wiring, incorrect shielding, and terminating. These events compound themselves by causing SY/MAX nodes to try and re-establish themselves on the network, resulting in unscheduled messages that will lock-up the OPC server(s). This causes reduced process visualization and disruption of the control system for relatively short amounts of time.

3.0 SCADA SYSTEM NEEDS

3.1 Recommended Projects

3.1.1 PLC Cabinet Replacements

There is an immediate concern surrounding the age of PLCs and equipment used at the waste water treatment facility. It is highly recommended that installation of new PLCs and control cabinets should accompany any process equipment upgrades or replacements. This allows for the process controls to be optimized in a new system rather than conform to the footprint of the existing system, as the existing programs would be difficult and expensive to modify. Based on the city’s desire to match the architecture used at the Advanced Water Purification Facility, any new PLC’s should be in the Allen Bradley Logix 5000 family of controllers. In interviews with plant personnel, this preference was also expressed.

The present state of the panels is such that a field cleanup of the panels is less cost effective than a replacement of the panel in its entirety, given the wiring conditions and age of other equipment inside.

3.1.2 PLC System Standardization

A PLC is an industrialized computer used to automate process used for the treatment and/or conveyance of water. Typically, each major process will have its own PLC.

During interviews with city personnel and ProUsys, there was a preference expressed for the Allen Bradley ControlLogix platform. As this was the platform used in the newly constructed Recycled Water Processing Facility, it is recommended that any new PLCs should also be of the Allen Bradley ControlLogix or CompactLogix platform.

Each PLC processor should be sized to support the required input/output (I/O) plus 25 percent spare I/O capacity for each type of I/O signal at every PLC. All spare I/O points shall be wired to field terminal blocks in the PLC cabinet. The PLC backplane shall include three spare backplane slots or 25 percent additional slots, whichever is greater. Provide a minimum of 50 percent spare program volatile memory. Communication ports should be provided to support the necessary networking requirements of the specific project. Provide a minimum of one Ethernet/IP port for connection to the process communications network as well as uploading and downloading of PLC application programs.

3.1.3 HMI System Standardization

The HMI is defined as operator interface devices with a graphic display. These provide operations or maintenance staff access to control and monitor process activities, setpoints, equipment status, and alarms within the PLC. The City of Oxnard's Waste Water facility HMI application was built with Rockwell Automation's Factory Talk View SE 6.0 software. Any new PLC should interface with the existing application, and the existing application should be modified to accommodate the new PLC.

3.1.4 Typical Control Methodologies

3.1.4.1 Process Control Interface System (PCIS) Control

The PCIS system refers to the operator interface system consisting of both the HMI and the SCADA interface.

Where indicated, provide HAND-OFF-AUTO and START-STOP selections in the PCIS, accessed from an HMI or SCADA for operators with sufficient security, to provide the following operating modes:

1. PCIS AUTO: The normal, automatic control mode of the strategy, which allows full PLC control in response to process conditions and programmed sequences.
2. PCIS HAND: Enables PCIS Manual control where control decisions are made by an operator through the PCIS START-STOP, OPEN/CLOSE, or other selections as indicated.
3. PCIS OFF: Automated PCIS control is disabled and PLC calls for all associated equipment to stop and valves to close or go to their identified safe state.
4. Program the PLC so that switching strategy between AUTO and HAND (either direction) occurs with a smooth transition. Keep running or position status unchanged when control is switched to HAND until a change is requested using the operator selections (START, STOP, OPEN, CLOSE). Keep running and position status unchanged when control is switched to AUTO until the control logic determines a change is required.

3.1.4.2 Motor Control

1. Provide local controls at each motor. The controls could be housed in a local control panel (LCP) at each motor or at the compartment containing the motor control hardware in the motor control center (MCC):
   a. LOCAL-OFF-REMOTE (LOR) selector switch.
   b. START pushbutton.
   c. STOP pushbutton.

2. Monitor the device's LOR switch to determine when the PLC has control of the associated equipment:
   a. Display current REMOTE status on the SCADA and HMI screens.
3. Monitor the device's running status from the starter auxiliary or run status input:
   a. Display the current status (running or stopped) on the SCADA and HMI screens.
   b. Use status to calculate total run time and daily run time, and to count total starts and daily starts.
   c. Provide time stamp for each start.
4. For motors 200 hp and greater, provide software to prevent exceeding the manufacturer's recommended maximum starts per hour.
5. When equipment control has been given to the PLC as reported by the LOCAL-OFF-REMOTE switch, allow selection of PCIS AUTO or PCIS HAND control modes based upon operator selection using the SCADA or HMI screens.
6. Starting, Stopping, and running when the device LOR is in LOCAL:
   a. With the LOR switch in the LOCAL position, the motor is controlled by the START and STOP pushbuttons.
   b. With the LOR switch in the OFF position, the motor is prohibited from running.
   c. With the LOR switch in the REMOTE position, the motor is controlled remotely.
7. Starting, stopping, and running when the device LOR is in REMOTE:
   a. When the motor is expected to be running (PLC has issued a START or RUN due to process conditions or operator selection), LOR is in REMOTE, and the device is not reported to be running, start an operator adjustable "Control Activation" time:
      1) Provide "Control Activation"{ timers for each piece of controlled equipment:
         a) If the LOR and required running status do not change, and the PLC does not receive running status within the "Control Activation" time period:
            (1) De-activate the output.
            (2) Place the device in a "Failed" state.
            (3) Generate a "Failed to Respond" alarm.
   b. When the motor is not expected to be running (PLC has issued a STOP or removed the RUN output, LOR is in REMOTE, and the device is reported to be running, start the "Control Activation" timer:
      1) If the LOR and required stopped status do not change, and the PLC does not lose the running status within the "Control Activation" timer period:
         a) Keep the RUN output off or the STOP output on.
         b) Place the device in a "Failed" state.
         c) Generate a "Failed to Respond" alarm.

c. Re-establish PLC control of a device in a “Failed” state only after operator turns the device’s LOR switch out of REMOTE, and back to REMOTE (i.e., REMOTE input to the PLC cycles off and back on).

8. Simultaneous starts:

a. Prevent more than one motor-driven load 25 hp or larger in the same facility from starting concurrently:

1) When starting one load, inhibit start logic for all other such equipment until the load being started is up to speed (reduced voltage solid state RVSS or variable frequency drive VFD, or after a setpoint time delay (full-voltage starters and miscellaneous equipment).

b. Use the same logic to prevent multiple large devices from starting concurrently on restoration of power after a power outage, whether operating on generator or utility power.

9. Speed control:

a. Modulate speed on VFD-driven motors using jog and hold, or process identification document (PID) control algorithms to maintain process conditions as described in the specific loop descriptions.

b. Operate speed control within a pre-defined range:

1) Minimum speed as determined by equipment manufacturer. The higher of:

a) Minimum motor speed to maintain adequate cooling for the type of load driven (constant or variable torque).

b) Minimum equipment speed, such as minimum speed to deliver flow or to deliver minimum flow for equipment cooling or lubrication.

2) Maximum speed 100 percent (60 Hz) or as identified by equipment manufacturer.

c. Where multiple equipment may operate together to maintain the same process condition:

1) Provide an operator selection for starting sequence.

2) Start the first equipment at a preset starting speed.

3) When one or more equipment is running and the speed control algorithm reaches a preset “Start Nex” speed value (initially 95 percent of speed range) through a preset time delay:

a) Start the next available equipment at the preset starting speed.

b) Ramp speed of previously running equipment down to a preset value based on the number of items running. Determine preset values for each condition based on equipment and system characteristics to provide approximately the same flow or process condition with the new load running at the starting speed.

c) Once the previously running equipment reaches the preset speed, resume the speed control algorithm for that equipment.

d) Ramp the speed of the equipment that had just started until it reaches the speed of the previously running equipment.

e) Operate all equipment at the same speed following the output of the speed control algorithm.

4) When two or more pieces of equipment are running, monitor for a “Stop Next” condition:

a) Where flow rate is monitored, use a preset “Stop Next” flow rate for each possible number and combination of equipment:

(1) Determine initial “Stop Next” speed based on the flow that can be provided with one fewer piece of equipment running at a speed slightly below the “Start Next” speed.

b) When the “Stop Next” condition exists through a preset time delay:

(1) Ramp Speed of running equipment except for the equipment to be stopped up to a preset value based on the number of items running. Determine preset values for each condition based on equipment and system characteristics to provide approximately the same total flow or process condition with one fewer load running (typically slightly below the preset “Start Next” speed) while ramping speed of equipment to be stopped down to the preset minimum speed.

(2) Stop the load once it reaches minimum speed.

(3) Operate all remaining equipment at the same speed following the output of the speed control algorithm.

3.1.5 <u>Facility SCADA and Control Communication Networking Standardization</u>

For PLC and SCADA, networks will utilize a fiber optic backbone for Ethernet/IP communication throughout the facility. Managed Ethernet switches shall be located in each PLC or network panel for both the SCADA and PLC network. A connection port shall be provided on the front of all PLC cabinets to allow connection to the SCADA network. Switches shall utilize the IEEE Rapid Spanning Tree Protocol (RSTP) for network routing and optimization in a ring topology. In the event of a network switch failure, RSTP will automatically determine the most efficient way to re-route network traffic in order to re-establish communication throughout the network. Vendor PLCs and control panels will also comply with this design.

Appendix C contains a typical diagram for an Industrial Network with the architecture and security infrastructure recommended by the National Institute of Standards and Technology (NIST) and the Department of Homeland Security (DHS). Staff interviews indicate that the ability to view facility status throughout the City’s Wide Area Network (WAN) is desired.

Further information can be found in NIST Special Publication (SP) 800-82, *Guide to Industrial Control Systems (ICS) Security*.

4.0 CAPITAL IMPROVEMENT PROGRAM

The purpose of this section is to summarize the estimated capital funding requirements for SCADA system projects. The costs presented here are based on direct replacement of equipment in layouts of the existing system. Project costs are estimated based on unit costs developed from estimates of similar facilities and configurations at other locations. Please see Project Memo (PM) 1.5 for a more detailed discussion on the Basis of Cost for the costs shown in Table 1.

Table 1 Recommended Capital Improvement Projects, Cost Estimates, and Phasing for OWTP SCADA(1)
Public Works Integrated Master Plan
City of Oxnard

Project Name	Driver	End Year	Start Year	Un-escalated Project Cost ($)
PLC Cabinet Replacements (12)	R&R	2018	2015	$4,601,000
SCADA Programming (12)	Performance	2021	2016	$4,989,000
Asset Management Software Package Installation	Performance	2022	2021	$104,000
Network Upgrades (12)	Performance	2022	2015	$776,000
Control Room Upgrades	Performance	2021	2016	$346,000
			TOTAL:	**$10,816,000**

Notes:
(1) Project costs, schedules, and phasing are based on data and information available at the time of the original date of preparation – December 2015. The updated CIP is contained in the Brief History section of the PMs, the Summary Report, and the Executive Summary.

4.1 Unit Costs

The unit cost multiplier used was based upon replacement of the existing twelve RTU and "MUX" control panels. For incremental replacements based on the process improvements identified in PM 3.7, the costs can be used proportionally.

APPENDIX A – WASTEWATER PCM EVALUATION

City of Oxnard WWTP
Condition Assessment Form

Facility: Waste Water Campus
Equipment Location: Plant Control Center
Equipment Name: SYMAX OPC Servers
Discipline: Electrical / Instrumentation

Equipment Information

Cabinet ID: ____
Cabinet Location: PCC
Process(es) Served: Multiple
Panel Dimensions: ____
GPS Location:

Inspection Date: 8/6/2014
Inspection By: K. Pepler
Install Date: ____
Condition*: **4** out of 5

Picture – Panel External

Picture – Panel Internal

General Comments:

*Condition
1 – Very Good
2 – Minor Defects
3 – Needs Significant Matenance
4 – Requires Rehabilitation
5 – Requires Replacement (>50%)

Controller Model : N/A

Component Models

Enclosure
Model Number: N/A
NEMA: None
Mounting: ____
Thermal Management: Ambient A/C
Accessories: ____
Side Panels: ____

PLC
Manufacturer: Dell
Processor: KEPServer
Communications: SY/COMM to OPC
Accessories: ____
Redundant Processors: Yes

UPS
Model: ____
Size: ____
Communication: ____
Condition*: out of 5

Components
Circuit Breaker: ____
SPD: ____
Relays: ____
HMI/OIT: ____
Ethernet: ____
Radio: ____
DC Power Supply: ____
Switches: ____
Amount of I/O: ____
Other: ____

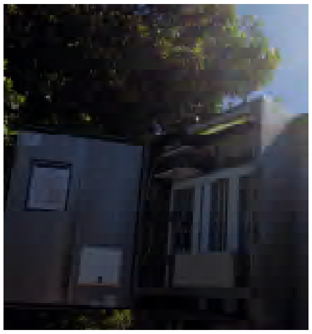
City of Oxnard WWTP
Condition Assessment Form

Facility: Waste Water
Equipment Location: Lift Station 2
Equipment Name: Harbor rd
Discipline: Electrical / Instrumentation

Equipment Information

Cabinet ID:	Lift Station 2	Inspection Date:	8/6/2014
Cabinet Location:		Inspection By:	K. Pepler
Process(es) Served:	Lift Station 2	Install Date:	
Panel Dimensions:		Condition*:	**3** out of 5
GPS Location:	34.151856 , -119.180149		

Picture – Panel External



Picture – Panel Internal

General Comments:

Manual Pump Controls on Front Cabinet which has pump controls.
Rear cabinet houses Control System hardware.

*Condition
1 – Very Good
2 – Minor Defects
3 – Needs Significant Matenance
4 – Requires Rehabilitation
5 – Requires Replacement (>50%)

Controller Model : AB Compact Logix

Component Models

Enclosure
Model Number:
NEMA: 4X
Mounting: Flange
Thermal Management: Forced Air
Accessories:
Side Panels: No

PLC
Manufacturer: Allen Bradley
Processor: L34E
Communications: Ethernet / Modem
Accessories:
Redundant Processors: No

UPS
Model: Yes
Size:
Communication:
Condition*: out of 5

Components
Circuit Breaker:
SPD:
Relays:
HMI/OIT:
Ethernet: 1 Switch
Radio:
DC Power Supply:
Switches:
Amount of I/O: 7
Other: Cabinets Built by FluidIQs

City of Oxnard WWTP
Condition Assessment Form

Facility: Waste Water
Equipment Location: Lift Station 4
Equipment Name:
Discipline: Electrical / Instrumentation

Equipment Information

Cabinet ID: Lift Station 4
Cabinet Location:
Process(es) Served: Lift Station 4
Panel Dimensions:
GPS Location: 34.190296 , -119.242545

Inspection Date: 8/6/2014
Inspection By: K. Pepler
Install Date:
Condition*: **3** out of 5

Picture – Panel External

Picture – Panel Internal

General Comments:

Manual Pump Controls on Front Cabinet which has pump controls.
Rear cabinet houses Control System hardware.

Controller Model : AB Compact Logix

*Condition
1 – Very Good
2 – Minor Defects
3 – Needs Significant Matenance
4 – Requires Rehabilitation
5 – Requires Replacement (>50%)

Component Models

Enclosure
Model Number:
NEMA: 4X
Mounting: Flange
Thermal Management: Forced Air
Accessories:
Side Panels: No

PLC
Manufacturer: Allen Bradley
Processor: L34E
Communications: Ethernet / Modem
Accessories:
Redundant Processors: No

UPS
Model: Yes
Size:
Communication:
Condition*: out of 5

Components
Circuit Breaker:
SPD:
Relays:
HMI/OIT:
Ethernet: 1 Switch
Radio:
DC Power Supply:
Switches:
Amount of I/O: 7
Other: Cabinets Built by FluidIQs

City of Oxnard WWTP
Condition Assessment Form

Facility: Waste Water Campus
Equipment Location: Lift Station 8
Equipment Name:
Discipline: Electrical / Instrumentation

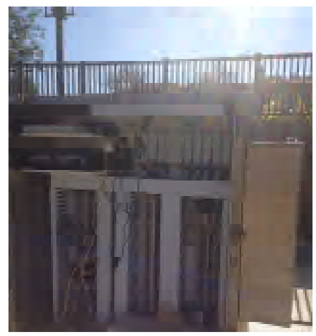
Equipment Information

Cabinet ID: Lift Station 8
Cabinet Location:
Process(es) Served: Lift Station 8
Panel Dimensions:
GPS Location: 34.188542 , -119.224652

Inspection Date: 8/6/2014
Inspection By: K. Pepler
Install Date:
Condition*: **3** out of 5

Picture – Panel External

Picture – Panel Internal



General Comments:

Manual Pump Controls on Front Cabinet which has pump controls.
Rear cabinet houses Control System hardware.

Controller Model : AB Compact Logix

*Condition
1 – Very Good
2 – Minor Defects
3 – Needs Significant Matenance
4 – Requires Rehabilitation
5 – Requires Replacement (>50%)

Component Models

Enclosure
Model Number:
NEMA: 4X
Mounting: Flange
Thermal Management: Forced Air
Accessories:
Side Panels: No

PLC
Manufacturer: Allen Bradley
Processor: L34E
Communications: Ethernet / Modem
Accessories:
Redundant Processors: No

UPS
Model: Yes
Size:
Communication:
Condition*: out of 5

Components
Circuit Breaker:
SPD:
Relays:
HMI/OIT:
Ethernet: 1 Switch
Radio:
DC Power Supply:
Switches:
Amount of I/O: 7
Other: Cabinets Built by FluidIQs

City of Oxnard WWTP
Condition Assessment Form

Facility: Waste Water Campus
Equipment Location: MCC DP1A
Equipment Name: ______
Discipline: Electrical / Instrumentation

Equipment Information

Cabinet ID:	MCC DP1A	Inspection Date:	8/6/2014
Cabinet Location:	Sedimentation Bldg	Inspection By:	K. Pepler
Process(es) Served:	Sedimentation	Install Date:	
Panel Dimensions:		Condition*:	3 out of 5
GPS Location:			

Picture – Panel External

Picture – Panel Internal

General Comments:

*Condition
1 – Very Good
2 – Minor Defects
3 – Needs Significant Matenance
4 – Requires Rehabilitation
5 – Requires Replacement (>50%)

Controller Model : ______

Component Models

Enclosure
Model Number: N/A
NEMA: 12
Mounting: ______
Thermal Management: ______
Accessories: ______
Side Panels: ______

PLC
Manufacturer: N/A
Processor: N/A
Communications: Hardwired
Accessories: ______
Redundant Processors: ______

UPS
Model: ______
Size: ______
Communication: ______
Condition*: out of 5

Components
Circuit Breaker: ______
SPD: ______
Relays: ______
HMI/OIT: ______
Ethernet: ______
Radio: ______
DC Power Supply: ______
Switches: ______
Amount of I/O: ______
Other: ______

City of Oxnard WWTP
Condition Assessment Form

Facility: Waste Water Campus
Equipment Location: Sedimentation
Equipment Name: MCC DP1B
Discipline: Electrical / Instrumentation

Equipment Information

Cabinet ID: MCC DP1B
Cabinet Location: Sedimentation
Process(es) Served: Sedimentation
Panel Dimensions: ______
GPS Location:

Inspection Date: 8/6/2014
Inspection By: K. Pepler
Install Date: ______
Condition*: 3 out of 5

Picture – Panel External

Picture – Panel Internal

General Comments:

Controller Model : ______

*Condition
1 – Very Good
2 – Minor Defects
3 – Needs Significant Matenance
4 – Requires Rehabilitation
5 – Requires Replacement (>50%)

Component Models

Enclosure
Model Number: ______
NEMA: ______
Mounting: ______
Thermal Management: ______
Accessories: ______
Side Panels: ______

PLC
Manufacturer: ______
Processor: ______
Communications: ______
Accessories: ______
Redundant Processors: ______

UPS
Model: ______
Size: ______
Communication: ______
Condition*: out of 5

Components
Circuit Breaker: ______
SPD: ______
Relays: ______
HMI/OIT: ______
Ethernet: ______
Radio: ______
DC Power Supply: ______
Switches: ______
Amount of I/O: ______
Other: ______

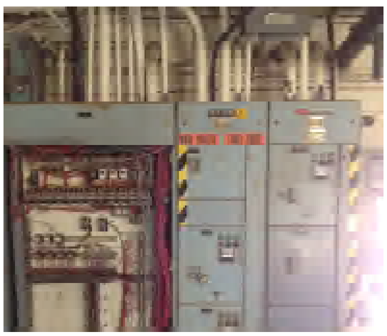
City of Oxnard WWTP
Condition Assessment Form

Facility: Waste Water Campus
Equipment Location: Influent Pump Station
Equipment Name: MCC DP2A
Discipline: Electrical / Instrumentation

Equipment Information

Cabinet ID:	MCC DP2A	Inspection Date:	8/6/2014
Cabinet Location:	Influent PS	Inspection By:	K. Pepler
Process(es) Served:	Influent	Install Date:	
Panel Dimensions:		Condition*:	**2** out of 5
GPS Location:			

Picture – Panel External



Picture – Panel Internal

General Comments:

*Condition
1 – Very Good
2 – Minor Defects
3 – Needs Significant Matenance
4 – Requires Rehabilitation
5 – Requires Replacement (>50%)

Controller Model : SquareD SY/MAX

Component Models

Enclosure
Model Number:
NEMA:
Mounting:
Thermal Management:
Accessories:
Side Panels:

PLC
Manufacturer: SquareD
Processor: SY/MAX 400
Communications: SY/COMM
Accessories:
Redundant Processors:

UPS
Model:
Size:
Communication:
Condition*: out of 5

Components
Circuit Breaker:
SPD:
Relays:
HMI/OIT:
Ethernet:
Radio:
DC Power Supply:
Switches:
Amount of I/O:
Other:

City of Oxnard WWTP
Condition Assessment Form

Facility: Waste Water Campus
Equipment Location: MCC DP3C
Equipment Name: MCC DP3C
Discipline: Electrical / Instrumentation

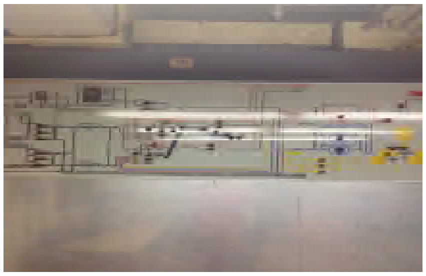
Equipment Information

Cabinet ID: MCC DP3C
Cabinet Location: MCC DP3C
Process(es) Served: ______
Panel Dimensions: ______
GPS Location:

Inspection Date: 8/6/2014
Inspection By: K. Pepler
Install Date: ______
Condition*: **3** out of 5

Picture – Panel External

Picture – Panel Internal



General Comments:

*Condition
1 – Very Good
2 – Minor Defects
3 – Needs Significant Matenance
4 – Requires Rehabilitation
5 – Requires Replacement (>50%)

Controller Model : ______

Component Models

Enclosure
Model Number: ______
NEMA: ______
Mounting: ______
Thermal Management: ______
Accessories: ______
Side Panels: ______

PLC
Manufacturer: SquareD
Processor: SY/MAX 400
Communications: SY/COMM
Accessories: ______
Redundant Processors: ______

UPS
Model: ______
Size: ______
Communication: ______
Condition*: out of 5

Components
Circuit Breaker: ______
SPD: ______
Relays: ______
HMI/OIT: ______
Ethernet: ______
Radio: ______
DC Power Supply: ______
Switches: ______
Amount of I/O: ______
Other: ______

City of Oxnard WWTP
Condition Assessment Form

Facility: Waste Water Campus
Equipment Location: Sedimentation
Equipment Name: MCC EDP1A
Discipline: Electrical / Instrumentation

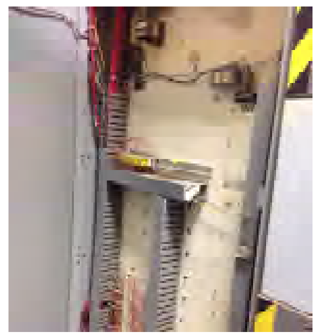
Equipment Information

Cabinet ID: ____________
Cabinet Location: ____________
Process(es) Served: ____________
Panel Dimensions: ____________
GPS Location:

Inspection Date: 8/6/2014
Inspection By: K. Pepler
Install Date: ____________
Condition*: **3** out of 5

Picture – Panel External

Picture – Panel Internal



General Comments:

*Condition
1 – Very Good
2 – Minor Defects
3 – Needs Significant Matenance
4 – Requires Rehabilitation
5 – Requires Replacement (>50%)

Controller Model : ____________

Component Models

Enclosure
Model Number: ____________
NEMA: ____________
Mounting: ____________
Thermal Management: ____________
Accessories: ____________
Side Panels: ____

PLC
Manufacturer: SquareD
Processor: SY/MAX 400
Communications: SY/COMM
Accessories: ____________
Redundant Processors: ____

UPS
Model: ____________
Size: ____________
Communication: ____________
Condition*: out of 5

Components
Circuit Breaker: ____________
SPD: ____________
Relays: ____________
HMI/OIT: ____________
Ethernet: ____________
Radio: ____________
DC Power Supply: ____________
Switches: ____________
Amount of I/O: ____
Other: ____________

City of Oxnard WWTP
Condition Assessment Form

Facility: Waste Water Campus
Equipment Location: Old Headworks
Equipment Name: MCC EDP1B
Discipline: Electrical / Instrumentation

Equipment Information

Cabinet ID: MCC EDP1B
Inspection Date: 8/6/2014
Cabinet Location: Old Headworks
Inspection By: K. Pepler
Process(es) Served: ______
Install Date: ______
Panel Dimensions: ______
Condition*: **5** out of 5
GPS Location:

Picture – Panel External

Picture – Panel Internal

General Comments:

Controller Model : ______

*Condition
1 – Very Good
2 – Minor Defects
3 – Needs Significant Matenance
4 – Requires Rehabilitation
5 – Requires Replacement (>50%)

Component Models

Enclosure
Model Number: ______
NEMA: ______
Mounting: ______
Thermal Management: ______
Accessories: ______
Side Panels: ______

PLC
Manufacturer: ______
Processor: ______
Communications: ______
Accessories: ______
Redundant Processors: ______

UPS
Model: ______
Size: ______
Communication: ______
Condition*: out of 5

Components
Circuit Breaker: ______
SPD: ______
Relays: ______
HMI/OIT: ______
Ethernet: ______
Radio: ______
DC Power Supply: ______
Switches: ______
Amount of I/O: ______
Other: ______

City of Oxnard WWTP
Condition Assessment Form

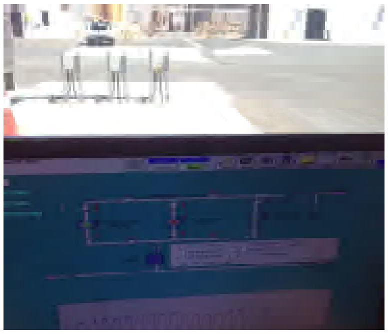
Facility: Waste Water Campus
Equipment Location: Old Headworks
Equipment Name: MCC EDP1B-1
Discipline: Electrical / Instrumentation

Equipment Information

Cabinet ID: MCC EDP1B-1
Inspection Date: 8/6/2014
Cabinet Location: Old Headworks
Inspection By: K. Pepler
Process(es) Served:
Install Date:
Panel Dimensions:
Condition*: **4** out of 5
GPS Location:

Picture – Panel External

Picture – Panel Internal



General Comments:

All but one breaker in MCC was locked out.

Controller Model :

*Condition
1 – Very Good
2 – Minor Defects
3 – Needs Significant Matenance
4 – Requires Rehabilitation
5 – Requires Replacement (>50%)

Component Models

Enclosure
Model Number:
NEMA:
Mounting:
Thermal Management:
Accessories:
Side Panels:

PLC
Manufacturer: SquareD
Processor: SY/MAX 400
Communications: Hardwired
Accessories:
Redundant Processors:

UPS
Model:
Size:
Communication:
Condition*: out of 5

Components
Circuit Breaker:
SPD:
Relays:
HMI/OIT:
Ethernet:
Radio:
DC Power Supply:
Switches:
Amount of I/O:
Other:

City of Oxnard WWTP
Condition Assessment Form

Facility: Waste Water Campus
Equipment Location: Digesters
Equipment Name: MCC GF
Discipline: Electrical / Instrumentation

Equipment Information

Cabinet ID: ________ Inspection Date: 8/6/2014
Cabinet Location: ________ Inspection By: K. Pepler
Process(es) Served: ________ Install Date: ________
Panel Dimensions: ________ Condition*: **5** out of 5
GPS Location:

Picture – Panel External

Picture – Panel External 2

General Comments:

Controller Model : ________

*Condition
1 – Very Good
2 – Minor Defects
3 – Needs Significant Matenance
4 – Requires Rehabilitation
5 – Requires Replacement (>50%)

Component Models

Enclosure
Model Number: ________
NEMA: ________
Mounting: ________
Thermal Management: ________
Accessories: ________
Side Panels: ____

PLC
Manufacturer: SquareD
Processor: SY/MAX
Communications: Hardwired
Accessories: ________
Redundant Processors: ____

UPS
Model: ________
Size: ________
Communication: ________
Condition*: out of 5

Components
Circuit Breaker: ________
SPD: ________
Relays: ________
HMI/OIT: ________
Ethernet: ________
Radio: ________
DC Power Supply: ________
Switches: ________
Amount of I/O: ____
Other: ________

City of Oxnard WWTP
Condition Assessment Form

Facility: Waste Water Campus
Equipment Location: North Control Center
Equipment Name: MCC NC
Discipline: Electrical / Instrumentation

Equipment Information

Cabinet ID: MCC NC
Inspection Date: 8/6/2014
Cabinet Location: North Control Area
Inspection By: K. Pepler
Process(es) Served: ______
Install Date: ______
Panel Dimensions: ______
Condition*: **2** out of 5
GPS Location:

Picture – Panel External

Picture – Panel Internal

General Comments:

*Condition
1 – Very Good
2 – Minor Defects
3 – Needs Significant Matenance
4 – Requires Rehabilitation
5 – Requires Replacement (>50%)

Controller Model : ______

Component Models

Enclosure
Model Number: ______
NEMA: ______
Mounting: ______
Thermal Management: ______
Accessories: ______
Side Panels: ______

PLC
Manufacturer: ______
Processor: ______
Communications: ______
Accessories: ______
Redundant Processors: ______

UPS
Model: ______
Size: ______
Communication: ______
Condition*: out of 5

Components
Circuit Breaker: ______
SPD: ______
Relays: ______
HMI/OIT: ______
Ethernet: ______
Radio: ______
DC Power Supply: ______
Switches: ______
Amount of I/O: ______
Other: ______

City of Oxnard WWTP
Condition Assessment Form

Facility: Waste Water Campus
Equipment Location: Influent Pump Station
Equipment Name: MUX 20
Discipline: Electrical / Instrumentation

Equipment Information

Cabinet ID: MUX 20
Cabinet Location: Influent PS
Process(es) Served:
Panel Dimensions:
GPS Location:

Inspection Date: 8/6/2014
Inspection By: K. Pepler
Install Date:
Condition*: **5** out of 5

Picture – Panel External

Picture – Panel Internal

General Comments:

Controller Model : SquareD SY/MAX

*Condition
1 – Very Good
2 – Minor Defects
3 – Needs Significant Matenance
4 – Requires Rehabilitation
5 – Requires Replacement (>50%)

Component Models

Enclosure
Model Number:
NEMA:
Mounting:
Thermal Management:
Accessories:
Side Panels:

PLC
Manufacturer: SquareD
Processor: SY/MAX 400
Communications: SY/COMM
Accessories:
Redundant Processors: N

UPS
Model: APC
Size:
Communication:
Condition*: out of 5

Components
Circuit Breaker:
SPD:
Relays:
HMI/OIT:
Ethernet:
Radio:
DC Power Supply:
Switches:
Amount of I/O:
Other:

City of Oxnard WWTP
Condition Assessment Form

Facility: Waste Water Campus
Equipment Location: Sedimentation
Equipment Name: MUX 30
Discipline: Electrical / Instrumentation

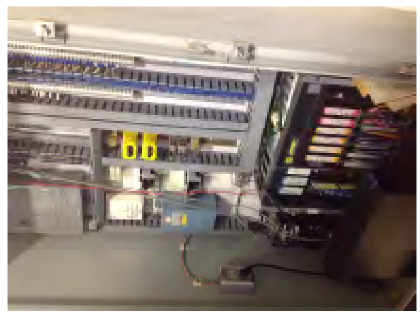
Equipment Information

Cabinet ID: ____
Cabinet Location: ____
Process(es) Served: ____
Panel Dimensions: ____
GPS Location:

Inspection Date: 8/6/2014
Inspection By: K. Pepler
Install Date: ____
Condition*: **5** out of 5

Picture – Panel External

Picture – Panel Internal



General Comments:

Controller Model : ____

*Condition
1 – Very Good
2 – Minor Defects
3 – Needs Significant Matenance
4 – Requires Rehabilitation
5 – Requires Replacement (>50%)

Component Models

Enclosure
Model Number: ____
NEMA: ____
Mounting: ____
Thermal Management: ____
Accessories: ____
Side Panels: ____

PLC
Manufacturer: SquareD
Processor: SY/MAX 400
Communications: SY/COMM
Accessories: ____
Redundant Processors: N

UPS
Model: APC
Size: ____
Communication: ____
Condition*: out of 5

Components
Circuit Breaker: ____
SPD: ____
Relays: ____
HMI/OIT: ____
Ethernet: ____
Radio: ____
DC Power Supply: ____
Switches: ____
Amount of I/O: ____
Other: ____

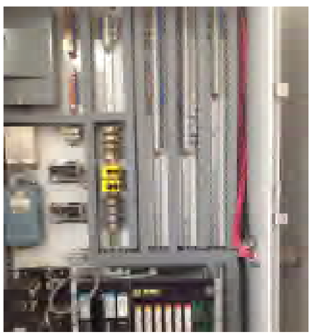
City of Oxnard WWTP
Condition Assessment Form

Facility: Waste Water Campus
Equipment Location: Digesters Bldg
Equipment Name: MUX 60
Discipline: Electrical / Instrumentation

Equipment Information

Cabinet ID: MUX 60
Inspection Date: 8/6/2014
Cabinet Location: Digesters Bldg
Inspection By: K. Pepler
Process(es) Served:
Install Date:
Panel Dimensions:
Condition*: **5** out of 5
GPS Location:

Picture – Panel External



Picture – Panel Internal

General Comments:

*Condition
1 – Very Good
2 – Minor Defects
3 – Needs Significant Matenance
4 – Requires Rehabilitation
5 – Requires Replacement (>50%)

Controller Model : SquareD SY/MAX

Component Models

Enclosure
Model Number:
NEMA:
Mounting:
Thermal Management:
Accessories:
Side Panels:

PLC
Manufacturer: SquareD
Processor: SY/MAX 400
Communications: SY/COMM
Accessories:
Redundant Processors: N

UPS
Model: None Found
Size:
Communication:
Condition*: out of 5

Components
Circuit Breaker:
SPD:
Relays:
HMI/OIT:
Ethernet:
Radio:
DC Power Supply:
Switches:
Amount of I/O:
Other:

City of Oxnard WWTP
Condition Assessment Form

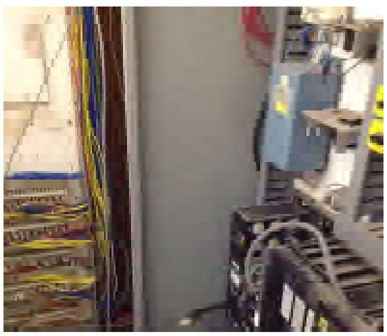
Facility: Waste Water Campus
Equipment Location: Old Influent Pump Station
Equipment Name: MUX 70
Discipline: Electrical / Instrumentation

Equipment Information

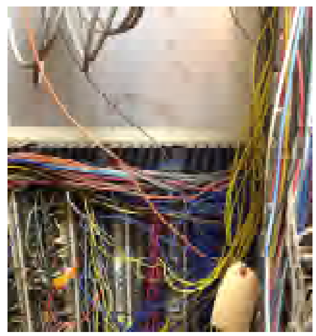
Cabinet ID: MUX 70
Cabinet Location: Old Influent PS
Process(es) Served:
Panel Dimensions:
GPS Location:

Inspection Date: 8/6/2014
Inspection By: K. Pepler
Install Date:
Condition*: **5** out of 5

Picture – Panel External



Picture – Panel Internal



General Comments:

Controller Model : SquareD SY/MAX

*Condition
1 – Very Good
2 – Minor Defects
3 – Needs Significant Matenance
4 – Requires Rehabilitation
5 – Requires Replacement (>50%)

Component Models

Enclosure
Model Number:
NEMA:
Mounting:
Thermal Management:
Accessories:
Side Panels:

PLC
Manufacturer: SquareD
Processor: SY/MAX 400
Communications: SY/COMM
Accessories:
Redundant Processors: N

UPS
Model: None Found
Size:
Communication:
Condition*: out of 5

Components
Circuit Breaker:
SPD:
Relays:
HMI/OIT:
Ethernet:
Radio:
DC Power Supply:
Switches:
Amount of I/O:
Other:

City of Oxnard WWTP
Condition Assessment Form

Facility: Waste Water Campus
Equipment Location: Landscaping Bldg
Equipment Name: New SCADA Server Rack
Discipline: Electrical / Instrumentation

Equipment Information

Cabinet ID: ____
Cabinet Location: Landscaping Bldg
Process(es) Served: Multiple
Panel Dimensions: ____
GPS Location:

Inspection Date: 8/6/2014
Inspection By: K. Pepler
Install Date: ____
Condition*: **2** out of 5

Picture – Panel External

Picture – Panel Internal

General Comments:

Server Rack is in isolated large "closet" with locked door in building that stores landscaping equipment.

Controller Model : Dell Poweredge

*Condition
1 – Very Good
2 – Minor Defects
3 – Needs Significant Matenance
4 – Requires Rehabilitation
5 – Requires Replacement (>50%)

Component Models

Enclosure
Model Number: ____
NEMA: ____
Mounting: ____
Thermal Management: ____
Accessories: ____
Side Panels: ____

PLC
Manufacturer: Dell
Processor: ____
Communications: ____
Accessories: KVM
Redundant Processors: N

UPS
Model: APC
Size: ____
Communication: ____
Condition*: out of 5

Components
Circuit Breaker: ____
SPD: ____
Relays: ____
HMI/OIT: ____
Ethernet: ____
Radio: ____
DC Power Supply: ____
Switches: ____
Amount of I/O: ____
Other: ____

City of Oxnard WWTP
Condition Assessment Form

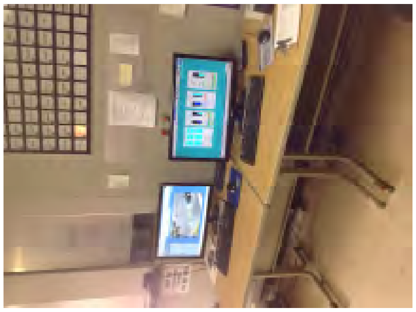
Facility: Waste Water Campus
Equipment Location: Plant Control Center
Equipment Name: HMI Computers/Console
Discipline: Electrical / Instrumentation

Equipment Information

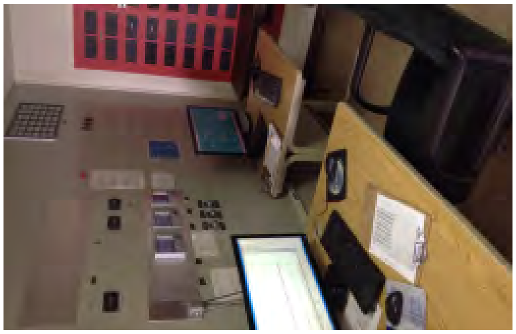
Cabinet ID: ____________
Cabinet Location: PCC
Process(es) Served: Multiple
Panel Dimensions: ____________
GPS Location:

Inspection Date: 8/6/2014
Inspection By: K. Pepler
Install Date: ____________
Condition*: **3** out of 5

Picture – Panel External



Picture – Panel Internal



General Comments:

*Condition
1 – Very Good
2 – Minor Defects
3 – Needs Significant Matenance
4 – Requires Rehabilitation
5 – Requires Replacement (>50%)

Controller Model : ____________

Component Models

Enclosure
Model Number: ____________
NEMA: ____________
Mounting: ____________
Thermal Management: ____________
Accessories: ____________
Side Panels: ______

PLC
Manufacturer: ____________
Processor: ____________
Communications: ____________
Accessories: ____________
Redundant Processors: ______

UPS
Model: ____________
Size: ____________
Communication: ____________
Condition*: out of 5

Components
Circuit Breaker: ____________
SPD: ____________
Relays: ____________
HMI/OIT: ____________
Ethernet: ____________
Radio: ____________
DC Power Supply: ____________
Switches: ____________
Amount of I/O: ______
Other: ____________

City of Oxnard WWTP
Condition Assessment Form

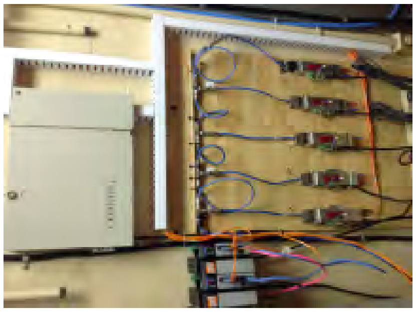
Facility: Waste Water Campus
Equipment Location: PCC
Equipment Name: RTU Network Panel
Discipline: Electrical / Instrumentation

Equipment Information

Cabinet ID: ____
Cabinet Location: PCC
Process(es) Served: Multiple
Panel Dimensions: ____
GPS Location:

Inspection Date: 8/6/2014
Inspection By: K. Pepler
Install Date: ____
Condition*: **4** out of 5

Picture – Panel External



Picture – Panel Internal

General Comments:

This is a recently "remade" panel for securing the Serial/BNC connections to the SY/MAX PLC controllers to the OPC Gateway PC's

Controller Model : ____

*Condition
1 – Very Good
2 – Minor Defects
3 – Needs Significant Matenance
4 – Requires Rehabilitation
5 – Requires Replacement (>50%)

Component Models

Enclosure
Model Number: ____
NEMA: ____
Mounting: ____
Thermal Management: ____
Accessories: ____
Side Panels: ____

PLC
Manufacturer: ____
Processor: ____
Communications: ____
Accessories: ____
Redundant Processors: N

UPS
Model: ____
Size: ____
Communication: ____
Condition*: out of 5

Components
Circuit Breaker: ____
SPD: ____
Relays: ____
HMI/OIT: ____
Ethernet: ____
Radio: ____
DC Power Supply: ____
Switches: ____
Amount of I/O: ____
Other: ____

City of Oxnard WWTP
Condition Assessment Form

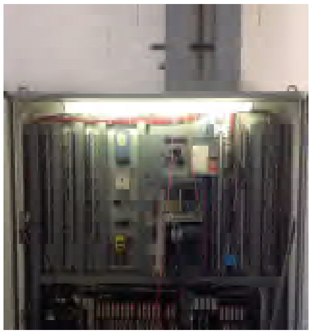
Facility: Waste Water Campus
Equipment Location: ____
Equipment Name: RTU 2
Discipline: Electrical / Instrumentation

Equipment Information

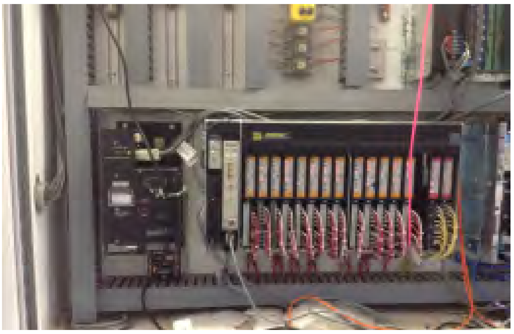
Cabinet ID: ____
Cabinet Location: ____
Process(es) Served: ____
Panel Dimensions: ____
GPS Location:

Inspection Date: 8/6/2014
Inspection By: K. Pepler
Install Date: ____
Condition*: **5** out of 5

Picture – Panel External



Picture – Panel Internal



General Comments:

Controller Model : SquareD SY/MAX

*Condition
1 – Very Good
2 – Minor Defects
3 – Needs Significant Matenance
4 – Requires Rehabilitation
5 – Requires Replacement (>50%)

Component Models

Enclosure
Model Number: ____
NEMA: ____
Mounting: ____
Thermal Management: ____
Accessories: ____
Side Panels: ____

PLC
Manufacturer: SquareD
Processor: SY/MAX 400
Communications: SY/COMM
Accessories: ____
Redundant Processors: N

UPS
Model: ____
Size: ____
Communication: ____
Condition*: out of 5

Components
Circuit Breaker: ____
SPD: ____
Relays: ____
HMI/OIT: ____
Ethernet: ____
Radio: ____
DC Power Supply: ____
Switches: ____
Amount of I/O: ____
Other: ____

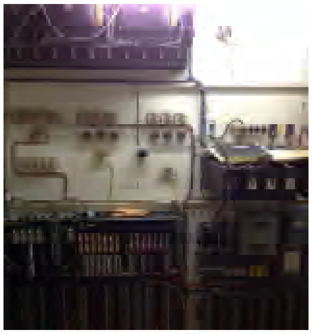
City of Oxnard WWTP
Condition Assessment Form

Facility: Waste Water Campus
Equipment Location: North Area Control Center
Equipment Name: RTU 5
Discipline: Electrical / Instrumentation

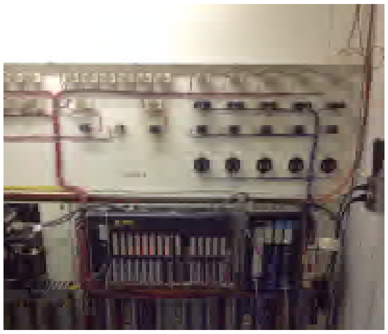
Equipment Information

Cabinet ID: RTU 5
Inspection Date: 8/6/2014
Cabinet Location: North Area CC
Inspection By: K. Pepler
Process(es) Served:
Install Date:
Panel Dimensions:
Condition*: **5** out of 5
GPS Location:

Picture – Panel External



Picture – Panel Internal



General Comments:

*Condition
1 – Very Good
2 – Minor Defects
3 – Needs Significant Matenance
4 – Requires Rehabilitation
5 – Requires Replacement (>50%)

Controller Model : SquareD SY/MAX

Component Models

Enclosure
Model Number:
NEMA:
Mounting:
Thermal Management:
Accessories:
Side Panels:

PLC
Manufacturer: SquareD
Processor: SY/MAX 400
Communications: SY/COMM
Accessories:
Redundant Processors: N

UPS
Model:
Size:
Communication:
Condition*: out of 5

Components
Circuit Breaker:
SPD:
Relays:
HMI/OIT:
Ethernet:
Radio:
DC Power Supply:
Switches:
Amount of I/O:
Other:

City of Oxnard WWTP
Condition Assessment Form

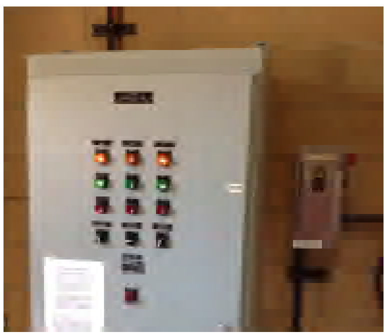
Facility: Waste Water Campus
Equipment Location: Interstage PS
Equipment Name: RTU 6
Discipline: Electrical / Instrumentation

Equipment Information

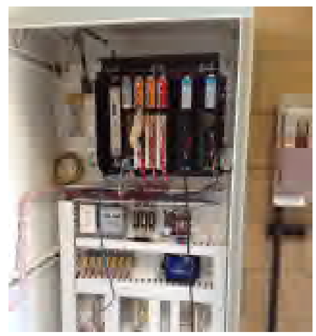
Cabinet ID: LCP-P
Cabinet Location: Interstage PS
Process(es) Served:
Panel Dimensions:
GPS Location:

Inspection Date: 8/6/2014
Inspection By: K. Pepler
Install Date:
Condition*: **4** out of 5

Picture – Panel External



Picture – Panel Internal



General Comments:

Controller Model : SquareD SY/MAX

*Condition
1 – Very Good
2 – Minor Defects
3 – Needs Significant Matenance
4 – Requires Rehabilitation
5 – Requires Replacement (>50%)

Component Models

Enclosure
Model Number:
NEMA:
Mounting:
Thermal Management:
Accessories:
Side Panels:

PLC
Manufacturer: SquareD
Processor: SY/MAX 400
Communications: SY/COMM
Accessories:
Redundant Processors: N

UPS
Model: None Seen
Size:
Communication:
Condition*: out of 5

Components
Circuit Breaker:
SPD:
Relays:
HMI/OIT:
Ethernet:
Radio:
DC Power Supply:
Switches:
Amount of I/O:
Other:

City of Oxnard WWTP
Condition Assessment Form

Facility: Waste Water Campus
Equipment Location: Main Electrical Bldg
Equipment Name: RTU 9
Discipline: Electrical / Instrumentation

Equipment Information

Cabinet ID: RTU-9
Cabinet Location:
Process(es) Served:
Panel Dimensions:
GPS Location:

Inspection Date: 8/6/2014
Inspection By: K. Pepler
Install Date:
Condition*: **5** out of 5

Picture – Panel External

Picture – Panel Internal

General Comments:

*Condition
1 – Very Good
2 – Minor Defects
3 – Needs Significant Matenance
4 – Requires Rehabilitation
5 – Requires Replacement (>50%)

Controller Model : SquareD SY/MAX

Component Models

Enclosure
Model Number:
NEMA:
Mounting:
Thermal Management:
Accessories:
Side Panels:

PLC
Manufacturer: SquareD
Processor: sy/max 400
Communications: SY/COMM
Accessories:
Redundant Processors: N

UPS
Model: Best ME
Size:
Communication:
Condition*: out of 5

Components
Circuit Breaker:
SPD:
Relays:
HMI/OIT:
Ethernet:
Radio:
DC Power Supply:
Switches:
Amount of I/O:
Other:

City of Oxnard WWTP
Condition Assessment Form

Facility: Waste Water Campus
Equipment Location: Gallery
Equipment Name: RTU 4
Discipline: Electrical / Instrumentation

Equipment Information

Cabinet ID: RTU-4
Cabinet Location:
Process(es) Served:
Panel Dimensions:
GPS Location:

Inspection Date: 8/6/2014
Inspection By: K. Pepler
Install Date:
Condition*: **4** out of 5

Picture – Panel External

Picture – Panel Internal

General Comments:

*Condition
1 – Very Good
2 – Minor Defects
3 – Needs Significant Matenance
4 – Requires Rehabilitation
5 – Requires Replacement (>50%)

Controller Model : SquareD SY/MAX

Component Models

Enclosure
Model Number:
NEMA: 4X
Mounting: Floor Mount
Thermal Management: FA
Accessories:
Side Panels:

PLC
Manufacturer: SquareD
Processor: SY/MAX
Communications: SY/COMM
Accessories:
Redundant Processors: N

UPS
Model:
Size:
Communication:
Condition*: out of 5

Components
Circuit Breaker:
SPD:
Relays:
HMI/OIT:
Ethernet:
Radio:
DC Power Supply:
Switches:
Amount of I/O:
Other:

APPENDIX B – PLC LIFECYCLES

Date

Address

Dear Schneider Electric Customer:

At Schneider Electric, we recognize that you have a lot of resources, knowledge and intellectual property invested in your Schneider Electric SY/MAX™ PLC applications. Because of this, we have continued to provide you with new SY/MAX PLC modules to help you protect your investment. We find ourselves in a situation where it is becoming increasingly difficult to secure the components required to maintain this level of support.

The End of Commercialization (EOC) of the SY/MAX PLC product offer will occur on 30 July 2014. End of Service (EOS) is scheduled for 30 July 2022. Last Buy is 31 March 2014. In the event that certain components become unavailable more quickly than anticipated, we will not be able to maintain the planned EOC or EOS dates for any module that requires the components that are no longer available. We are making this announcement now to provide you with ample time to determine how best to manage your application.

It is important to know that we offer several tools to minimize the impact of upgrading your applications. We can provide mounting plates that will allow you to mount new Modicon™ Quantum™ PLCs in the cabinet using the same mounting holes that were already drilled for the SY/MAX PLC. We also offer Quick Wiring Adapters that let you move your field wiring terminal from the SY/MAX I/O module directly to the new Quantum I/O modules. By using the same terminal strips and wiring used to connect to your existing SY/MAX I/O, you can reduce your down time for the upgrade and the potential for wiring errors considerably. The commissioning of the upgrade will take much less time.

We can also convert your existing application directly into Unity™ Pro IEC ladder logic. The converted program will look and operate very much the same as before. This will reduce the amount of time and effort required for your people to get up to speed on the new application software program. This conversion service uses a proprietary conversion utility to greatly reduce the time taken to convert your PLC logic versus manual methods.

We help you manage your budget, productivity and profitability during the upgrade by offering options in how to perform the upgrade. You could change everything at the same time. You would experience only one period of scheduled down time to do this. When complete, you would have a new application that would allow you to take advantage of all the new technology available in our newest Modicon Quantum PLCs to help you improve your operating efficiency

Schneider Electric
1415 South Roselle Road
Palatine, IL 60067-7399
Tel. (847) 397-2600 Fax (847) 925-7500
www.us.schneider-electric.com

You could also schedule your upgrade to be completed in phases. This would allow you to manage your budget and minimize the down time during each phase of the upgrade process. This approach is especially helpful if you have limited time for regular maintenance outages.. The same tools still apply. The new Modicon Quantum PLC can manage both the Quantum I/O and any SY/MAX I/O remaining in your application. In either scenario, our goal is to help you minimize the business impact of performing an upgrade.

If you have any questions, you should contact your Schneider Electric authorized Distributor or your Schneider Electric Industry Business Account Manager or Application Engineer.

Sincerely,

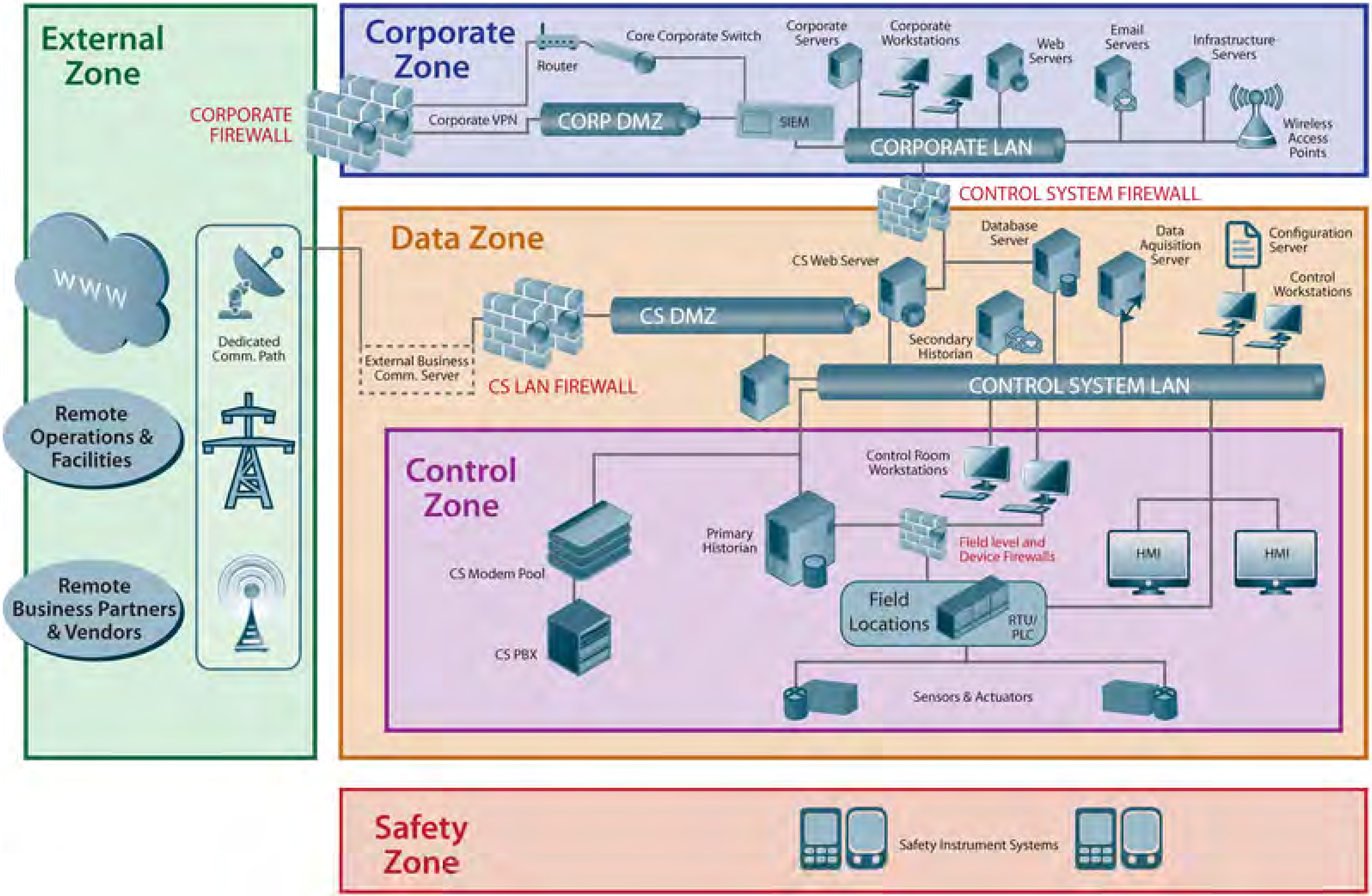
Schneider Electric Representative

Brochure: “Boost your productivity by upgrading your SQD Sy/MAX PLCs”

http://static.schneider-electric.us/docs/Automation%20Products/SYMAX%20Programmable%20Controller/8000BR1259_US_Symax%20Upgrade%20BR.pdf

Schneider Electric
1415 South Roselle Road
Palatine, IL 60067-7399
Tel. (847) 397-2600 Fax (847) 925-7500
www.us.schneider-electric.com

APPENDIX C - ICS NETWORK ARCHITECTURE


External Zone
Corporate Zone
Router
Core Corporate Switch
Corporate Servers
Corporate Workstations
Web Servers
Email Servers
Infrastructure Servers
CORPORATE FIREWALL
Corporate VPN
CORP DMZ
SIEM
CORPORATE LAN
Wireless Access Points
CONTROL SYSTEM FIREWALL
WWW
Dedicated Comm. Path
Data Zone
Database Server
Data Aquisition Server
Configuration Server
CS Web Server
Control Workstations
CS DMZ
Secondary Historian
External Business Comm. Server
CS LAN FIREWALL
CONTROL SYSTEM LAN
Remote Operations & Facilities
Control Zone
Control Room Workstations
Primary Historian
Field level and Device Firewalls
HMI
HMI
CS Modem Pool
Field Locations
RTU/ PLC
Remote Business Partners & Vendors
CS PBX
Sensors & Actuators
Safety Zone
Safety Instrument Systems

This document is released for the purpose of information exchange review and planning only under the authority of Tracy Anne Clinton, September 2017, State of California, PE No. 48199 and Shawn A. Dent, September 2017

City Of Oxnard

Public Works Integrated Master Plan

WASTEWATER

PROJECT MEMORANDUM 3.11
FLOW MONITORING

REVISED FINAL DRAFT
September 2017

2700 YGNACIO VALLEY ROAD, SUITE 300 • WALNUT CREEK, CALIFORNIA 94598 • P. 925.932.1710 • F. 925.930.0208

PREFACE

The analysis and evaluations contained in these Project Memorandum (PM) are based on data and information available at the time of the original date of publication, December 2015. After development of the December 2015 Final Draft PMs, the City continued to move forward on two concurrent aspects: 1) advancing the facilities planning for the water, wastewater, recycled water, and stormwater facilities; and 2) developing Updated Cost of Service (COS) Studies (Carollo, 2017) for the wastewater/collection system and the water/distribution system. The updated 2017 COS studies contain the most recent near-term Capital Improvement Projects (CIP). **The complete updated CIP based on the near-term and long-term projects is contained in the Brief History and Overview of the City of Oxnard Public Works Department's Integrated Planning Efforts: May 2014 – August 2017 section.**

At the time of this Revised PWIMP, minor edits were also incorporated into the PMs. Minor edits included items such as table title changes and updating reports that were completed after the December 2015 original publication date.

City Of Oxnard

Public Works Integrated Master Plan

WASTEWATER

PROJECT MEMORANDUM 3.11
FLOW MONITORING

TABLE OF CONTENTS

Page

LIST OF TABLES

FLOW MONITORING

1.0 INTRODUCTION

V&A Incorporated (V&A) was contracted to conduct both dry and wet weather sanitary sewer flow monitoring within the City of Oxnard. V&A conducted dry weather flow monitoring at 10 open-channel flow monitoring sites from August 2, 2014 to August 24, 2014 and the results can be seen in Appendix A. V&A performed wet weather flow monitoring at 10 open-channel flow monitoring sites from December 9, 2014 to February 25, 2015. Except for one location, the wet weather monitoring sites were at the same locations as the dry weather study. The flow monitoring for Site 4A was performed one manhole upstream from Site 4 as the new site had better hydraulic conditions for flow monitoring. Rainfall data for five rainfall recording sites was obtained from the Ventura County Watershed Protection District Hydrologic Data Server. The results of the wet weather flow monitoring can be seen in Appendix B.

1.1 Project Memorandums (PMs) Used for Reference

The wastewater flow monitoring outlined in this PM was made in concert with recommendations and analyses from other related PMs:

- PM 3.1 - Wastewater System - Background Summary.
- PM 3.2 - Wastewater System - Flow and Load Projections.
- PM 3.3 - Wastewater System - Infrastructure Modeling and Alternatives.
- PM 3.4 - Wastewater System - Treatment Plant Performance and Capacity.

2.0 DRY WEATHER FLOW MONITORING FINDINGS

2.1 Pipeline Capacity Analysis During Dry Weather Flow Monitoring

Table 1 summarizes the peak recorded flows, levels, d/D ratios, and peaking factors per site during the flow monitoring period. The capacity analysis is presented on a site-by-site basis and represents the hydraulic conditions only at the flow monitoring conditions. Hydraulic conditions in other areas of the collection system will differ.

Peaking factor is defined as the peak measured flow divided by the average dry weather flow (ADWF). All flow monitoring sites had dry weather peaking factors below the typical design threshold value of 3.0.

Table 1	Capacity Analysis Summary for Dry Weather Flow Monitoring Public Works Integrated Master Plan City of Oxnard					
Site	**ADWF (mgd)**	**Peak Measured Flow (mgd)**	**Peaking Factor**	**Diameter (in)**	**Peak Level (in)**	**d/D Ratio**
Site 1	5.14	8.44	1.64	41.5	19.8	0.48
Site 2	2.70	3.83	1.42	36	16.1	0.45
Site 3	7.13	13.53	1.90	60	21.5	0.36
Site 4	4.30	7.06	1.64	33	14.5	0.44
Site 5	1.34	2.85	2.13	36	14.0	0.39
Site 6	1.35	2.38	1.76	24	15.1	0.63
Site 7	0.31	0.53	1.71	24	5.9	0.25
Site 8	1.84	2.96	1.61	27	11.6	0.43
Site 9	2.04	3.34	1.64	42	8.5	0.20
Site 10	1.91	3.46	1.81	37	16.3	0.44

The d/D Ratio is the peak measured depth of flow (d) divided by the pipe diameter (D). All flow monitoring sites also had dry weather d/D ratios below the typical design threshold value of 0.75.

3.0 WET WEATHER FLOW MONITORING FINDINGS

3.1 Rainfall Data

During the wet weather flow monitoring period, there were two notable rainfall events observed from the five rainfall recording sites. Rainfall Event 1 occurred from December 11, 2014 to December 12, 2014; the amount of rainfall was between 1.89 to 2.55 inches for the five rainfall recording sites. Rainfall Event 2 occurred from January 10, 2015 to January 11, 2015; the amount of rainfall was between 1.46 to 2.26 inches for the five rainfall recording sites. Rainfall Event 1 had a return frequency greater than a 5-year storm event for a 6-hour duration. If longer durations are considered, Rainfall Event 1 was greater than a 2-year storm event for a 12-hour duration and greater than a 1-year storm event for a 2-day duration. Rainfall Event 2 was less than a 1-year storm event for all durations.

3.2 Baseline Flow Analysis

Table 2 summarizes the baseline flow data measured during both the dry and wet weather flow monitoring. The baseline flows compare well with each other except for Site 2 and Site 4.

The flow patterns measured at Site 2 were not indicative of residential flow contributions, but more industrial or retail flows. If the service area is mostly industrial, then flows may be expected to be sporadic. The sporadic flows could account for the discrepancy between the ADWFs observed during the dry weather and wet weather flow monitoring.

Table 2 Baseline Flow Summary
Public Works Integrated Master Plan
City of Oxnard

Site	Overall ADWF (mgd)(1)	Dry Weather ADWF (mgd)(2)
Site 1	4.823	5.142
Site 2	2.194	2.702
Site 3	6.988	7.134
Site 4A	3.153	4.301(3)
Site 5	1.408	1.341
Site 6	1.197	1.351
Site 7	0.333	0.311
Site 8	1.638	1.840
Site 9	2.306	2.041
Site 10	2.128	1.913

Notes:
(1) ADWF observed during wet weather flow monitoring.
(2) ADWF observed during dry weather flow monitoring.
(3) Refers to data from Site 4. There was no dry weather flow monitoring conducted for Site 4A.

As mentioned previously, all the wet weather flow monitoring sites were at the same locations as the dry weather study except for one location. Site 4, which was monitored during the dry weather study, had inconsistent hydraulics. Additionally, Site 4 had turbulent conditions and was not an ideal site to capture accurate flow monitoring data. Based on discussions between V&A and the City of Oxnard, the wet weather monitoring for Site 4 was relocated to a different location with suitable hydraulic conditions to ensure accuracy and repeatability. The new flow monitoring location, labeled Site 4A, was placed one manhole upstream from Site 4.

3.3 Pipeline Capacity Analysis During Wet Weather Flow Monitoring

Table 3 summarizes the peak recorded flows, levels, d/D ratios, and peaking factors per site during the flow monitoring period. The capacity analysis is presented on a site-by-site basis and represents the hydraulic conditions only at the flow monitoring conditions. Hydraulic conditions in other areas of the collection system will differ. All sites had peaking factors and d/D ratios that were lower than the typical design threshold. No surcharging was observed at any of the flow monitoring sites.

Table 3	Capacity Analysis Summary for Wet Weather Flow Monitoring Public Works Integrated Master Plan City of Oxnard					
Site	ADWF (mgd)	Peak Measured Flow (mgd)	Peaking Factor	Diameter (in)	Peak Level (in)	d/D Ratio
Site 1	4.823	8.312	1.7	41.5	20.0	0.48
Site 2	2.194	6.002	2.7	36	21.2	0.59
Site 3	6.988	14.352	2.1	60	24.1	0.40
Site 4	3.153	5.729	1.8	33	23.1	0.70
Site 5	1.408	3.074	2.2	36	13.5	0.37
Site 6	1.197	2.292	1.9	24	11.0	0.46
Site 7	0.333	0.620	1.9	24	5.9	0.25
Site 8	1.638	4.540	2.8	27	15.5	0.57
Site 9	2.306	4.053	1.8	42	9.5	0.23
Site 10	2.128	4.024	1.9	37	14.9	0.40

3.4 Inflow Results

Inflow results were obtained from Rainfall Event 1 since it was the most intensive short-term rainfall event observed. Table 4 summarizes the peak measured I/I flows and inflow analysis results. The inflow component of inflow and infiltration (I/I) often causes a peak flow problem in the sewer system and often dictates the required capacity of downstream pipes and transport facilities to carry these peak instantaneous flows.

Table 4	Inflow and Infiltration Analysis Summary Public Works Integrated Master Plan City of Oxnard		
Site	ADWF (mgd)	Peak I/I Rate (mgd)	Peak I/I per ADWF
Site 1	4.823	3.468	0.7
Site 2	2.194	3.242	1.5
Site 3	6.988	5.545	0.8
Site 4A	3.153	4.512	1.4
Site 5	1.408	2.044	1.5
Site 6	1.197	1.081	0.9
Site 7	0.333	0.248	0.7
Site 8	1.638	3.725	2.3
Site 9	2.306	1.884	0.8
Site 10	2.128	1.052	0.5

3.5 Infiltration Results

Based on the data, the rain dependent infiltration (RDI) rates for all the flow monitoring sites in the City of Oxnard were minimal or negligible. RDI analysis would typically be run 24-hours after the conclusion of a rainfall event; however, within 8 hours or so, the flow rates had already returned to baseline levels. Although the RDI rates were negligible, there are many sewers that travel through perched aquifers that have infiltration regardless of rainfall.

APPENDIX A – DRY WEATHER SANITARY SEWER FLOW MONITORING STUDY

SANITARY SEWER FLOW MONITORING STUDY

City of Oxnard

October 2014

CITY OF OXNARD
SANITARY SEWER FLOW MONITORING STUDY

Prepared for

Carollo Engineers
89 Newbury Street, Suite 104
Danvers, MA 01923

Prepared by

V&A

October 2014

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

ABBREVIATIONS USED IN THIS REPORT

Abbreviation	Term
ADWF	average dry weather flow
BL	Baseline
CO	carbon monoxide
d/*D*	depth/diameter ratio
FM	flow monitor
H_2S	hydrogen sulfide
LEL	lower explosive limit
mgd	million gallons per day
Q	flow rate
SSO	sanitary sewer overflow
WWTP	Wastewater Treatment Plant

INTRODUCTION

Scope and Purpose

V&A Consulting Engineers, Inc. (V&A) was retained by Carollo Engineers to perform a sanitary sewer flow monitoring study within the City of Oxnard, California (City). Flow monitoring was performed over a period of approximately three weeks from August 2, 2014 to August 24, 2014 at 10 open-channel flow monitoring sites. The purpose of this study was to measure sanitary sewer flows at the flow monitoring sites and estimate available sewer capacity.

Flow Monitoring Sites

Flow monitoring sites are the locations where the flow monitors were placed. Capacity and flow rate information is presented on a site-by-site basis. The flow monitoring locations are listed in Table 1 and shown in Figure 1.

Table 1. List of Flow Monitoring Locations

Site	Pipe Diameter (in)	Location
Site 1	41.5	McWane Boulevard, east of Perkins Road Latitude: 34.140102°; Longitude: -119.183253°
Site 2	36	Magellan Avenue Latitude: 34.144846°; Longitude: -119.183017°
Site 3	60	J Street and E Port Hueneme Road Latitude: 34.148103°; Longitude: -119.1862°
Site 4	33	J Street and W Hueneme Road Latitude: 34.147435°; Longitude: -119.186003°
Site 5	36	S Rice Avenue and East of Emerson Avenue Latitude: 34.181916°; Longitude: -119.142732°
Site 6	24	S Rose Avenue and E Wooley Road Latitude: 34.189341°; Longitude: -119.160081°
Site 7	24	E Gonzales Road and Bahia Drive Latitude: 34.219168°; Longitude: -119.17503°
Site 8	27	J Street, between Spruce Street and Teakwood Street Latitude: 34.171606°; Longitude: -119.185694°
Site 9	42	N Ventura Road, between Devonshire Drive and Doris Avenue Latitude: 34.210324°; Longitude: -119.194643°
Site 10	37	West of W Hemlock Street and Jetty Street Latitude: 34.181227°; Longitude: -119.211645°

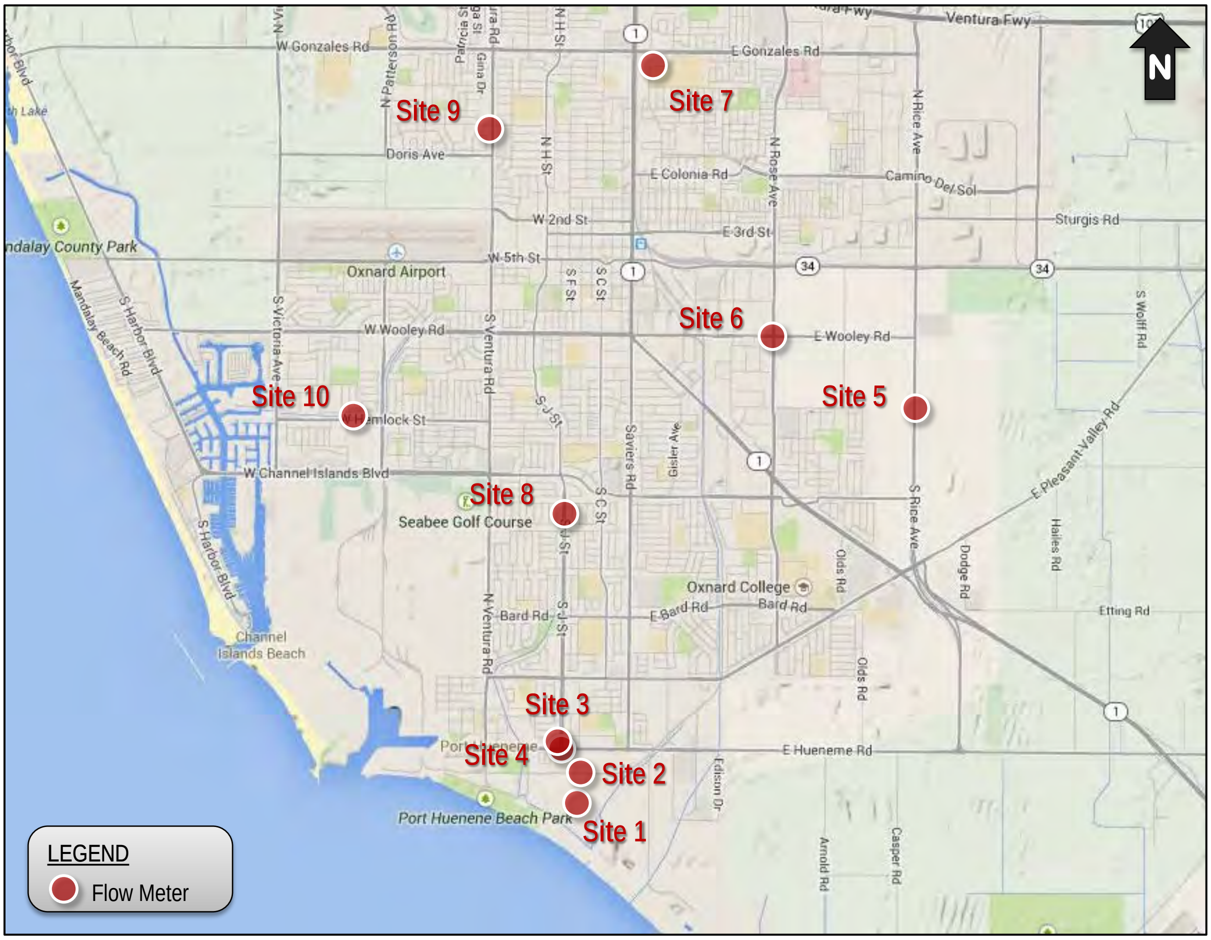


Figure 1. Flow Monitoring Site Map

METHODS AND PROCEDURES

Confined Space Entry

A confined space (Photo 1) is defined as any space that is large enough and so configured that a person can bodily enter and perform assigned work, has limited or restricted means for entry or exit and is not designed for continuous employee occupancy. In general, the atmosphere must be constantly monitored for sufficient levels of oxygen (19.5% to 23.5%), and the absence of hydrogen sulfide (H_2S) gas, carbon monoxide (CO) gas, and lower explosive limit (LEL) levels. A typical confined space entry crew has members with OSHA-defined responsibilities of Entrant, Attendant and Supervisor. The Entrant is the individual performing the work. He or she is equipped with the necessary personal protective equipment needed to perform the job safely, including a personal four-gas monitor (Photo 2). If it is not possible to maintain line-of-sight with the Entrant, then more Entrants are required until line-of-sight can be maintained. The Attendant is responsible for maintaining contact with the Entrants to monitor the atmosphere using another four-gas monitor and maintaining records of all Entrants, if there are more than one. The Supervisor is responsible for developing the safe work plan for the job at hand prior to entering.

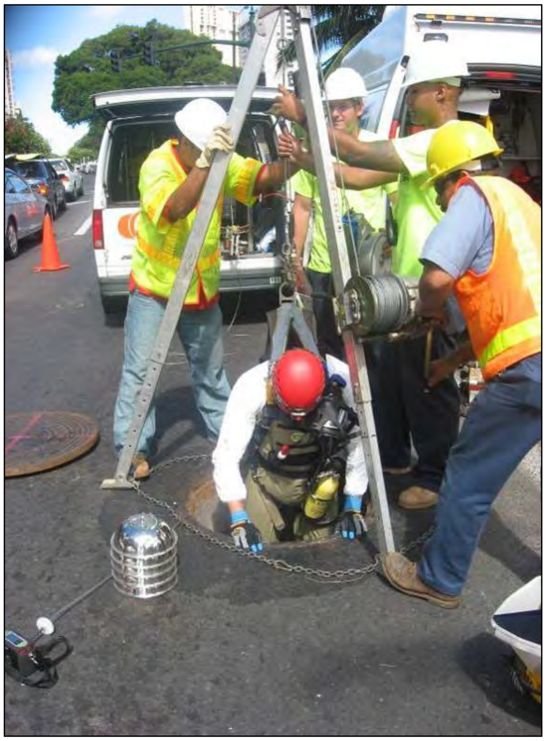


Photo 1. Confined Space Entry

Photo 2. Typical Personal Four-Gas Monitor

Flow Meter Installation

Teledyne Isco 2150 meters were installed by V&A in the sewer lines listed in Table 1. Isco 2150 meters use submerged sensors with a pressure transducer to collect depth readings and an ultrasonic Doppler sensor to determine the average fluid velocity. The ultrasonic sensor emits high-frequency sound waves, which are reflected by air bubbles and suspended particles in the flow. The sensor receives the reflected signal and determines the Doppler frequency shift, which indicates the estimated average flow velocity. The sensor is typically mounted at a manhole inlet to take advantage of smoother upstream flow conditions. The sensor may be offset to one side to lessen the chances of fouling and sedimentation where these problems are expected to occur. Manual level and velocity measurements were taken during installation of the flow meters and again when they were removed and were compared to simultaneous level and velocity readings from the flow meters to ensure proper calibration and accuracy. Figure 2 shows a typical installation for a flow meter with a submerged sensor.

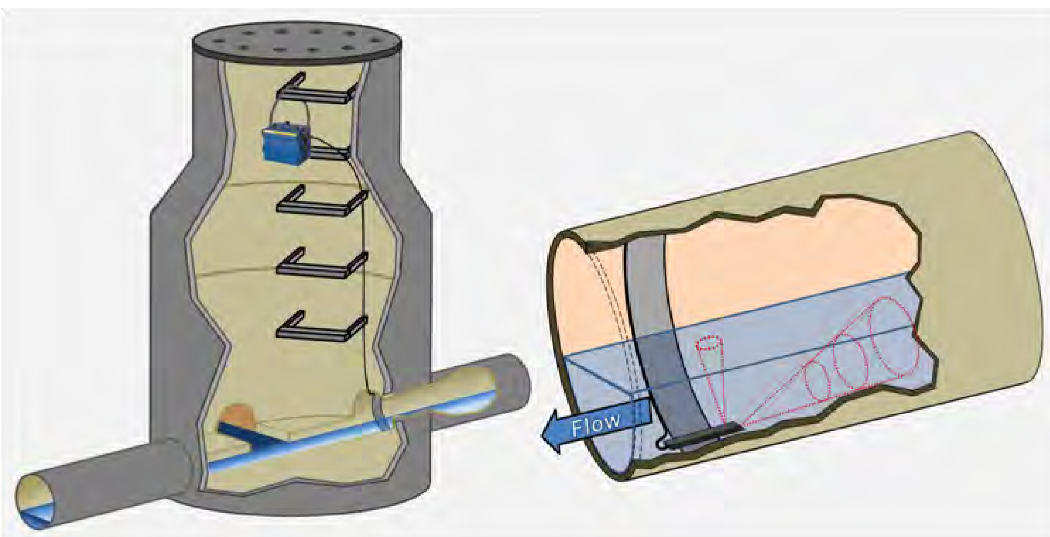


Figure 2. Typical Installation for Flow Meter with Submerged Sensor

Flow Calculation

Data retrieved from the flow meter was placed into a spreadsheet program for analysis. Data analysis includes data comparison to field calibration measurements, as well as necessary geometric adjustments as required for sediment (sediment reduces the pipe's wetted cross-sectional area available to carry flow). Area-velocity flow metering uses the continuity equation,

$$Q = v \cdot A = v \cdot (A_T - A_S)$$

where Q : Volume flow rate
v: Average velocity as determined by the ultrasonic sensor
A: Cross-sectional area available to carry flow
A_T: Total cross-sectional area for both wastewater and sediment
A_S: Cross-sectional area of sediment.

For circular pipe,

$$A_T = \left[\frac{D^2}{4}\cos^{-1}\left(1-\frac{2d_W}{D}\right)\right]-\left[\left(\frac{D}{2}-d_W\right)\left(\frac{D}{2}\right)\sin\left(\cos^{-1}\left(1-\frac{2d_W}{D}\right)\right)\right]$$

$$A_S = \left[\frac{D^2}{4}\cos^{-1}\left(1-\frac{2d_S}{D}\right)\right]-\left[\left(\frac{D}{2}-d_S\right)\left(\frac{D}{2}\right)\sin\left(\cos^{-1}\left(1-\frac{2d_S}{D}\right)\right)\right]$$

where d_W: Distance between wastewater level and pipe invert
d_S: Depth of sediment
D: Pipe Diameter

RESULTS AND ANALYSIS

Observation of Sediment

During flow meter installation and removal, sediment was observed from three sites (Table 3). No sediment was found at the other monitoring sites.

Table 2. Summary of Sediment Condition

Monitoring Site	Depth of Sediment (in.)
Site 1	1.25
Site 3	0.50
Site 5	6.00

Average Dry Weather Flow

Days least affected by rainfall were used to estimate dry weather flows. Typically within a given week, there are four distinct diurnal flow curves that can be established:

- **Mondays through Thursdays:** morning peaks between 8:00 am and 9:00 am, evening peaks between 9:00 pm and 10:00 pm.
- **Fridays:** similar to the Mondays-Thursdays flow curve, but with decreased evening flows from 7:00 pm to midnight.
- **Saturdays:** morning peaks between 11:00 am and 1:00 pm, and a flattened evening peak flow similar to Friday evenings.
- **Sundays:** similar to the Sundays flow curve, but with increased evening flows from 7:00 pm to midnight as people prepare for the work week. The evening flow patterns are similar to the Mondays through Thursdays flow curve.

Figure 5 illustrates the varying flow patterns within a work week (sample data, not from this study).

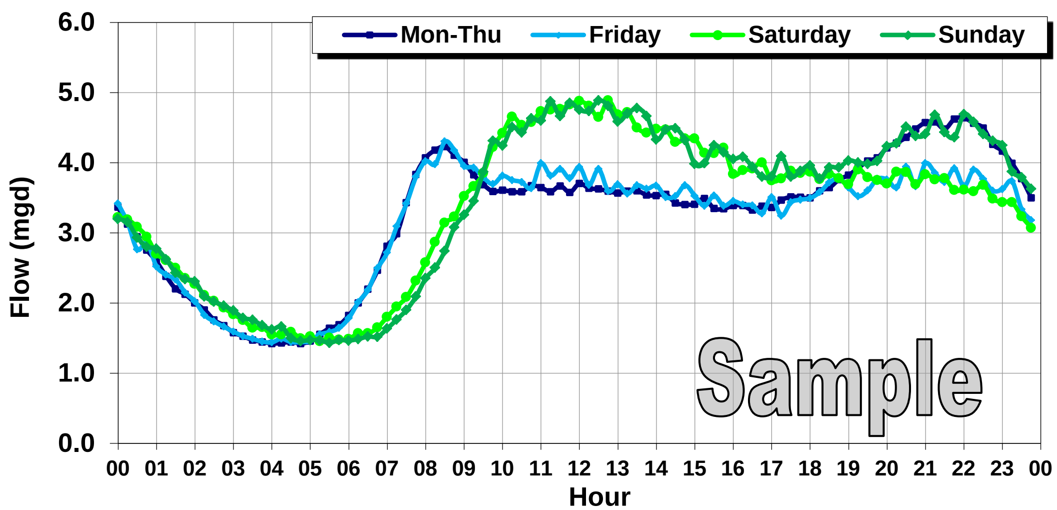


Figure 3. Sample ADWF Diurnal Flow Patterns

This distinction could be important for inflow and infiltration (I/I) analysis, were a storm event to occur during the evening hours on a Friday, Saturday or Sunday. The ADWF curves for this study were taken from the dry days from August 2 through August 24, 2014. The overall average dry weather flow (ADWF) is calculated per the following equation:

$$ADWF = \left(ADWF_{Mon-Thu} \times \frac{4}{7}\right) + \left(ADWF_{Fri} \times \frac{1}{7}\right) + \left(ADWF_{Sat} \times \frac{1}{7}\right) + \left(ADWF_{Sun} \times \frac{1}{7}\right),$$

Table 4 lists the average dry weather flow (ADWF) recorded during this study for the flow monitoring sites. Figure 6 shows a schematic diagram of the overall ADWF and flow levels. Detailed graphs of the ADWF data on a site-by-site basis are included in *Appendix A*.

Table 3. Average Dry Weather Flow Summary

Monitoring Site	Monday - Thursday (mgd)	Friday (mgd)	Saturday (mgd)	Sunday (mgd)	Overall Average (mgd)
Site 1	5.39	5.18	4.71	4.55	5.14
Site 2	2.76	2.86	2.66	2.35	2.70
Site 3	7.03	7.09	7.23	7.51	7.13
Site 4	4.28	4.29	4.39	4.30	4.30
Site 5	1.48	1.38	1.11	0.97	1.34
Site 6	1.44	1.40	1.17	1.13	1.35
Site 7	0.31	0.31	0.31	0.32	0.31
Site 8	1.82	1.86	1.89	1.84	1.84
Site 9	2.01	2.01	2.11	2.11	2.04
Site 10	1.88	1.85	2.00	2.04	1.91

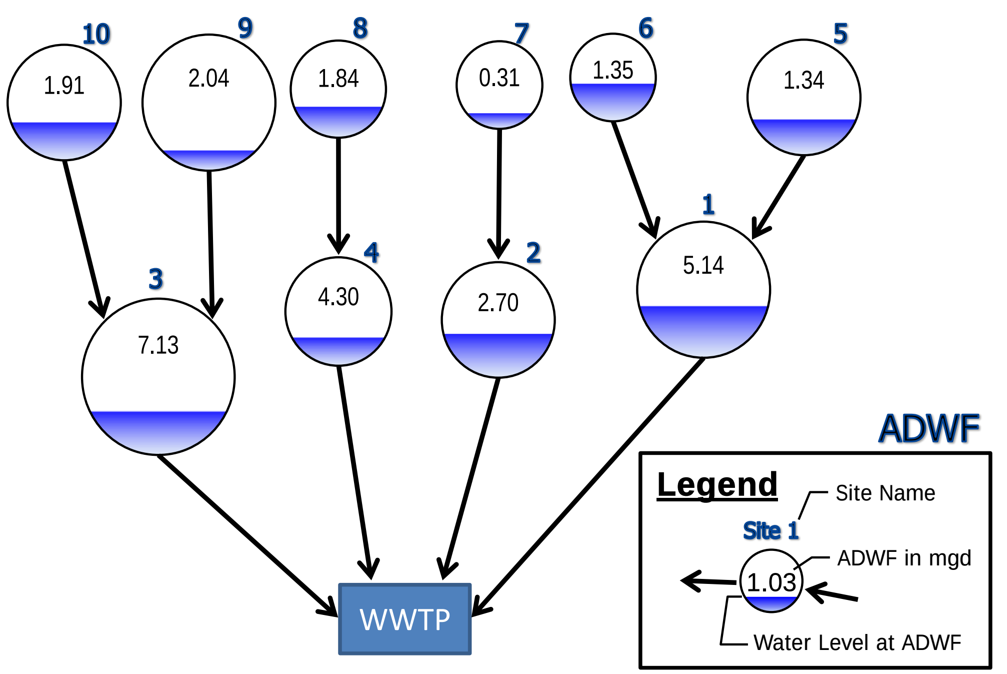


Figure 4. Average Dry Weather Flow Schematic

Peak Measured Flows and Pipeline Capacity Analysis

It is necessary to determine peak measured flows and the flow level (depths) at the peak flow in order to understand the capacity of the collection system. The peak flows and flow levels reported are from the peak measurements as taken across the entirety of the flow monitoring period. Peak flows and levels may not correspond to a rainfall event, but instead may be caused due to blockages, grease or roots that cause a backflow condition. The following capacity analysis terms are defined as follows:

- ❖ **Peaking Factor:** Peaking factor is defined as the peak measured flow divided by the average dry weather flow (ADWF). A peaking factor threshold value of 3.0 is commonly used for sanitary sewer design.
- ❖ ***d*/*D* Ratio:** The *d*/*D* ratio is the peak measured depth of flow (*d*) divided by the pipe diameter (*D*). A threshold value of 0.75 is commonly used for sanitary sewer design.

Table 3 summarizes the peak recorded flows, levels, *d*/*D* ratios, and peaking factors per site during the entire flow monitoring period. Capacity analysis data is presented on a site-by-site basis and represents the hydraulic conditions only at the point site locations. Hydraulic conditions in other areas of the collection system will differ. In this study, all flow monitoring sites had peaking factors and d/D ratios lower than the design threshold values.

Table 4. Capacity Analysis Summary

Site	ADWF (mgd)	Peak Measured Flow (mgd)	Peaking Factor	Diameter (in)	Peak Level (in)	*d*/*D* Ratio
Site 1	5.14	8.44	1.64	41.5	19.8	0.48
Site 2	2.70	3.83	1.42	36	16.1	0.45
Site 3	7.13	13.53	1.90	60	21.5	0.36
Site 4	4.30	7.06	1.64	33	14.5	0.44
Site 5	1.34	2.85	2.13	36	14.0	0.39
Site 6	1.35	2.38	1.76	24	15.1	0.63
Site 7	0.31	0.53	1.71	24	5.9	0.25
Site 8	1.84	2.96	1.61	27	11.6	0.43
Site 9	2.04	3.34	1.64	42	8.5	0.20
Site 10	1.91	3.46	1.81	37	16.3	0.44

The following capacity analysis items are noted:

- ❖ **Peaking Factor:** All sites had dry weather peaking factors below typical threshold values.
- ❖ **d/D Ratio:** All sites had dry weather d/D ratios below typical threshold values.

Figure 4 and Figure 5 show bar graphs summarizing the site-by-site peaking factors and d/D ratios, respectively.

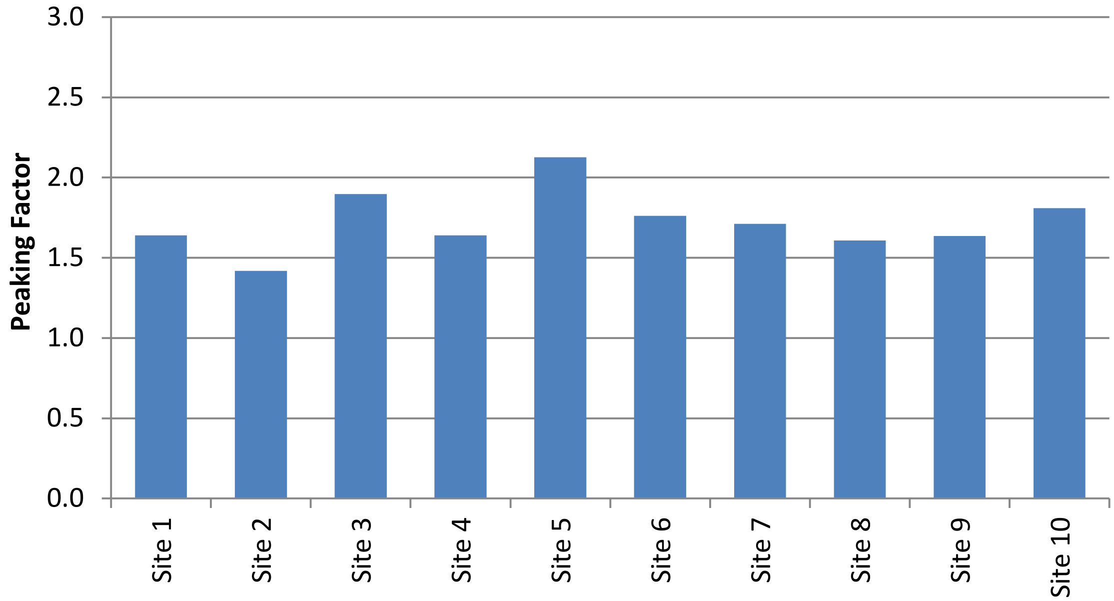


Figure 5. Capacity Summary Bar Graphs: Peaking Factors

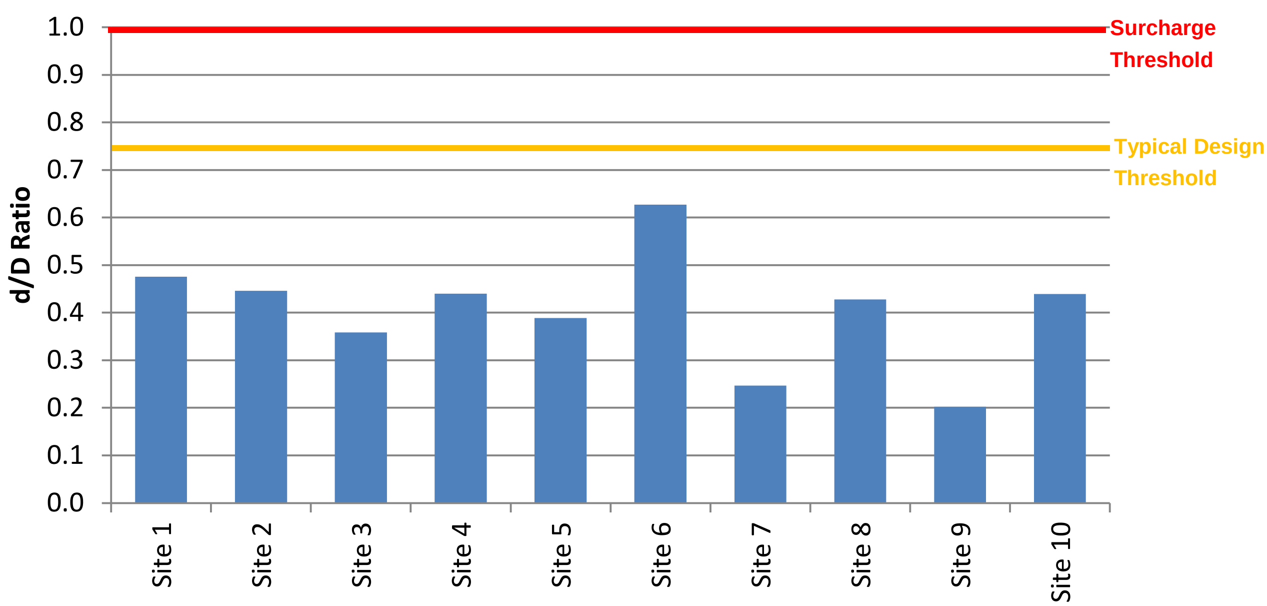


Figure 6. Capacity Summary Bar Graphs: d/D Ratios

Figure 6 shows the schematic diagram of the monitoring sites and the peak measured flows with peak flow levels. However, it is not valid to perform a flow balance when looking at peak measured flows through a collection system due to flow attenuation.

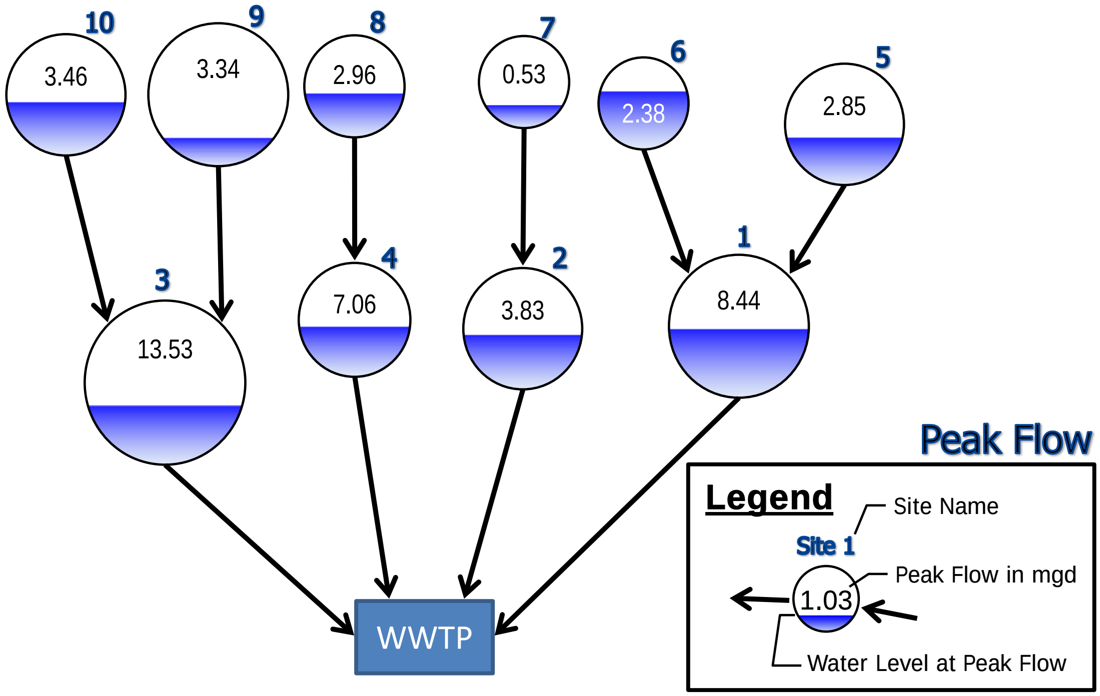


Figure 7. Peak Measured Flow Schematic

APPENDIX A

FLOW MONITORING SITES: DATA, GRAPHS, INFORMATION

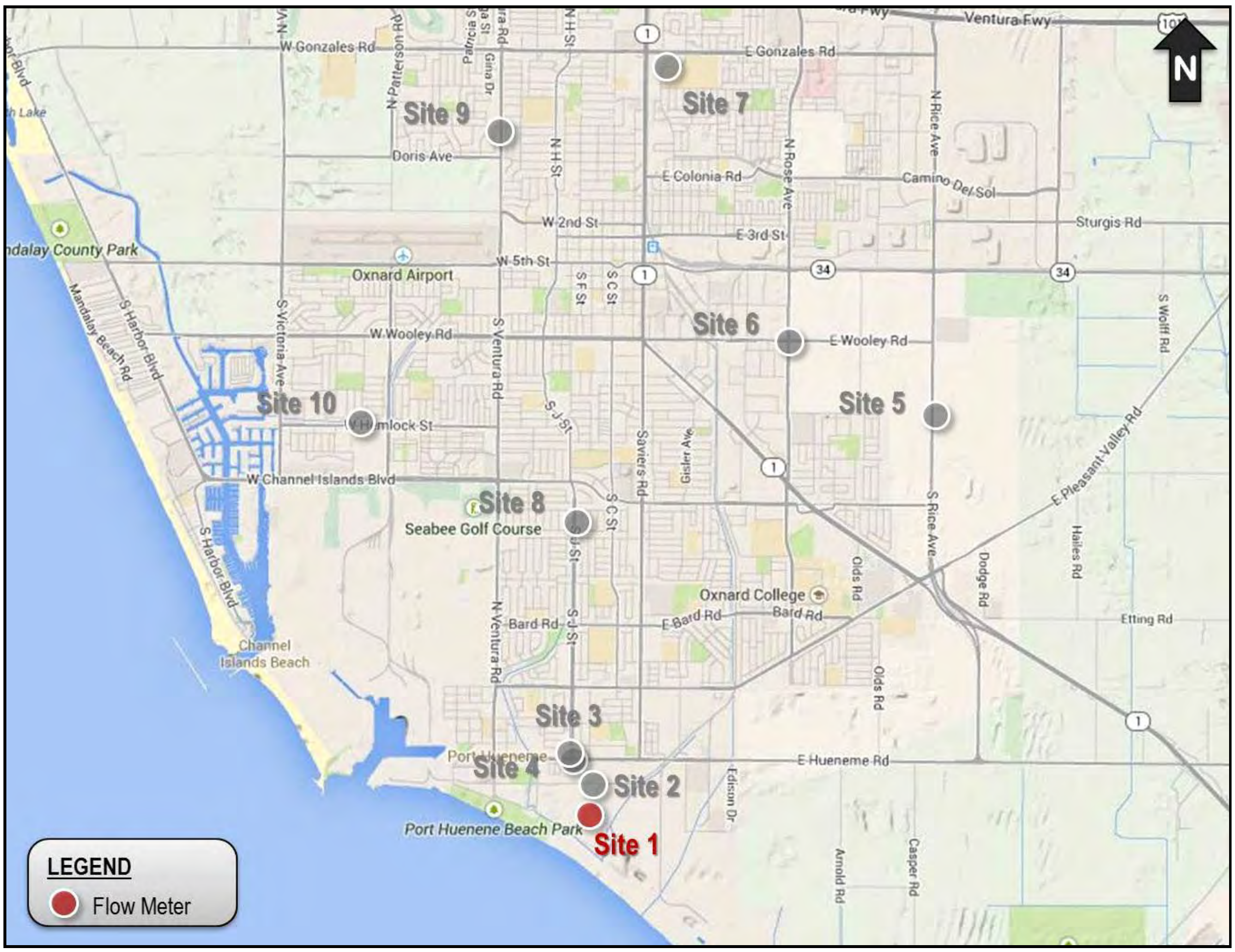
City of Oxnard

Sanitary Sewer Flow Monitoring
Temporary Monitoring: August, 2014

Monitoring Site: Site 1

Location: McWane Boulevard, east of Perkins Road

Data Summary Report



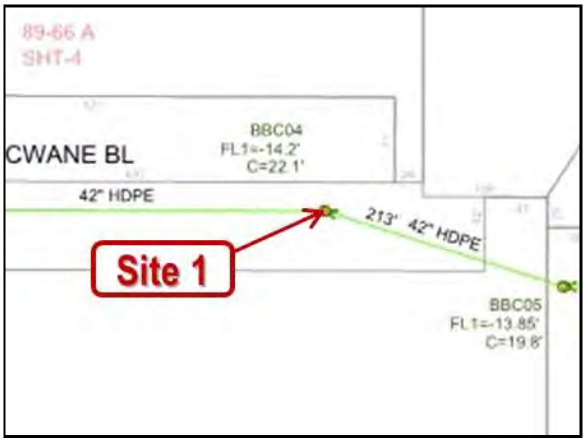
Vicinity Map: Site 1

SITE 1

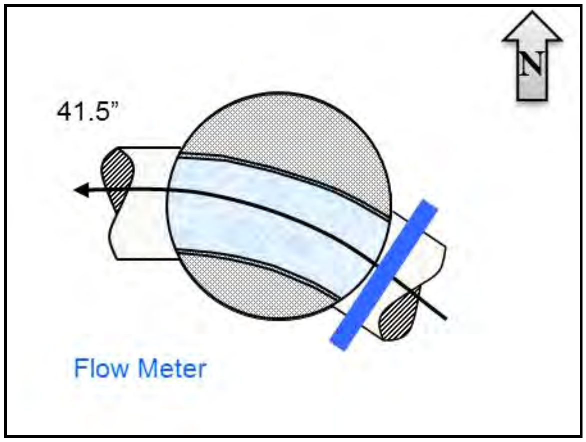
Site Information

Location:	McWane Boulevard, east of Perkins Road
Coordinates:	119.1833° W, 34.1401° N
Rim Elevation:	10 feet
Pipe Diameter:	41.5 inches
Baseline Flow:	5.142 mgd
Peak Measured Flow:	8.438 mgd

Satellite Map

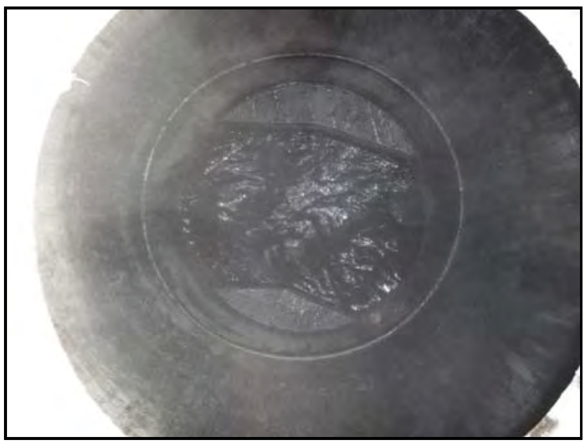


Sanitary Map



Flow Diagram

Street View



Plan View

SITE 1

Additional Site Photos

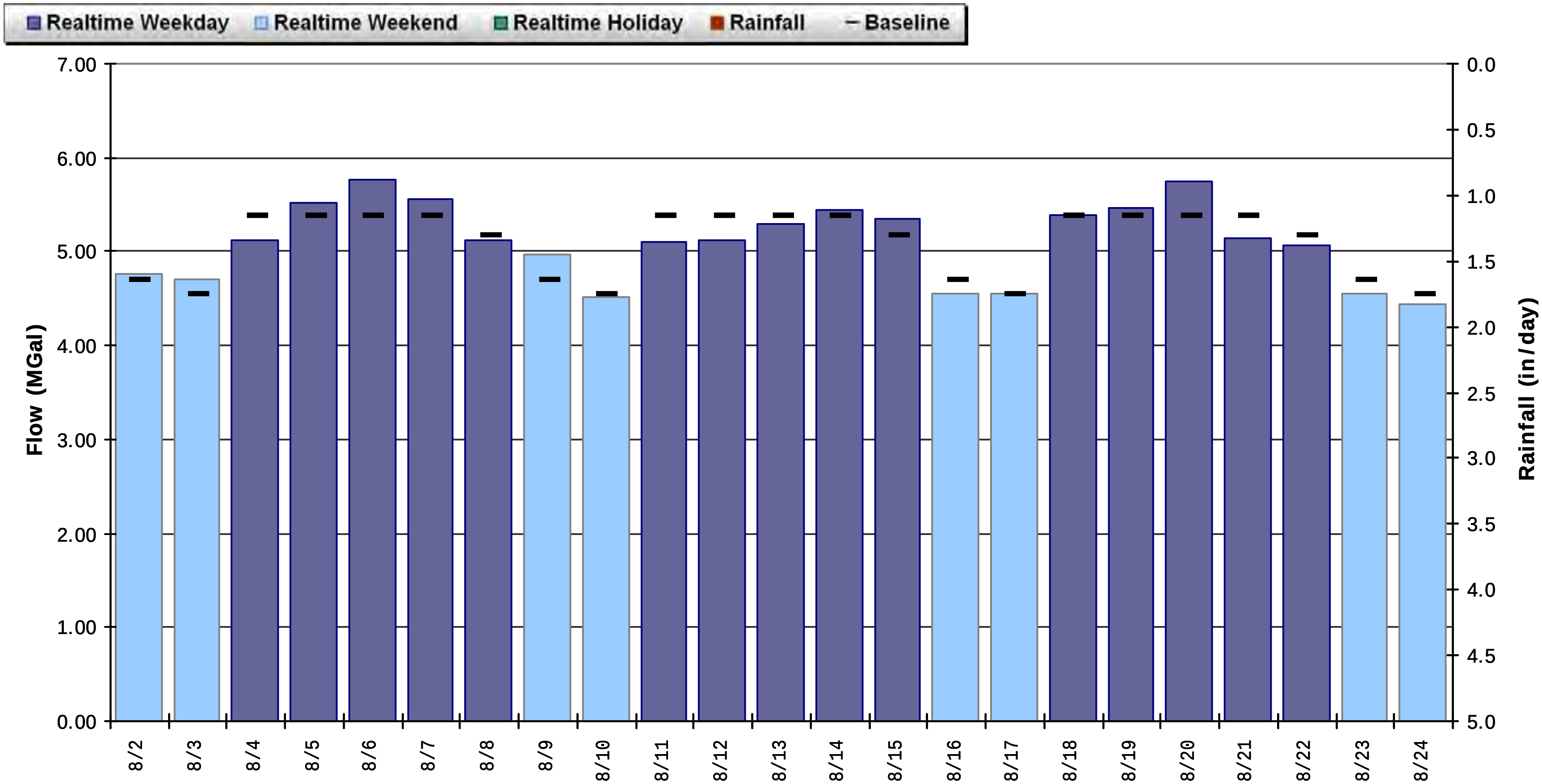
Effluent Pipe

Influent Pipe

SITE 1
Period Flow Summary: Daily Flow Totals

Avg Period Flow: 5.098 MGal **Peak Daily Flow: 5.768 MGal** **Min Daily Flow: 4.436 MGal**

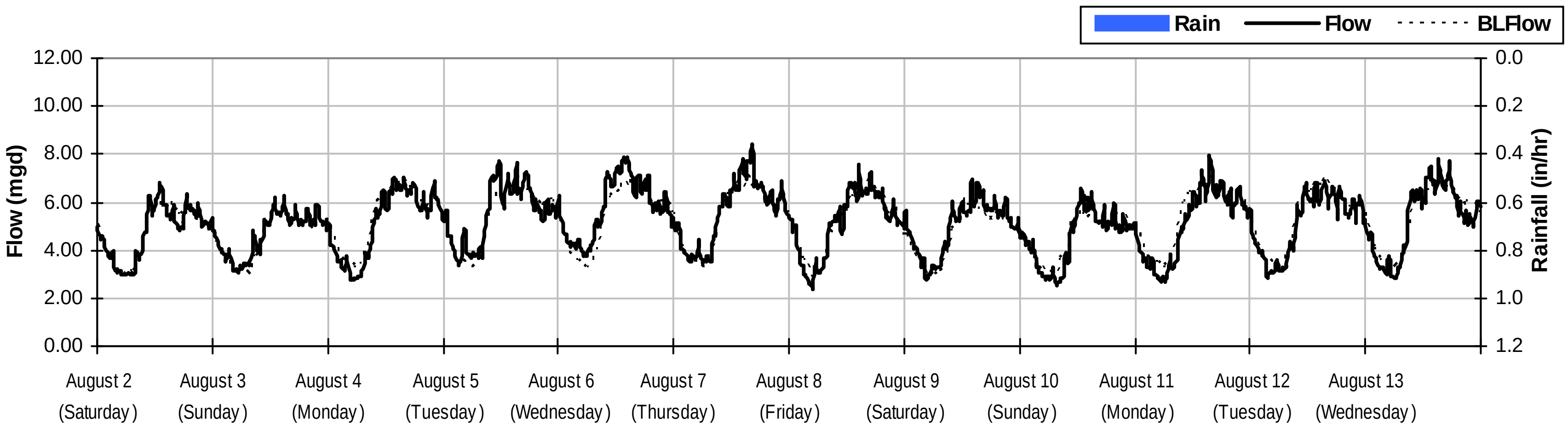
Total Monthly Rainfall: 0.00 inches

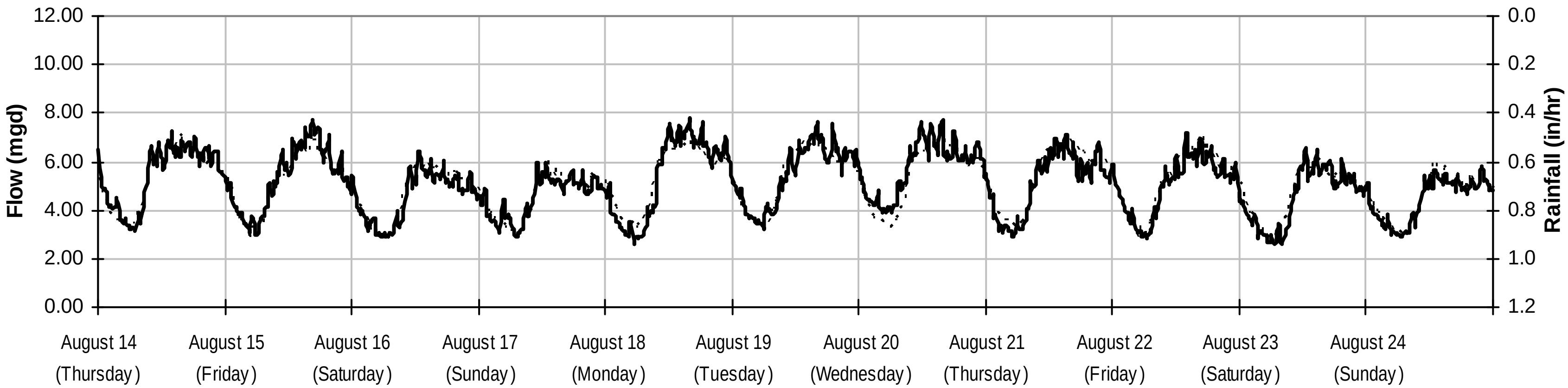


SITE 1

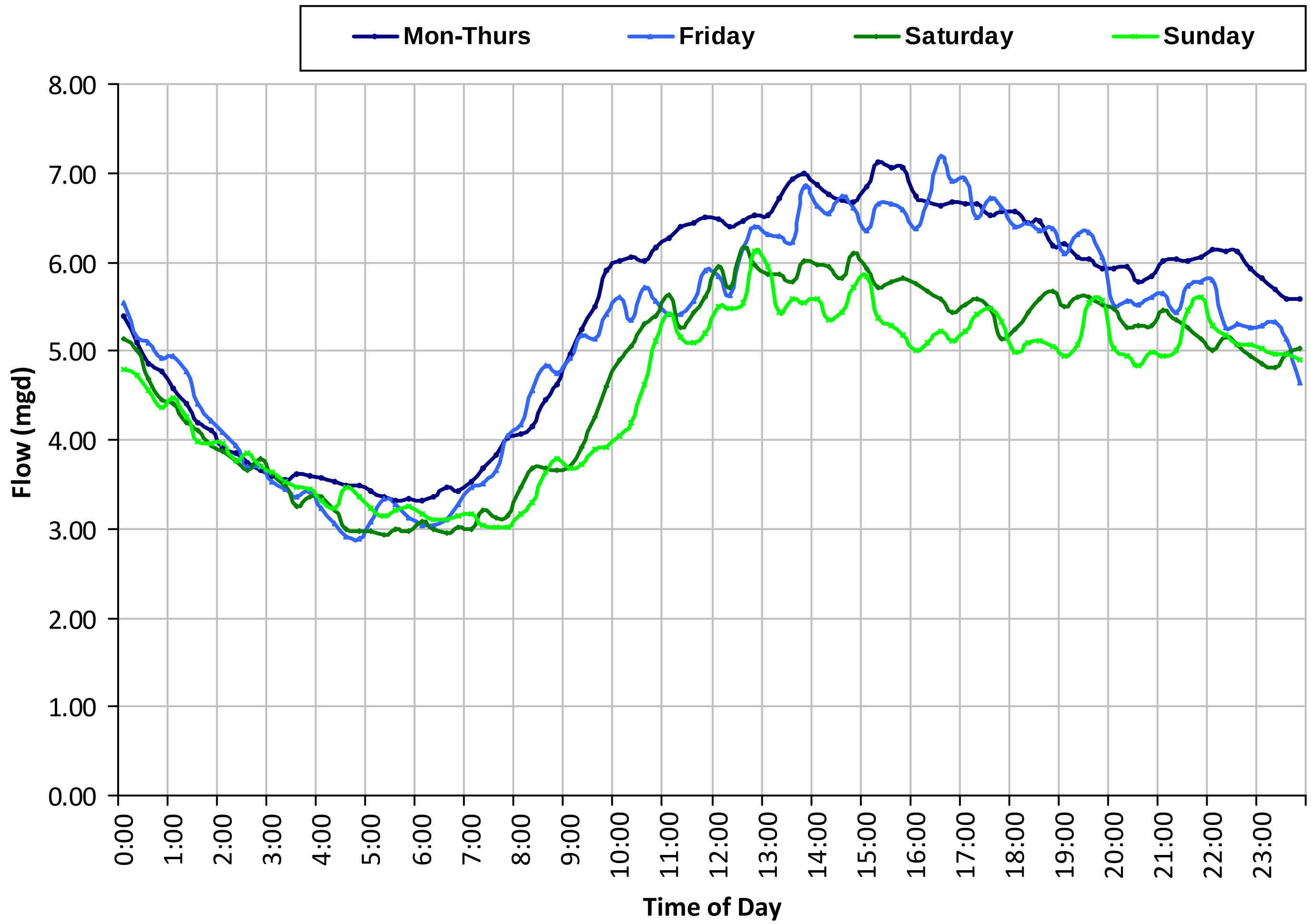
Flow Summary: 8/2/2014 to 8/24/2014

Total Period Rainfall: 0.00 inches **Avg Flow: 5.098 mgd** **Peak Flow: 8.438 mgd** **Min Flow: 2.386 mgd**



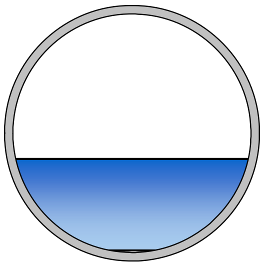


SITE 1
Baseline Flow Hydrographs



Baseline Flow:

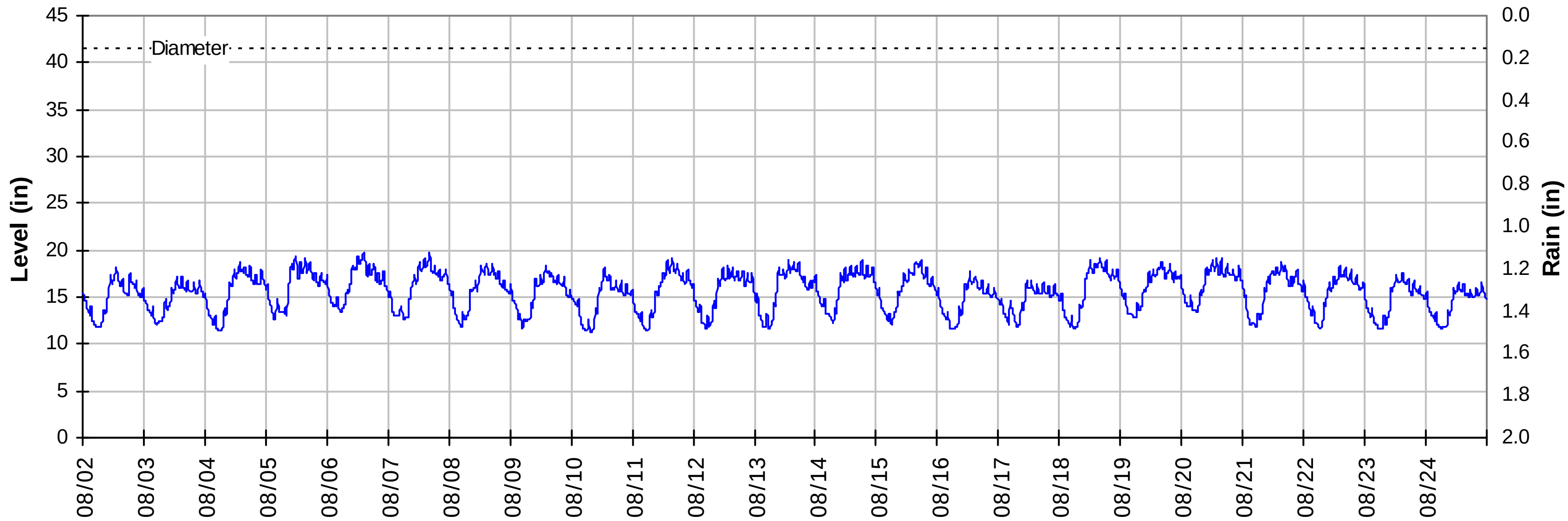
5.142 *mgd*

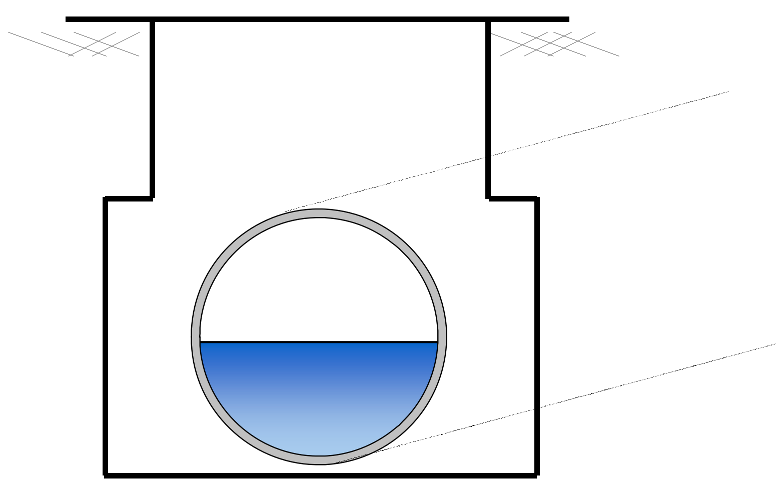


SITE 1

Site Capacity and Surcharge Summary

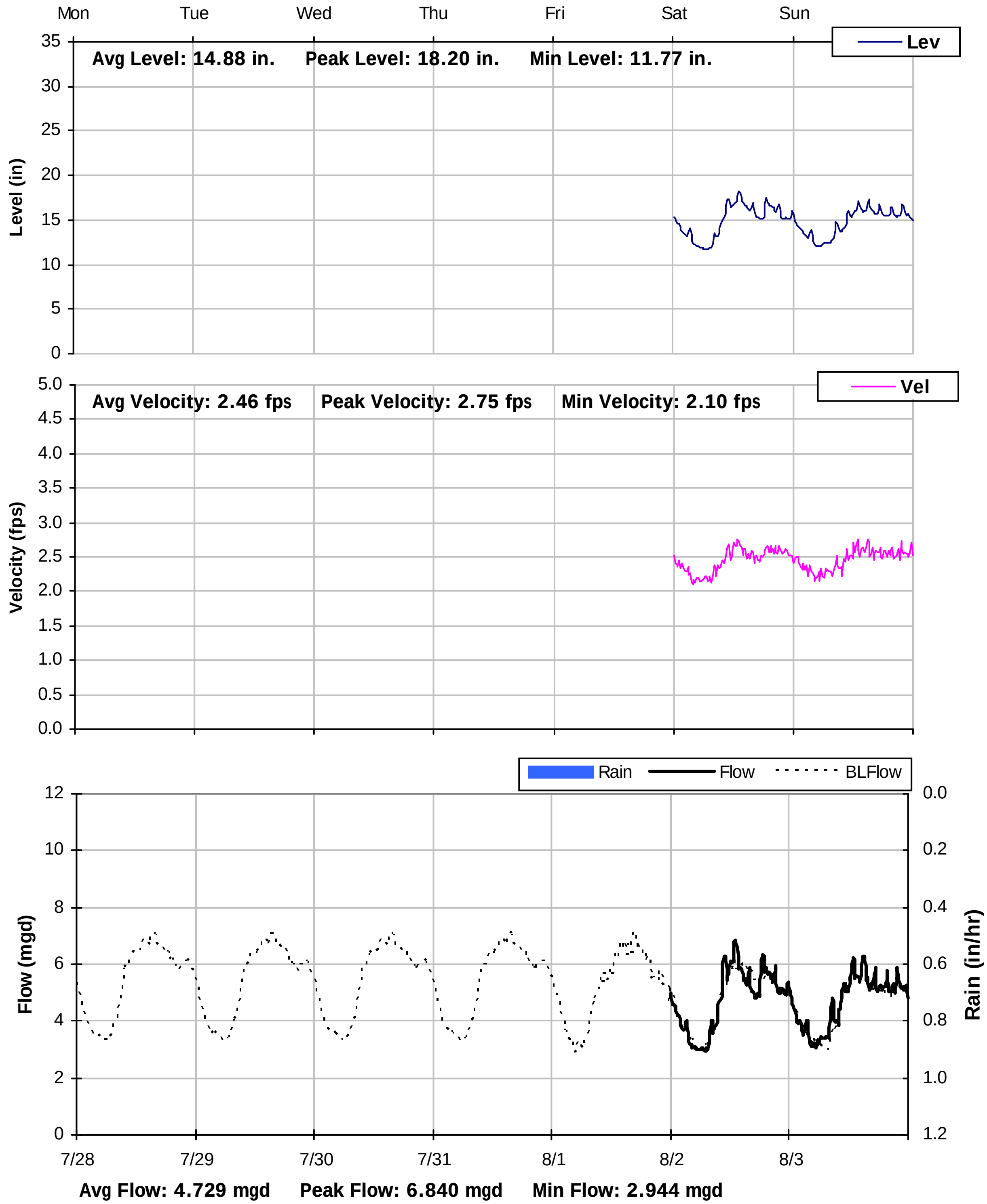
Realtime Flow Levels with Rainfall Data over Monitoring Period



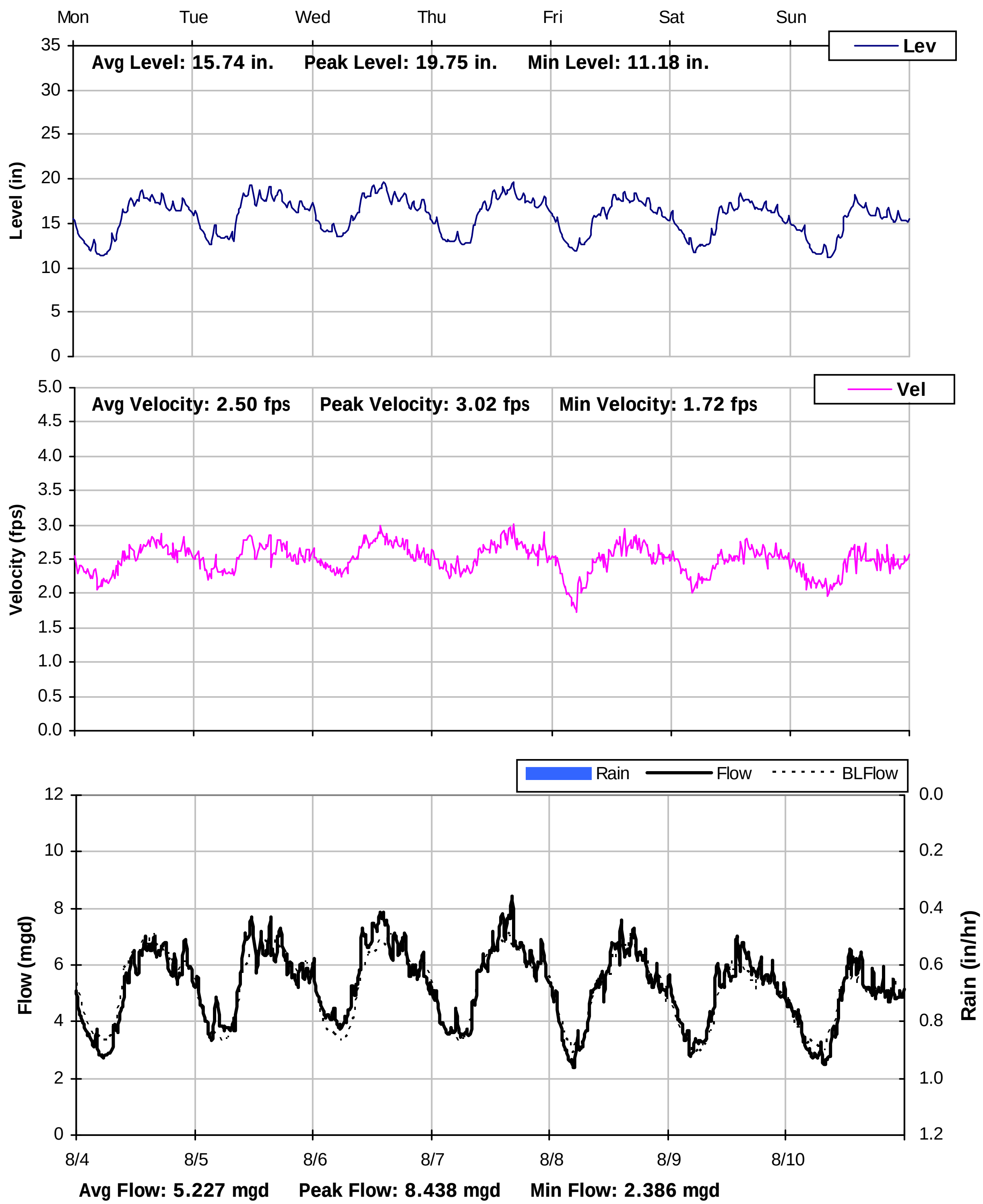


Pipe Diameter:	41.5	*inches*
Peak Measured Level:	19.8	*inches*
Peak d/D Ratio:	0.48	

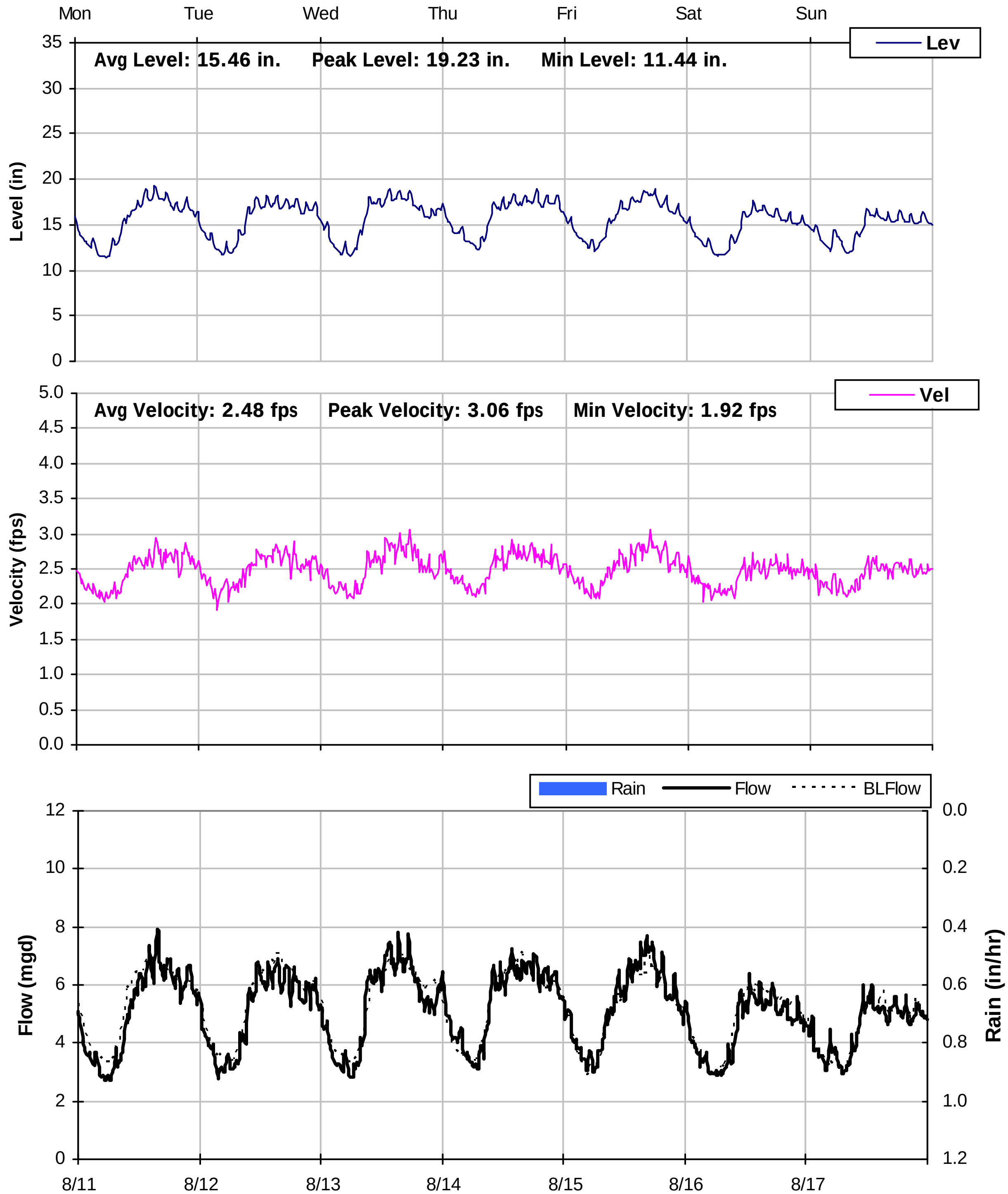
SITE 1
Weekly Level, Velocity and Flow Hydrographs
7/28/2014 to 8/4/2014



SITE 1
Weekly Level, Velocity and Flow Hydrographs
8/4/2014 to 8/11/2014

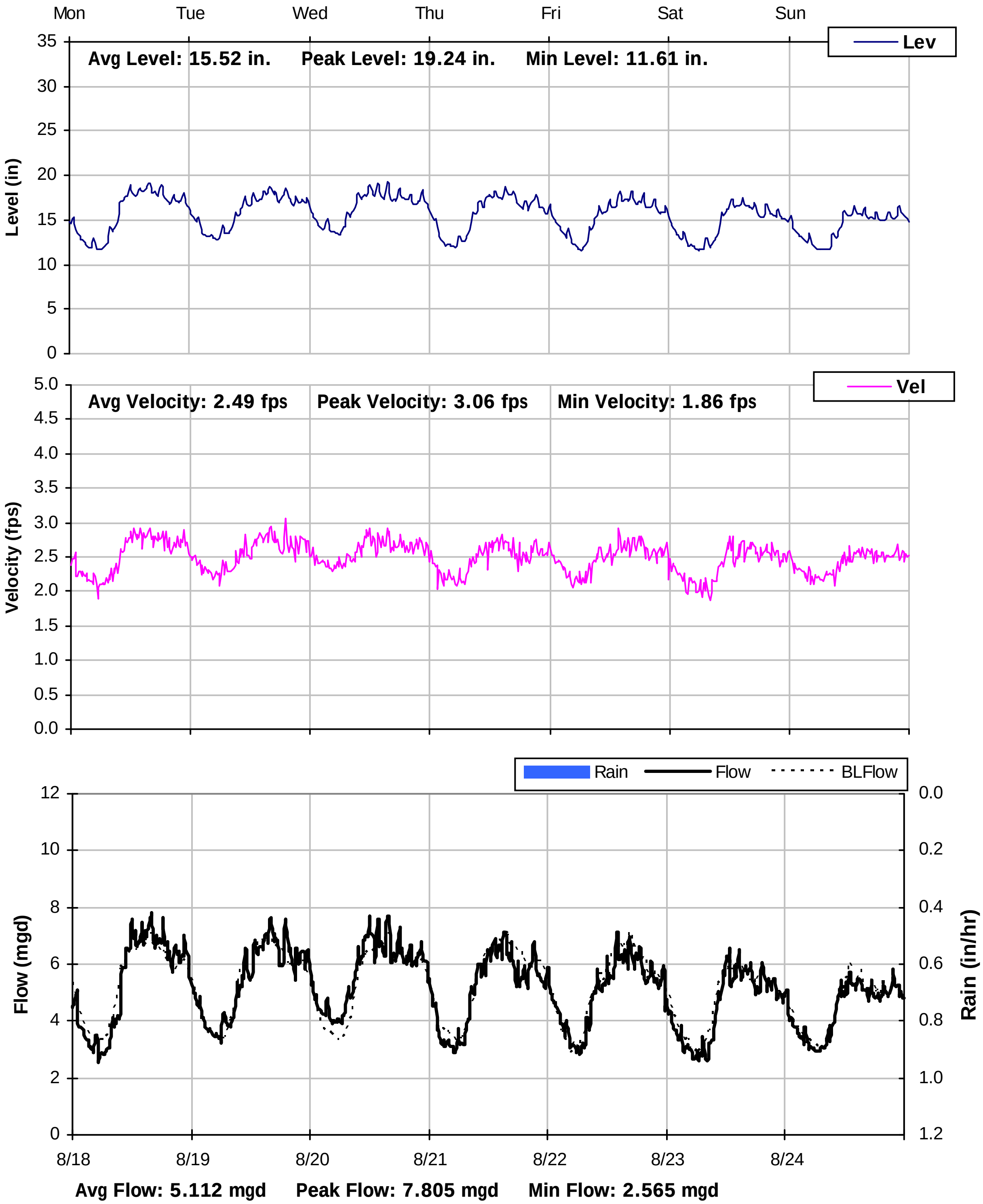


SITE 1
Weekly Level, Velocity and Flow Hydrographs
8/11/2014 to 8/18/2014



Avg Flow: 5.059 mgd **Peak Flow: 7.935 mgd** **Min Flow: 2.701 mgd**

SITE 1
Weekly Level, Velocity and Flow Hydrographs
8/18/2014 to 8/25/2014



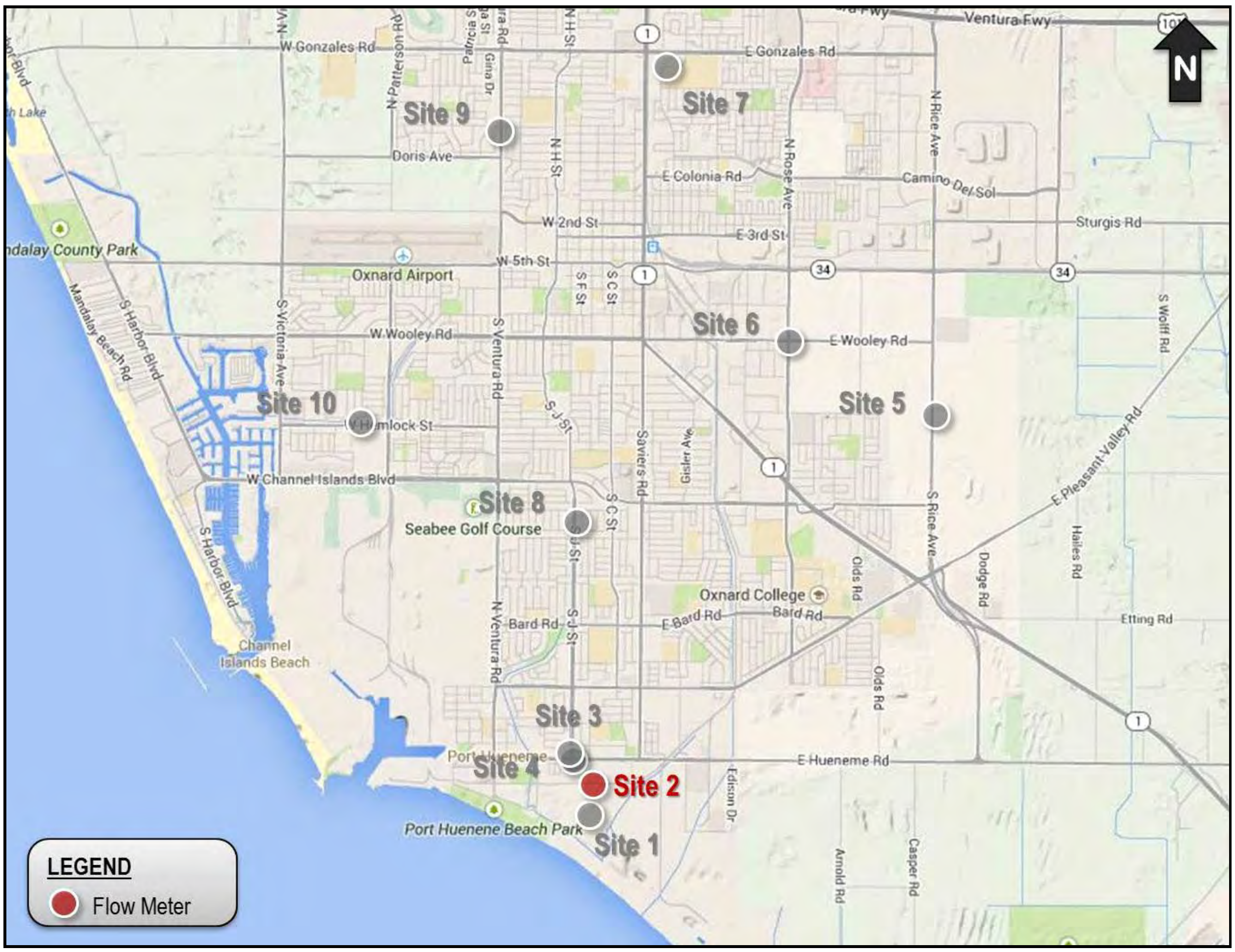
City of Oxnard

Sanitary Sewer Flow Monitoring
Temporary Monitoring: August, 2014

Monitoring Site: Site 2

Location: Magellan Avenue

Data Summary Report



Vicinity Map: Site 2

SITE 2

Site Information

Location: Magellan Avenue

Coordinates: 119.1830° W, 34.1448° N

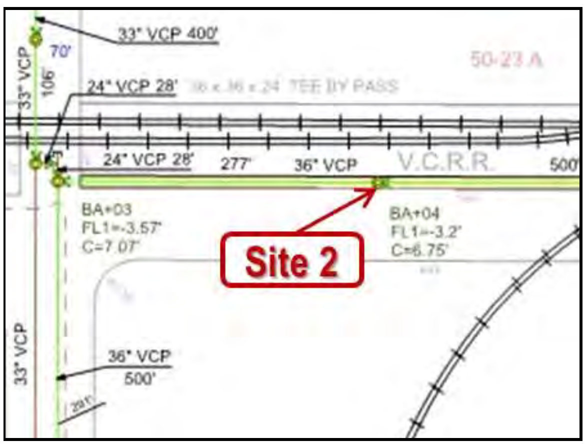
Rim Elevation: 13 feet

Pipe Diameter: 36 inches

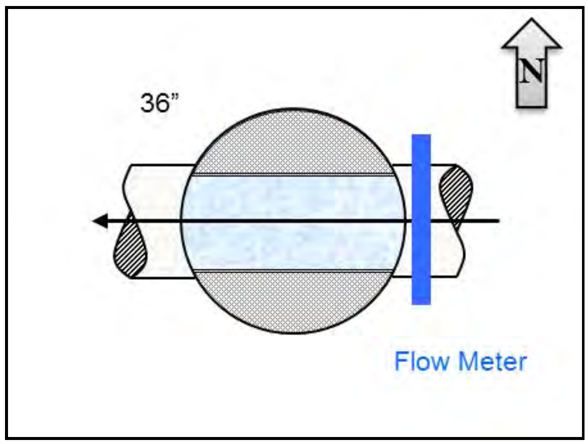
Baseline Flow: 2.702 mgd

Peak Measured Flow: 3.833 mgd

Satellite Map



Sanitary Map



Flow Diagram

Street View

Plan View

SITE 2

Additional Site Photos

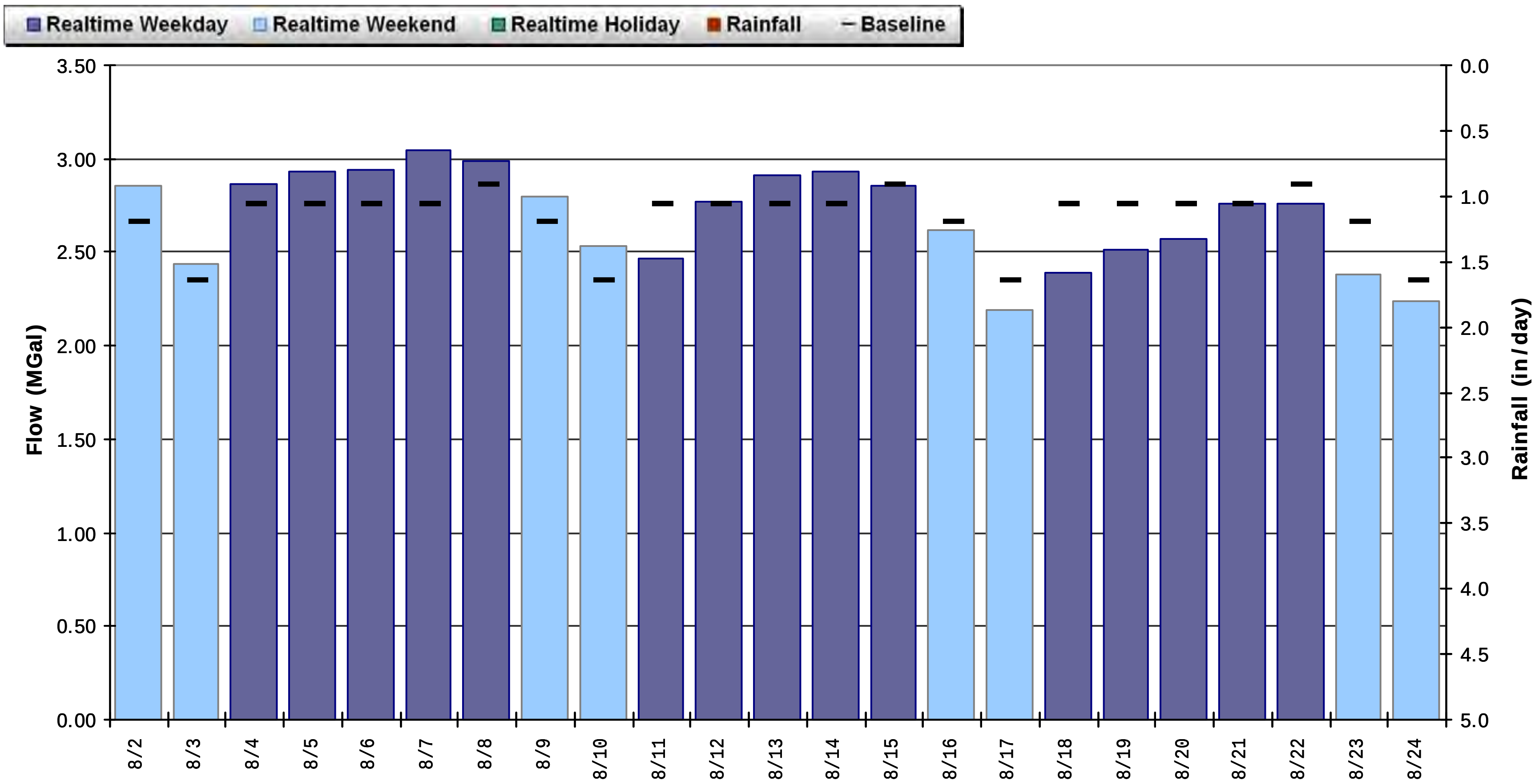
Effluent Pipe

Influent Pipe

SITE 2
Period Flow Summary: Daily Flow Totals

Avg Period Flow: 2.685 MGal **Peak Daily Flow: 3.043 MGal** **Min Daily Flow: 2.192 MGal**

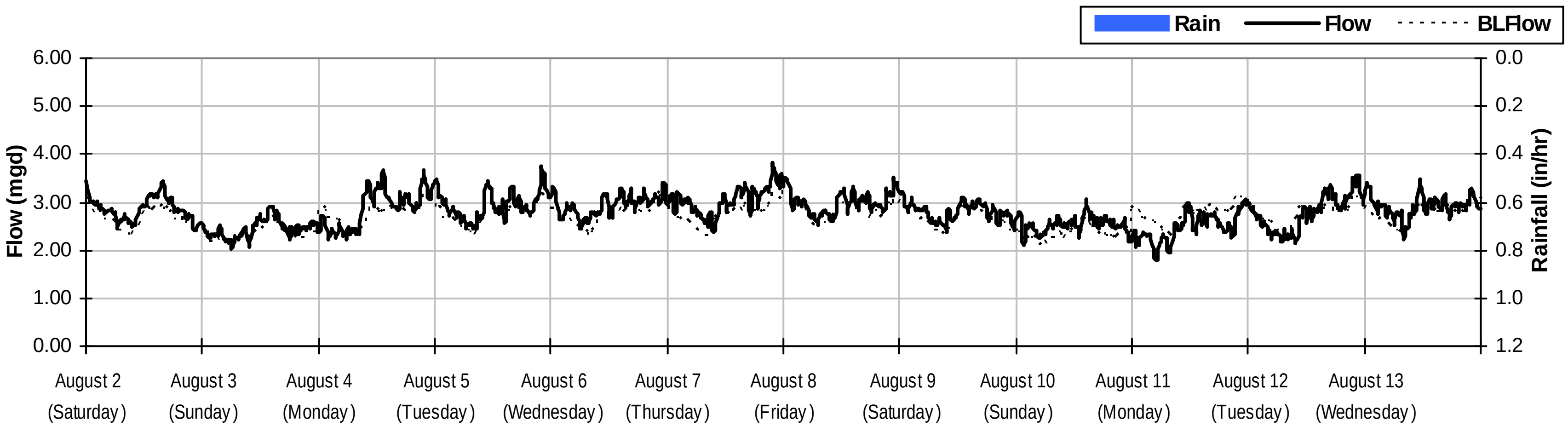
Total Monthly Rainfall: 0.00 inches

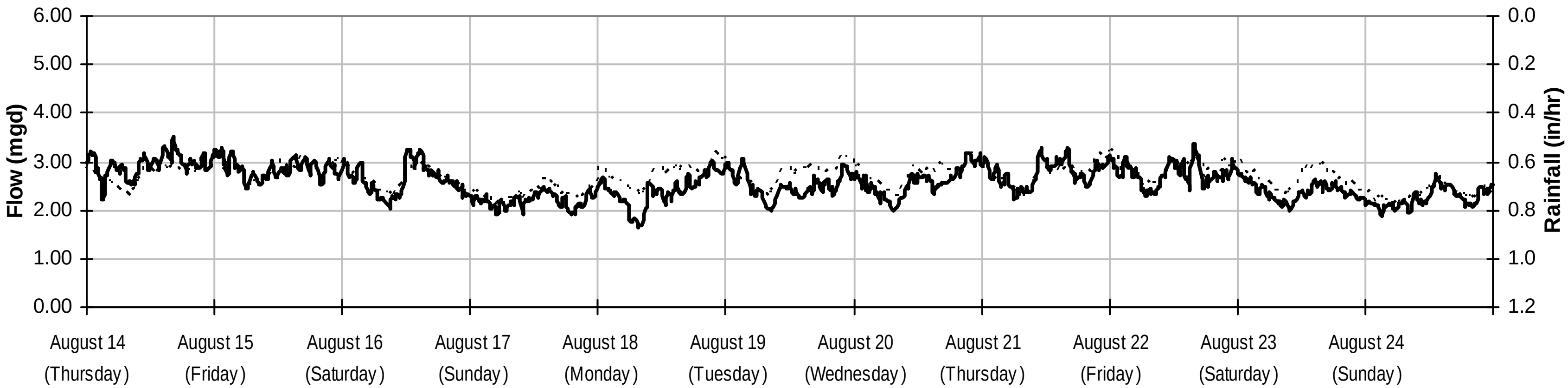


SITE 2

Flow Summary: 8/2/2014 to 8/24/2014

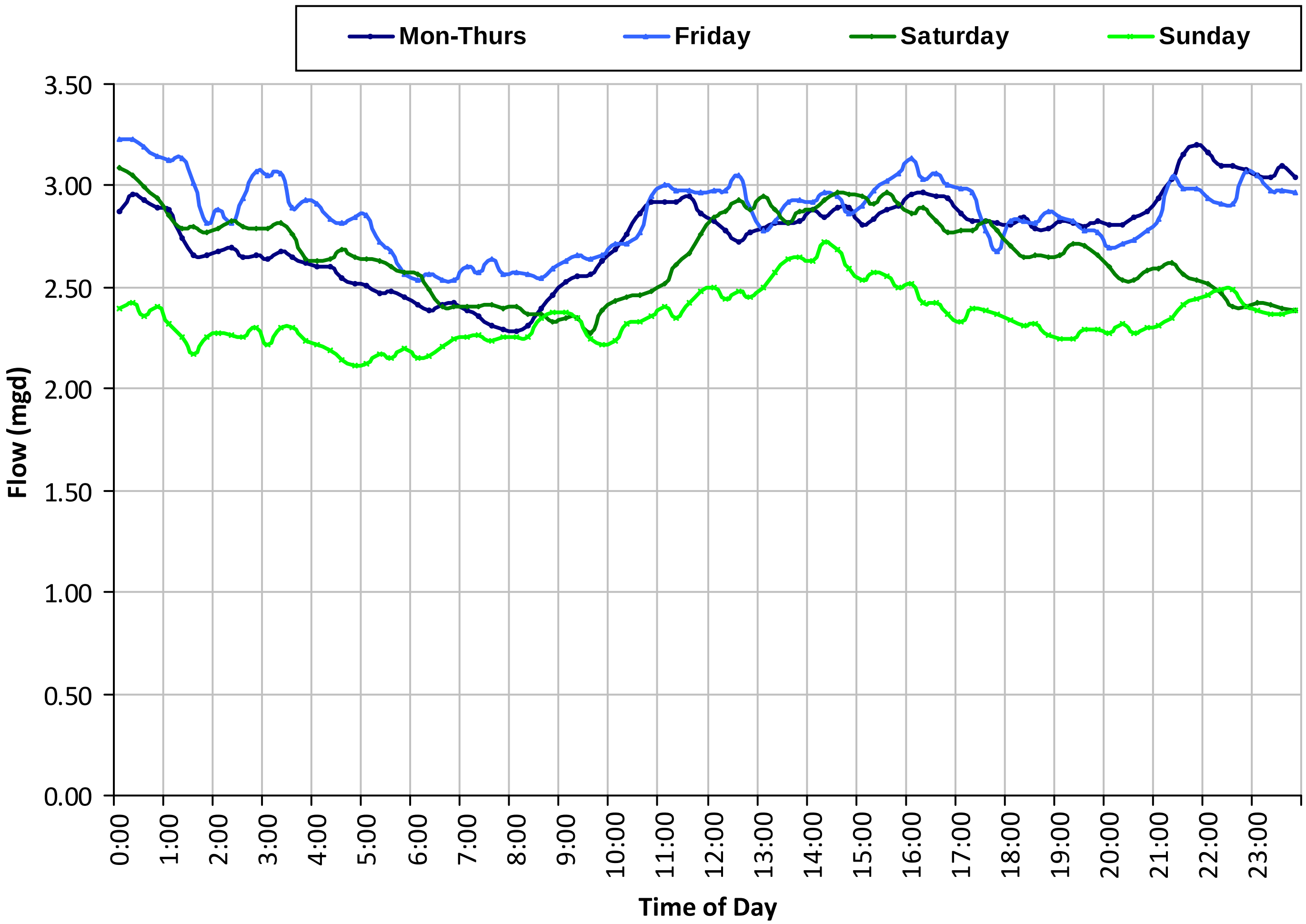
Total Period Rainfall: 0.00 inches **Avg Flow: 2.685 mgd** **Peak Flow: 3.833 mgd** **Min Flow: 1.657 mgd**





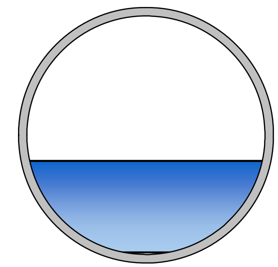
SITE 2

Baseline Flow Hydrographs



Baseline Flow:

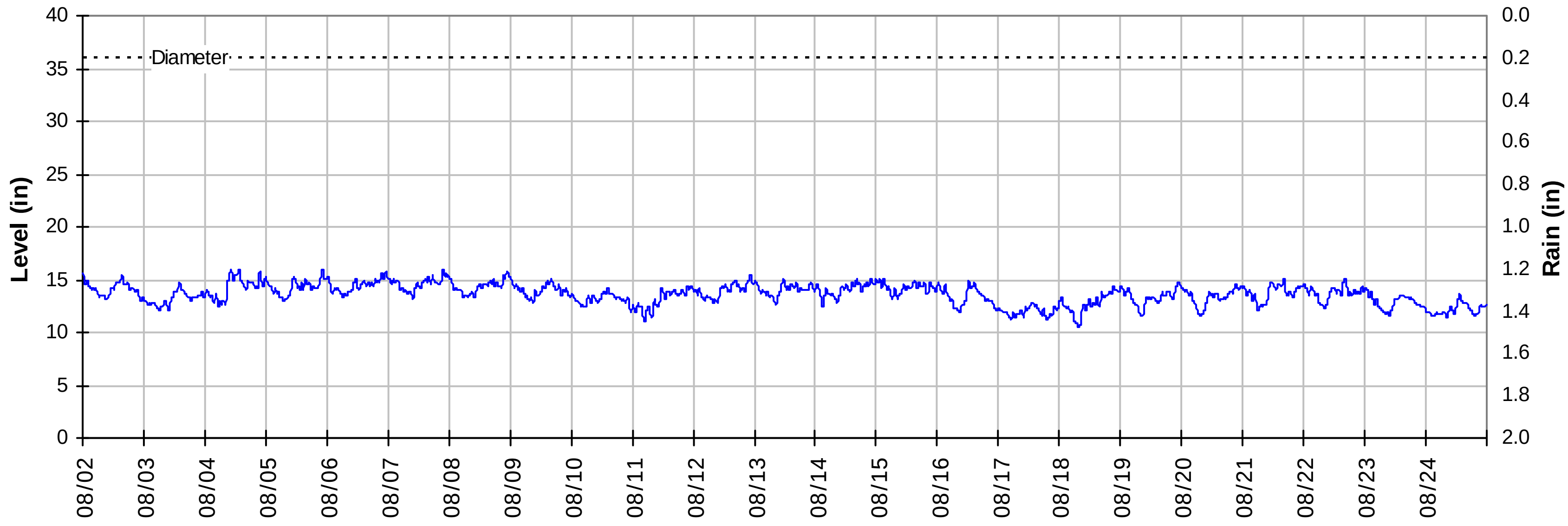
2.702 *mgd*

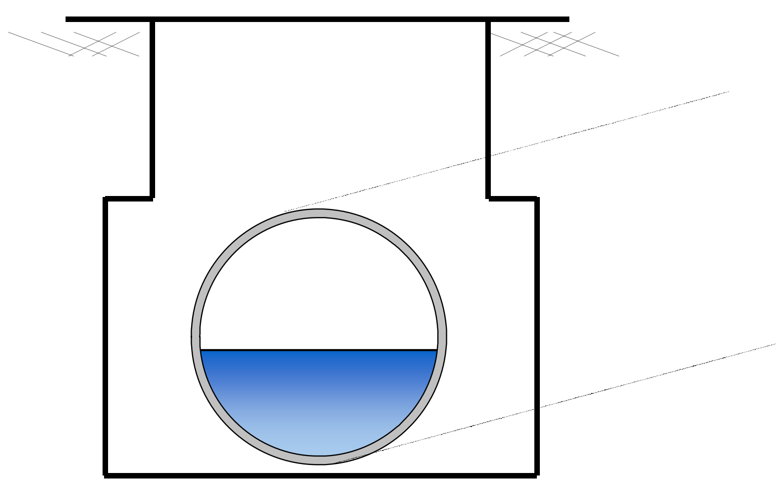


SITE 2

Site Capacity and Surcharge Summary

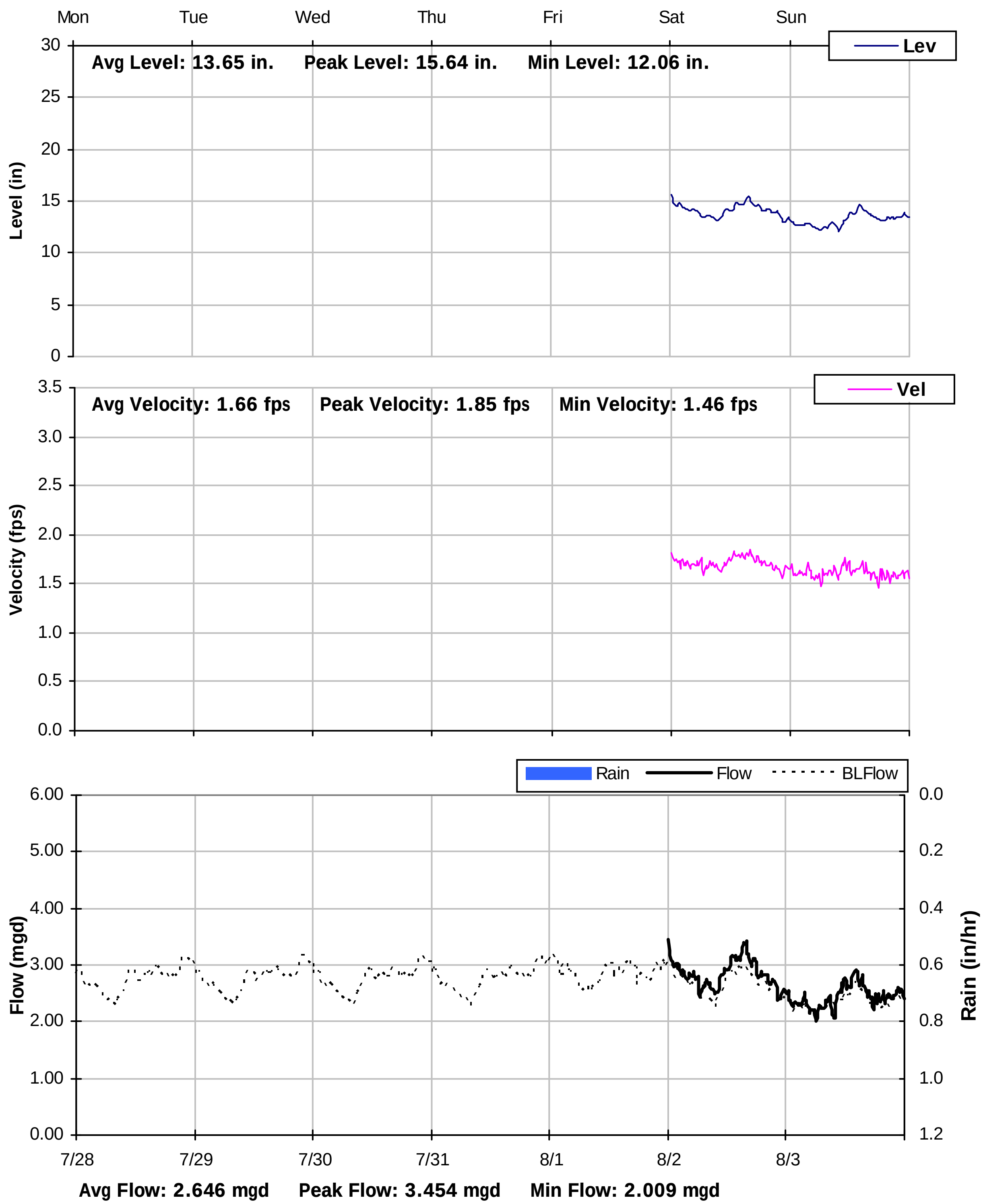
Realtime Flow Levels with Rainfall Data over Monitoring Period





Pipe Diameter:	36	*inches*
Peak Measured Level:	16.1	*inches*
Peak d/D Ratio:	0.45	

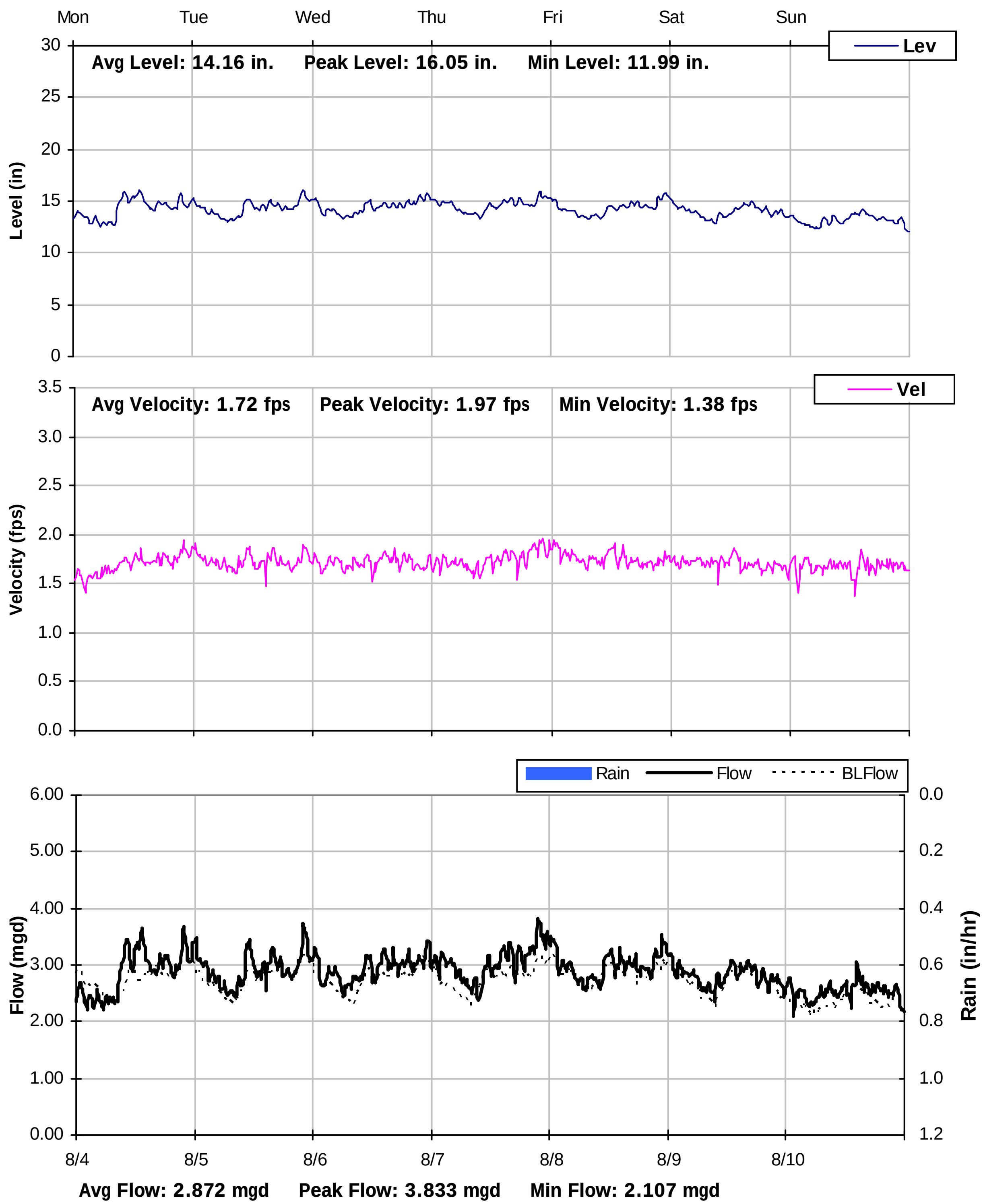
SITE 2
Weekly Level, Velocity and Flow Hydrographs
7/28/2014 to 8/4/2014



SITE 2

Weekly Level, Velocity and Flow Hydrographs

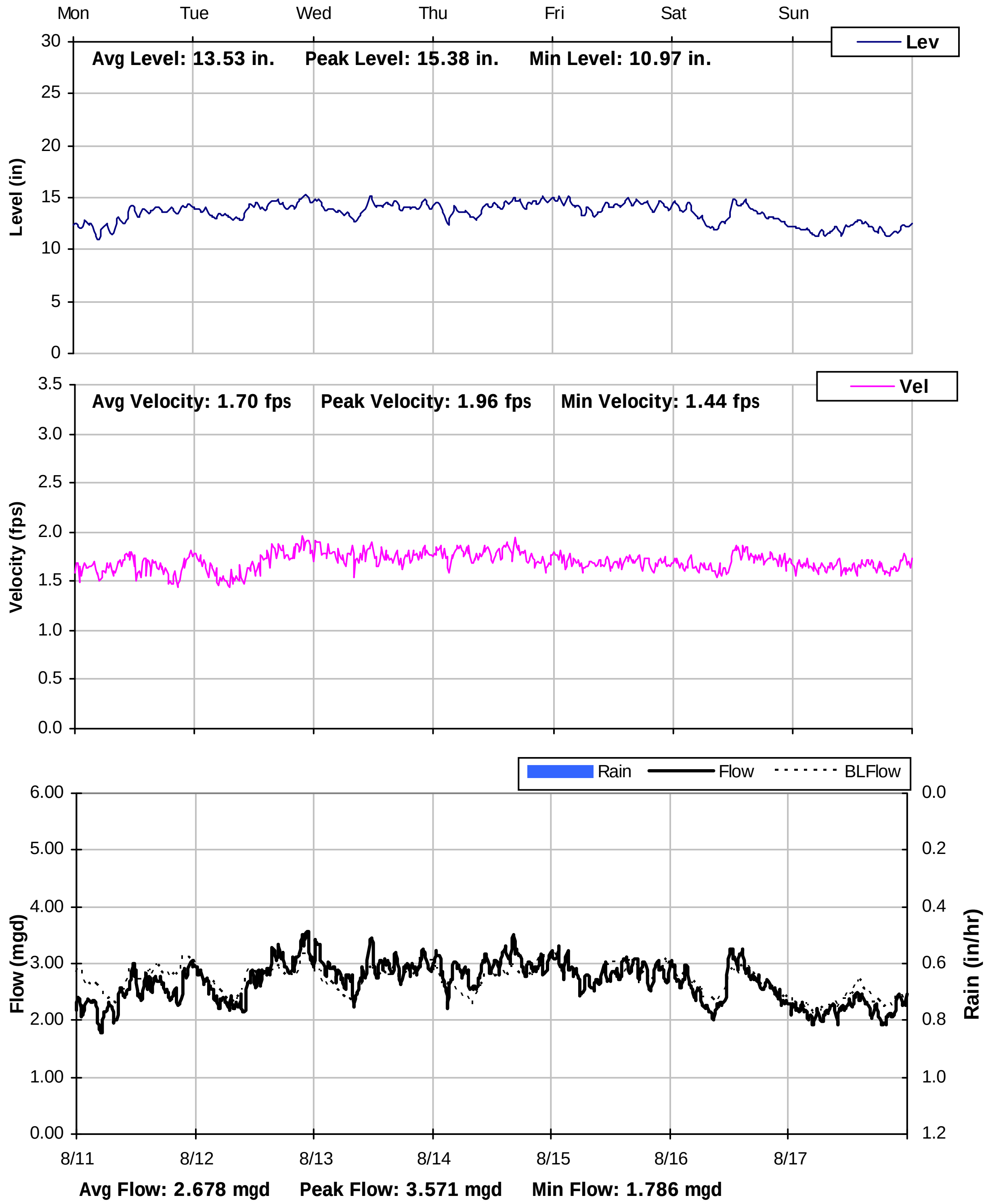
8/4/2014 to 8/11/2014



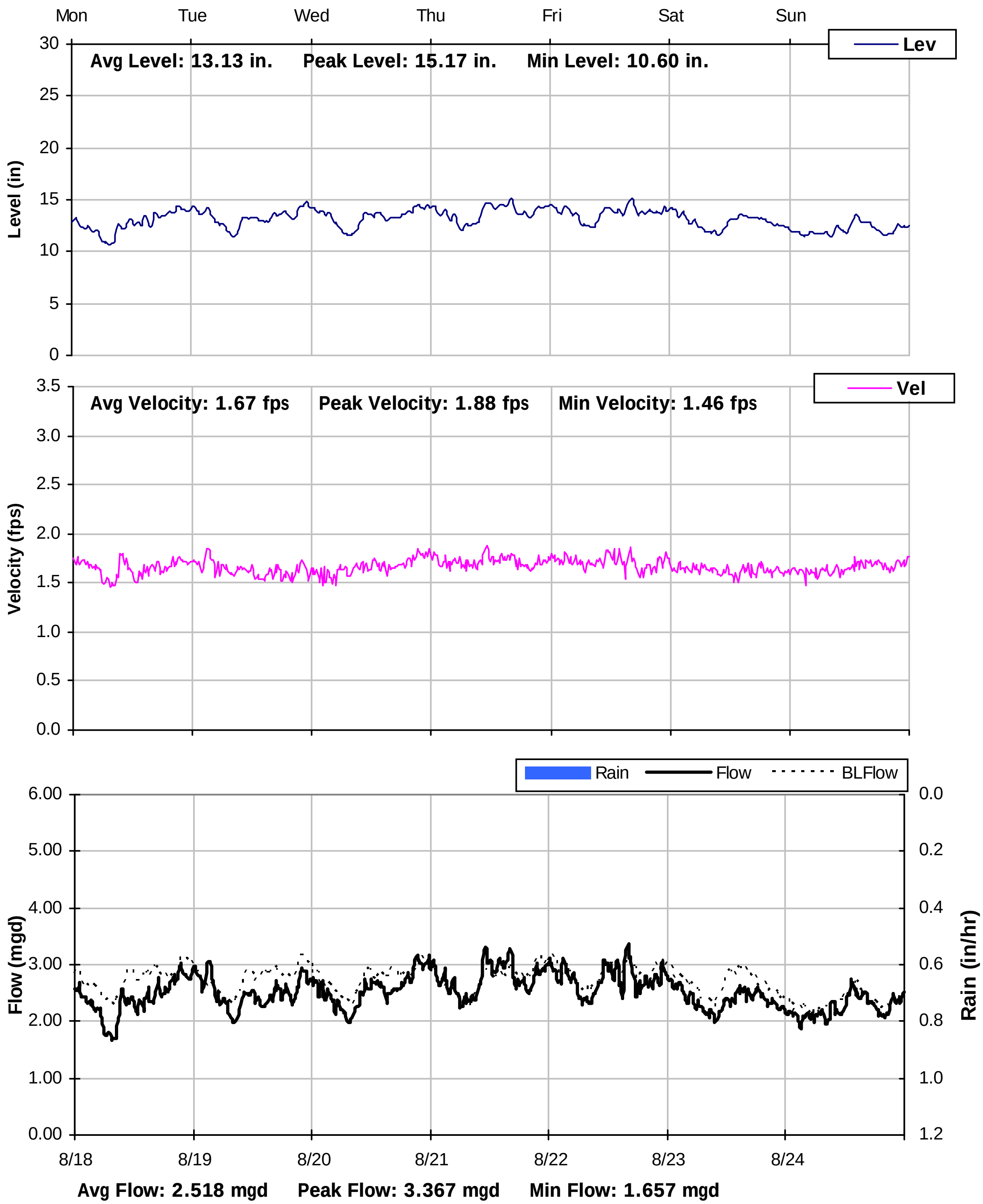
SITE 2

Weekly Level, Velocity and Flow Hydrographs

8/11/2014 to 8/18/2014



SITE 2
Weekly Level, Velocity and Flow Hydrographs
8/18/2014 to 8/25/2014



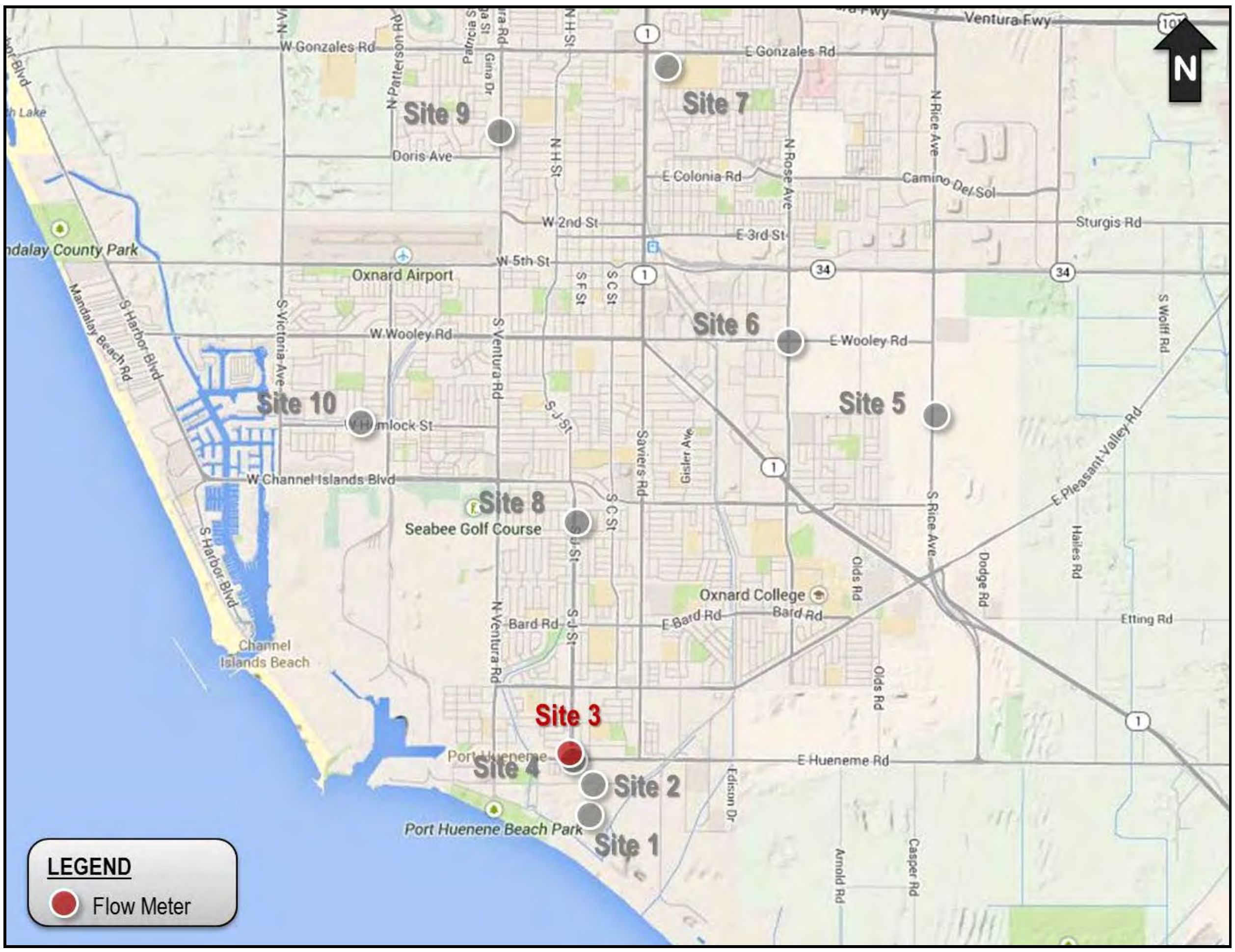
City of Oxnard

Sanitary Sewer Flow Monitoring
Temporary Monitoring: August, 2014

Monitoring Site: Site 3

Location: J Street and E Port Hueneme Road

Data Summary Report



Vicinity Map: Site 3

SITE 3

Site Information

Location: J Street and E Port Hueneme Road

Coordinates: 119.1862° W, 34.1481° N

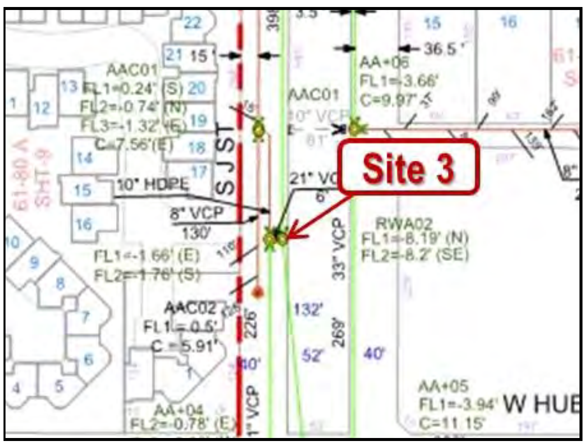
Rim Elevation: 13 feet

Pipe Diameter: 60 inches

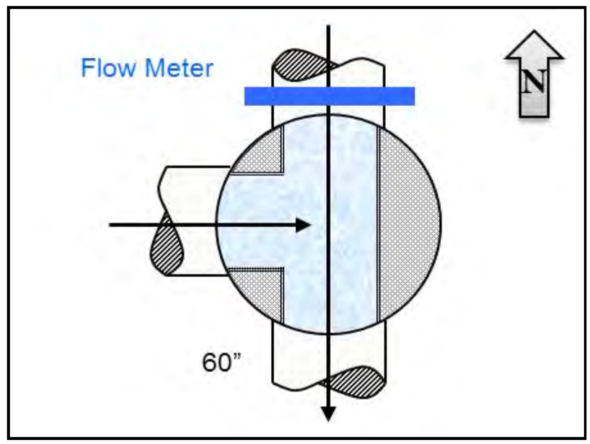
Baseline Flow: 7.134 mgd

Peak Measured Flow: 13.534 mgd

Satellite Map



Sanitary Map



Flow Diagram

Street View

Plan View

SITE 3

Additional Site Photos

Effluent Pipe

Influent Pipe

SITE 3

Additional Site Photos

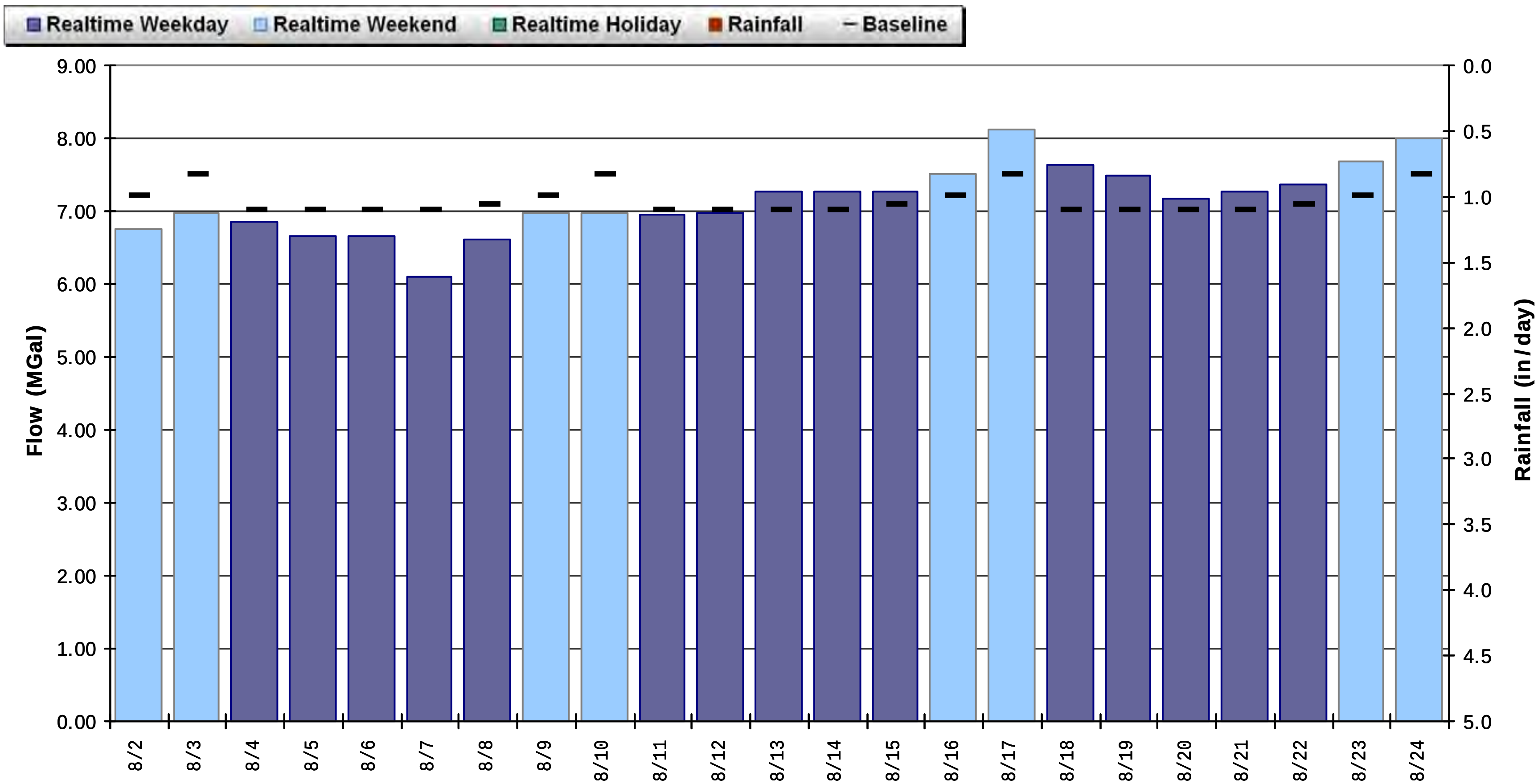
Lateral Pipe

SITE 3

Period Flow Summary: Daily Flow Totals

Avg Period Flow: 7.155 MGal **Peak Daily Flow: 8.119 MGal** **Min Daily Flow: 6.109 MGal**

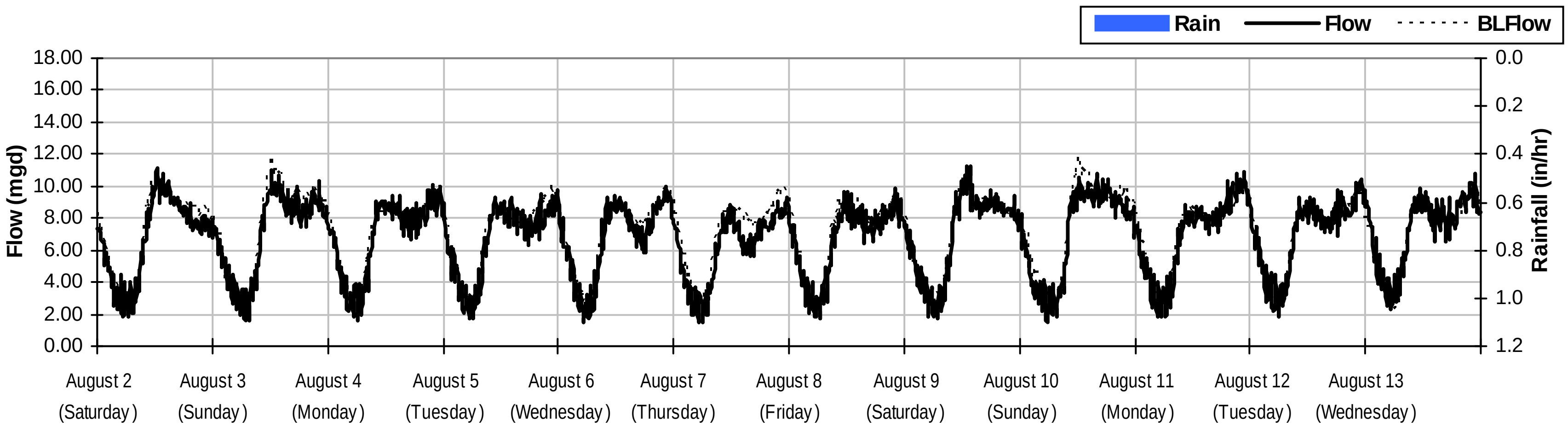
Total Monthly Rainfall: 0.00 inches

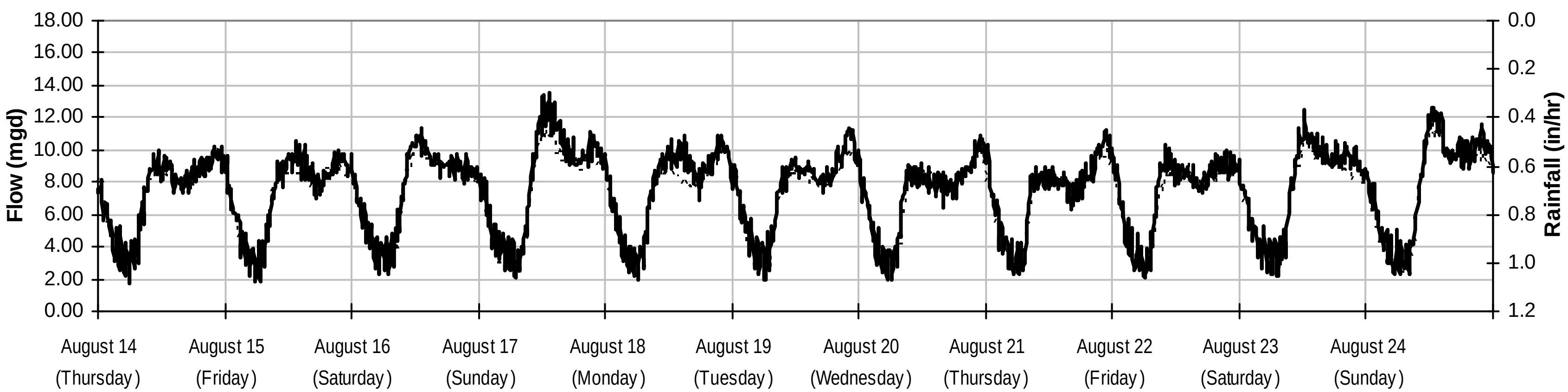


SITE 3

Flow Summary: 8/2/2014 to 8/24/2014

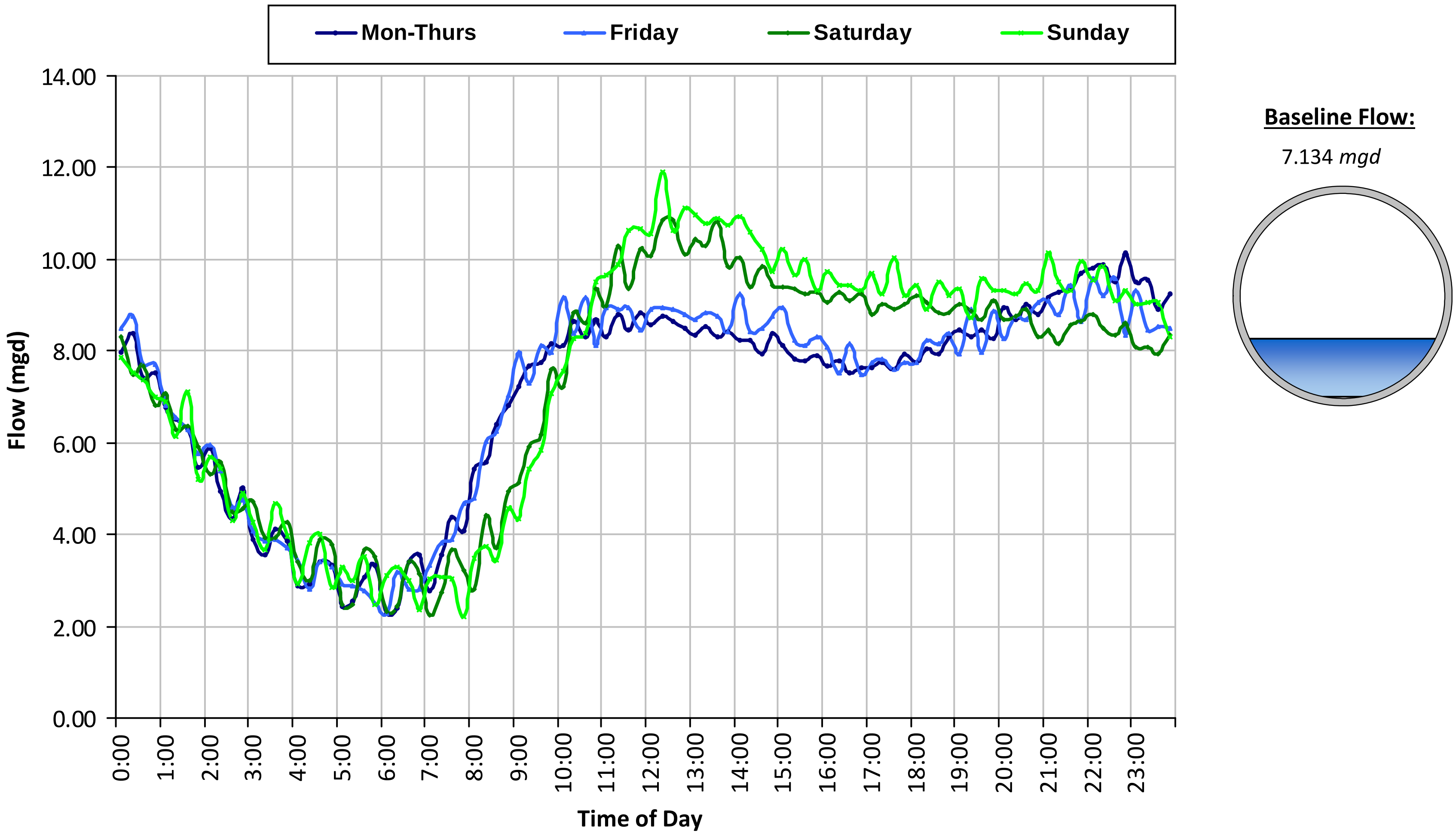
Total Period Rainfall: 0.00 inches **Avg Flow: 7.155 mgd** **Peak Flow: 13.534 mgd** **Min Flow: 1.478 mgd**





SITE 3

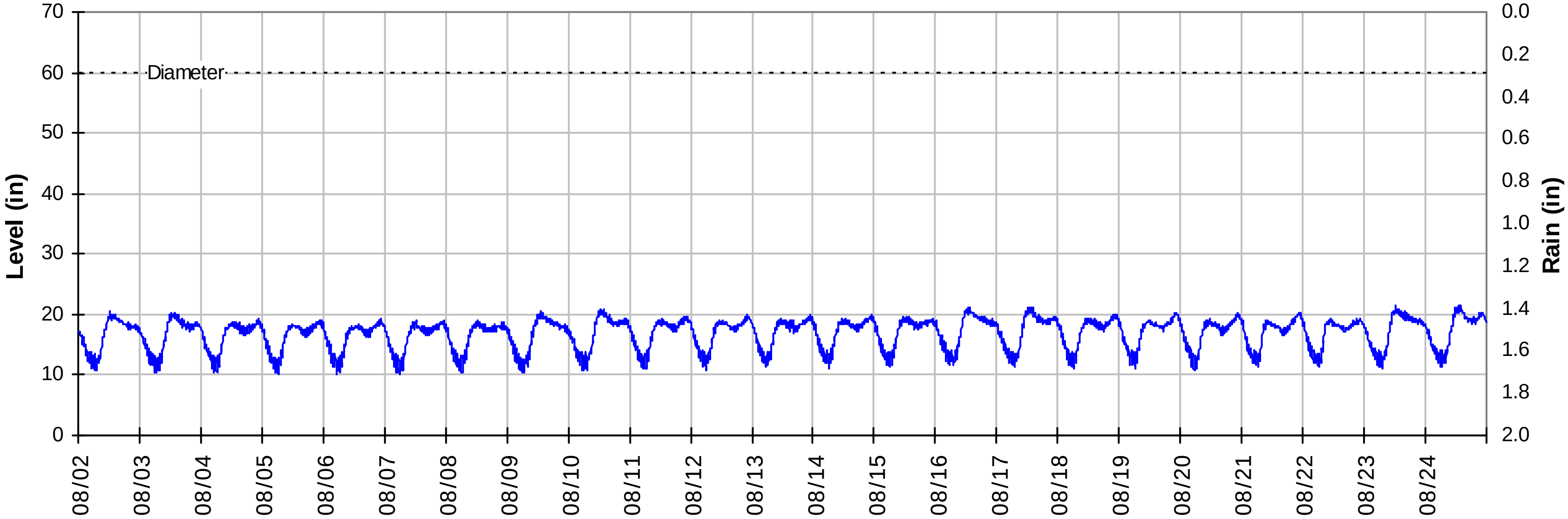
Baseline Flow Hydrographs

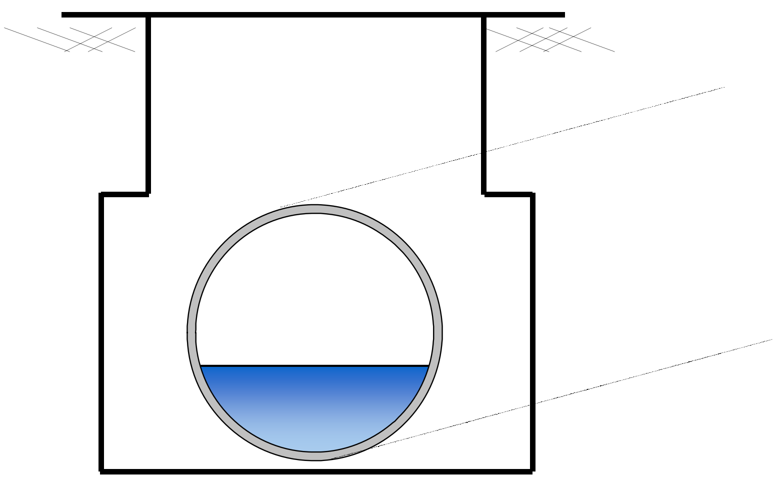


SITE 3

Site Capacity and Surcharge Summary

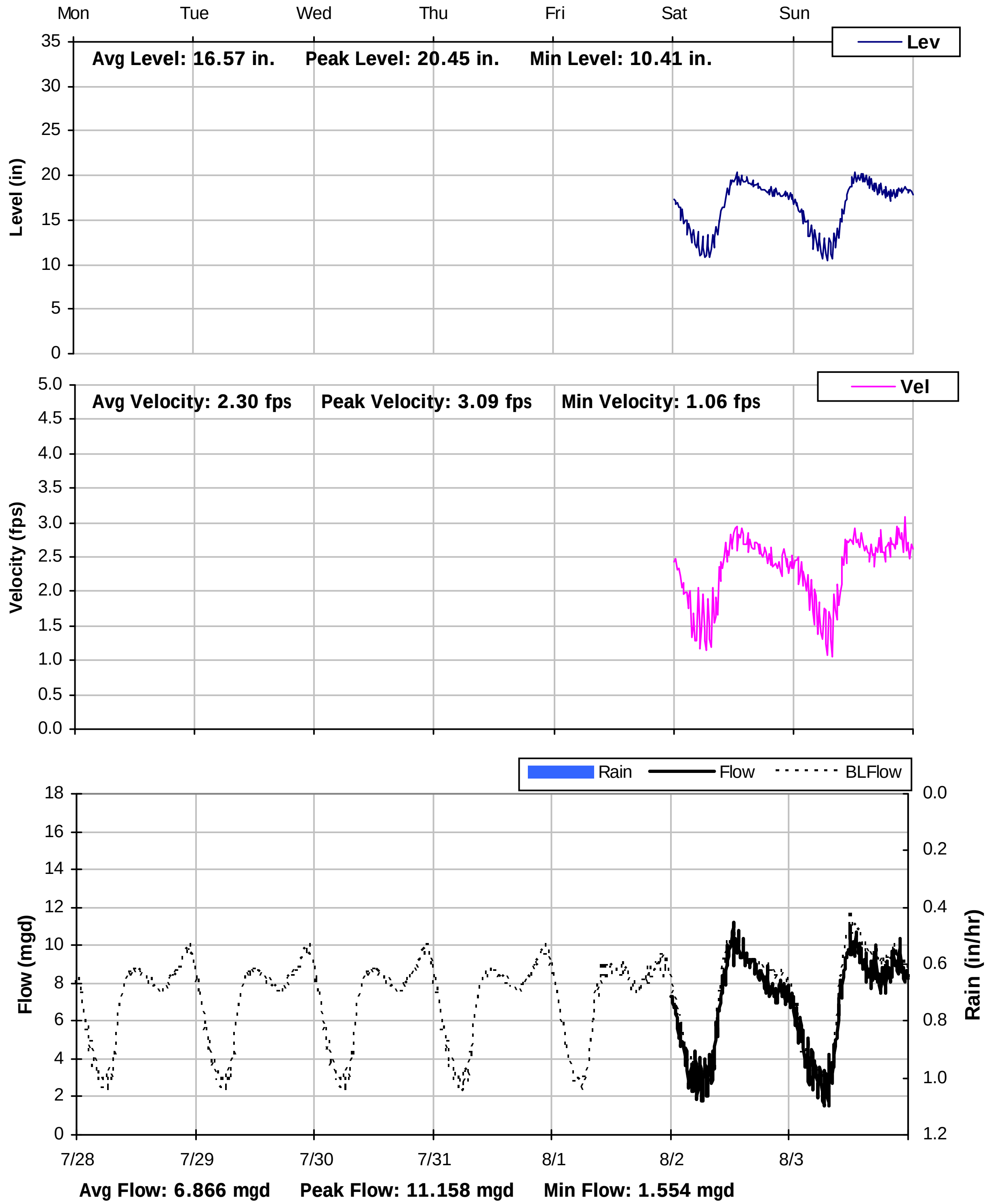
Realtime Flow Levels with Rainfall Data over Monitoring Period



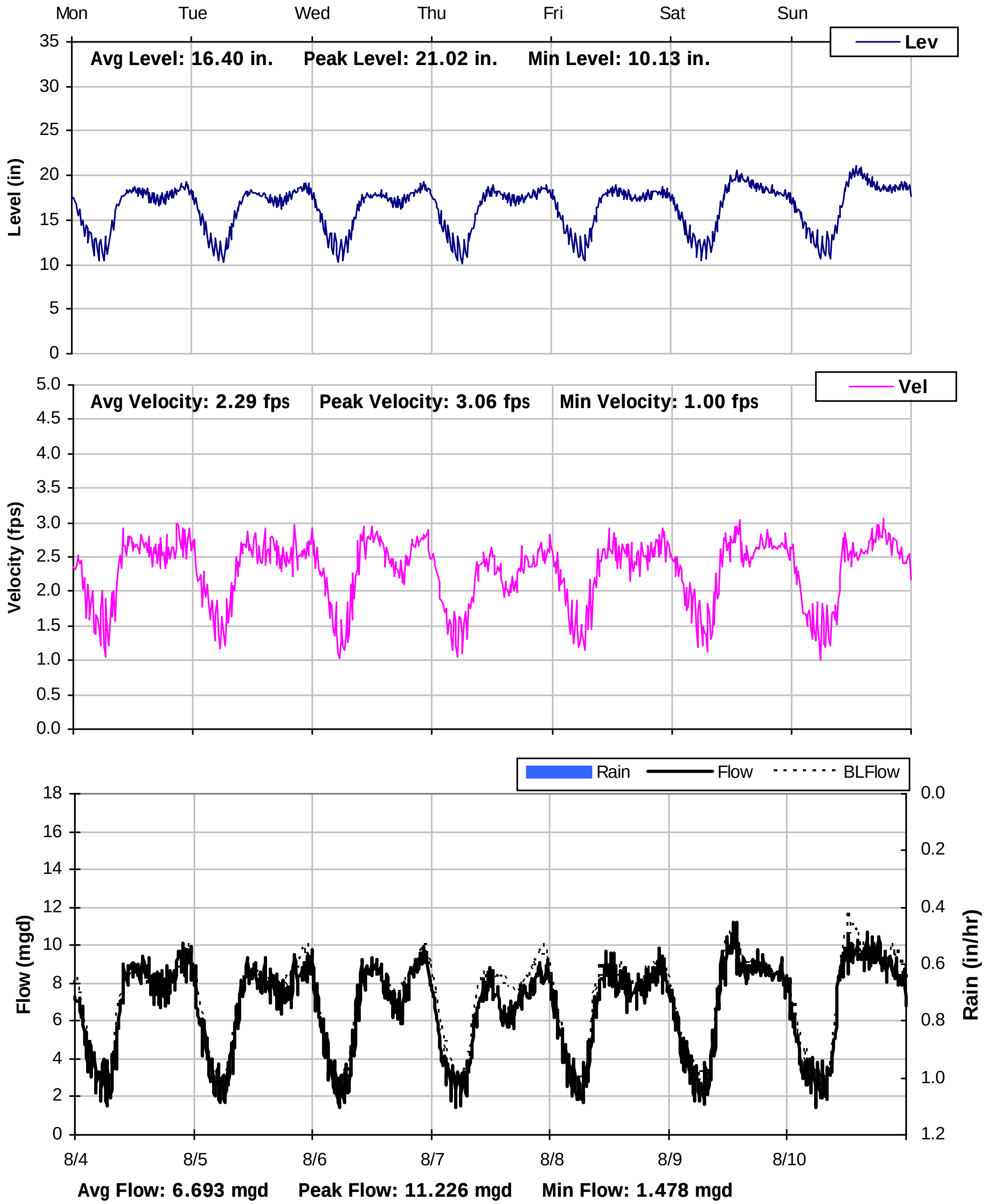


Pipe Diameter:	60	*inches*
Peak Measured Level:	21.5	*inches*
Peak d/D Ratio:	0.36	

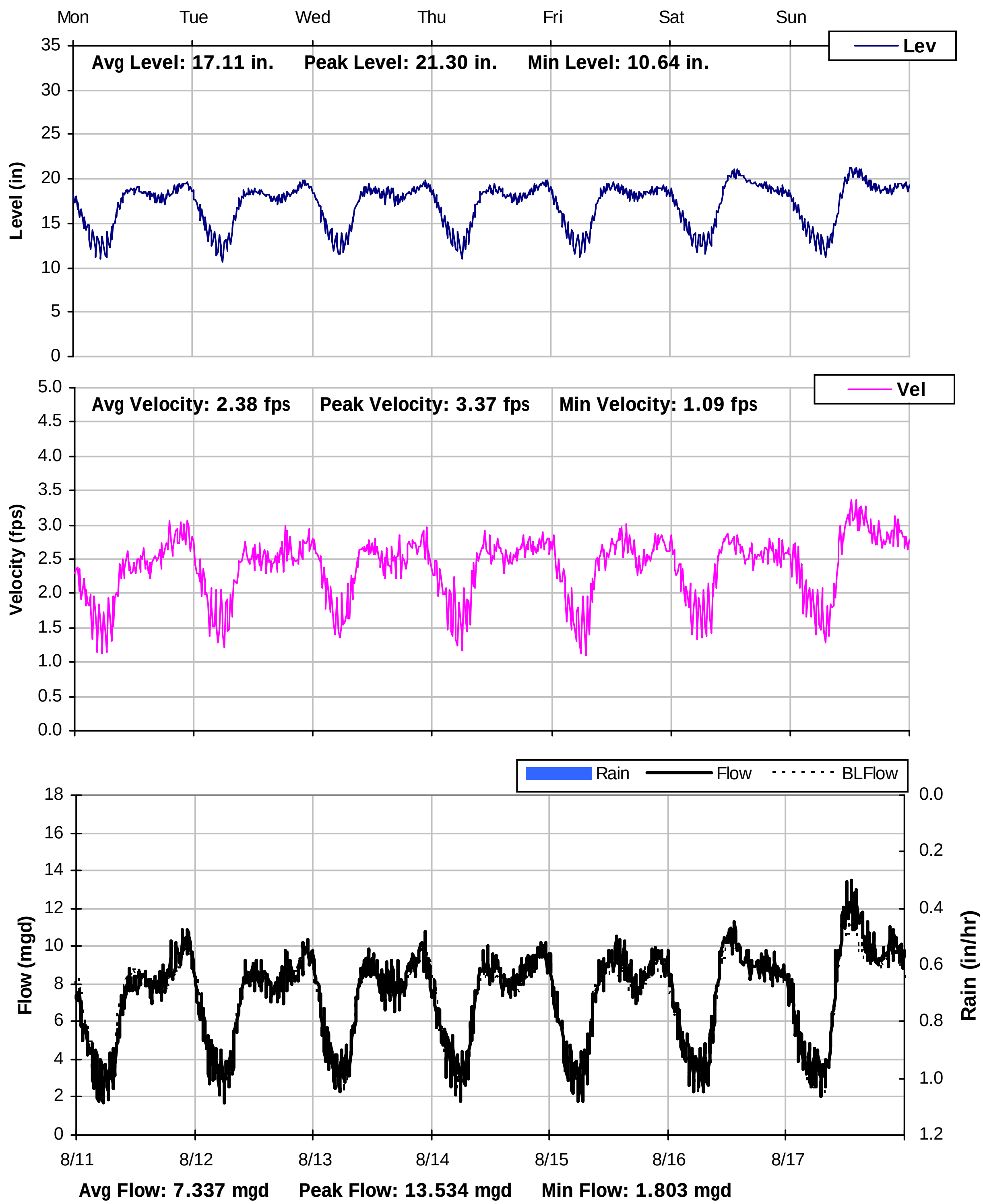
SITE 3
Weekly Level, Velocity and Flow Hydrographs
7/28/2014 to 8/4/2014



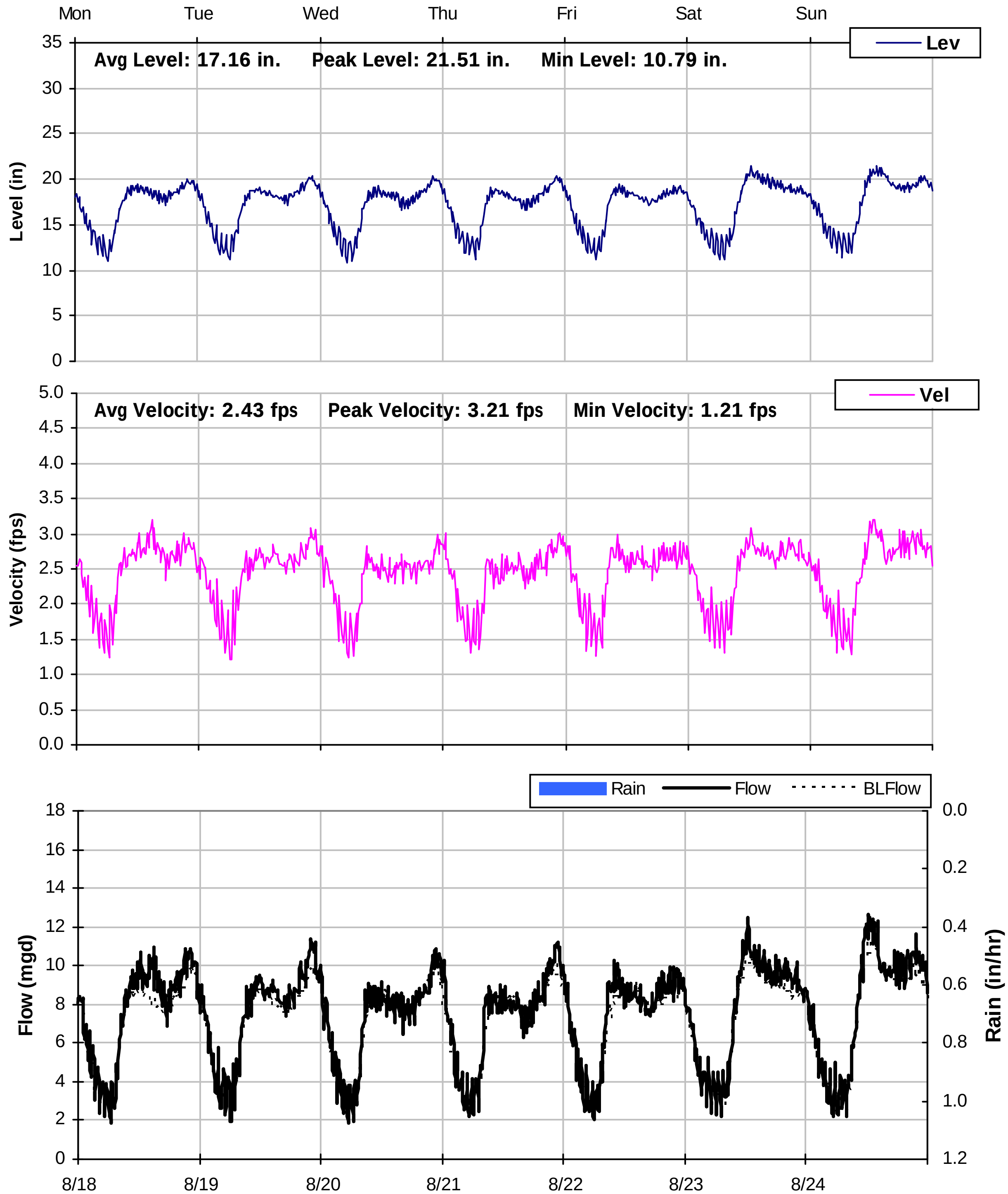
SITE 3
Weekly Level, Velocity and Flow Hydrographs
8/4/2014 to 8/11/2014



SITE 3
Weekly Level, Velocity and Flow Hydrographs
8/11/2014 to 8/18/2014



SITE 3
Weekly Level, Velocity and Flow Hydrographs
8/18/2014 to 8/25/2014



Avg Flow: 7.518 mgd **Peak Flow: 12.668 mgd** **Min Flow: 1.894 mgd**

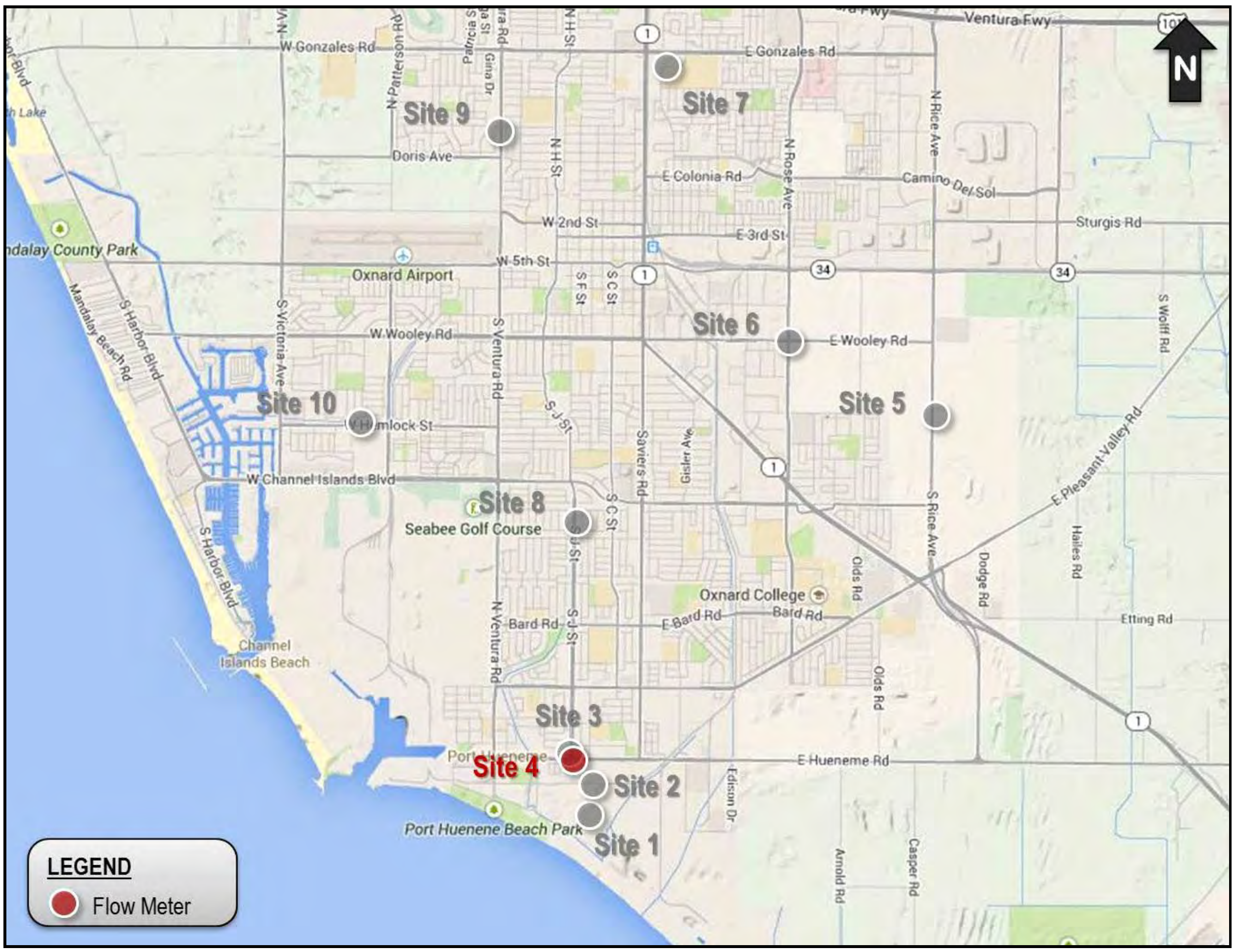
City of Oxnard

Sanitary Sewer Flow Monitoring
Temporary Monitoring: August, 2014

Monitoring Site: Site 4

Location: J Street and W Hueneme Road

Data Summary Report



Vicinity Map: Site 4

SITE 4

Site Information

Location: J Street and W Hueneme Road

Coordinates: 119.1860° W, 34.1474° N

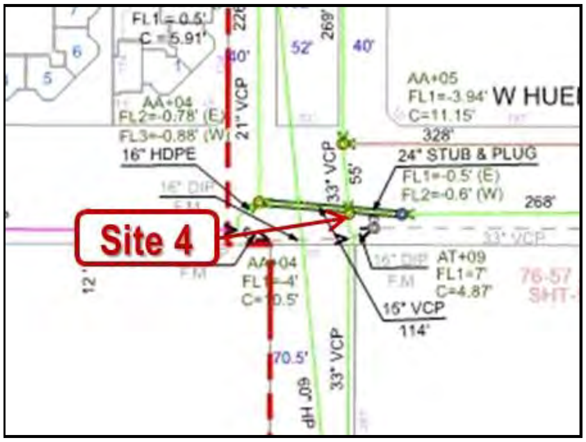
Rim Elevation: 12 feet

Pipe Diameter: 33 inches

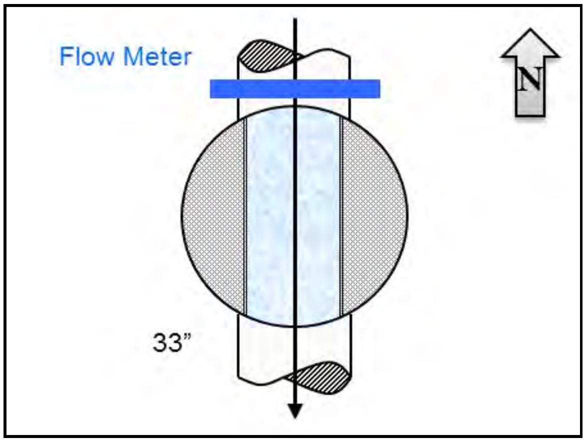
Baseline Flow: 4.301 mgd

Peak Measured Flow: 7.057 mgd

Satellite Map



Sanitary Map



Flow Diagram

Street View

Plan View

SITE 4

Additional Site Photos

Effluent Pipe

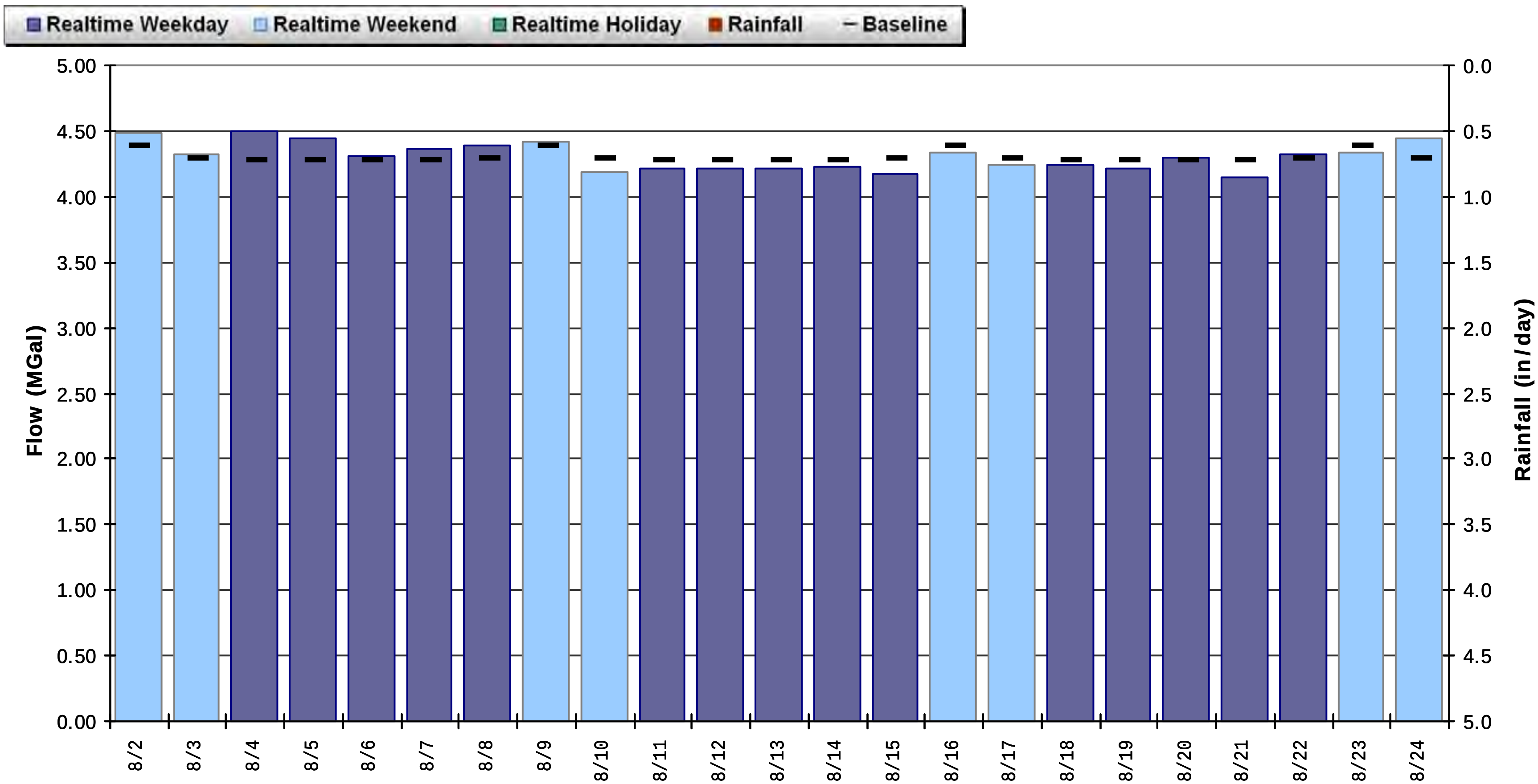
Influent Pipe

SITE 4

Period Flow Summary: Daily Flow Totals

Avg Period Flow: 4.305 MGal **Peak Daily Flow: 4.503 MGal** **Min Daily Flow: 4.141 MGal**

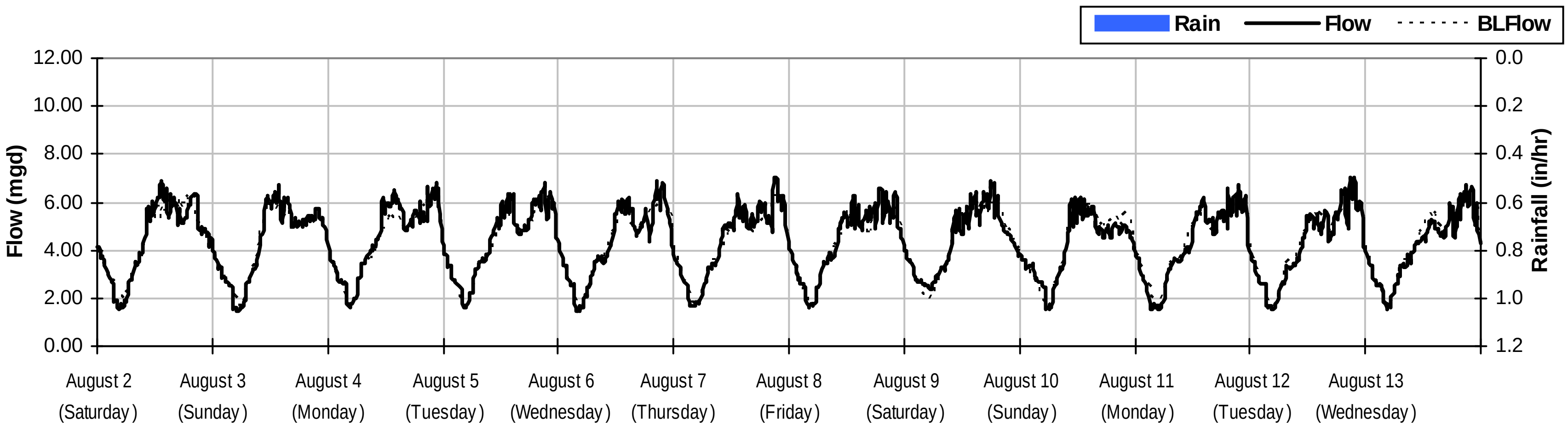
Total Monthly Rainfall: 0.00 inches

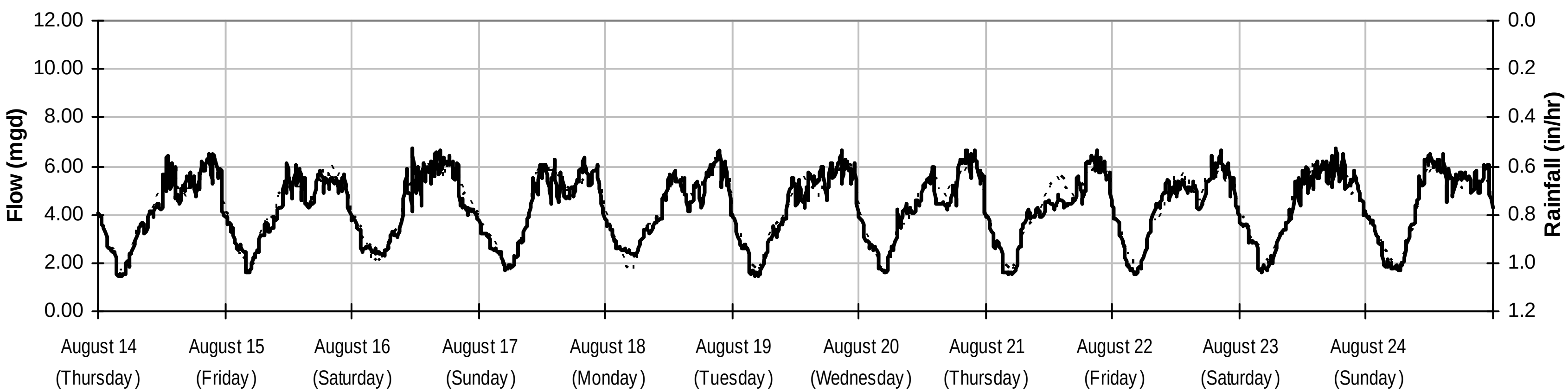


SITE 4

Flow Summary: 8/2/2014 to 8/24/2014

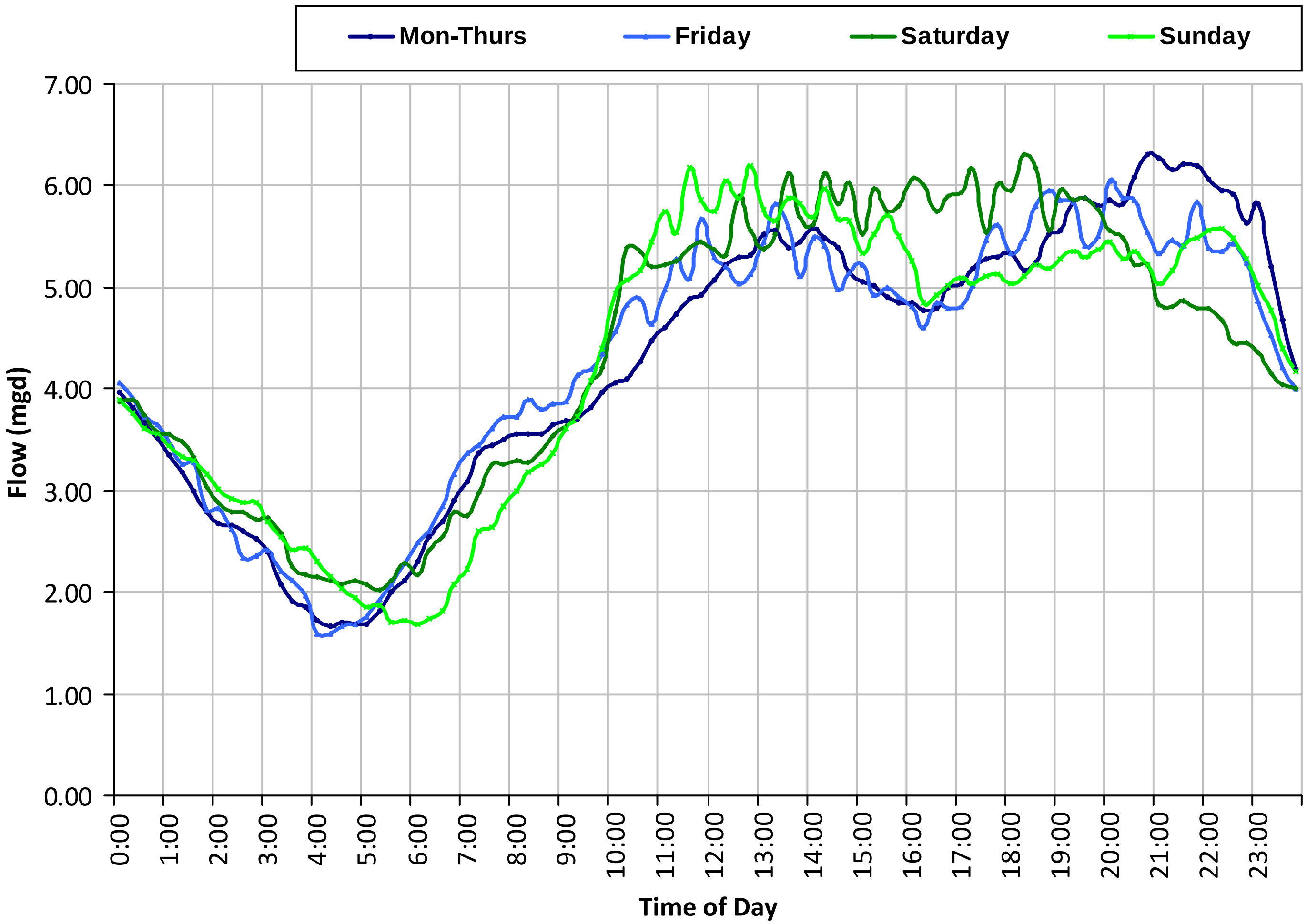
Total Period Rainfall: 0.00 inches **Avg Flow: 4.305 mgd** **Peak Flow: 7.057 mgd** **Min Flow: 1.427 mgd**





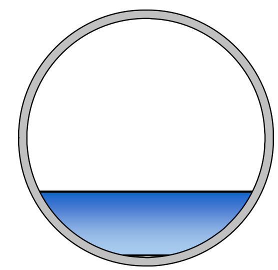
SITE 4

Baseline Flow Hydrographs



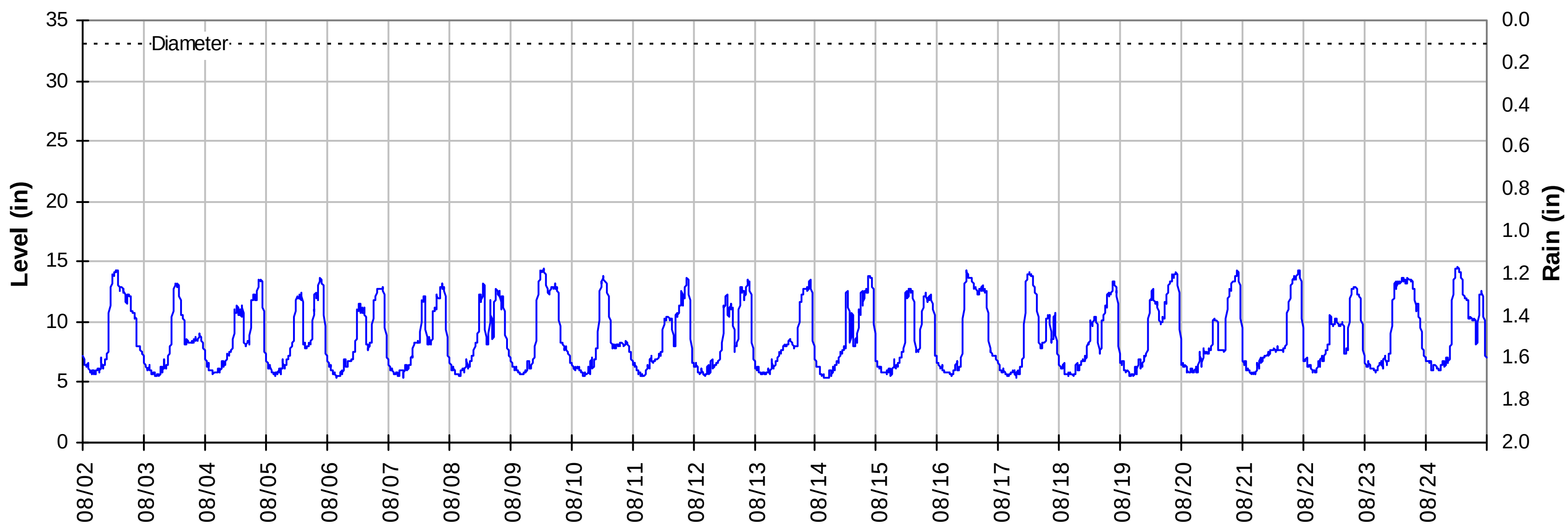
Baseline Flow:

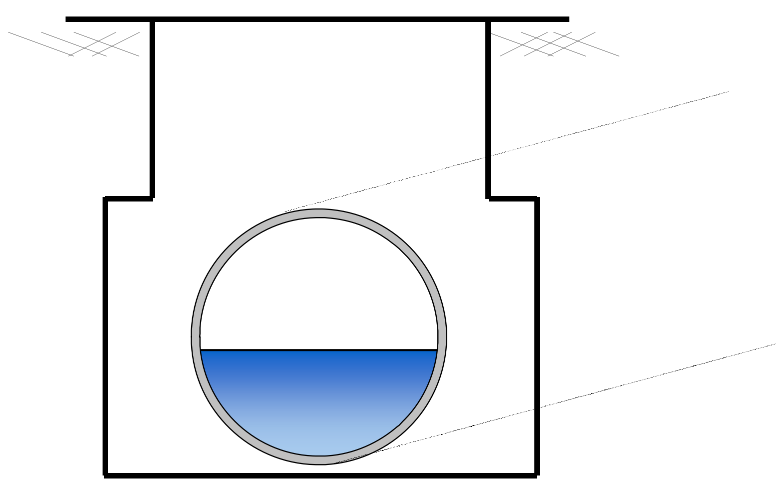
4.301 *mgd*



SITE 4
Site Capacity and Surcharge Summary

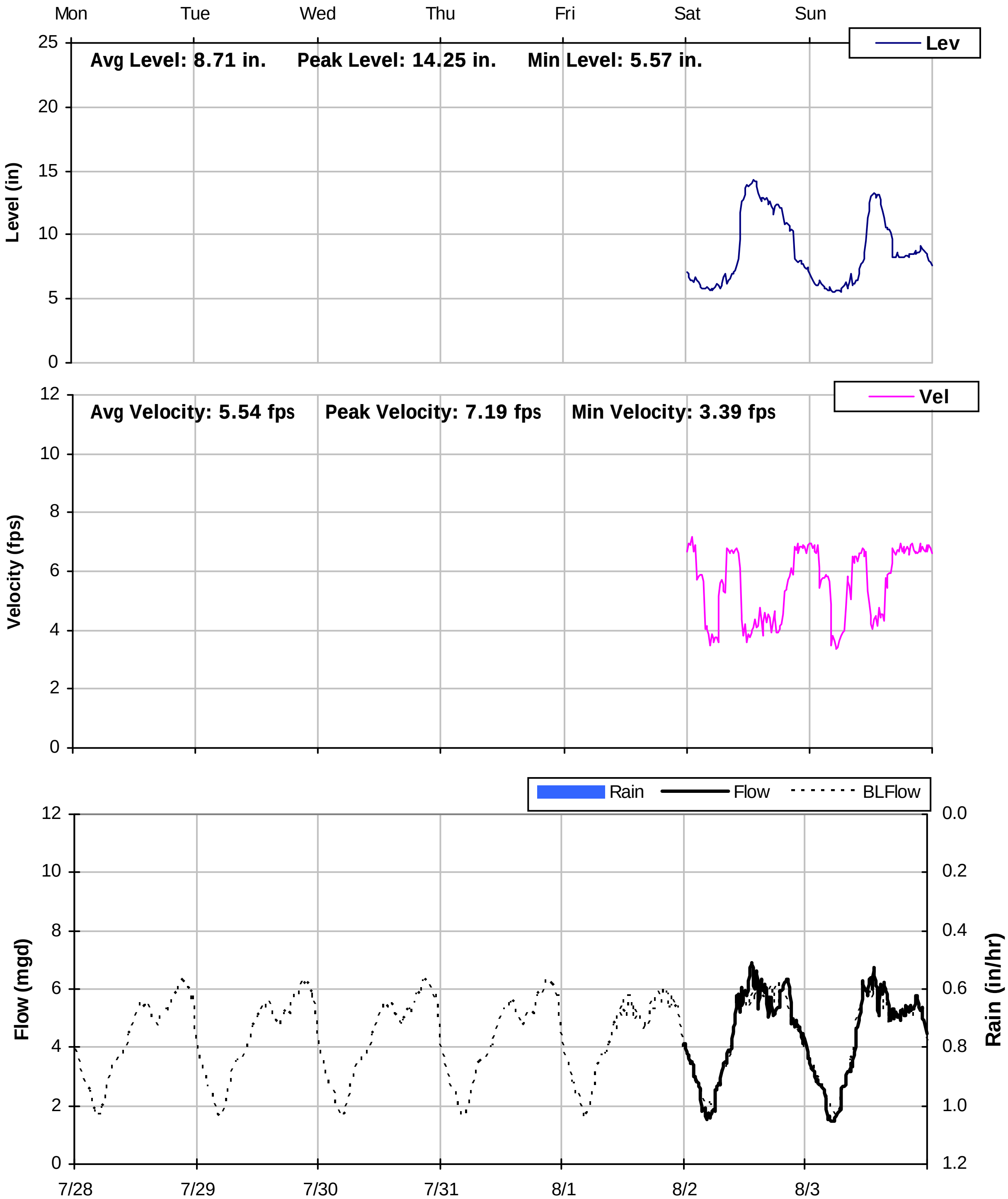
Realtime Flow Levels with Rainfall Data over Monitoring Period





Pipe Diameter:	33	*inches*
Peak Measured Level:	14.5	*inches*
Peak d/D Ratio:	0.44	

SITE 4
Weekly Level, Velocity and Flow Hydrographs
7/28/2014 to 8/4/2014

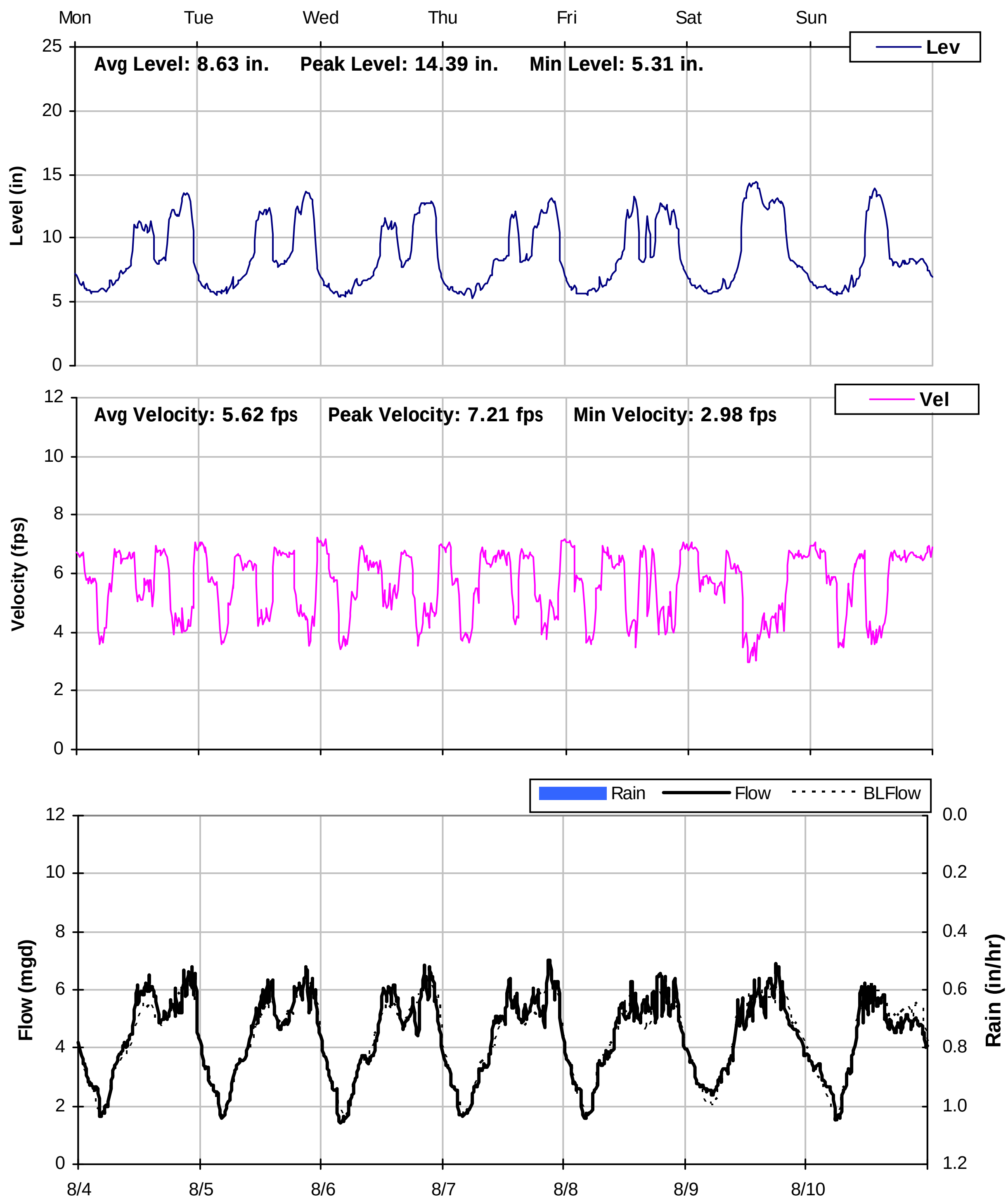


Avg Flow: 4.403 mgd **Peak Flow: 6.885 mgd** **Min Flow: 1.471 mgd**

SITE 4

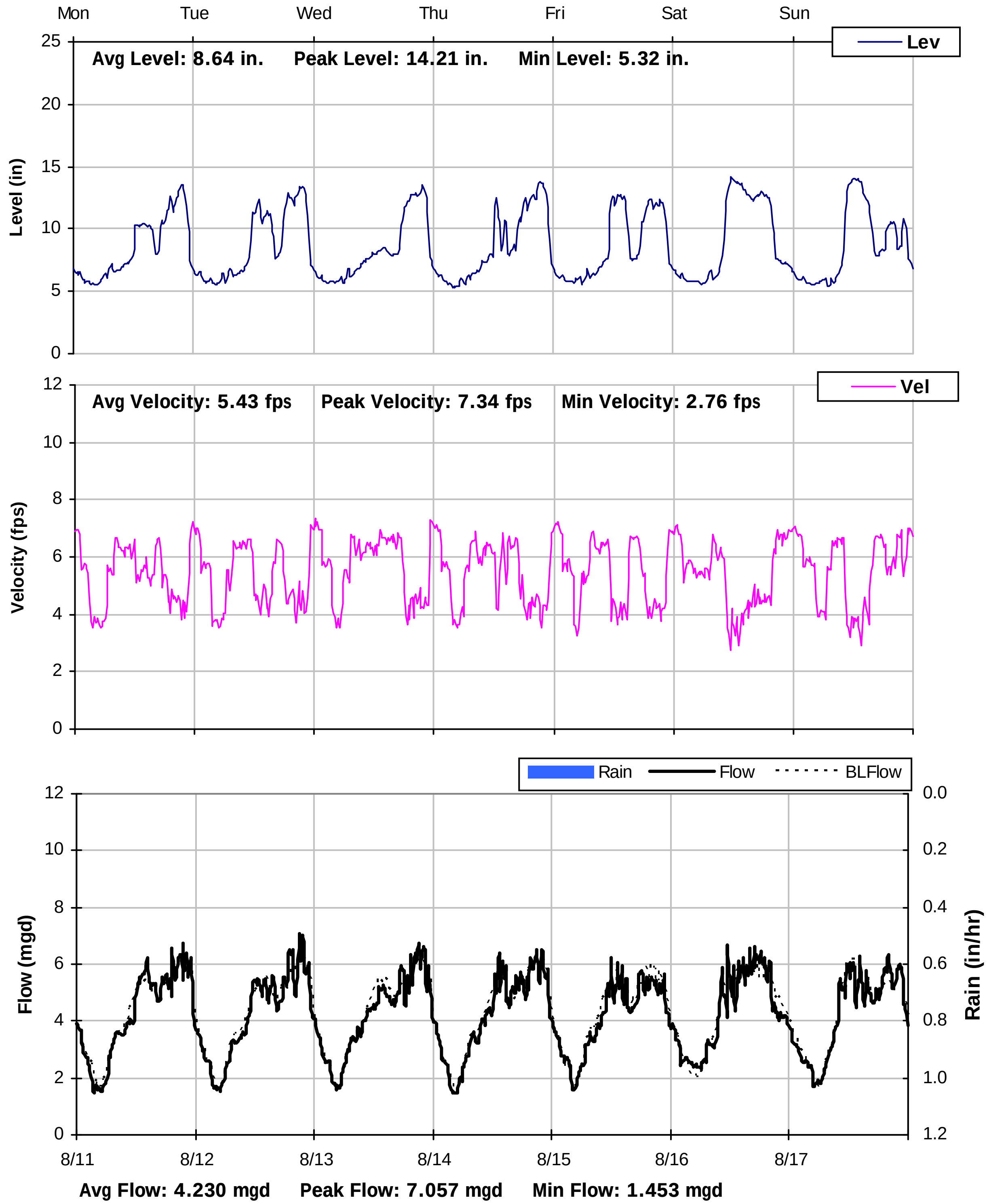
Weekly Level, Velocity and Flow Hydrographs

8/4/2014 to 8/11/2014



Avg Flow: 4.373 mgd **Peak Flow: 7.030 mgd** **Min Flow: 1.427 mgd**

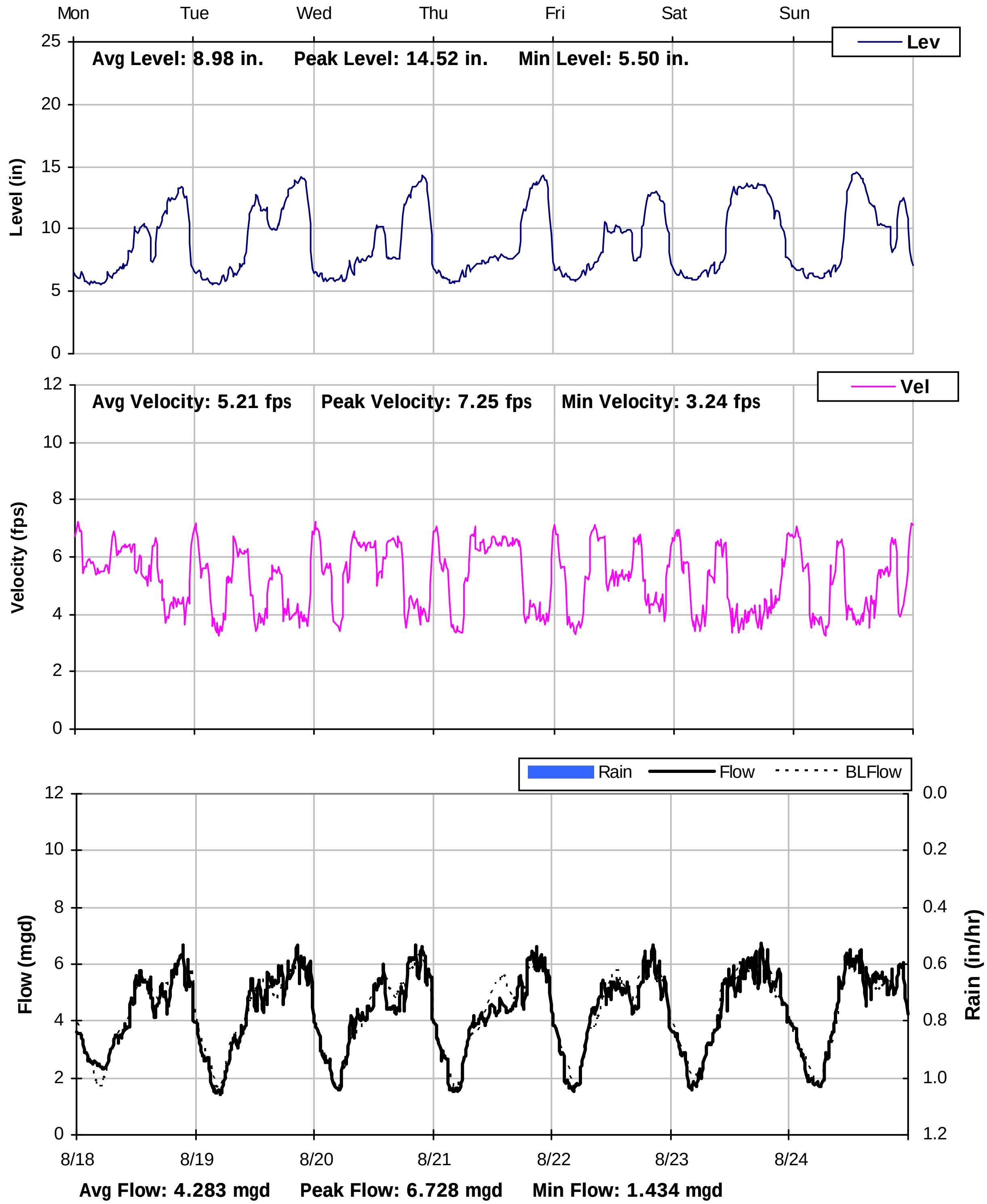
SITE 4
Weekly Level, Velocity and Flow Hydrographs
8/11/2014 to 8/18/2014



SITE 4

Weekly Level, Velocity and Flow Hydrographs

8/18/2014 to 8/25/2014



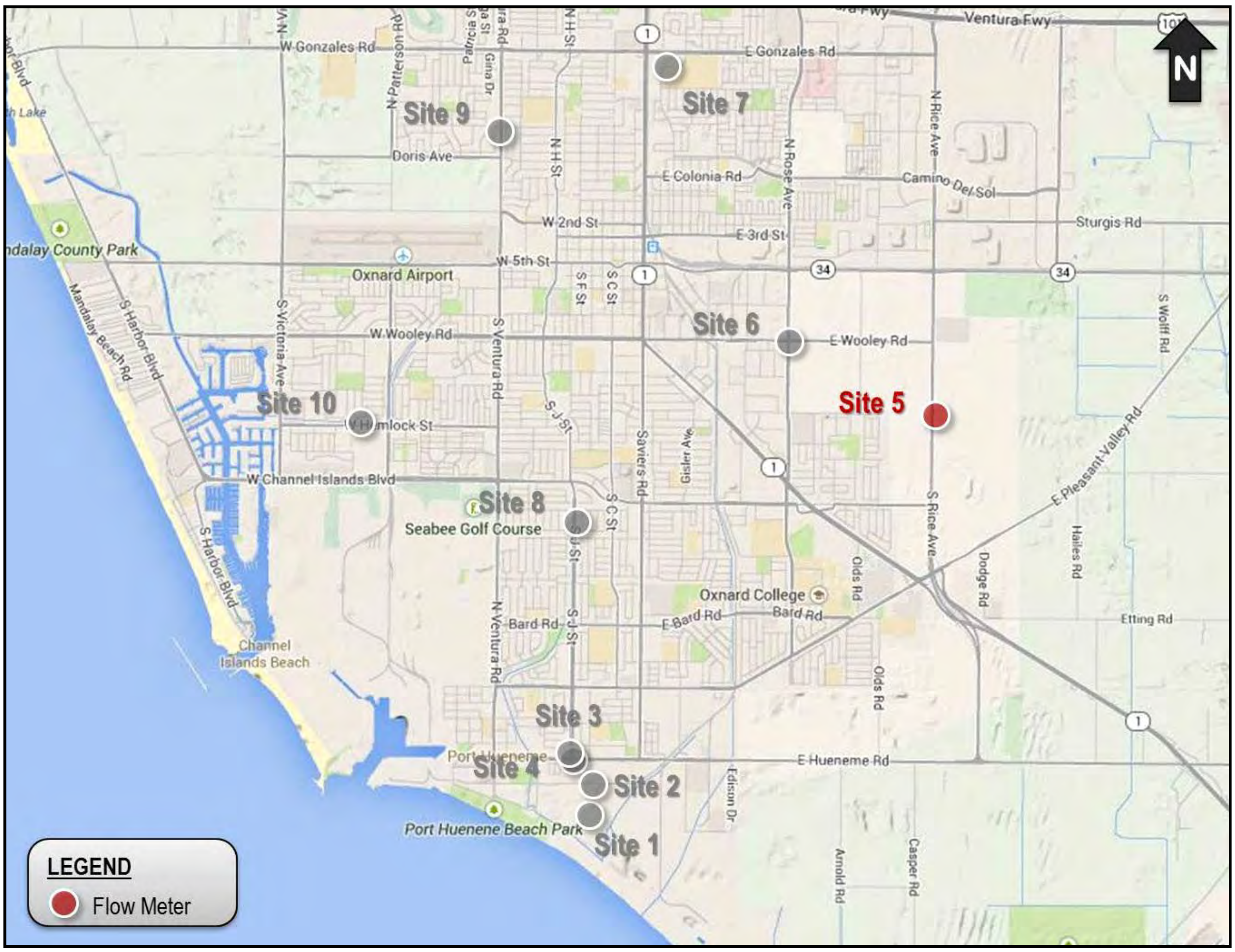
City of Oxnard

Sanitary Sewer Flow Monitoring
Temporary Monitoring: August, 2014

Monitoring Site: Site 5

Location: S Rice Avenue and East of Emerson Avenue

Data Summary Report



Vicinity Map: Site 5

SITE 5

Site Information

Location: S Rice Avenue and East of Emerson Avenue

Coordinates: 119.1427° W, 34.1819° N

Rim Elevation: 44 feet

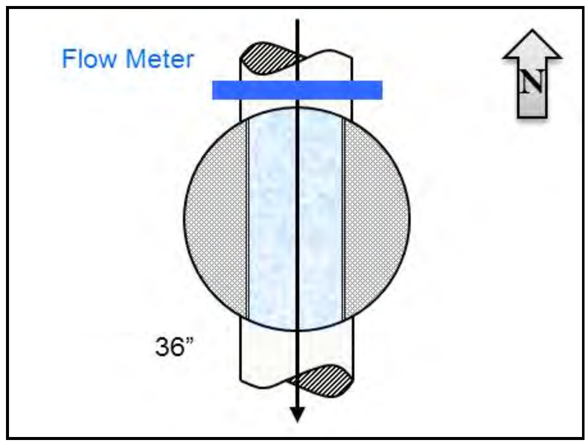
Pipe Diameter: 36 inches

Baseline Flow: 1.341 mgd

Peak Measured Flow: 2.852 mgd

Satellite Map

Sanitary Map



Flow Diagram


Street View


Plan View

SITE 5

Additional Site Photos

Effluent Pipe

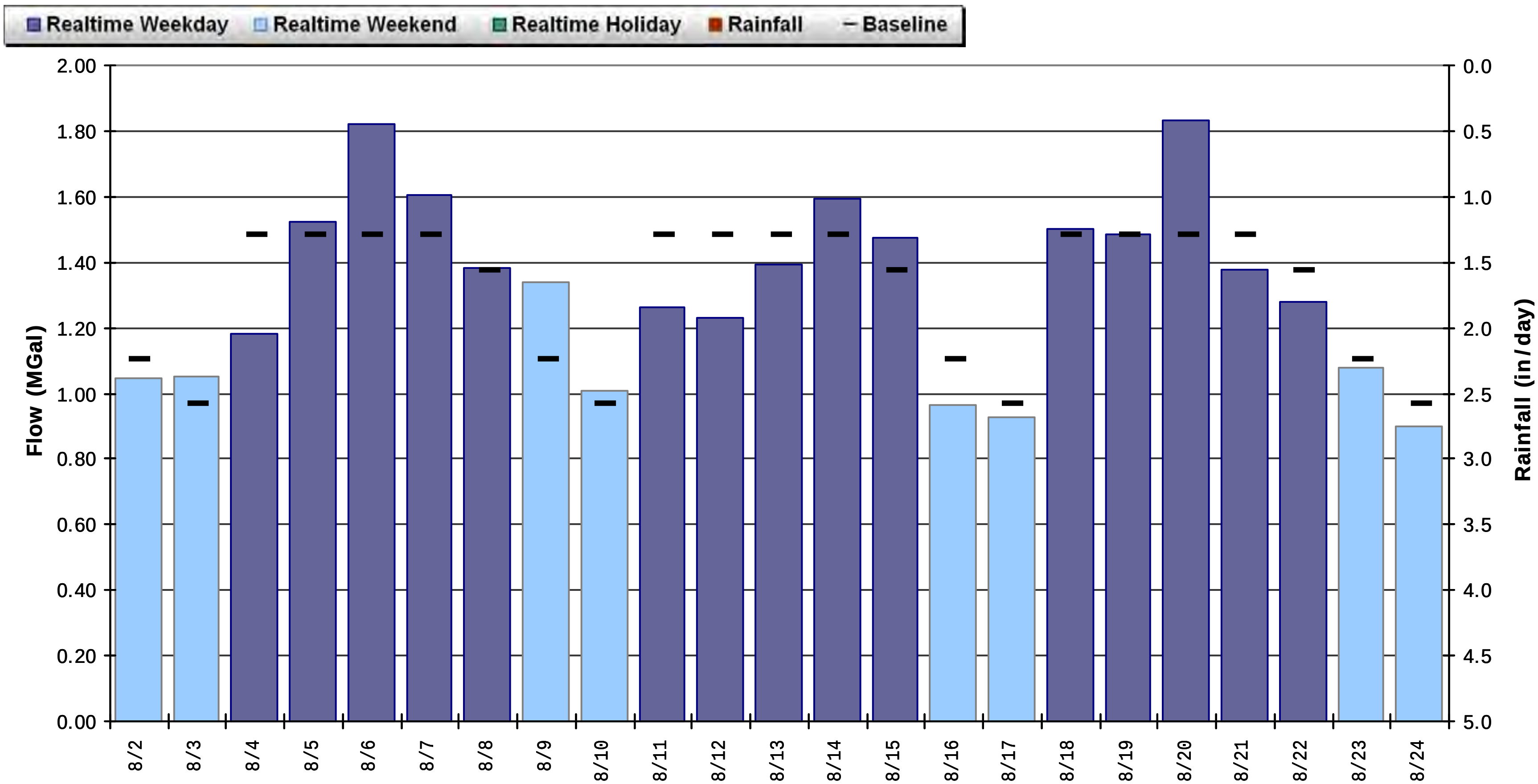
Influent Pipe

SITE 5

Period Flow Summary: Daily Flow Totals

Avg Period Flow: 1.315 MGal **Peak Daily Flow: 1.831 MGal** **Min Daily Flow: 0.898 MGal**

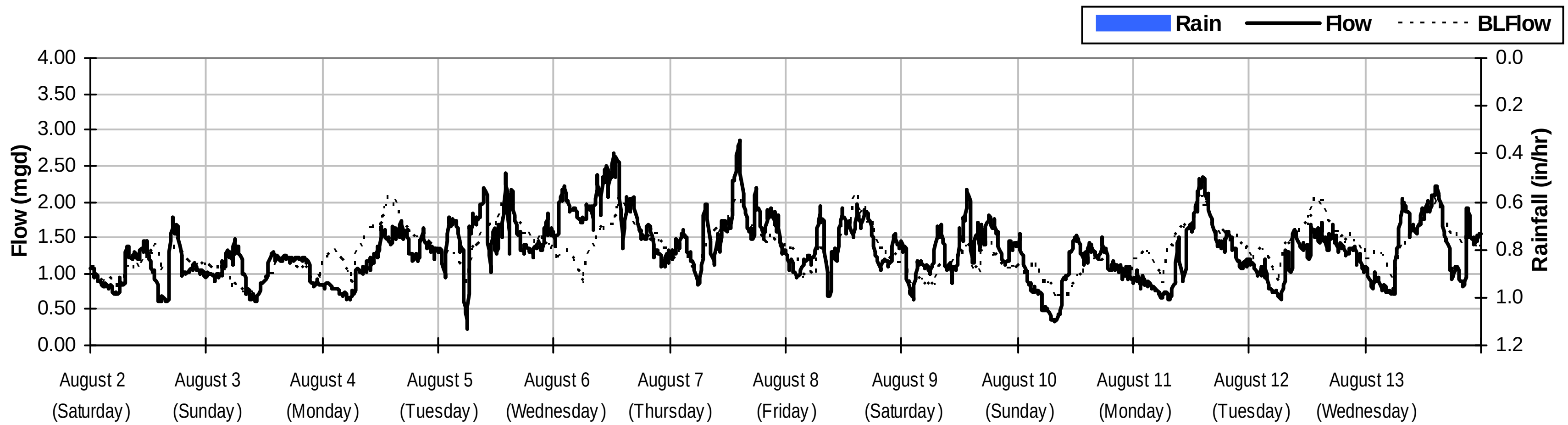
Total Monthly Rainfall: 0.00 inches

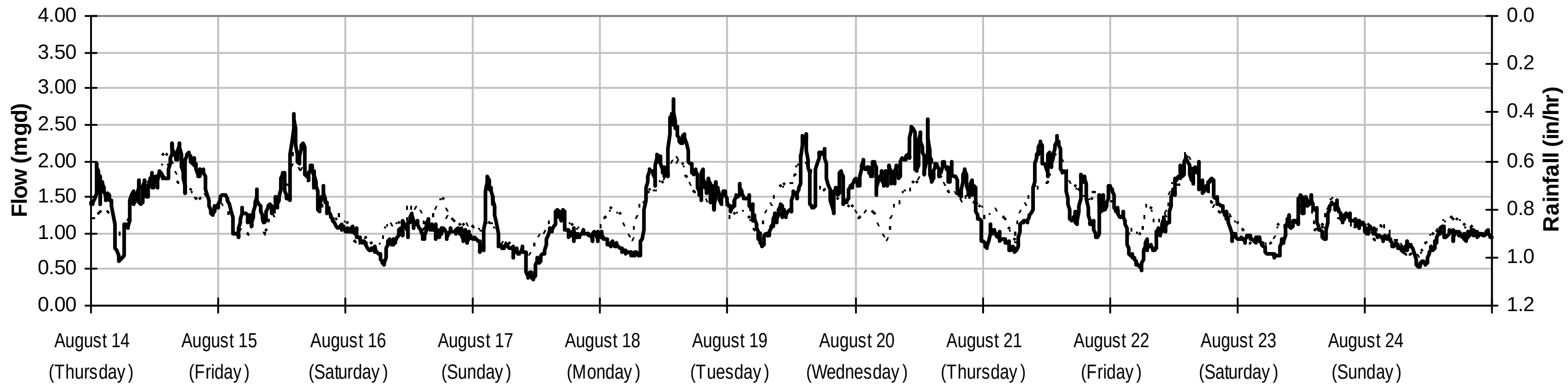


SITE 5

Flow Summary: 8/2/2014 to 8/24/2014

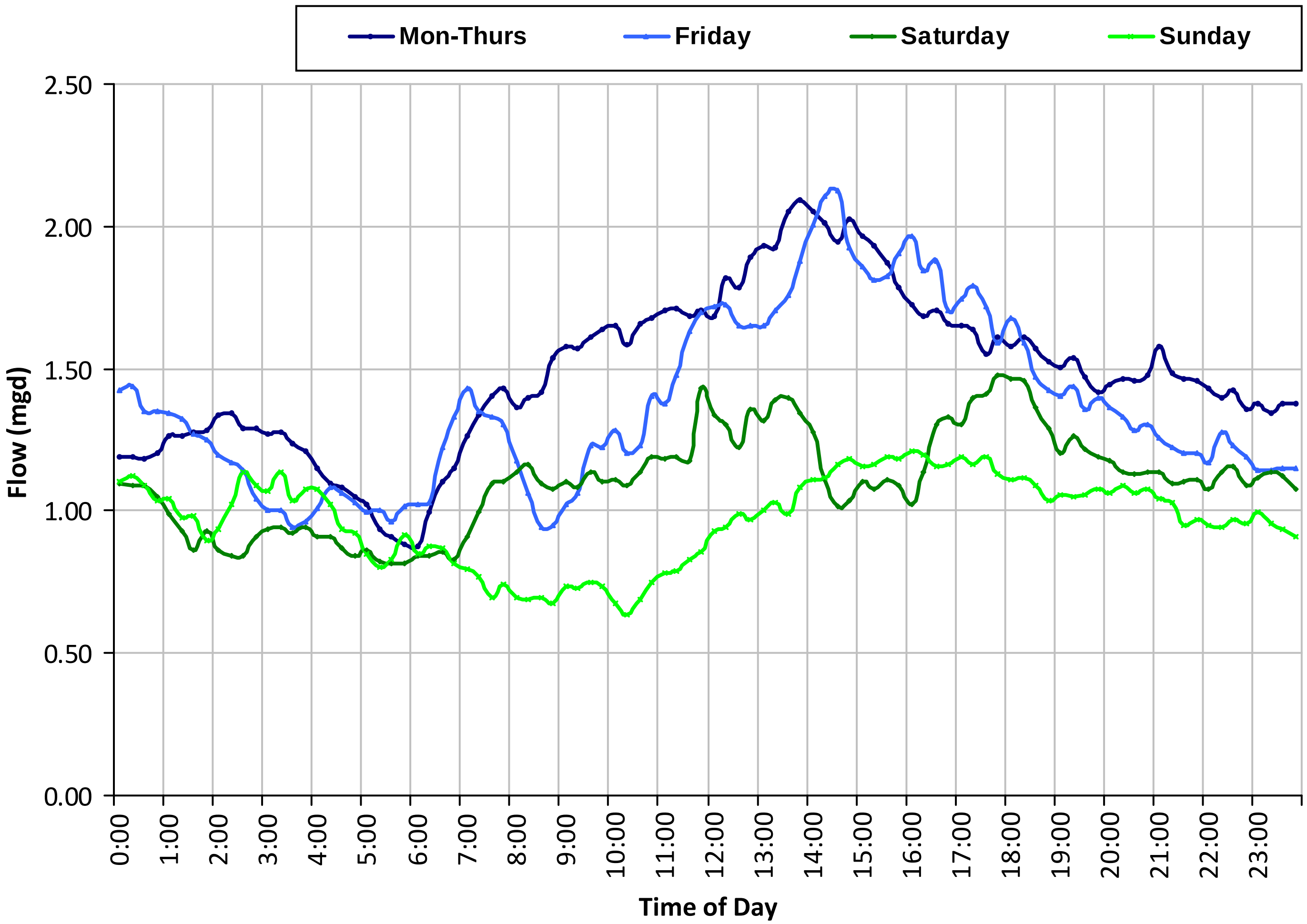
Total Period Rainfall: 0.00 inches **Avg Flow: 1.315 mgd** **Peak Flow: 2.852 mgd** **Min Flow: 0.233 mgd**





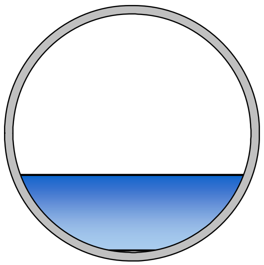
SITE 5

Baseline Flow Hydrographs



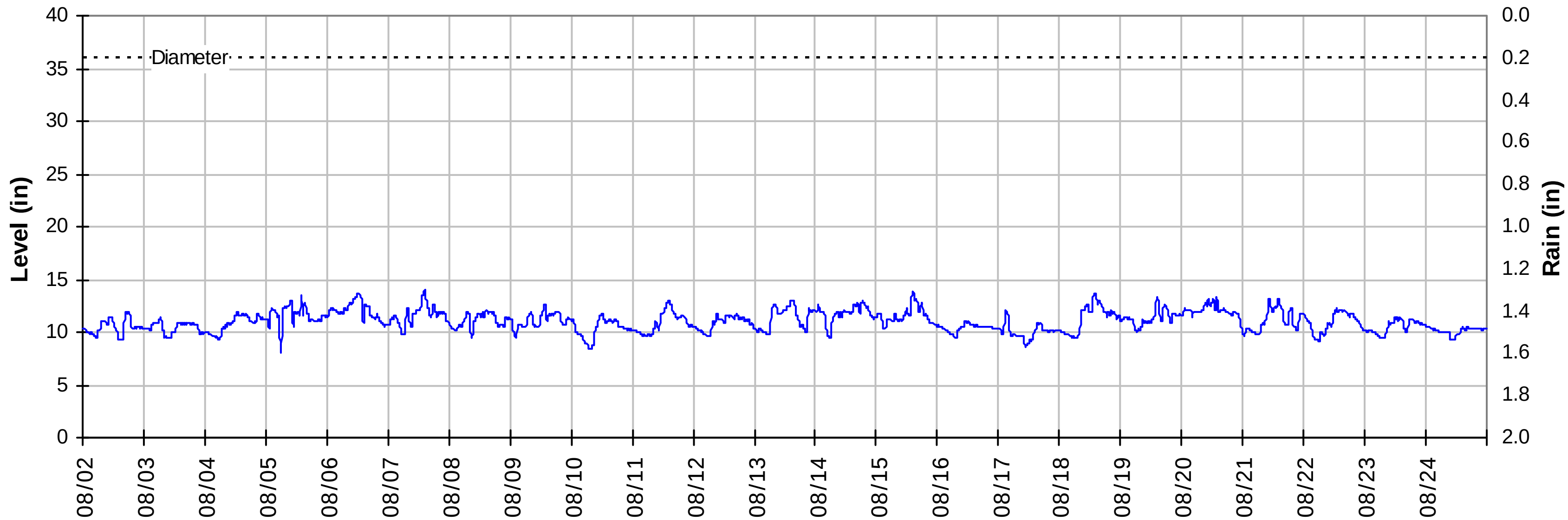
Baseline Flow:

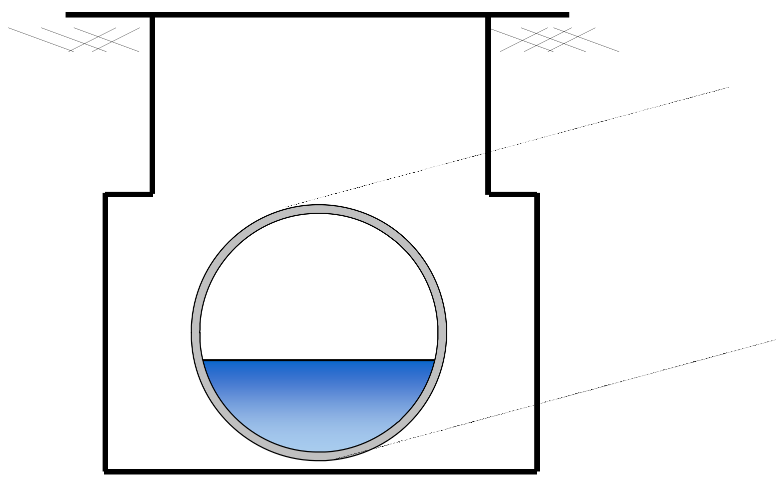
1.341 *mgd*



SITE 5
Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Monitoring Period



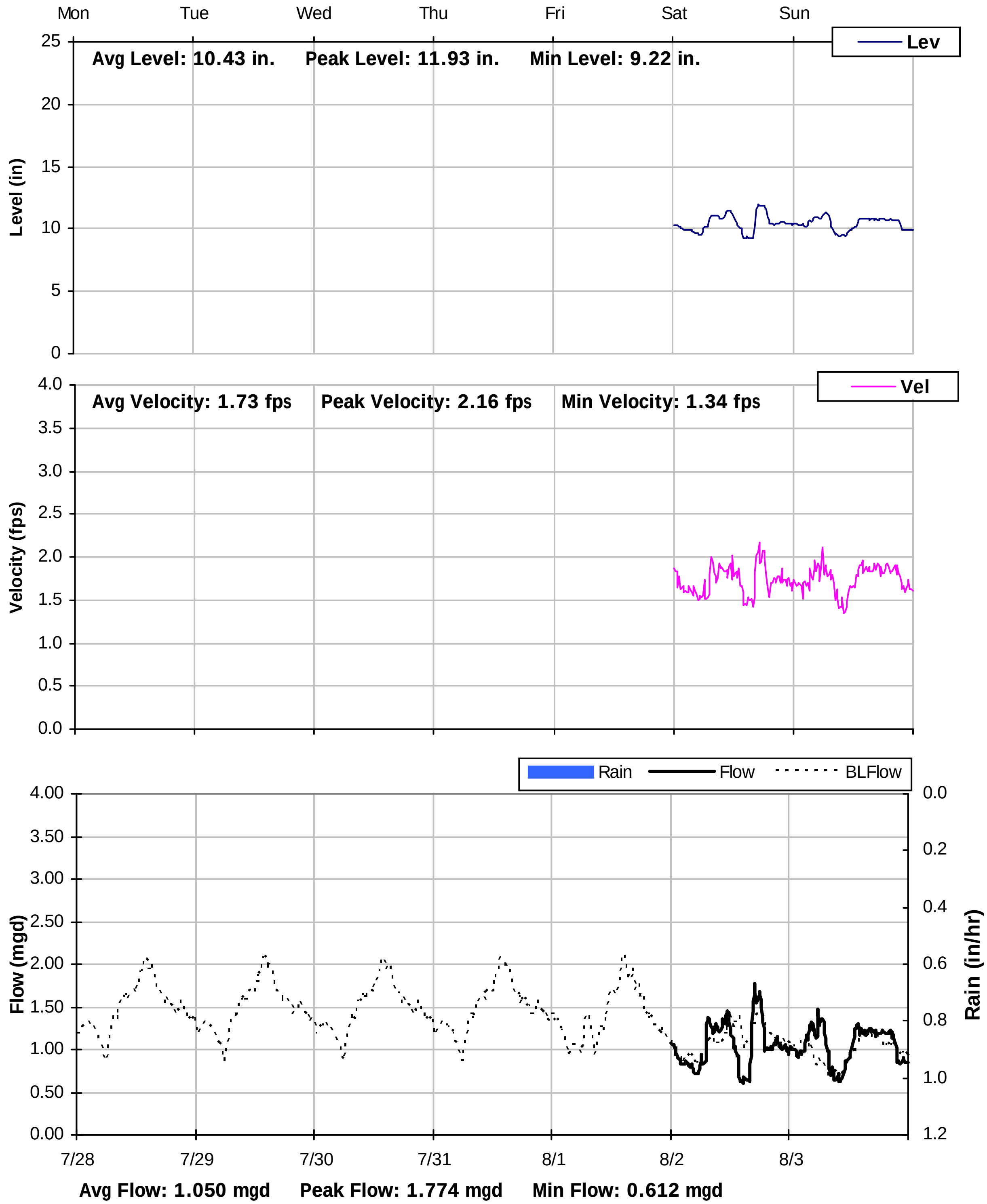


Pipe Diameter:	36	*inches*
Peak Measured Level:	14	*inches*
Peak d/D Ratio:	0.39	

SITE 5

Weekly Level, Velocity and Flow Hydrographs

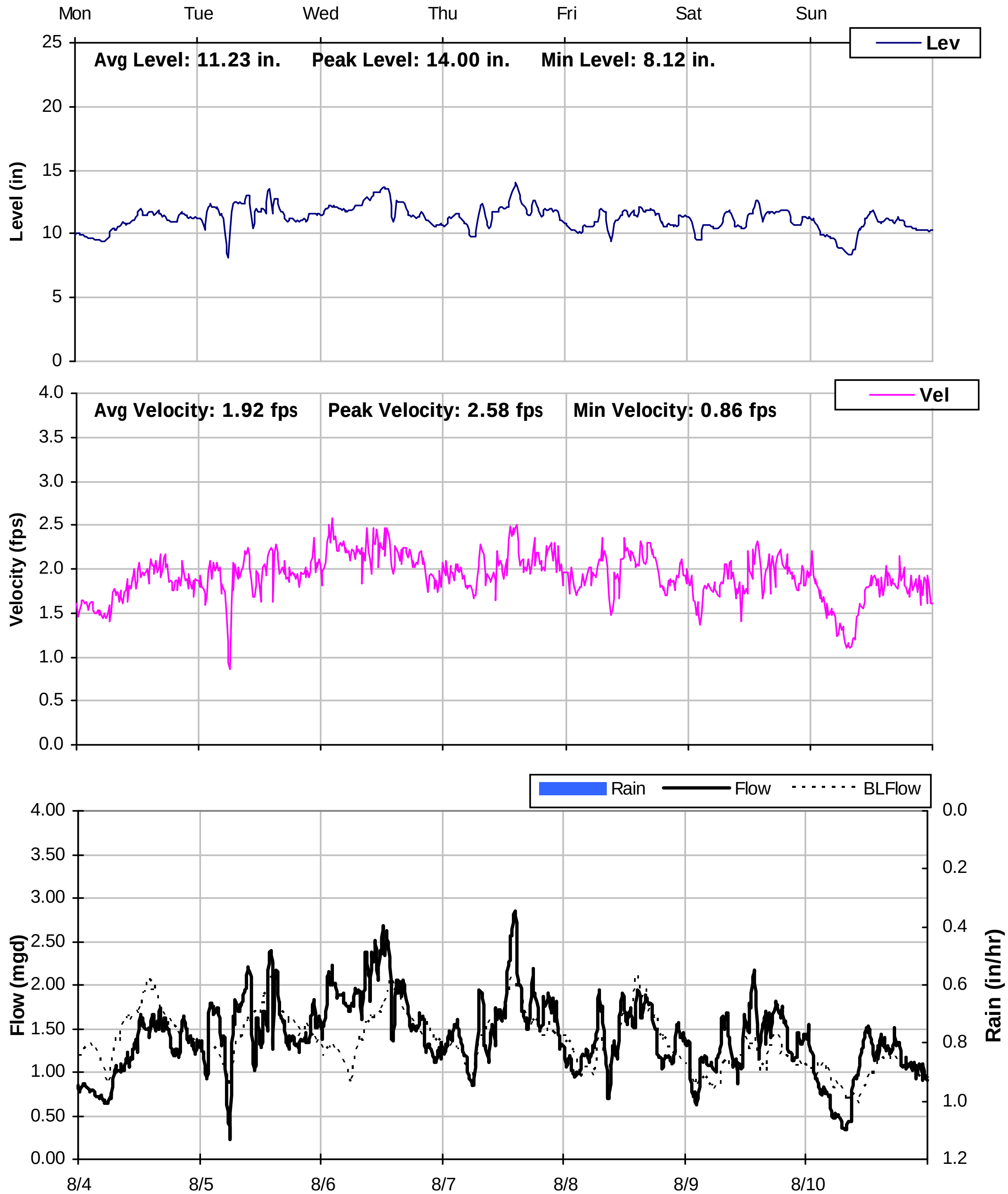
7/28/2014 to 8/4/2014



SITE 5

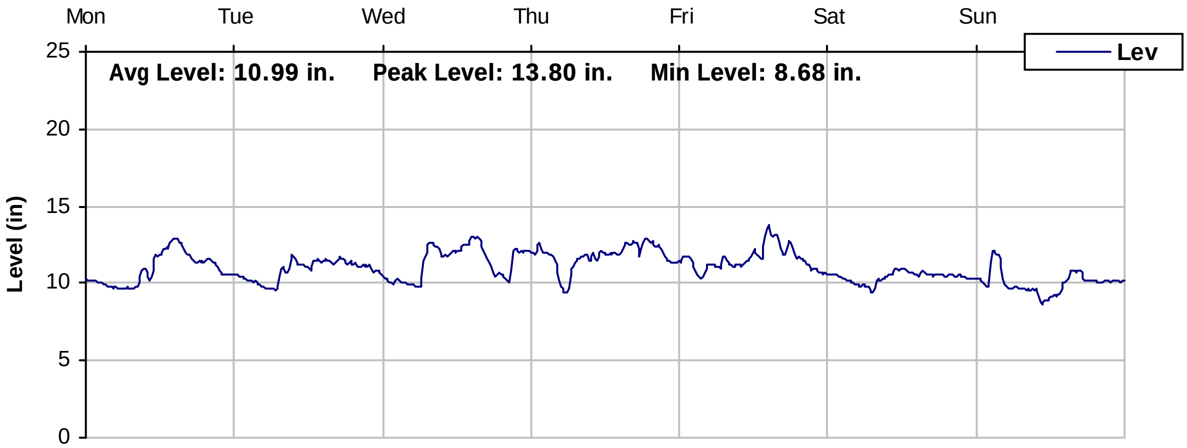
Weekly Level, Velocity and Flow Hydrographs

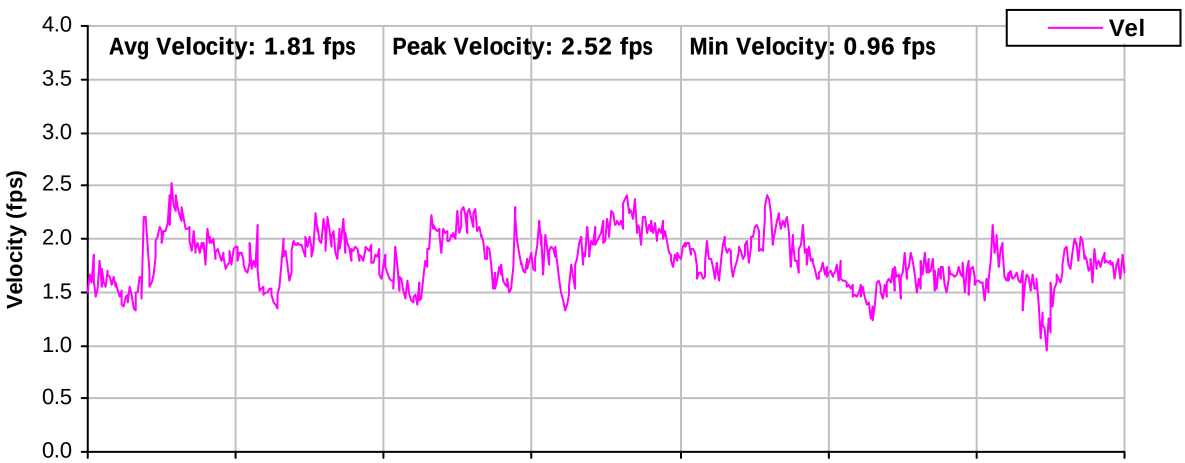
8/4/2014 to 8/11/2014

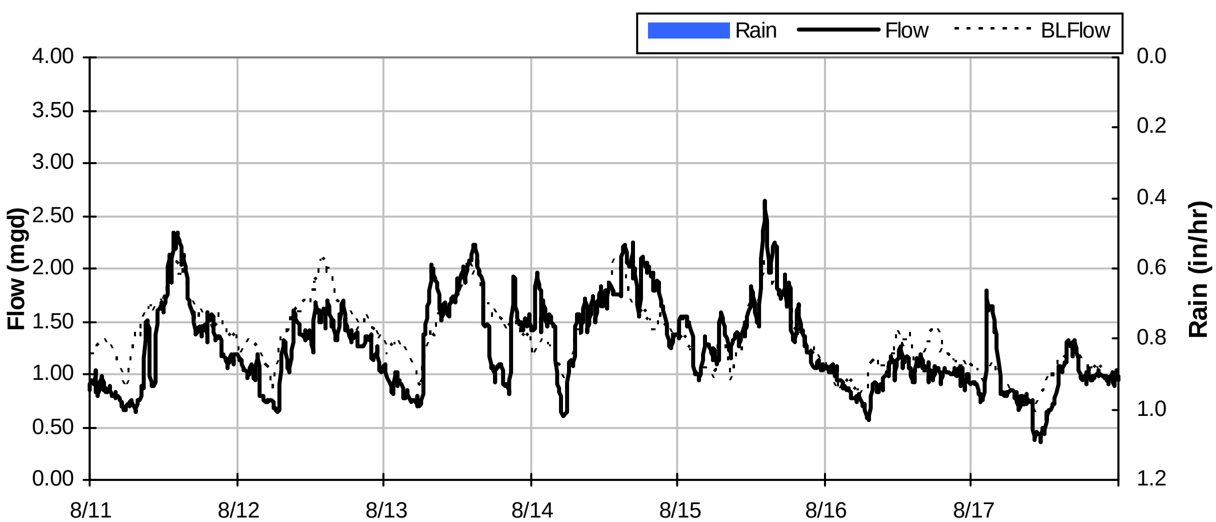


Avg Flow: 1.408 mgd Peak Flow: 2.852 mgd Min Flow: 0.233 mgd

SITE 5
Weekly Level, Velocity and Flow Hydrographs
8/11/2014 to 8/18/2014

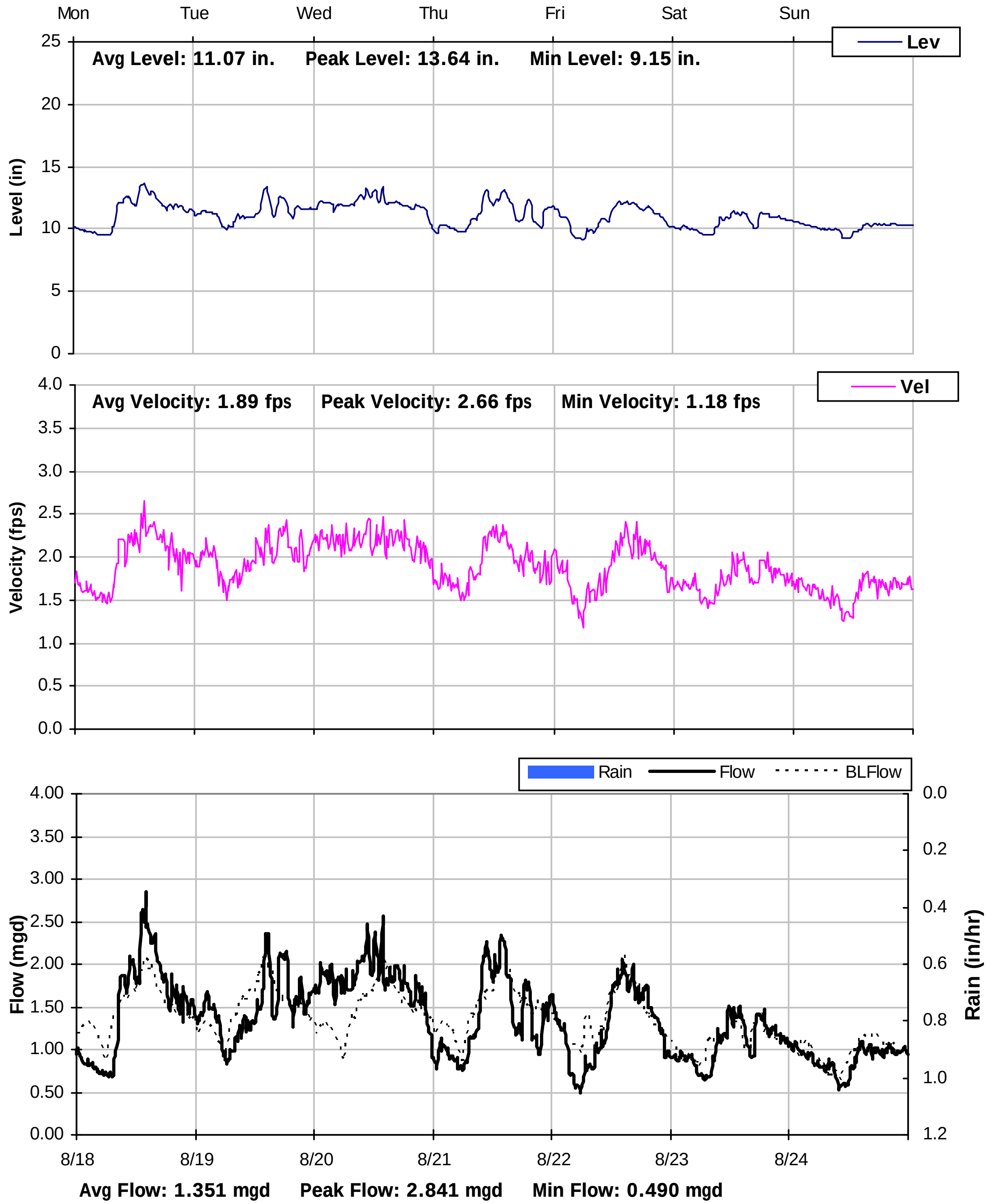






Avg Flow: 1.263 mgd Peak Flow: 2.646 mgd Min Flow: 0.359 mgd

SITE 5
Weekly Level, Velocity and Flow Hydrographs
8/18/2014 to 8/25/2014



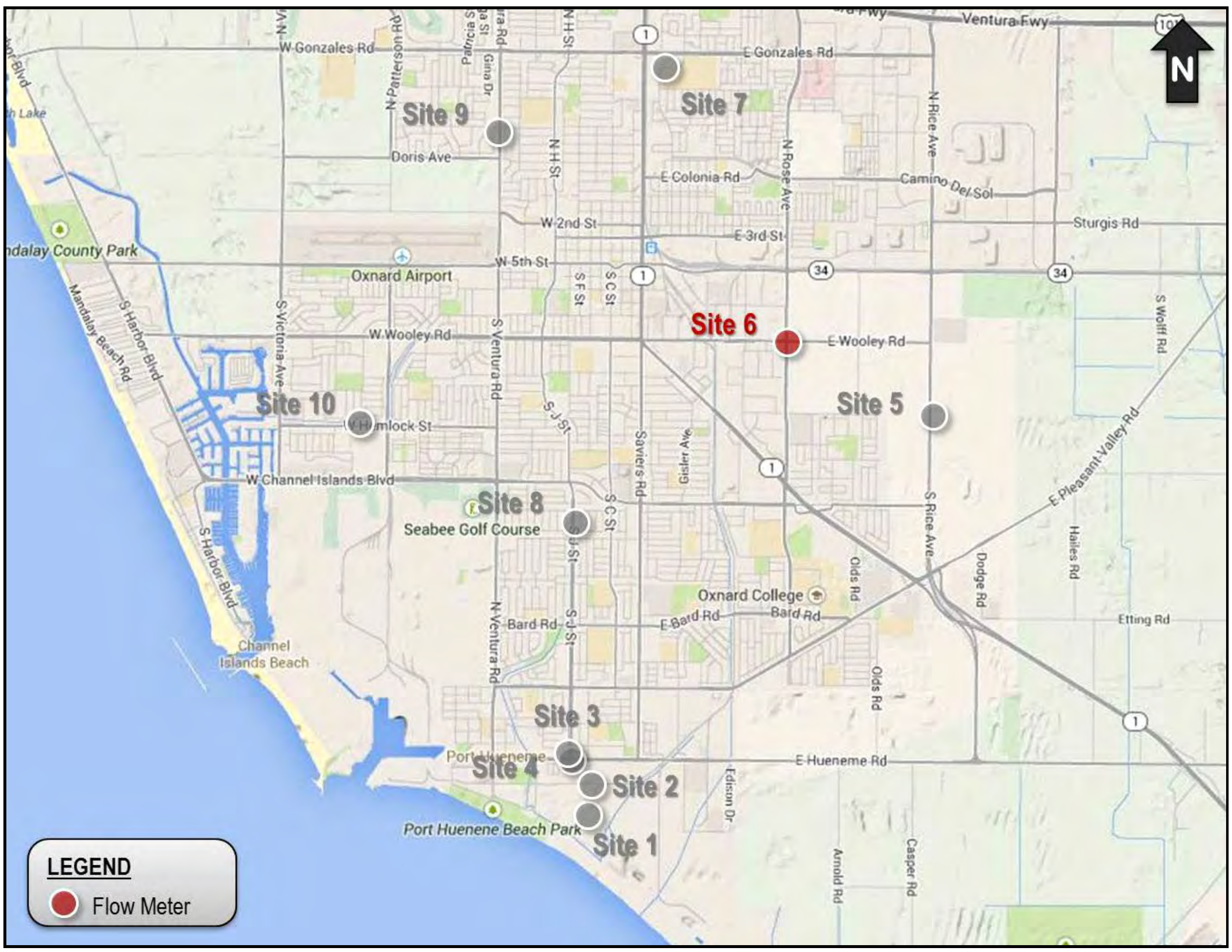
City of Oxnard

Sanitary Sewer Flow Monitoring
Temporary Monitoring: August, 2014

Monitoring Site: Site 6

Location: S Rose Avenue and E Wooley Road

Data Summary Report



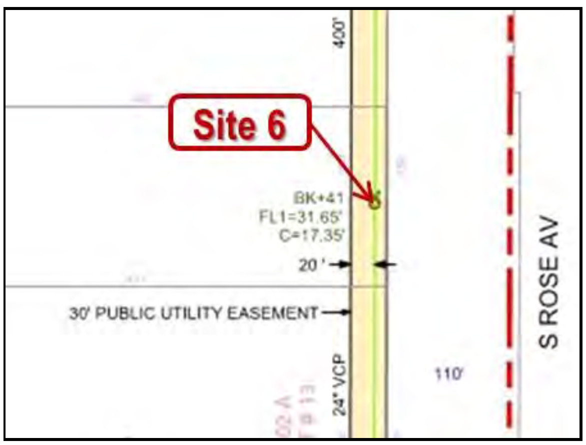
Vicinity Map: Site 6

SITE 6

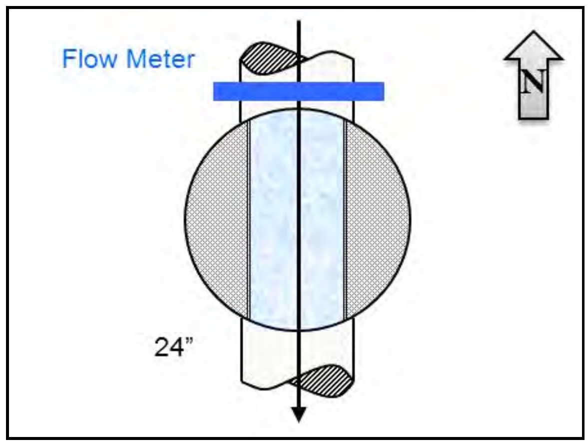
Site Information

Location:	S Rose Avenue and E Wooley Road
Coordinates:	119.1601° W, 34.1893° N
Rim Elevation:	49 feet
Pipe Diameter:	24 inches
Baseline Flow:	1.351 mgd
Peak Measured Flow:	2.381 mgd

Satellite Map



Sanitary Map



Flow Diagram

Street View

Plan View

SITE 6

Additional Site Photos

Effluent Pipe

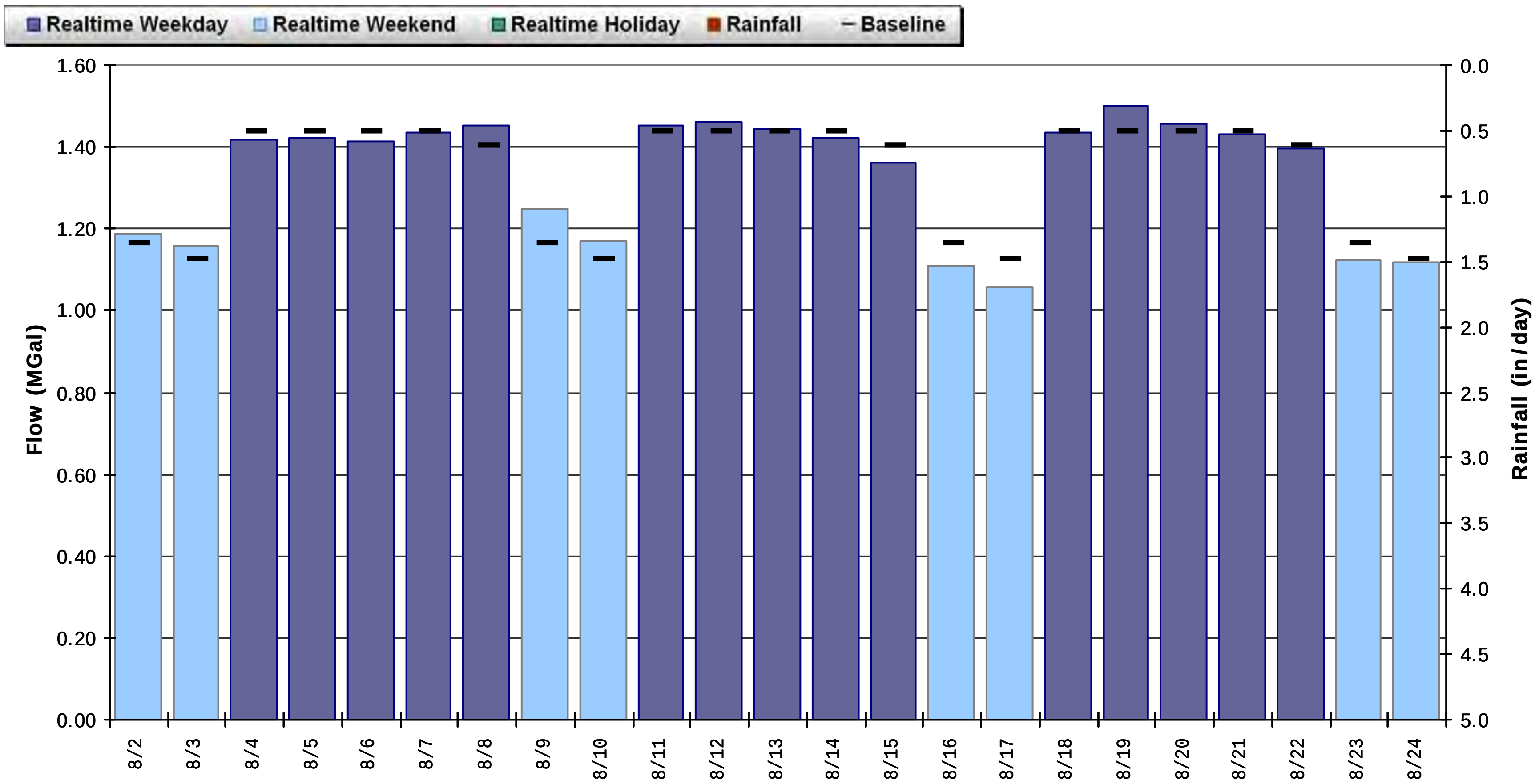
Influent Pipe

SITE 6

Period Flow Summary: Daily Flow Totals

Avg Period Flow: 1.333 MGal **Peak Daily Flow: 1.502 MGal** **Min Daily Flow: 1.058 MGal**

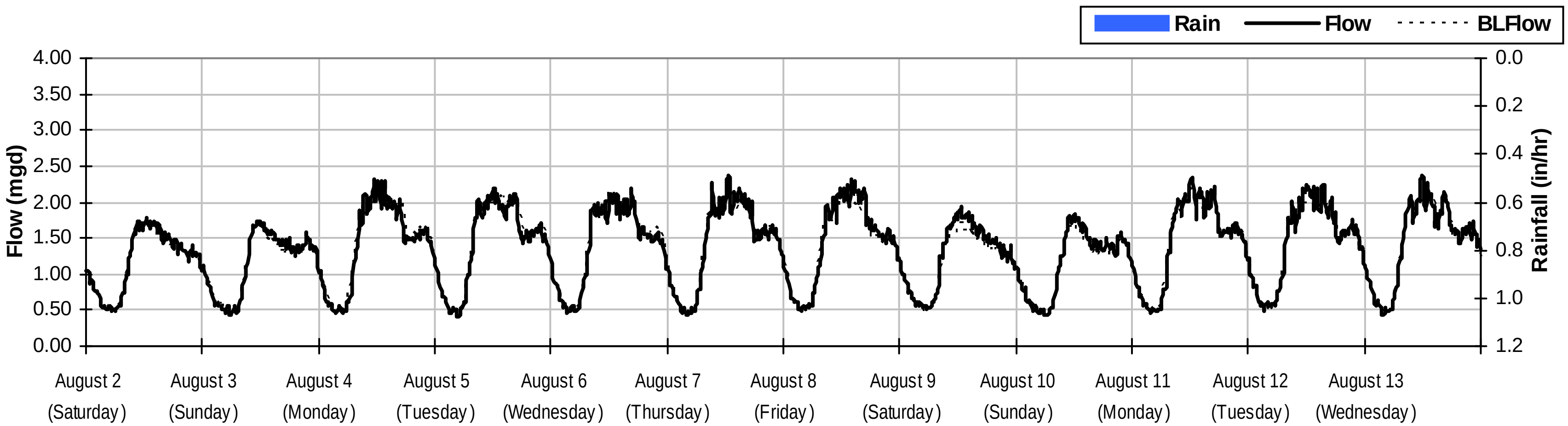
Total Monthly Rainfall: 0.00 inches

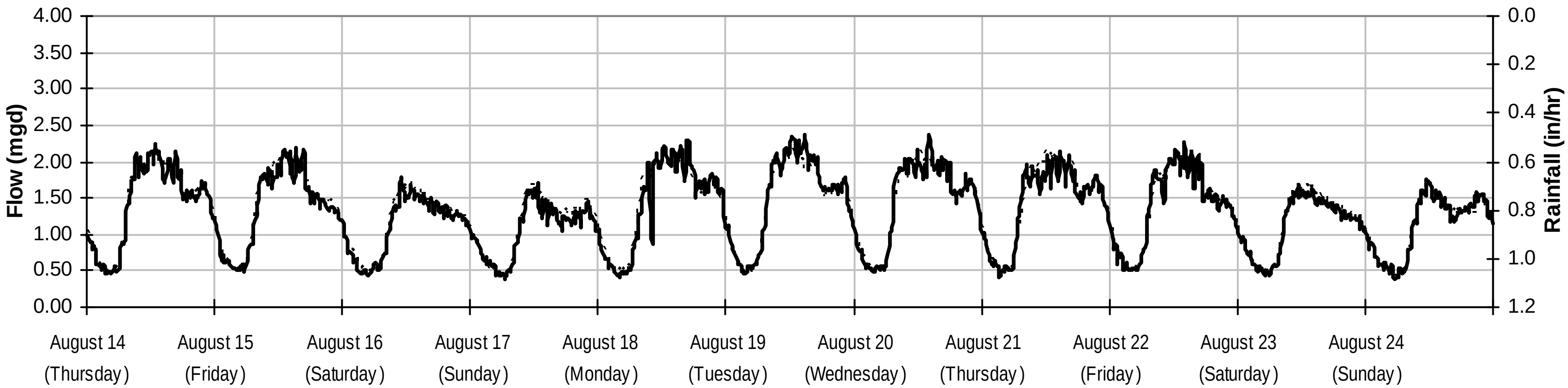


SITE 6

Flow Summary: 8/2/2014 to 8/24/2014

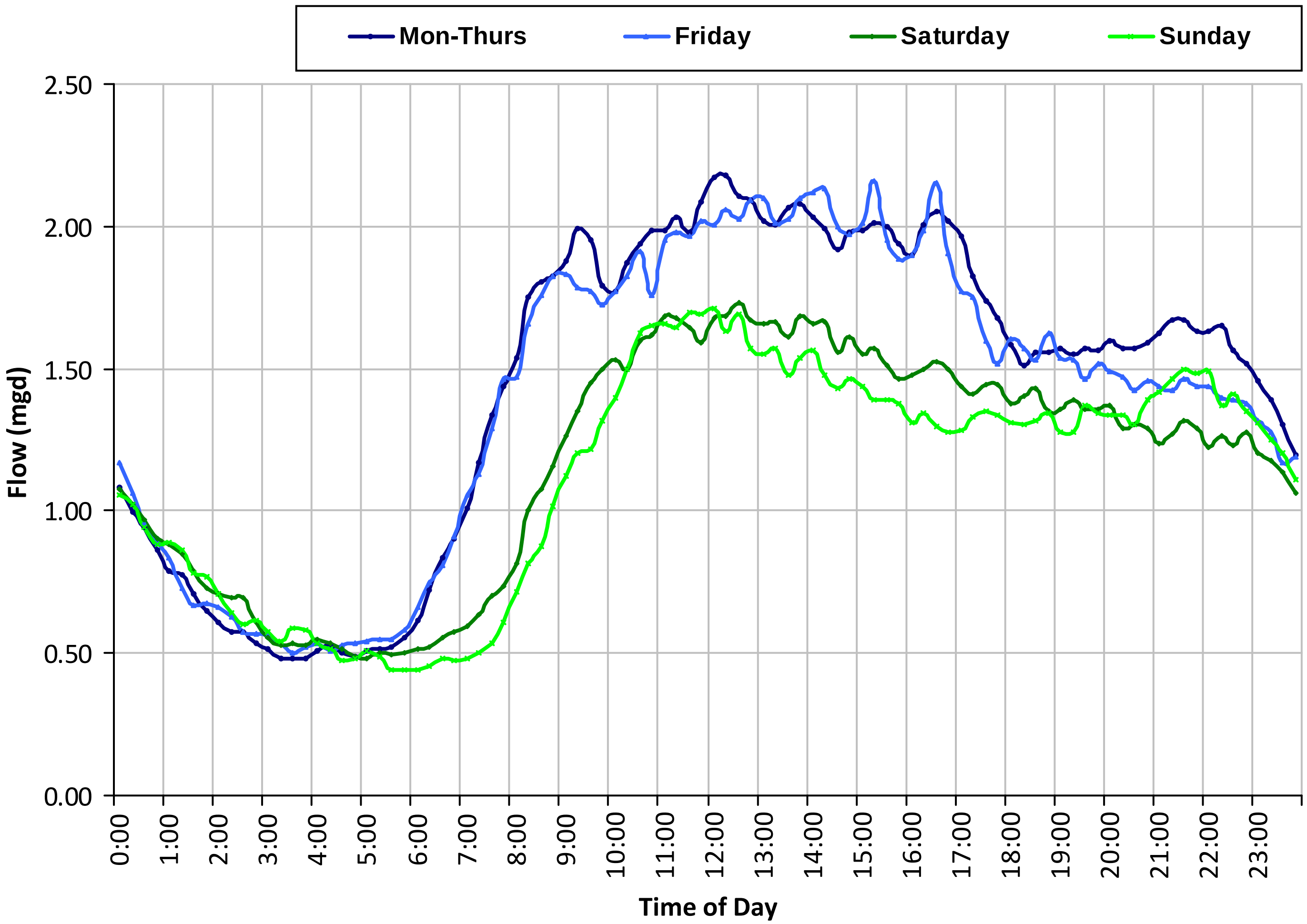
Total Period Rainfall: 0.00 inches **Avg Flow: 1.333 mgd** **Peak Flow: 2.381 mgd** **Min Flow: 0.375 mgd**





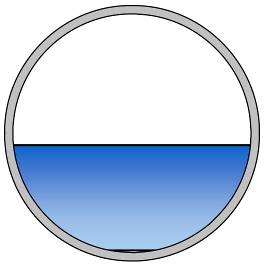
SITE 6

Baseline Flow Hydrographs



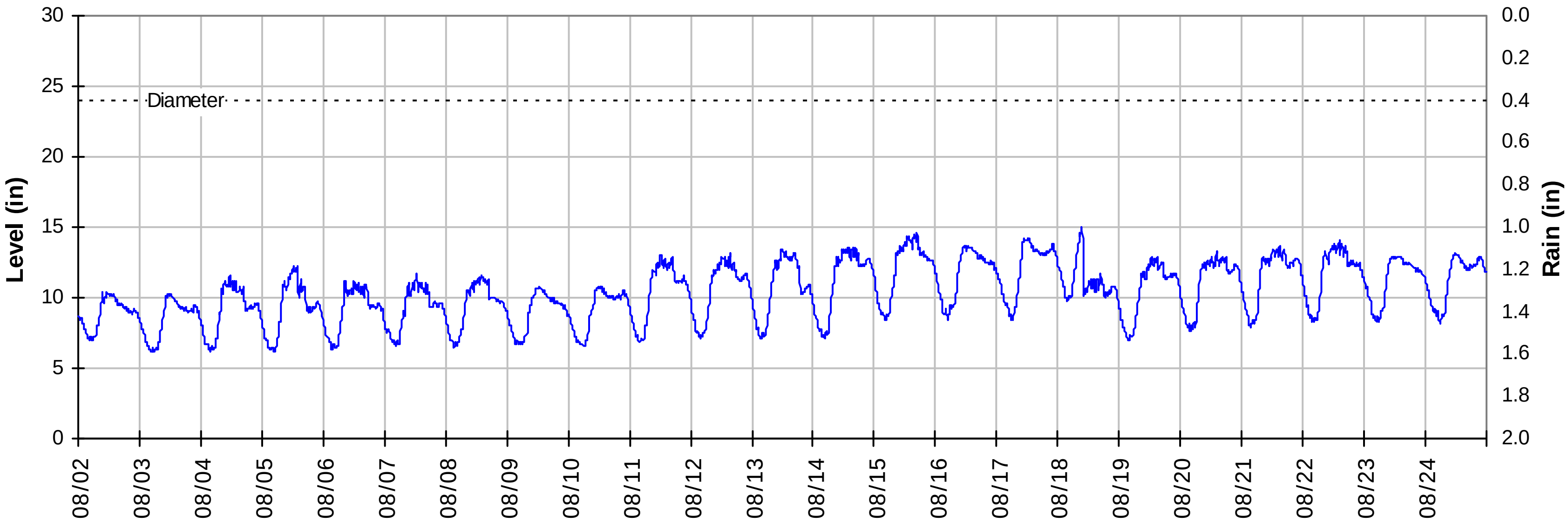
Baseline Flow:

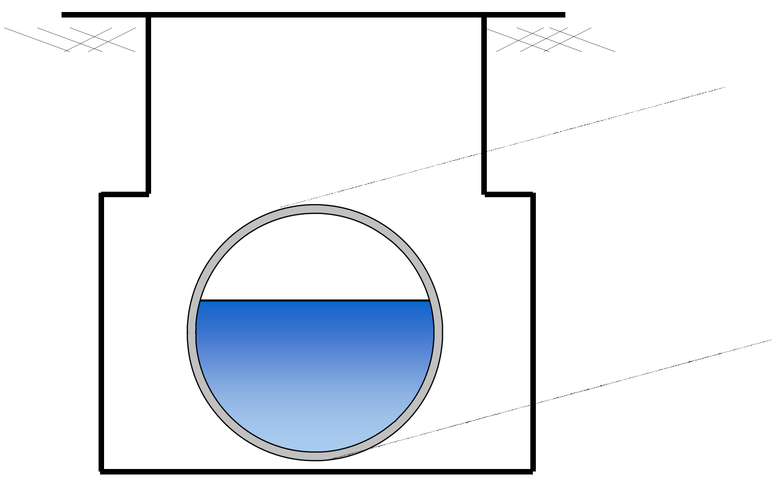
1.351 *mgd*



SITE 6
Site Capacity and Surcharge Summary

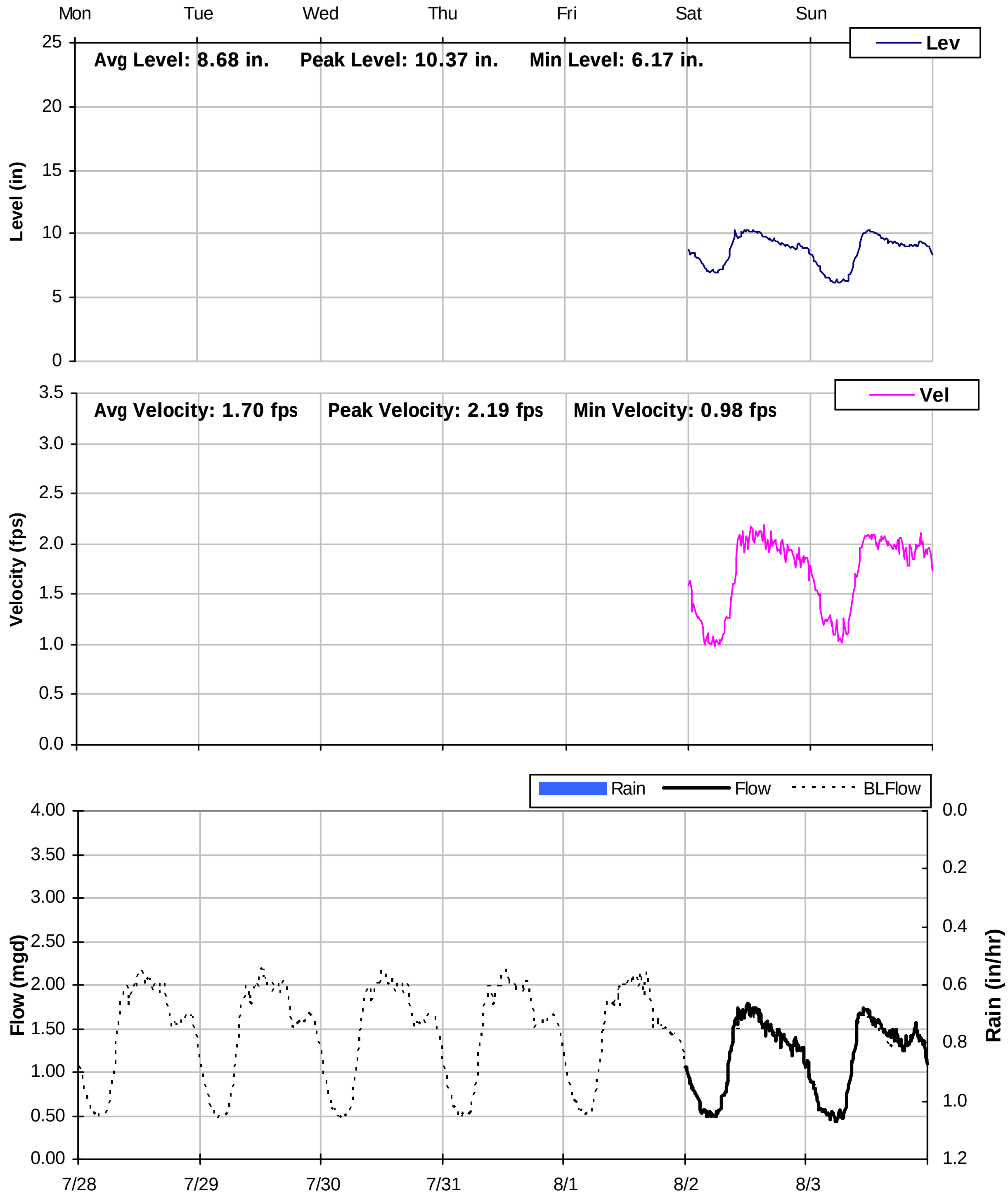
Realtime Flow Levels with Rainfall Data over Monitoring Period





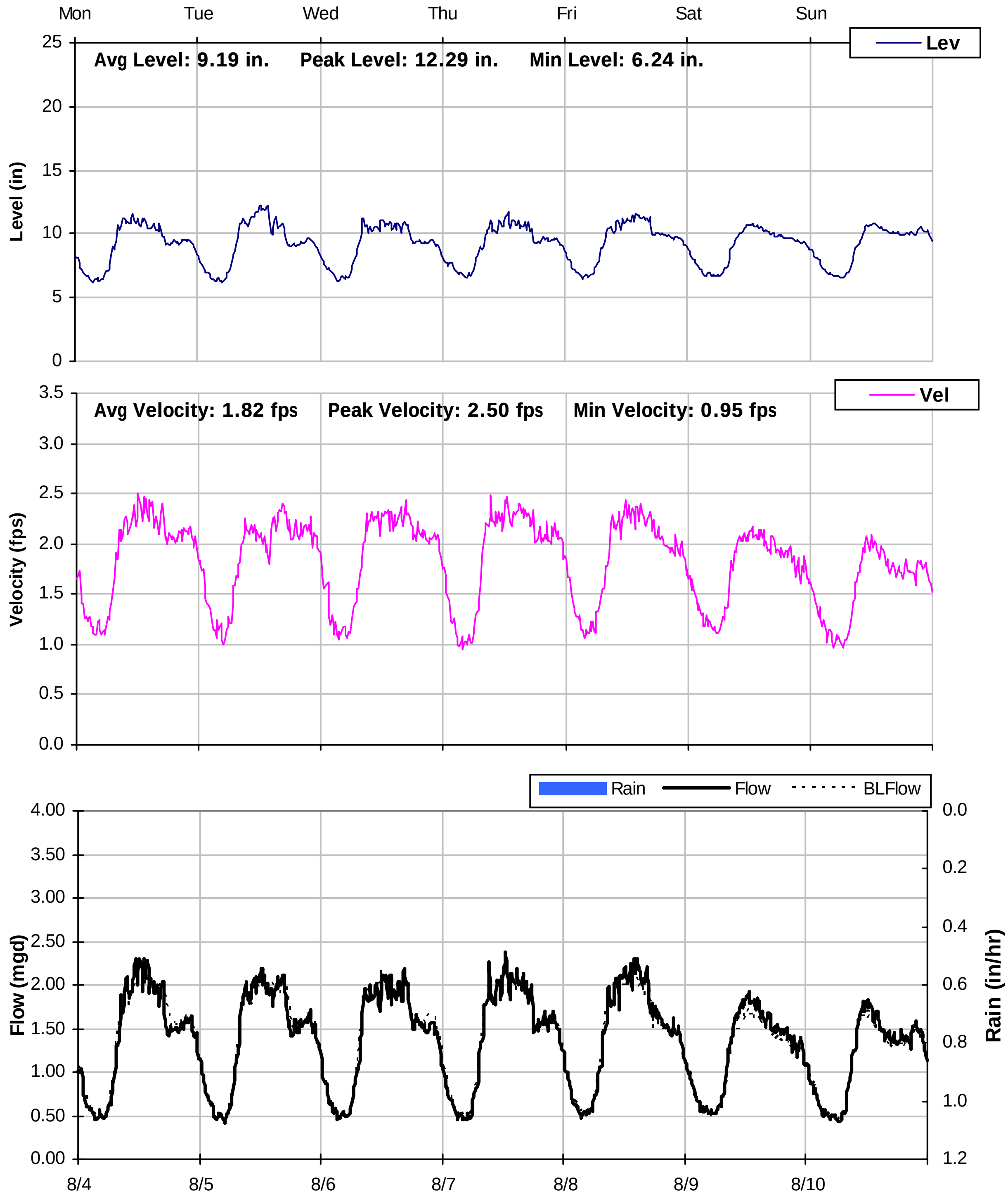
Pipe Diameter:	24	*inches*
Peak Measured Level:	15.1	*inches*
Peak d/D Ratio:	0.63	

SITE 6
Weekly Level, Velocity and Flow Hydrographs
7/28/2014 to 8/4/2014



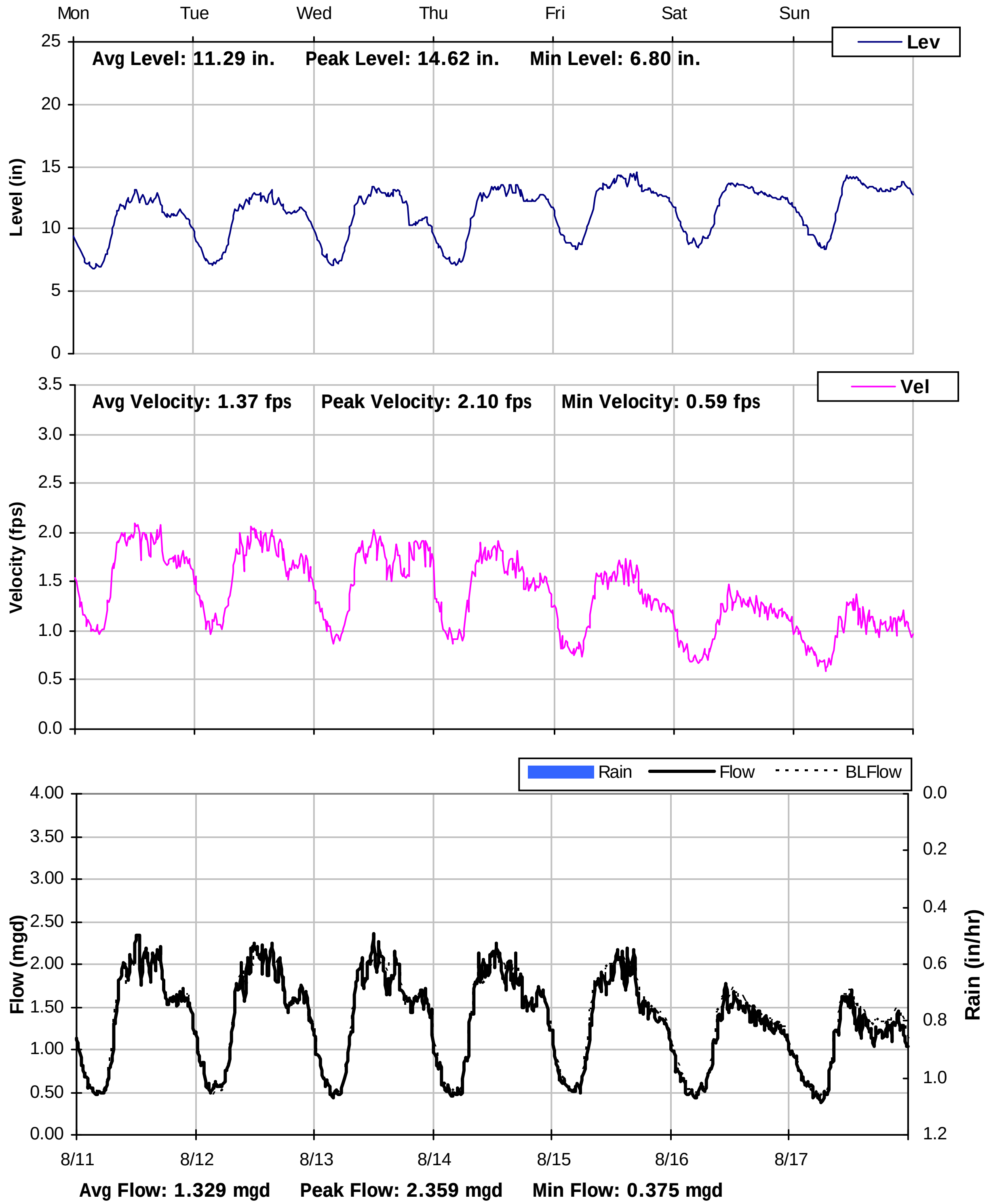
Avg Flow: 1.173 mgd **Peak Flow: 1.786 mgd** **Min Flow: 0.428 mgd**

SITE 6
Weekly Level, Velocity and Flow Hydrographs
8/4/2014 to 8/11/2014

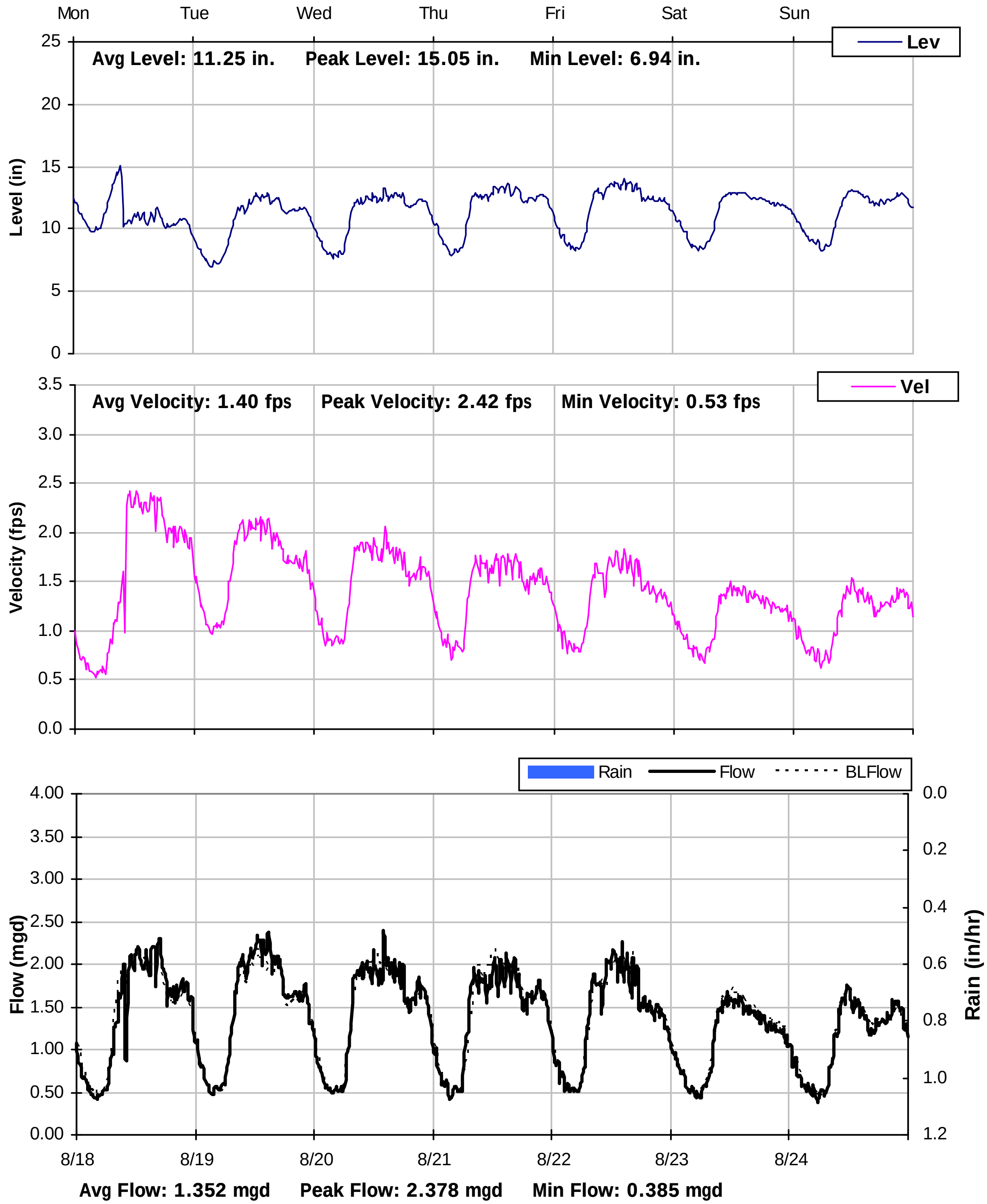


Avg Flow: 1.365 mgd **Peak Flow: 2.381 mgd** **Min Flow: 0.418 mgd**

SITE 6
Weekly Level, Velocity and Flow Hydrographs
8/11/2014 to 8/18/2014



SITE 6
Weekly Level, Velocity and Flow Hydrographs
8/18/2014 to 8/25/2014



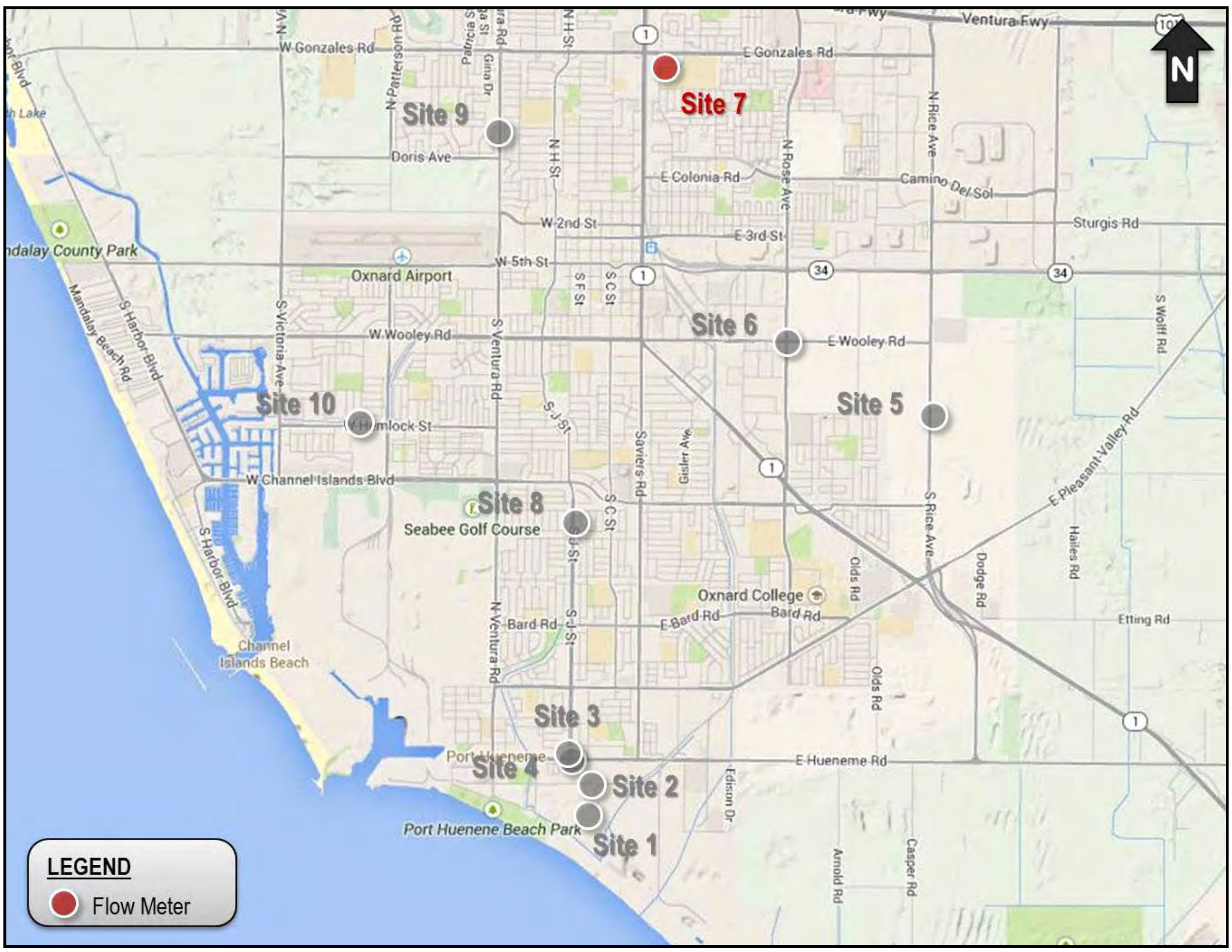
City of Oxnard

Sanitary Sewer Flow Monitoring
Temporary Monitoring: August, 2014

Monitoring Site: Site 7

Location: E Gonzales Road and Bahia Drive

Data Summary Report



Vicinity Map: Site 7

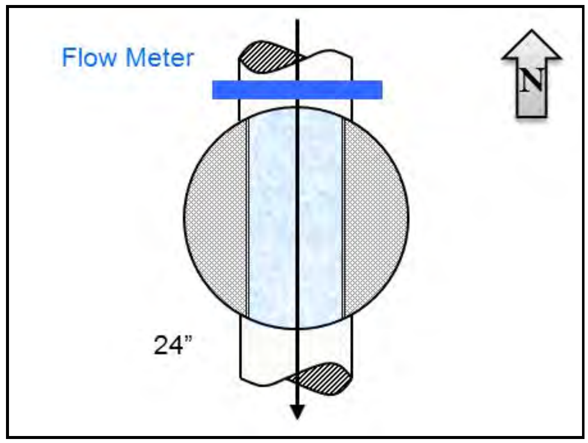
SITE 7

Site Information

Location:	E Gonzales Road and Bahia Drive
Coordinates:	119.1750° W, 34.2192° N
Rim Elevation:	74 feet
Pipe Diameter:	24 inches
Baseline Flow:	0.311 mgd
Peak Measured Flow:	0.532 mgd

Satellite Map

Sanitary Map



Flow Diagram


Street View


Plan View

SITE 7

Additional Site Photos

Effluent Pipe

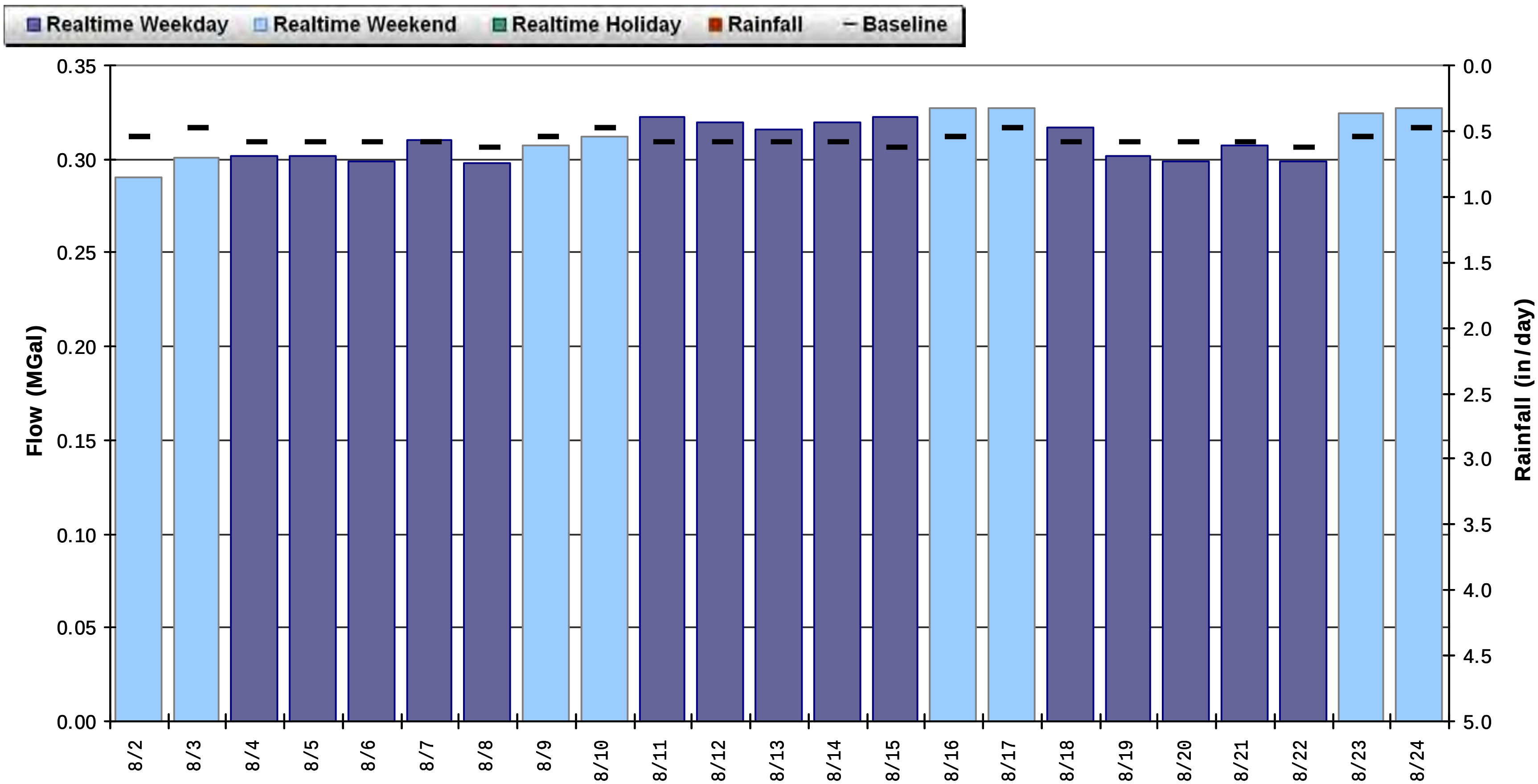
Influent Pipe

SITE 7

Period Flow Summary: Daily Flow Totals

Avg Period Flow: 0.311 MGal **Peak Daily Flow: 0.327 MGal** **Min Daily Flow: 0.290 MGal**

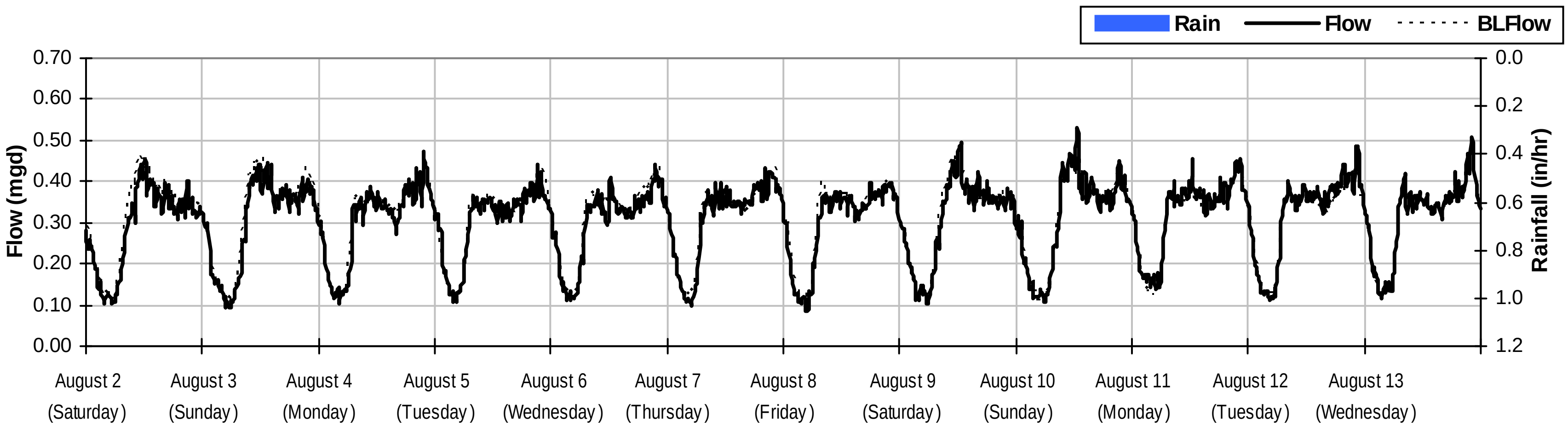
Total Monthly Rainfall: 0.00 inches

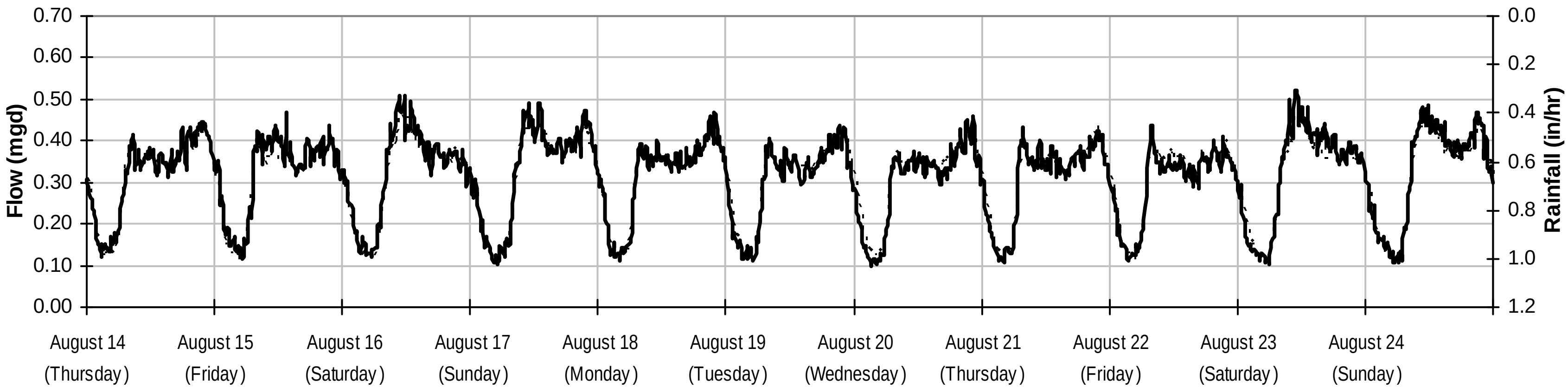


SITE 7

Flow Summary: 8/2/2014 to 8/24/2014

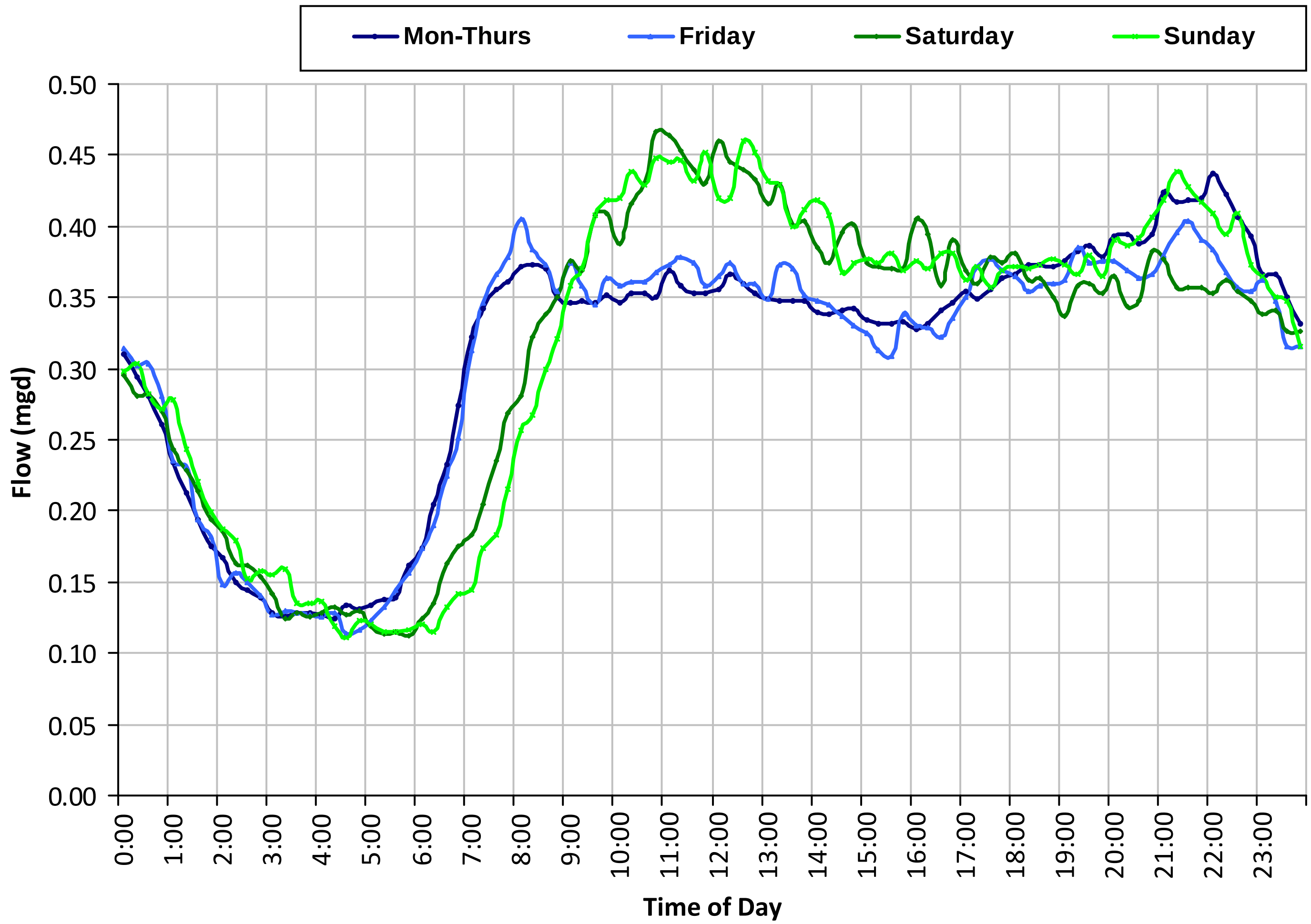
Total Period Rainfall: 0.00 inches **Avg Flow: 0.311 mgd** **Peak Flow: 0.532 mgd** **Min Flow: 0.085 mgd**

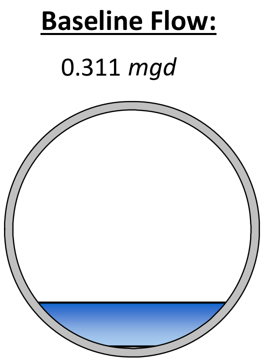




SITE 7

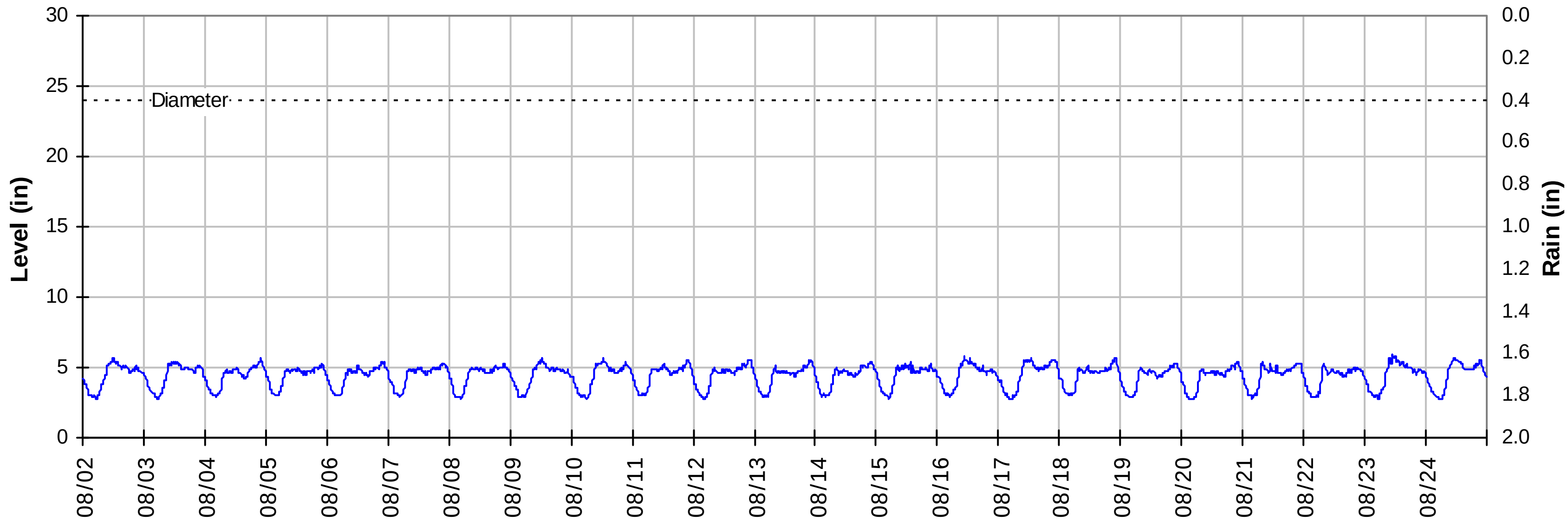
Baseline Flow Hydrographs

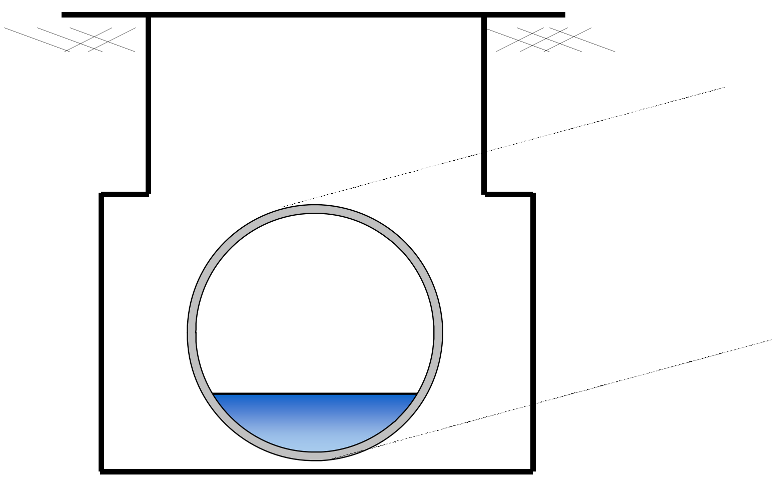




SITE 7
Site Capacity and Surcharge Summary

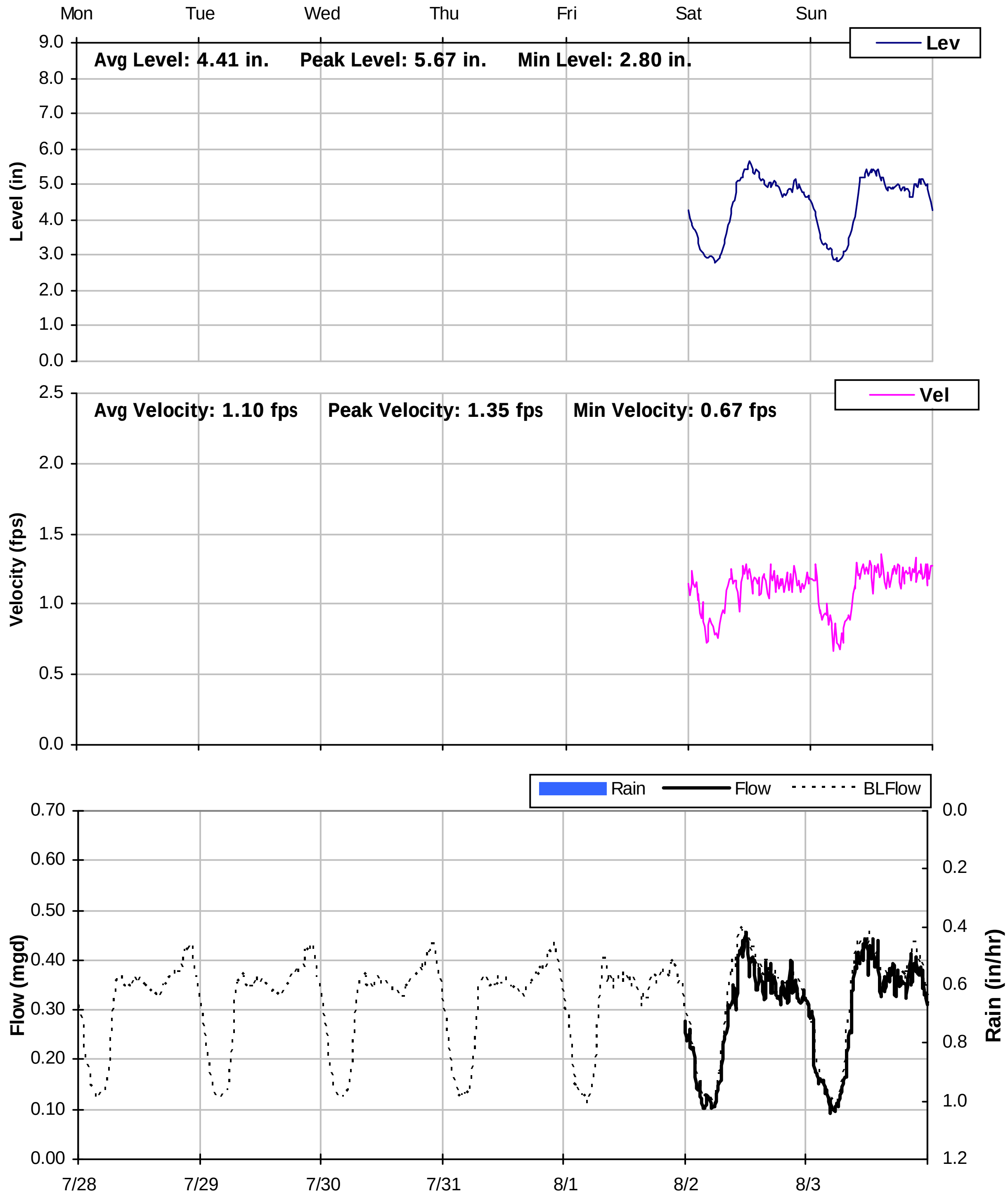
Realtime Flow Levels with Rainfall Data over Monitoring Period





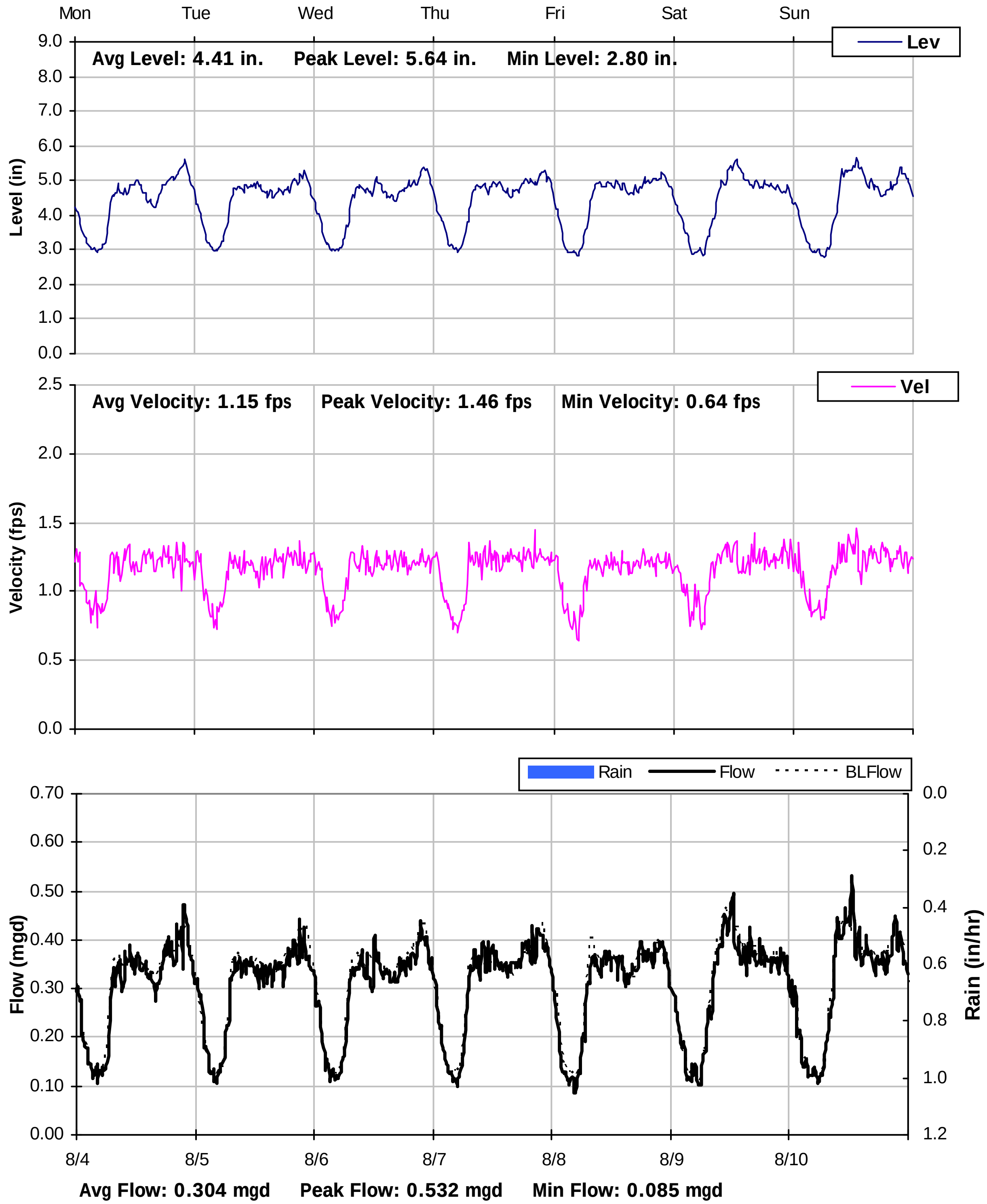
Pipe Diameter:	24	*inches*
Peak Measured Level:	5.93	*inches*
Peak d/D Ratio:	0.25	

SITE 7
Weekly Level, Velocity and Flow Hydrographs
7/28/2014 to 8/4/2014

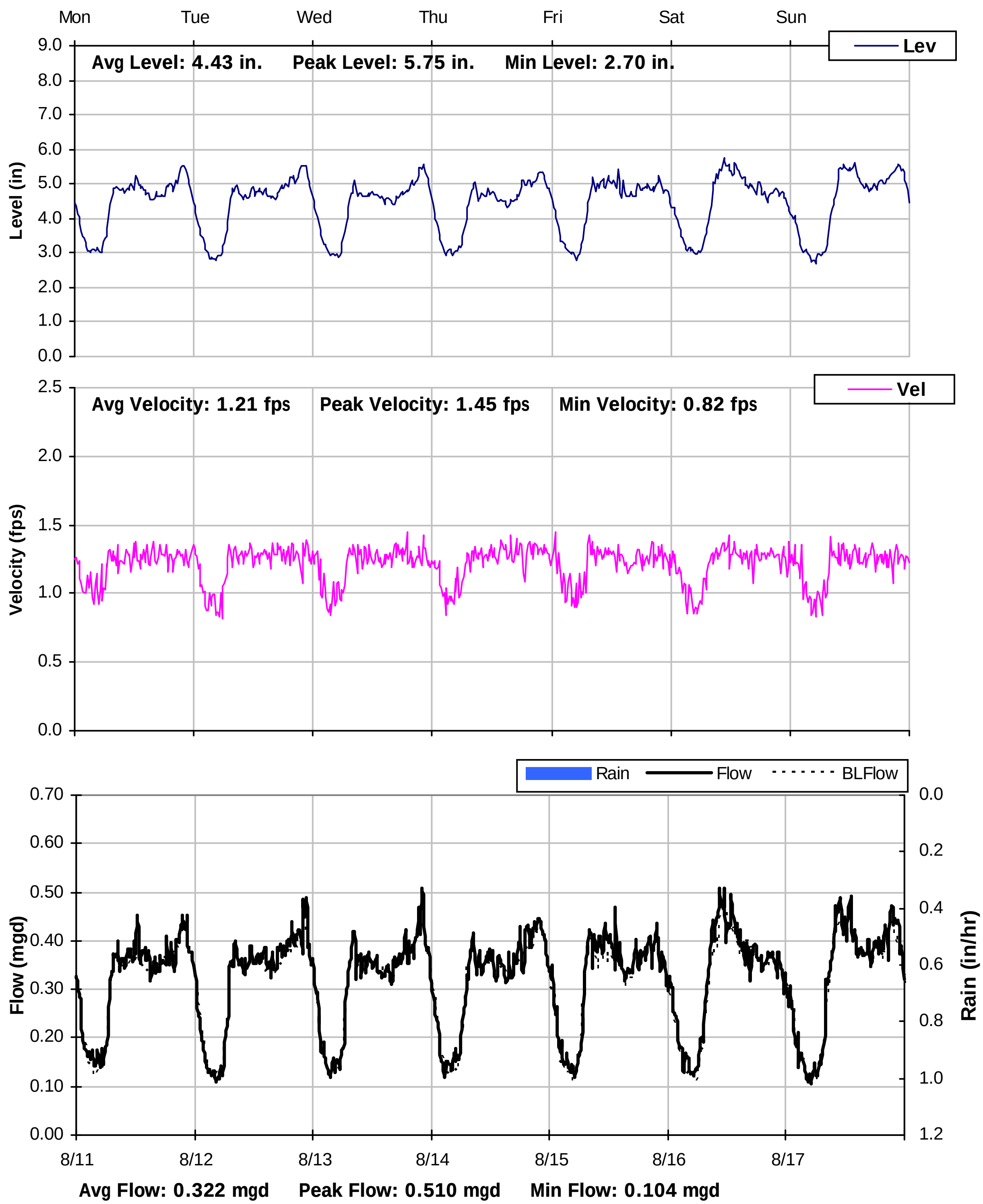


Avg Flow: 0.295 mgd **Peak Flow: 0.457 mgd** **Min Flow: 0.092 mgd**

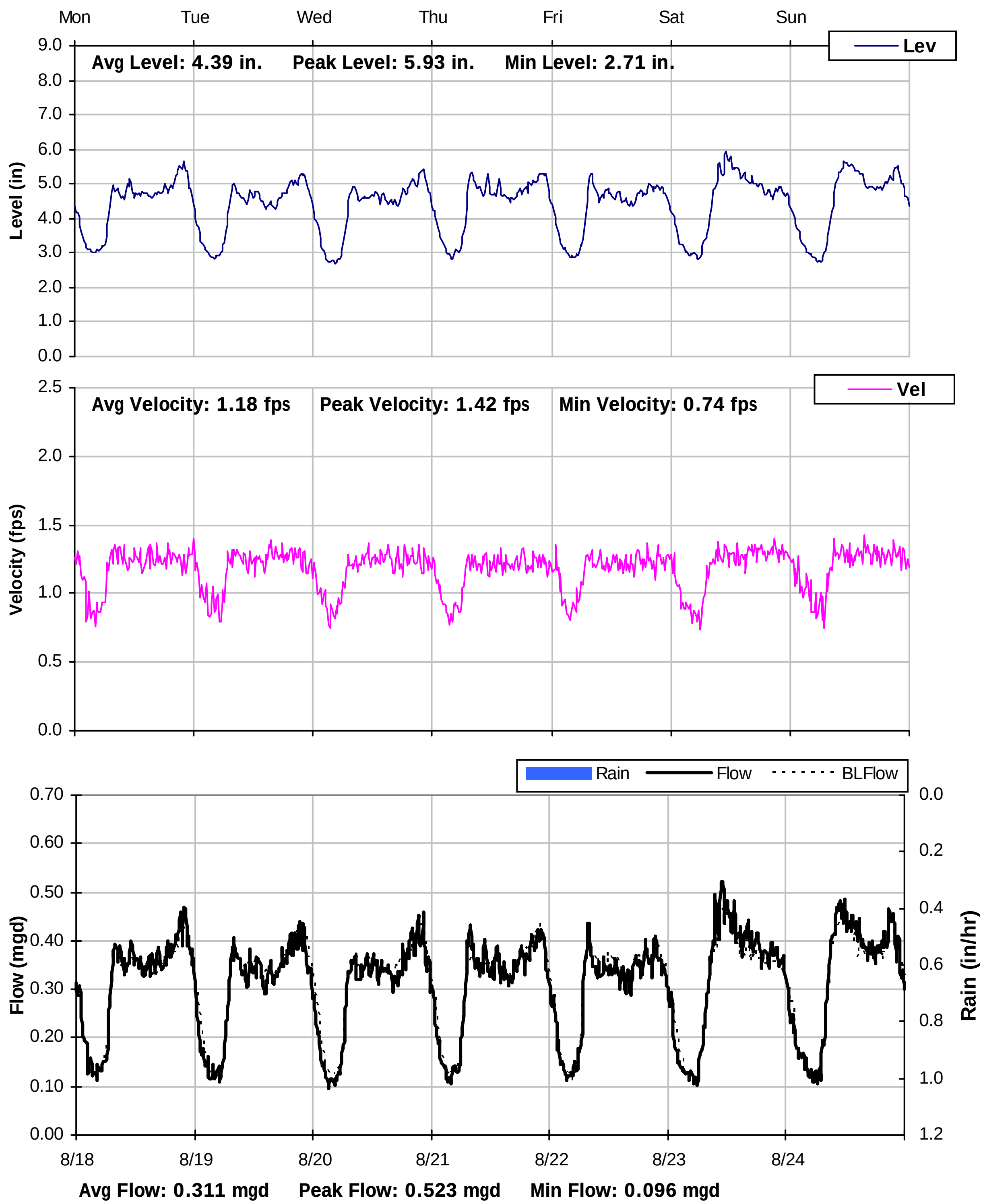
SITE 7
Weekly Level, Velocity and Flow Hydrographs
8/4/2014 to 8/11/2014



SITE 7
Weekly Level, Velocity and Flow Hydrographs
8/11/2014 to 8/18/2014



SITE 7
Weekly Level, Velocity and Flow Hydrographs
8/18/2014 to 8/25/2014



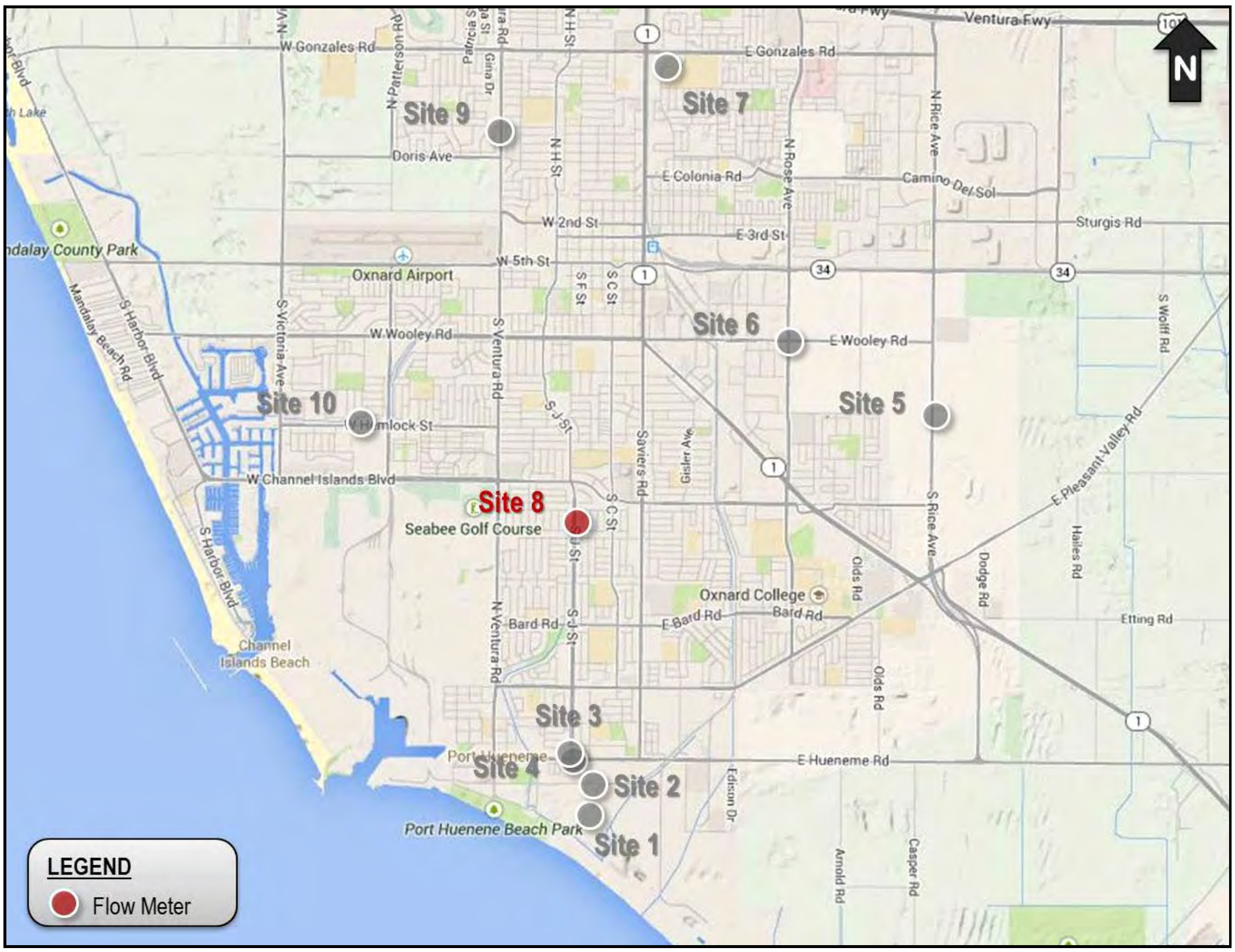
City of Oxnard

Sanitary Sewer Flow Monitoring
Temporary Monitoring: August, 2014

Monitoring Site: Site 8

Location: J Street, between Spruce Street and Teakwood Street

Data Summary Report



Vicinity Map: Site 8

SITE 8

Site Information

Location: J Street, between Spruce Street and Teakwood Street

Coordinates: 119.1857° W, 34.1716° N

Rim Elevation: 25 feet

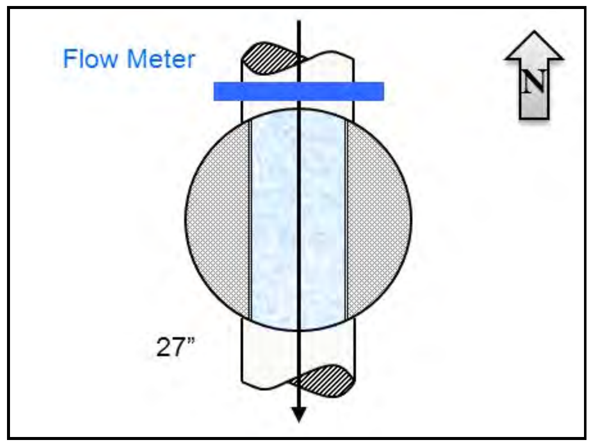
Pipe Diameter: 27 inches

Baseline Flow: 1.840 mgd

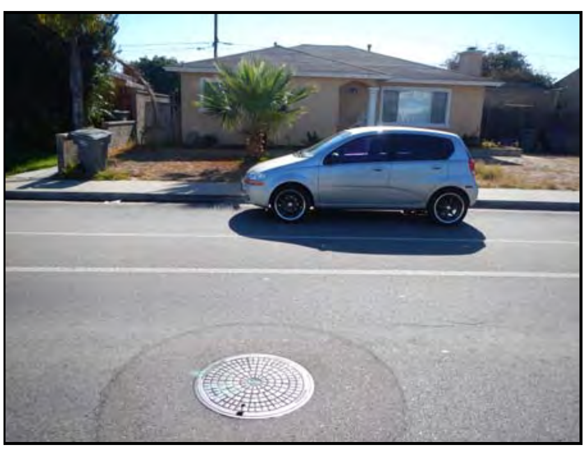
Peak Measured Flow: 2.958 mgd

Satellite Map

Sanitary Map



Flow Diagram



Street View

Plan View

SITE 8

Additional Site Photos

Effluent Pipe

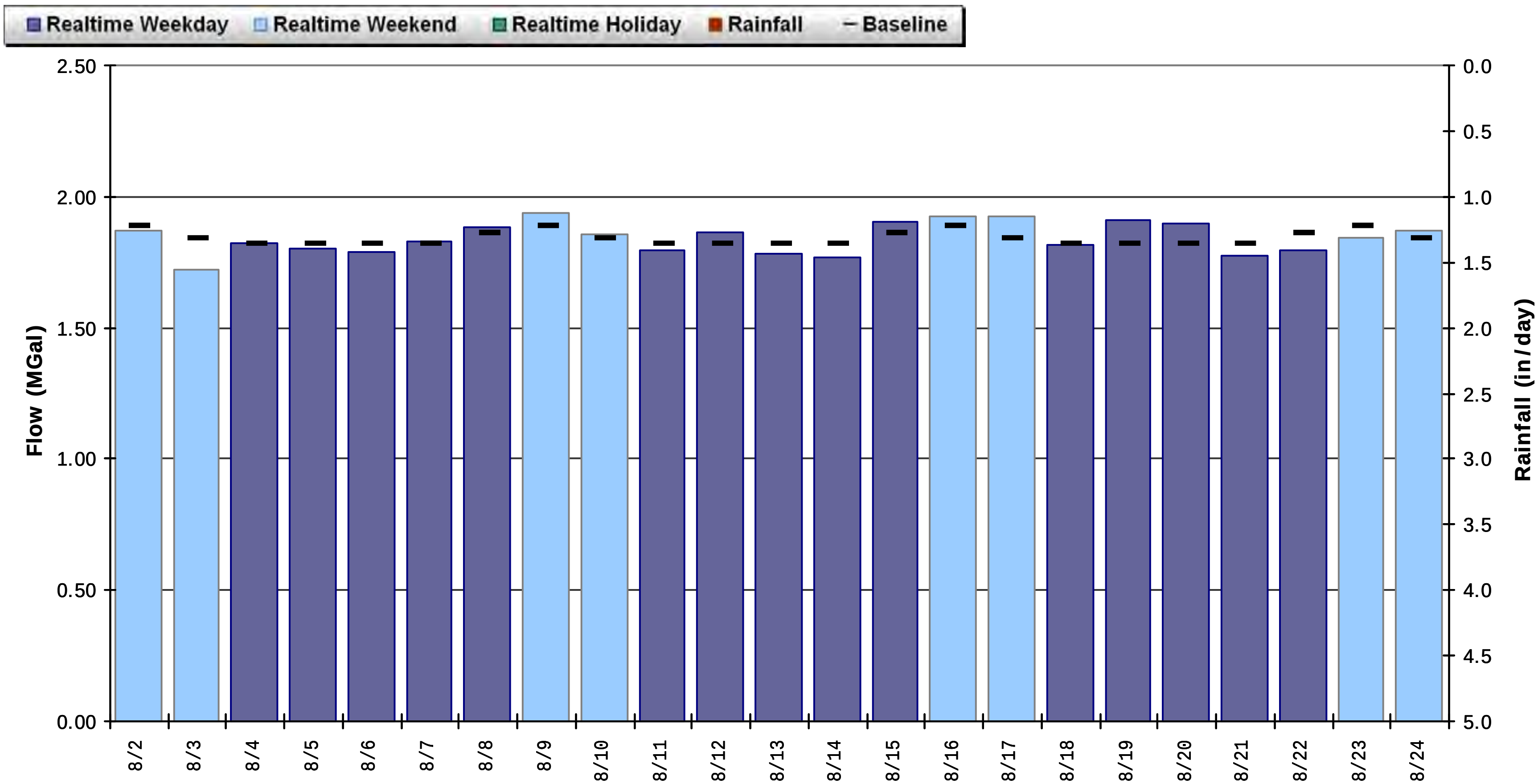
Influent Pipe

SITE 8

Period Flow Summary: Daily Flow Totals

Avg Period Flow: 1.842 MGal **Peak Daily Flow: 1.937 MGal** **Min Daily Flow: 1.721 MGal**

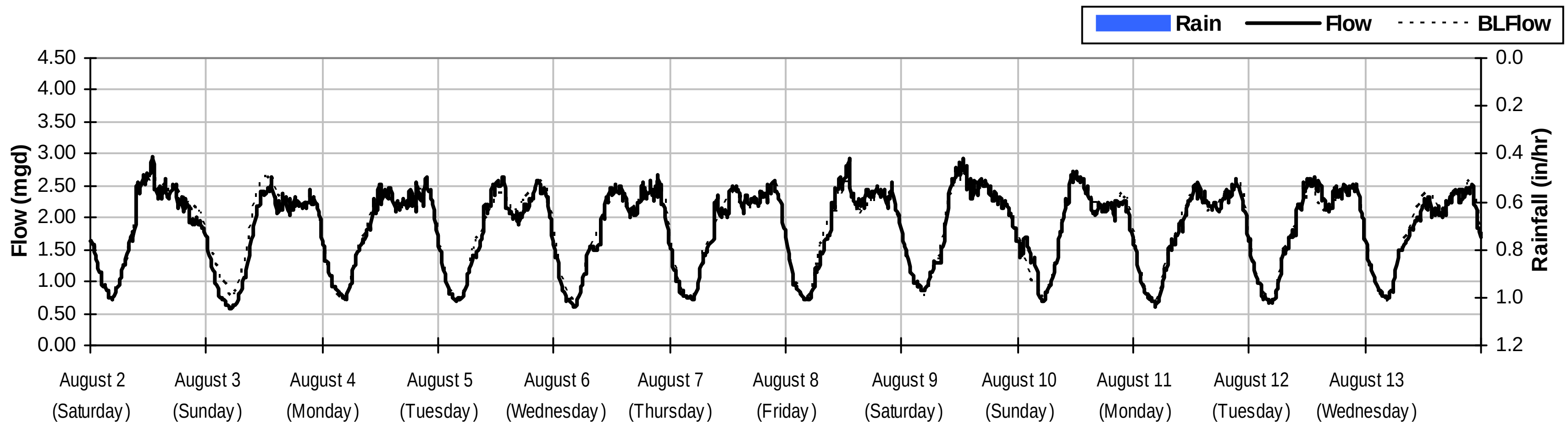
Total Monthly Rainfall: 0.00 inches

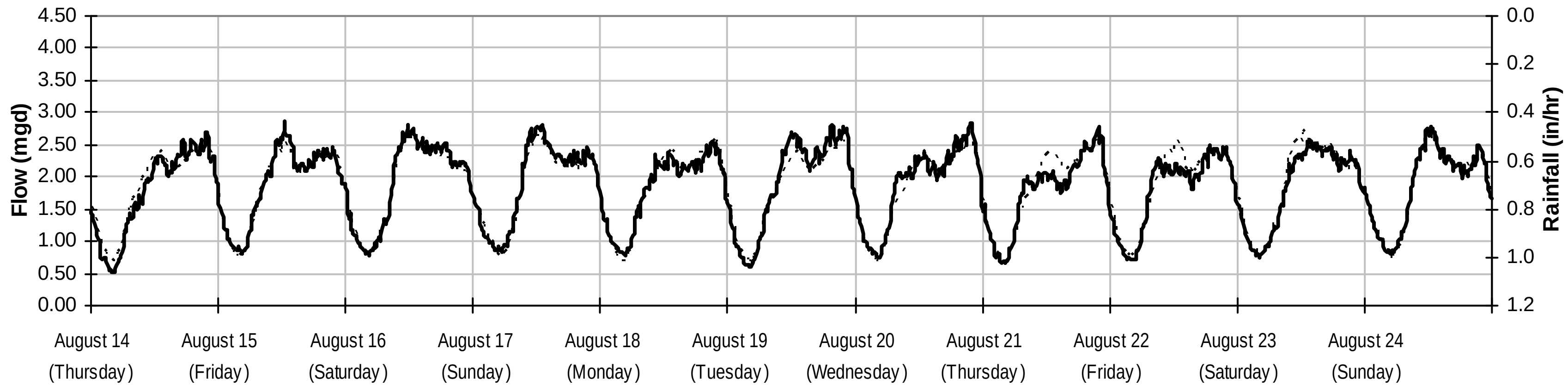


SITE 8

Flow Summary: 8/2/2014 to 8/24/2014

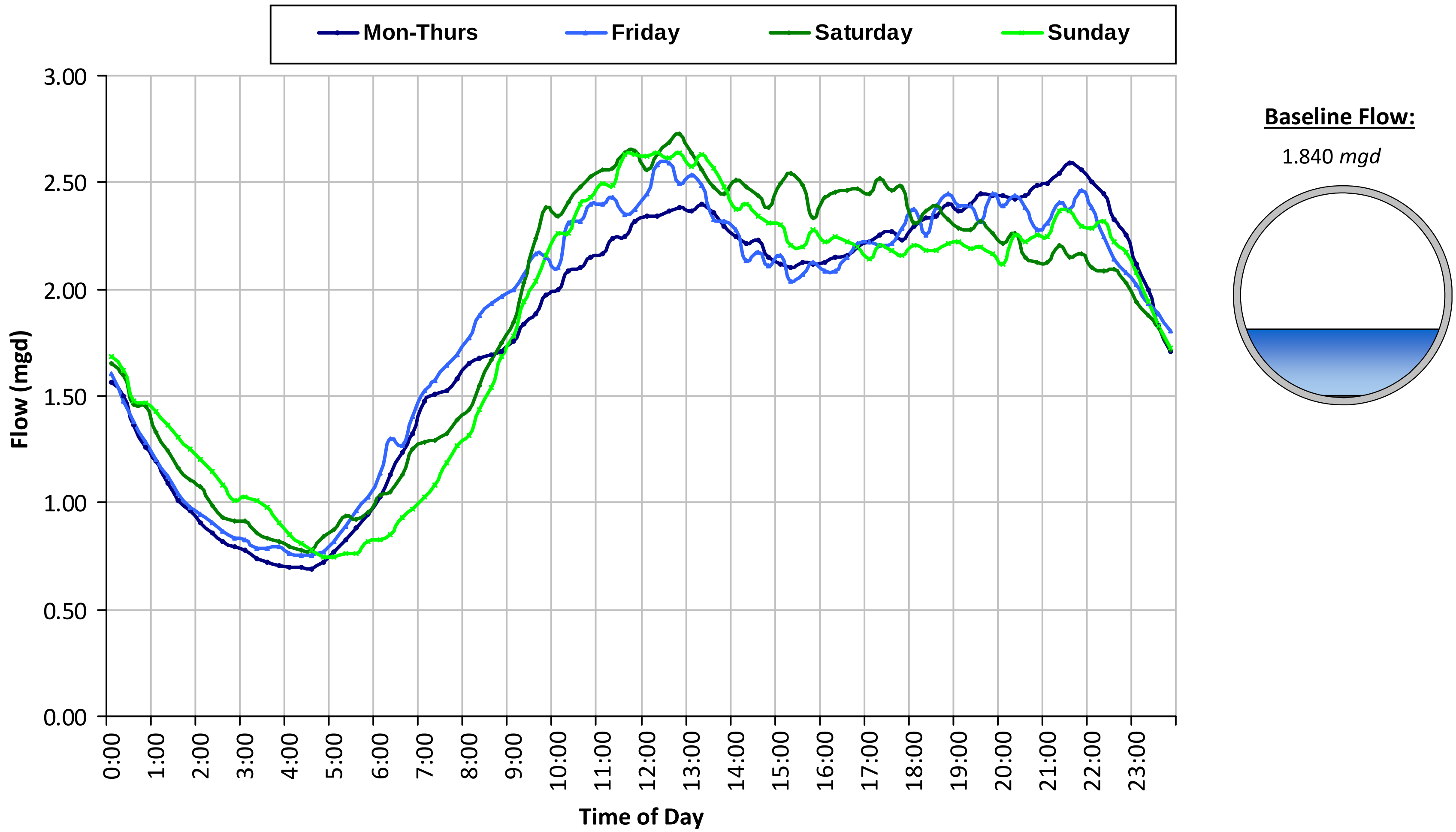
Total Period Rainfall: 0.00 inches **Avg Flow: 1.842 mgd** **Peak Flow: 2.958 mgd** **Min Flow: 0.525 mgd**





SITE 8

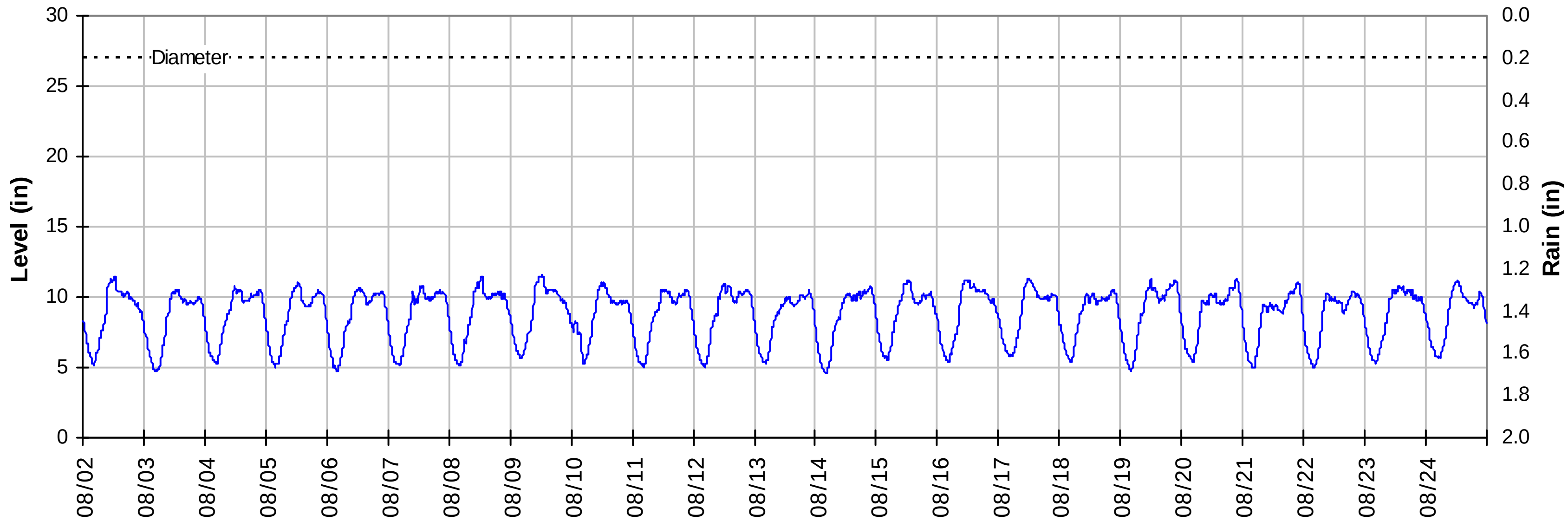
Baseline Flow Hydrographs

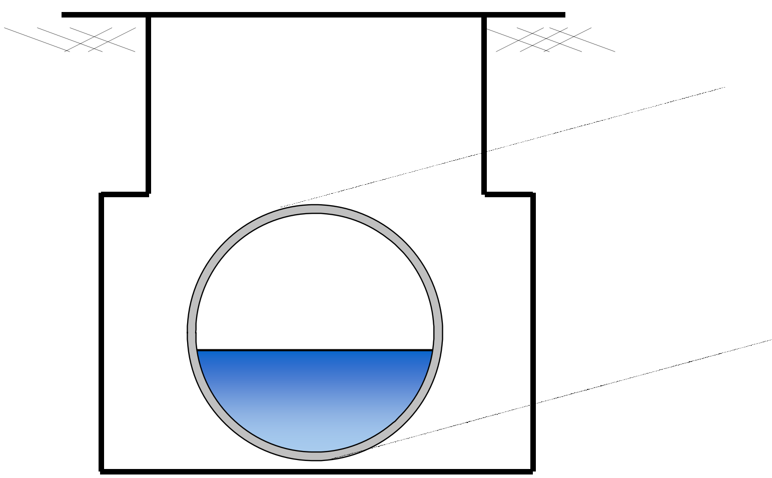


SITE 8

Site Capacity and Surcharge Summary

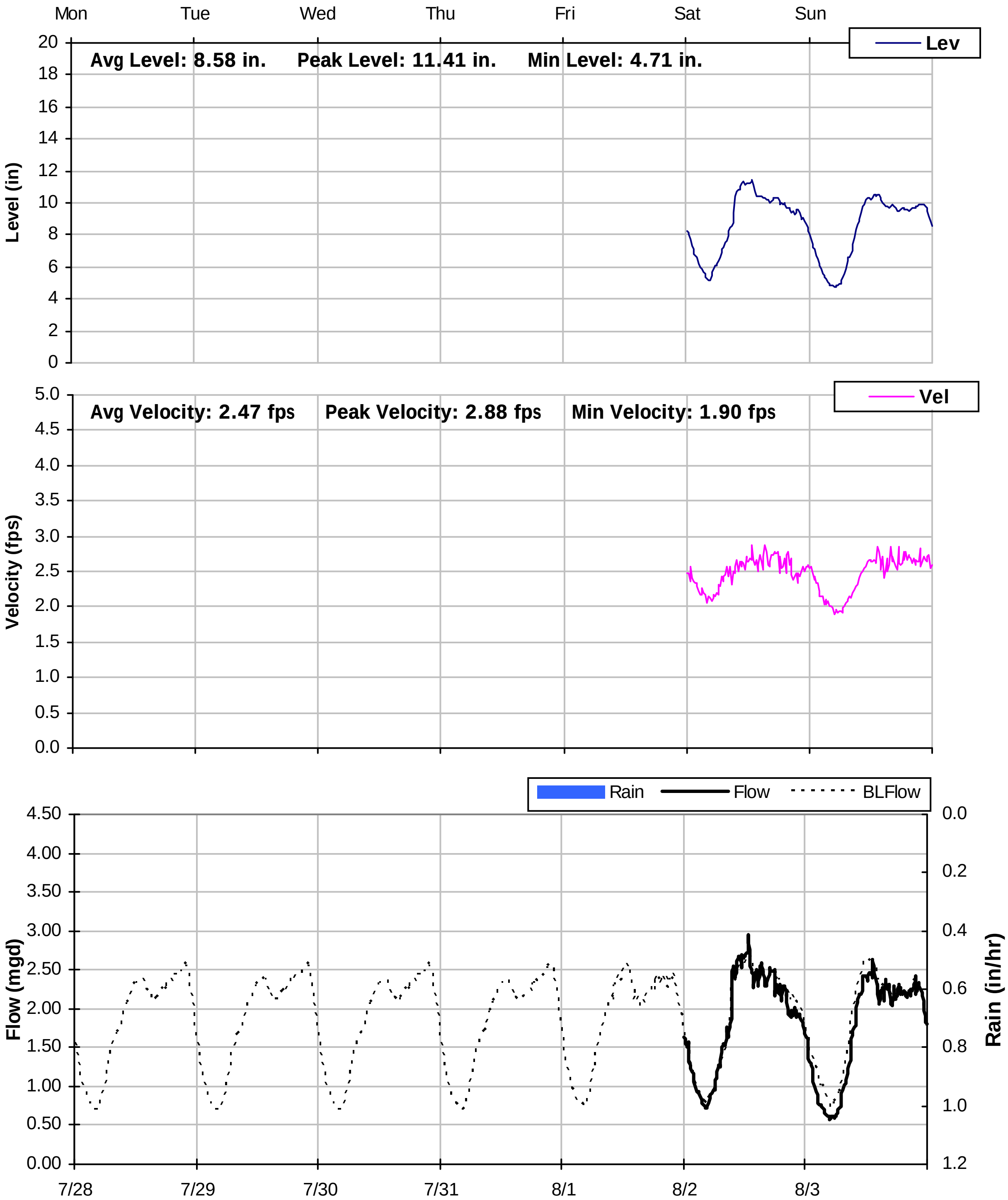
Realtime Flow Levels with Rainfall Data over Monitoring Period





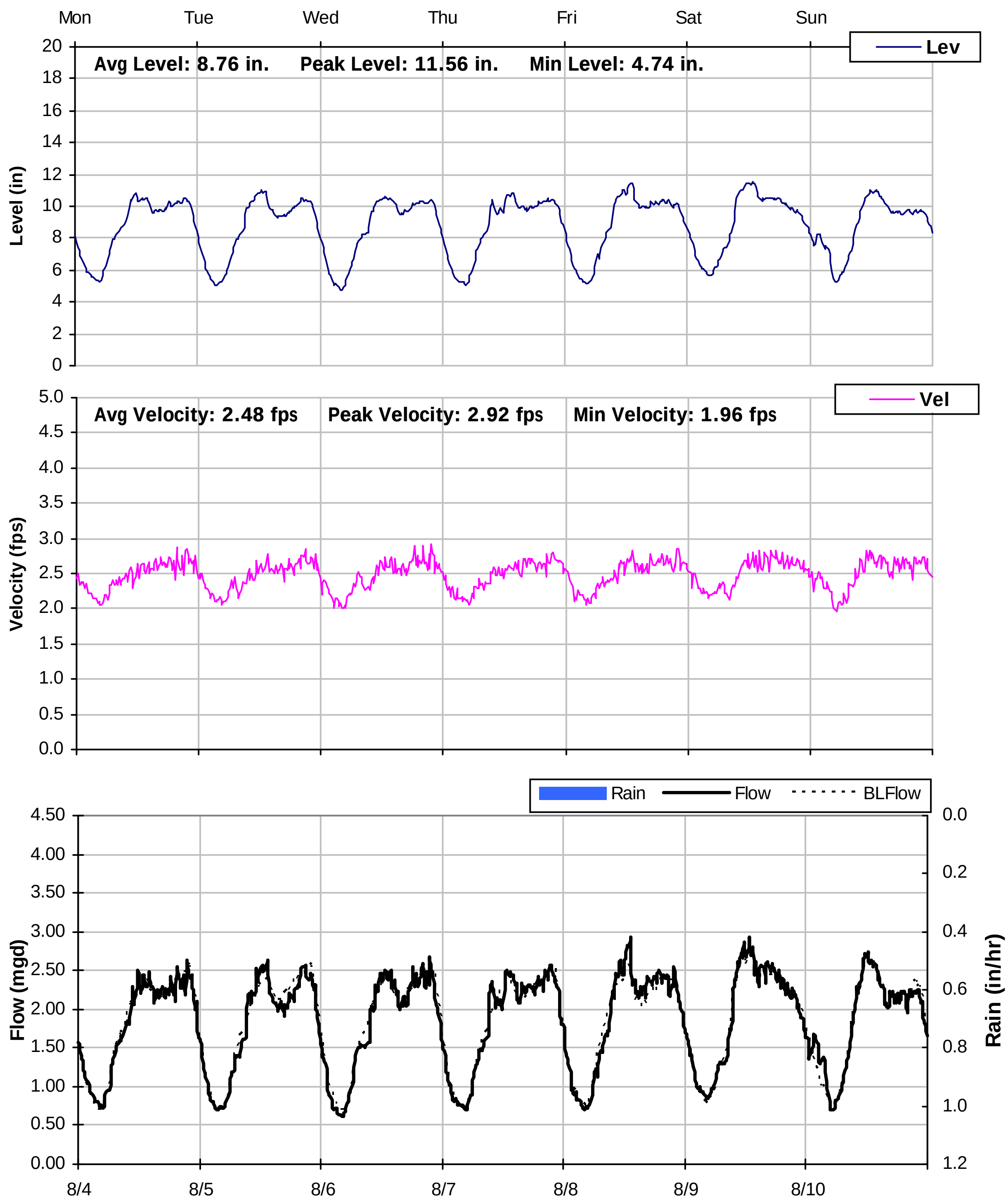
Pipe Diameter:	27	*inches*
Peak Measured Level:	11.6	*inches*
Peak d/D Ratio:	0.43	

SITE 8
Weekly Level, Velocity and Flow Hydrographs
7/28/2014 to 8/4/2014



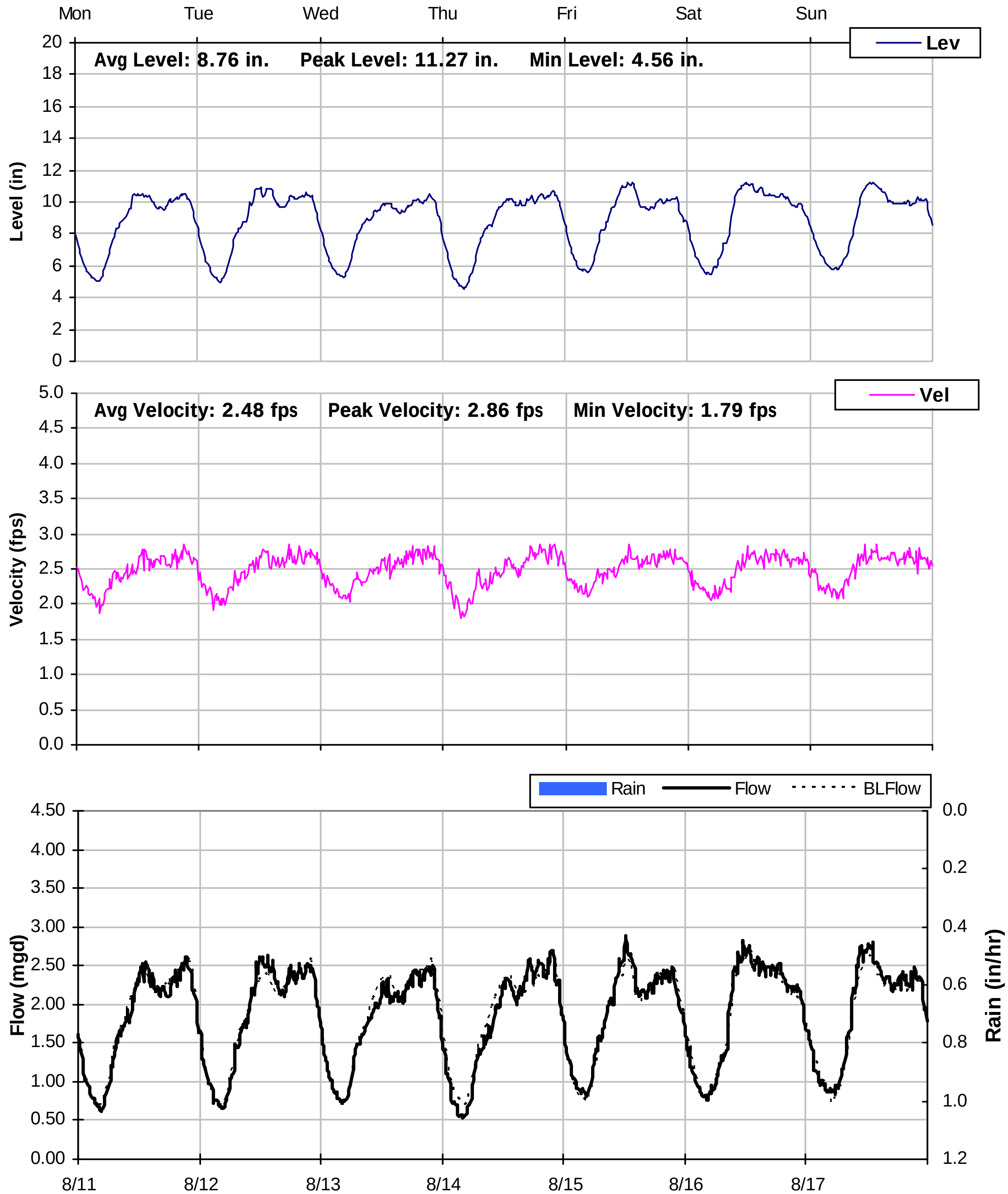
Avg Flow: 1.797 mgd Peak Flow: 2.958 mgd Min Flow: 0.572 mgd

SITE 8
Weekly Level, Velocity and Flow Hydrographs
8/4/2014 to 8/11/2014



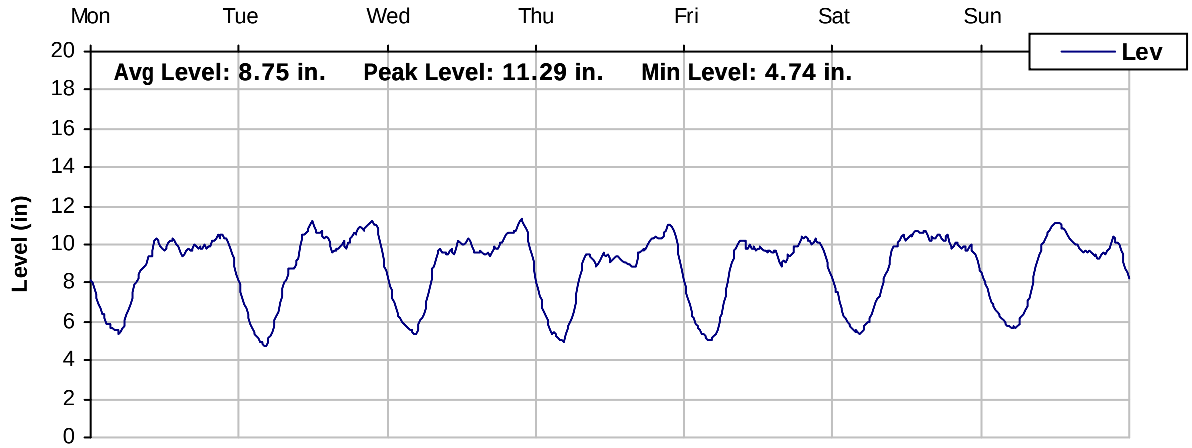
Avg Flow: 1.844 mgd **Peak Flow: 2.930 mgd** **Min Flow: 0.608 mgd**

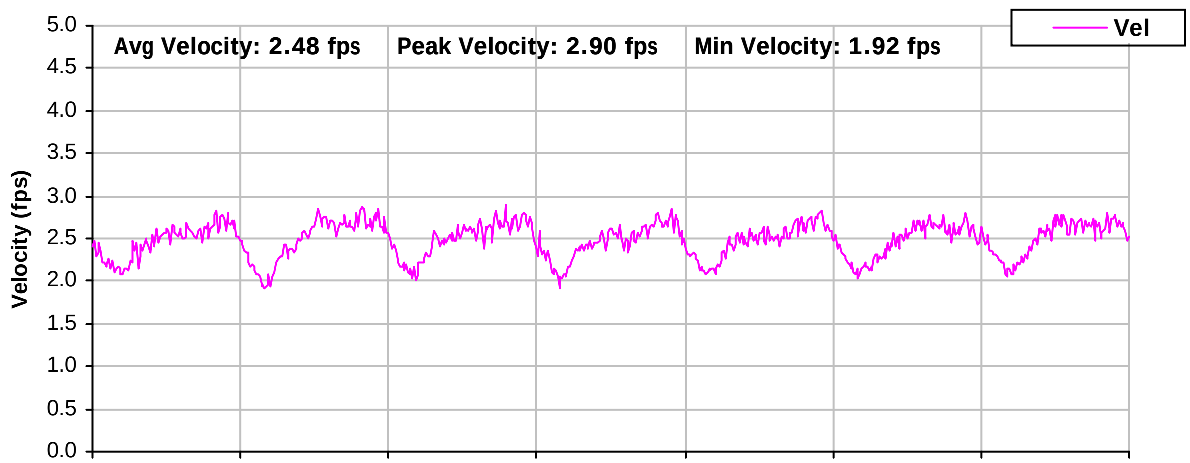
SITE 8
Weekly Level, Velocity and Flow Hydrographs
8/11/2014 to 8/18/2014

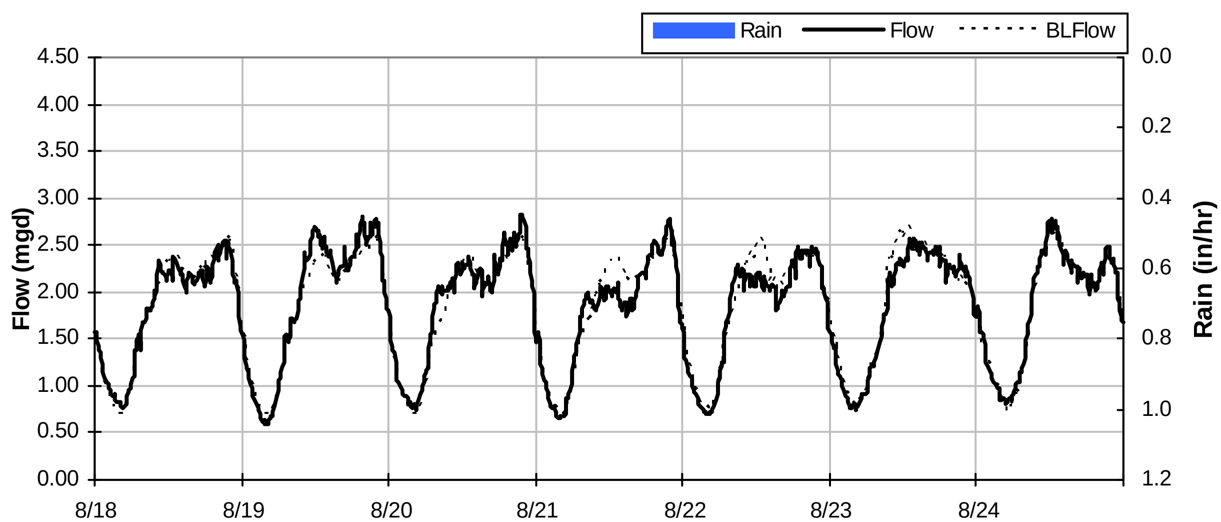


Avg Flow: 1.850 mgd **Peak Flow: 2.876 mgd** **Min Flow: 0.525 mgd**

SITE 8
Weekly Level, Velocity and Flow Hydrographs
8/18/2014 to 8/25/2014







Avg Flow: 1.844 mgd **Peak Flow: 2.833 mgd** **Min Flow: 0.594 mgd**

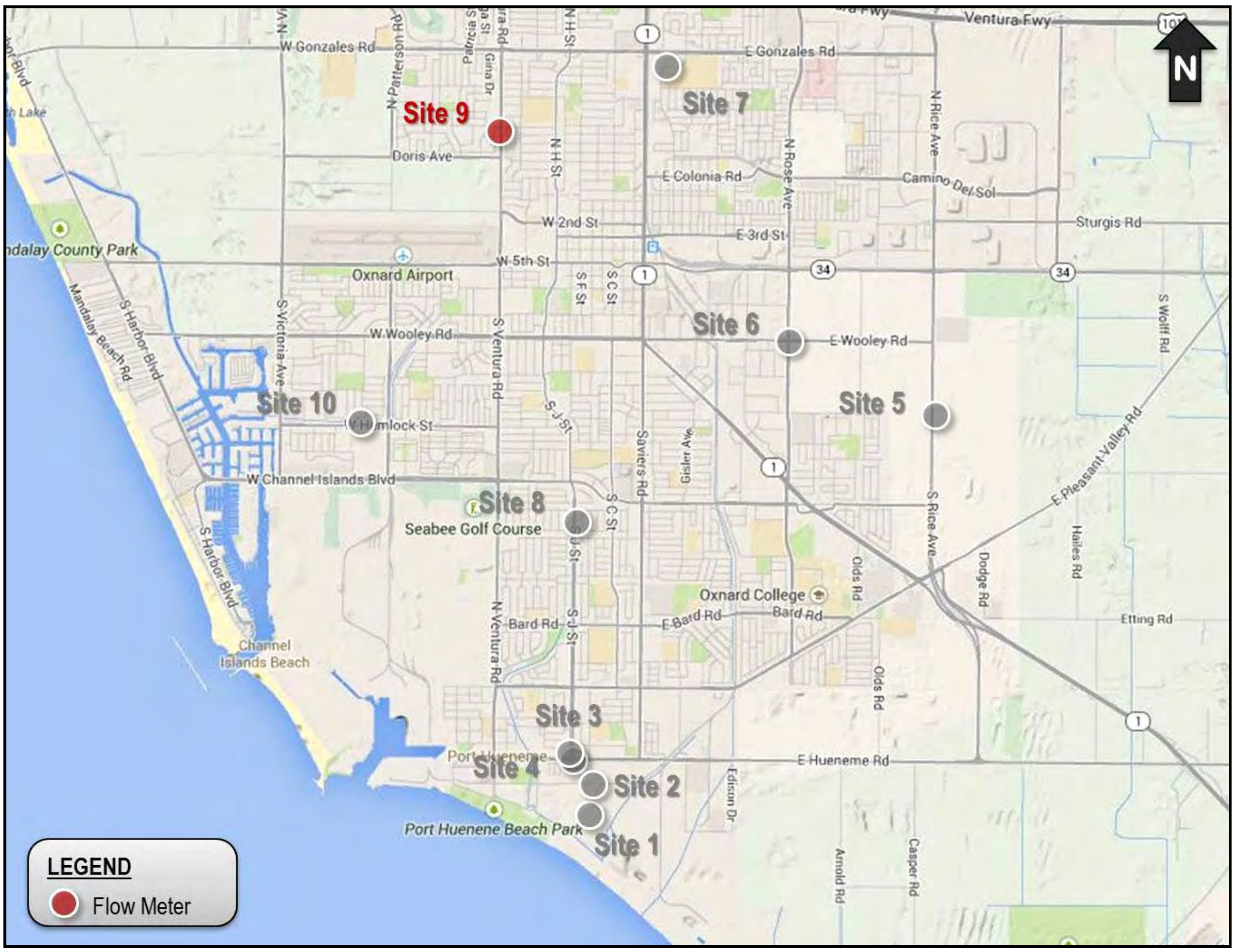
City of Oxnard

Sanitary Sewer Flow Monitoring
Temporary Monitoring: August, 2014

Monitoring Site: Site 9

Location: N Ventura Road, between Devonshire Drive and Doris Avenue

Data Summary Report



Vicinity Map: Site 9

SITE 9

Site Information

Location: N Ventura Road, between Devonshire Drive and Doris Avenue

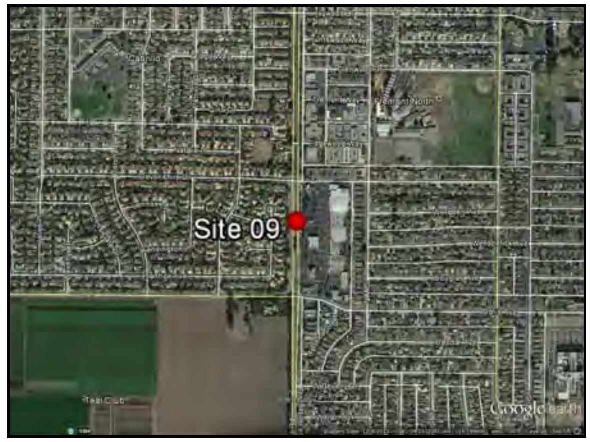
Coordinates: 119.1946° W, 34.2103° N

Rim Elevation: 54 feet

Pipe Diameter: 42 inches

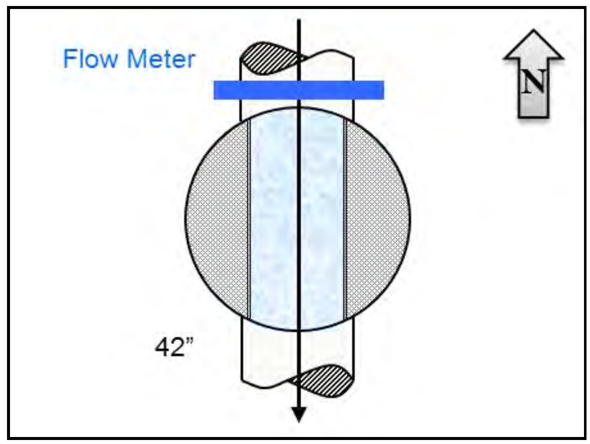
Baseline Flow: 2.041 mgd

Peak Measured Flow: 3.340 mgd



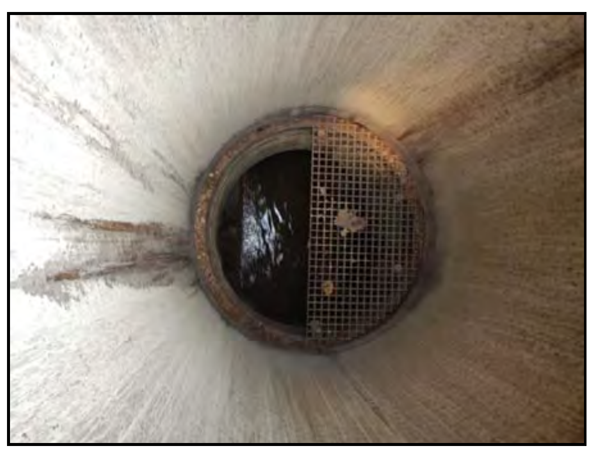
Satellite Map

Sanitary Map



Flow Diagram

Street View



Plan View

SITE 9

Additional Site Photos

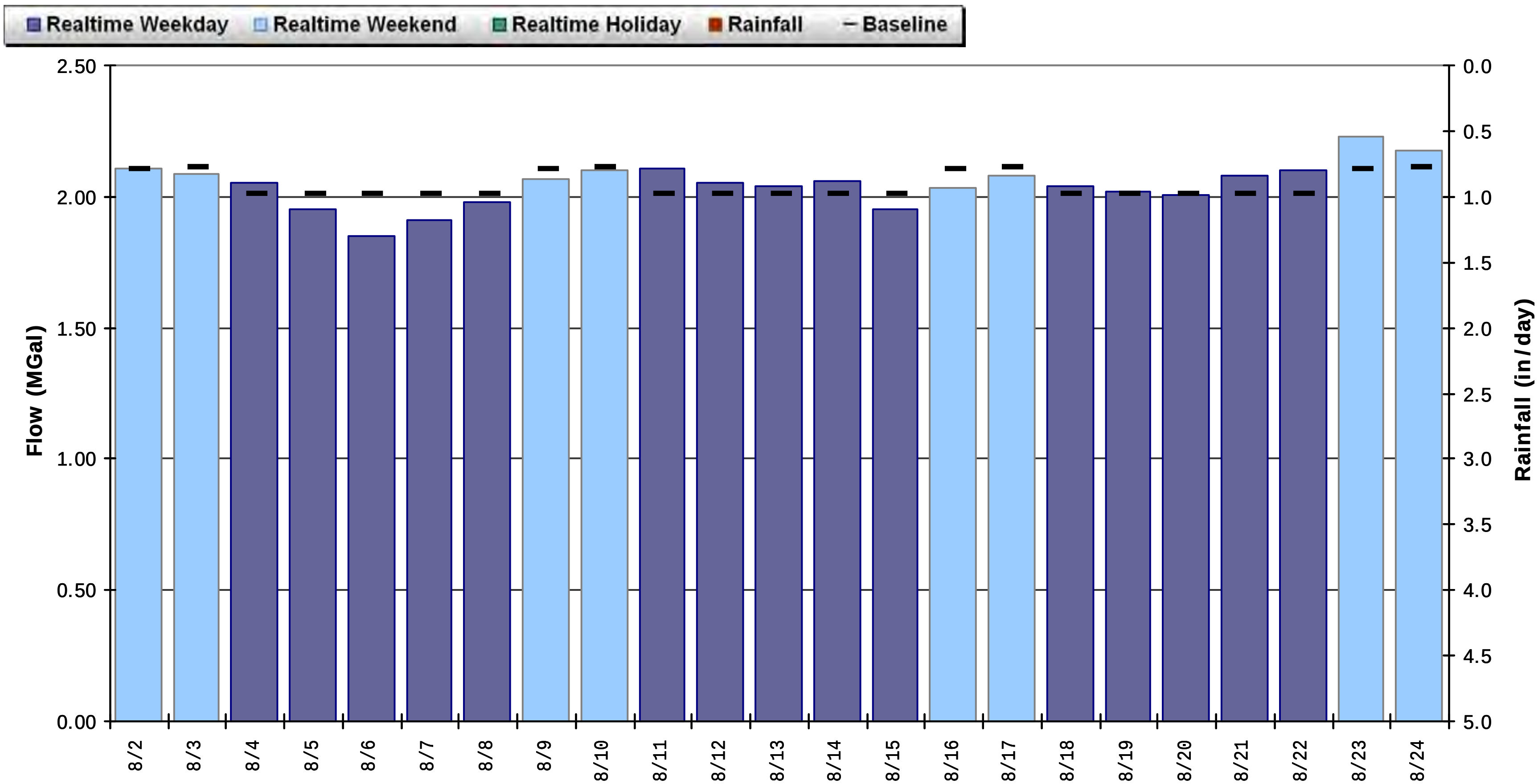
Effluent Pipe

Influent Pipe

SITE 9
Period Flow Summary: Daily Flow Totals

Avg Period Flow: 2.047 MGal   Peak Daily Flow: 2.231 MGal   Min Daily Flow: 1.849 MGal

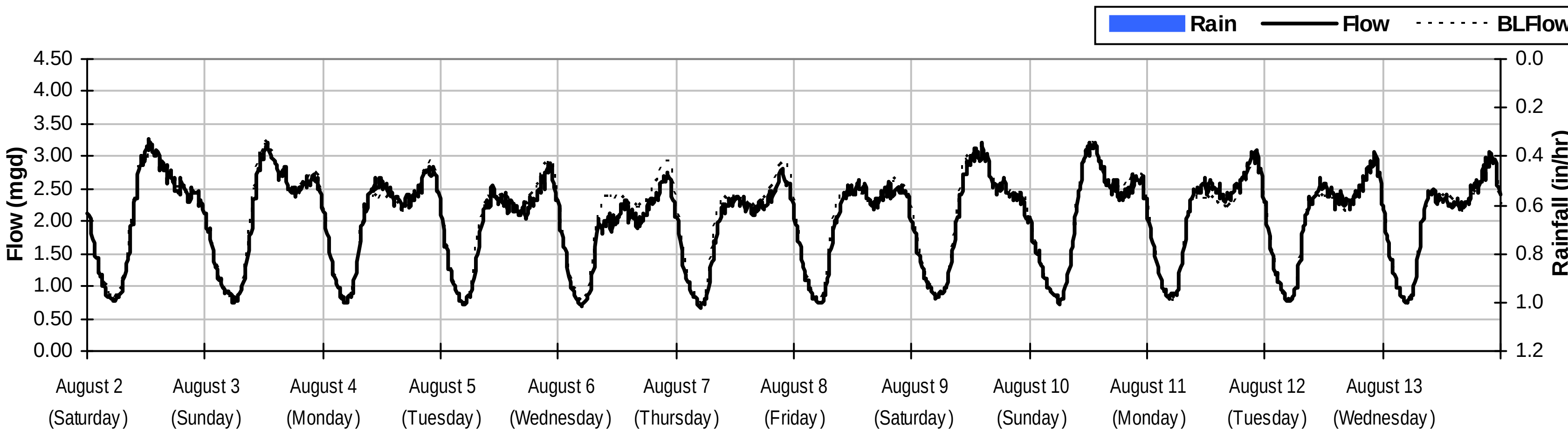
Total Monthly Rainfall: 0.00 inches

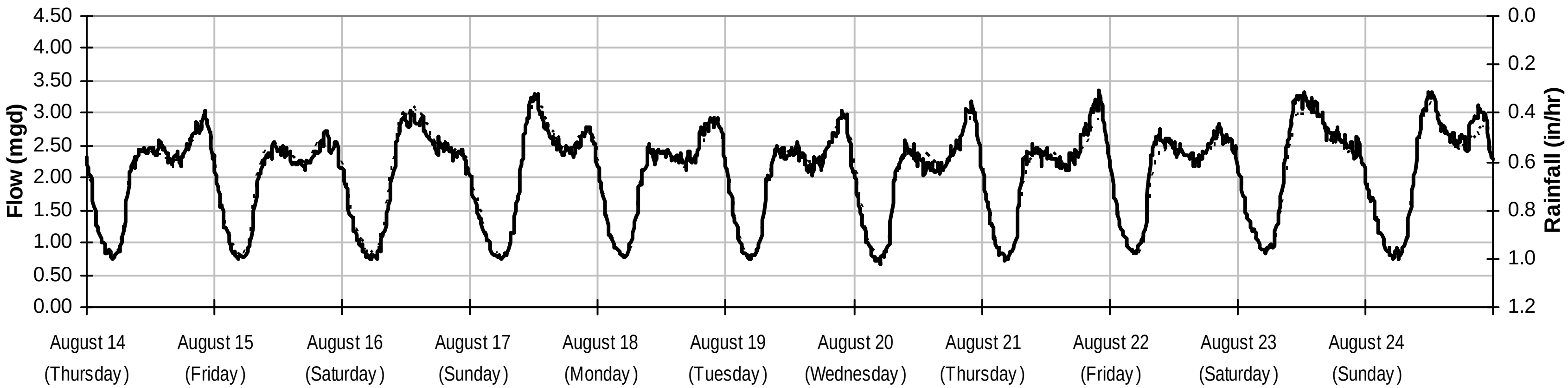


SITE 9

Flow Summary: 8/2/2014 to 8/24/2014

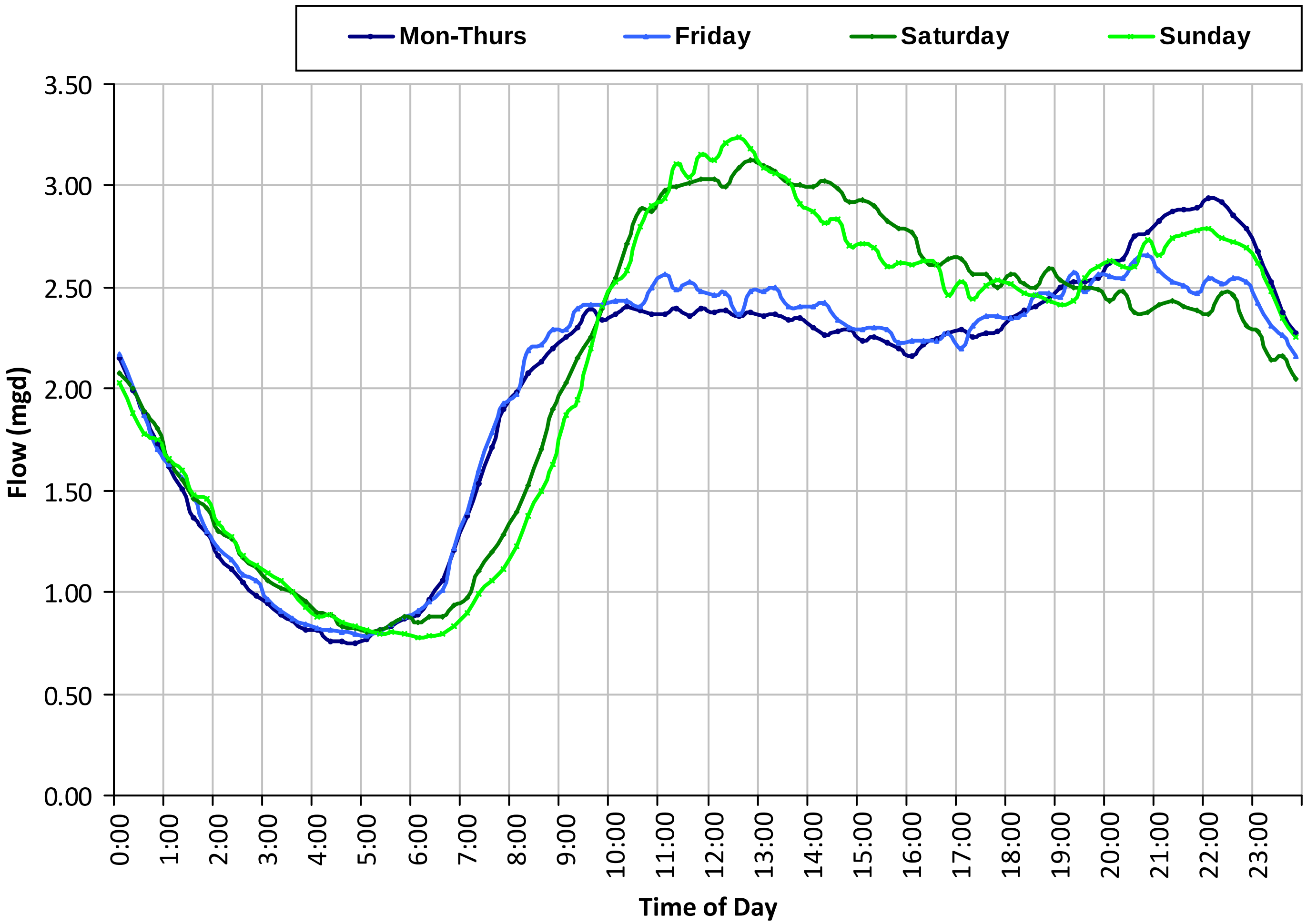
Total Period Rainfall: 0.00 inches **Avg Flow: 2.047 mgd** **Peak Flow: 3.340 mgd** **Min Flow: 0.661 mgd**





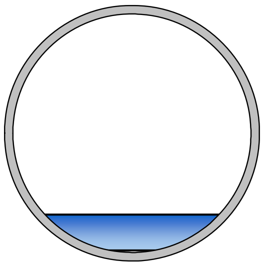
SITE 9

Baseline Flow Hydrographs



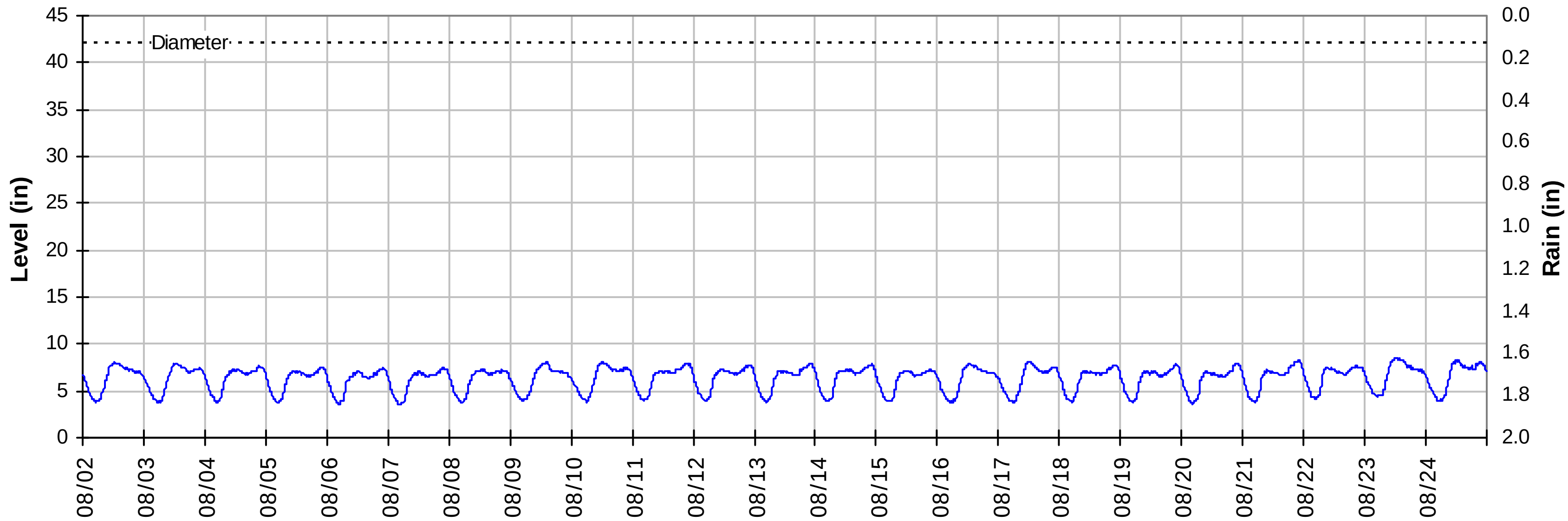
Baseline Flow:

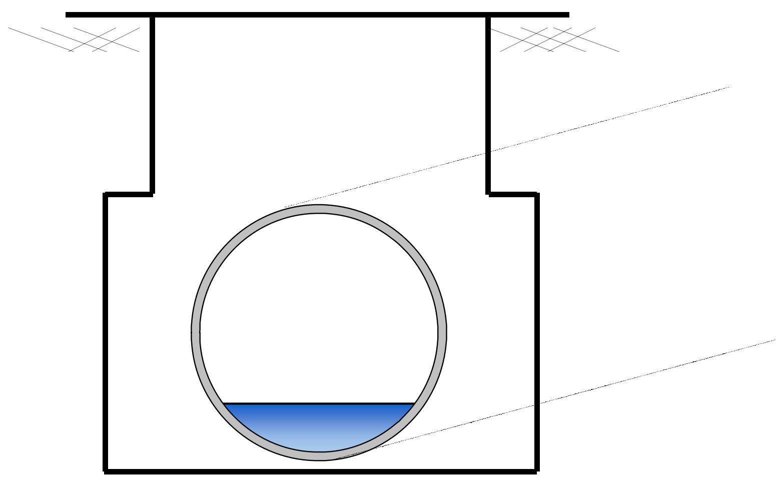
2.041 *mgd*



SITE 9
Site Capacity and Surcharge Summary

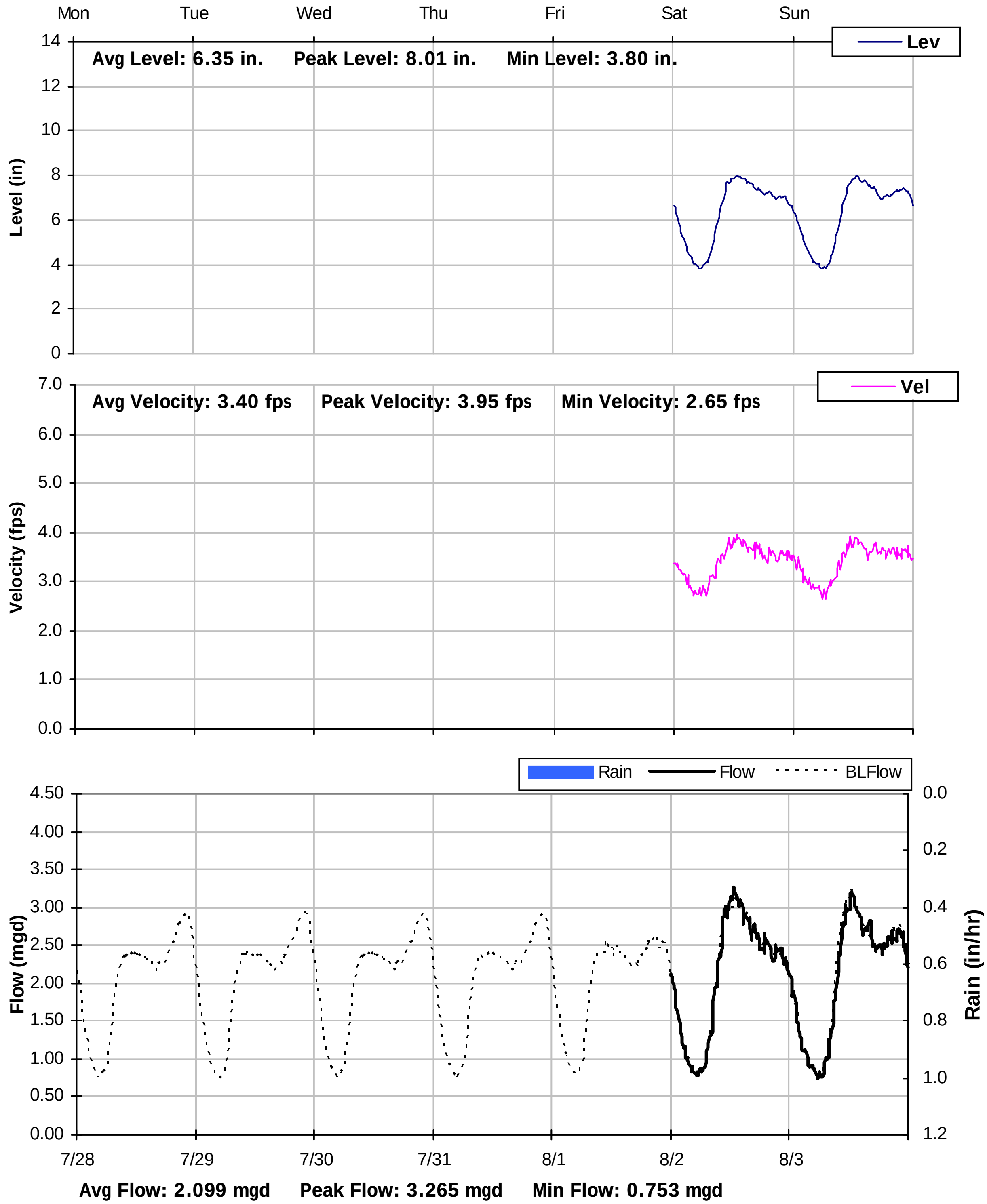
Realtime Flow Levels with Rainfall Data over Monitoring Period



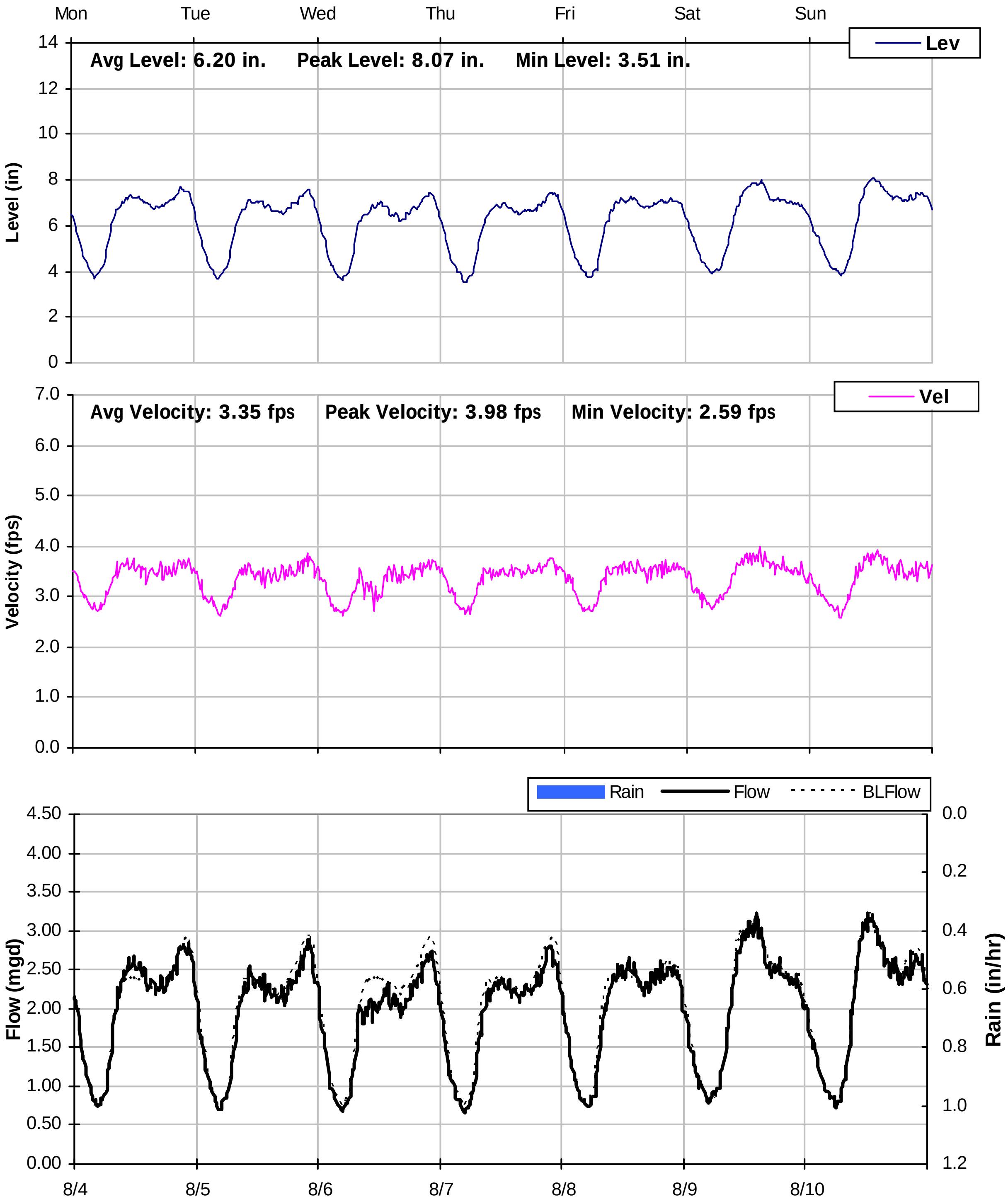


Pipe Diameter:	42	*inches*
Peak Measured Level:	8.49	*inches*
Peak d/D Ratio:	0.20	

SITE 9
Weekly Level, Velocity and Flow Hydrographs
7/28/2014 to 8/4/2014

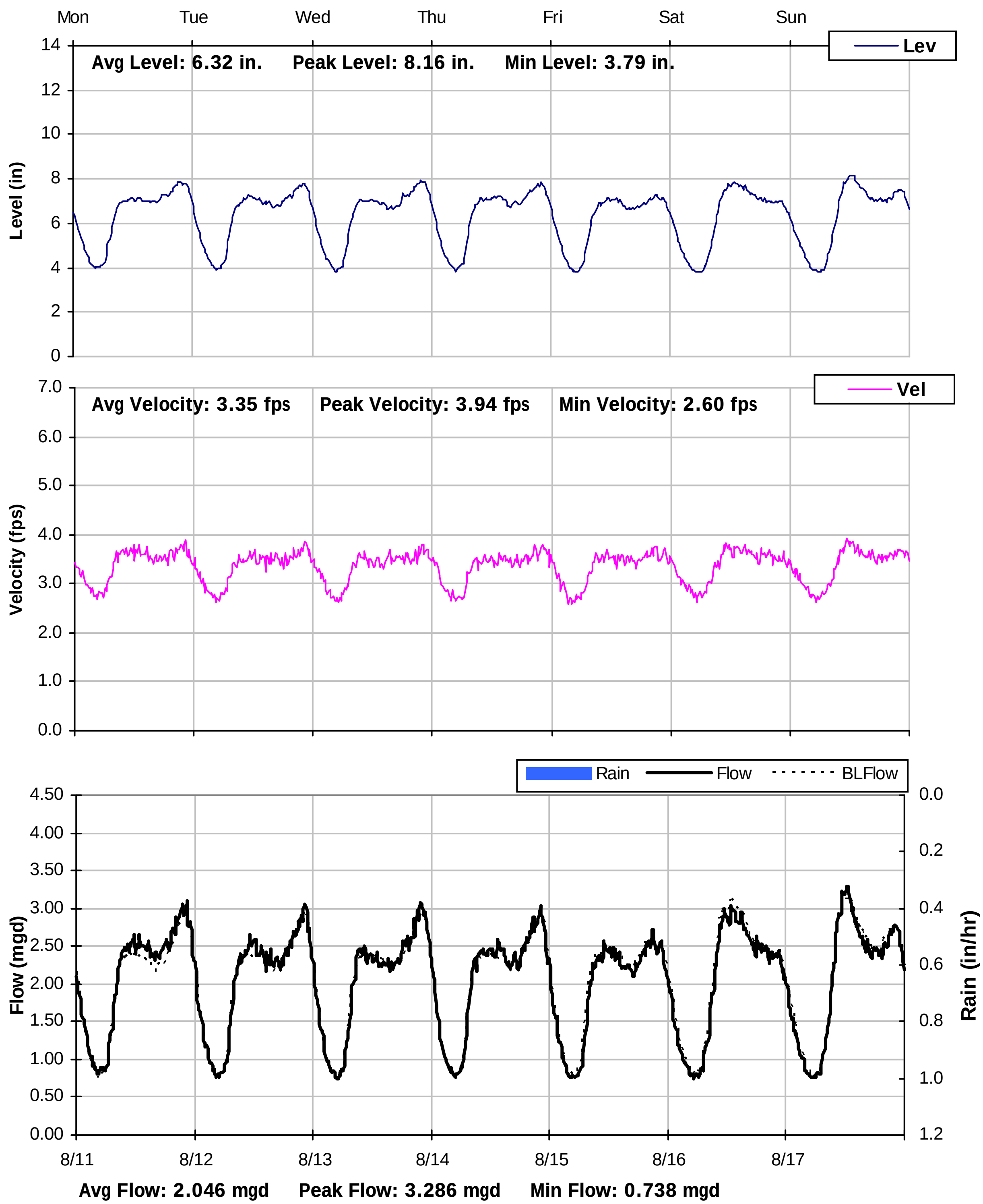


SITE 9
Weekly Level, Velocity and Flow Hydrographs
8/4/2014 to 8/11/2014

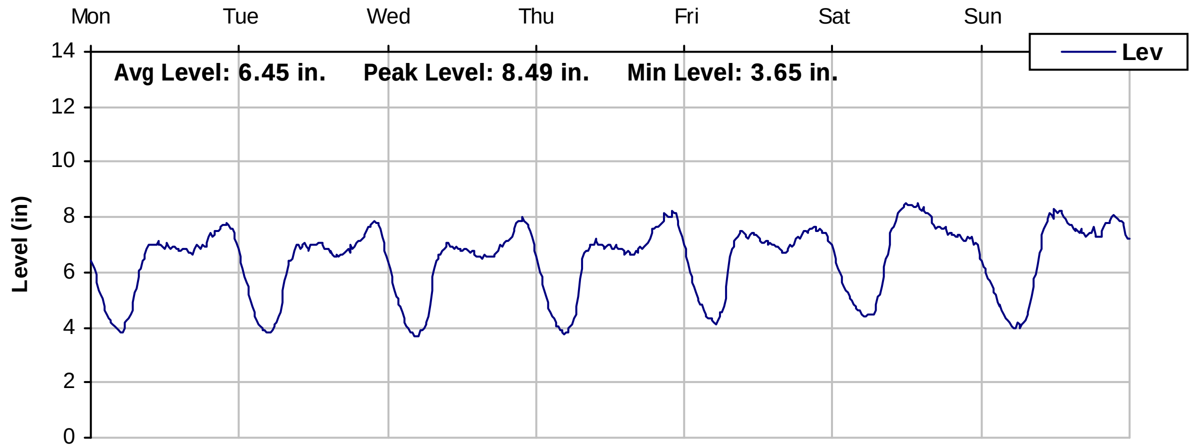


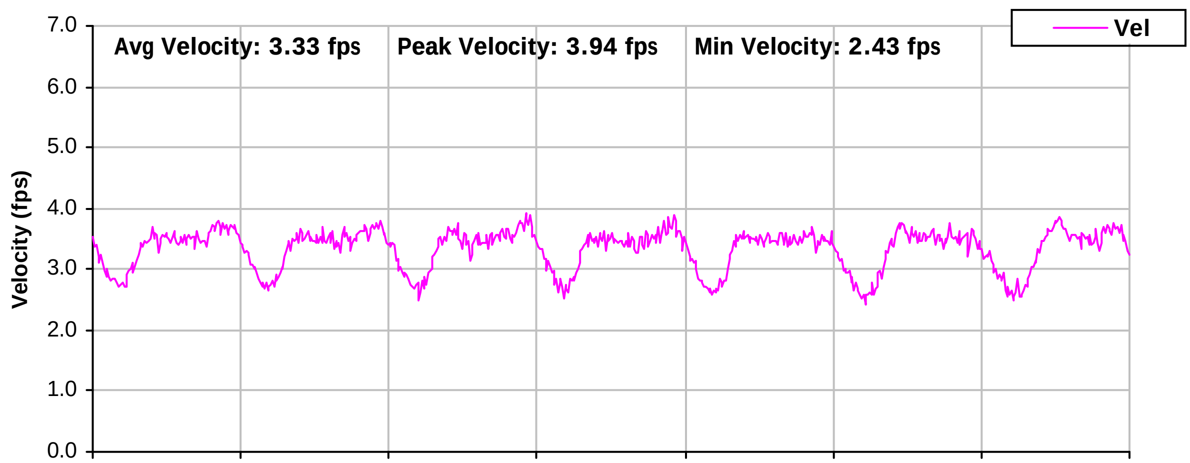
Avg Flow: 1.987 mgd **Peak Flow: 3.221 mgd** **Min Flow: 0.661 mgd**

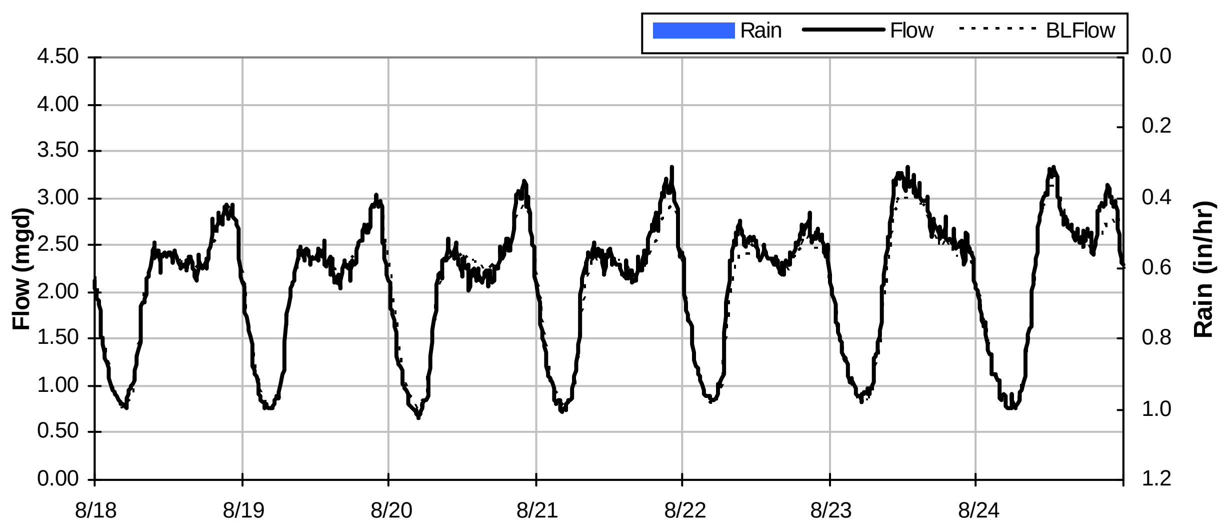
SITE 9
Weekly Level, Velocity and Flow Hydrographs
8/11/2014 to 8/18/2014



SITE 9
Weekly Level, Velocity and Flow Hydrographs
8/18/2014 to 8/25/2014







Avg Flow: 2.094 mgd **Peak Flow: 3.340 mgd** **Min Flow: 0.662 mgd**

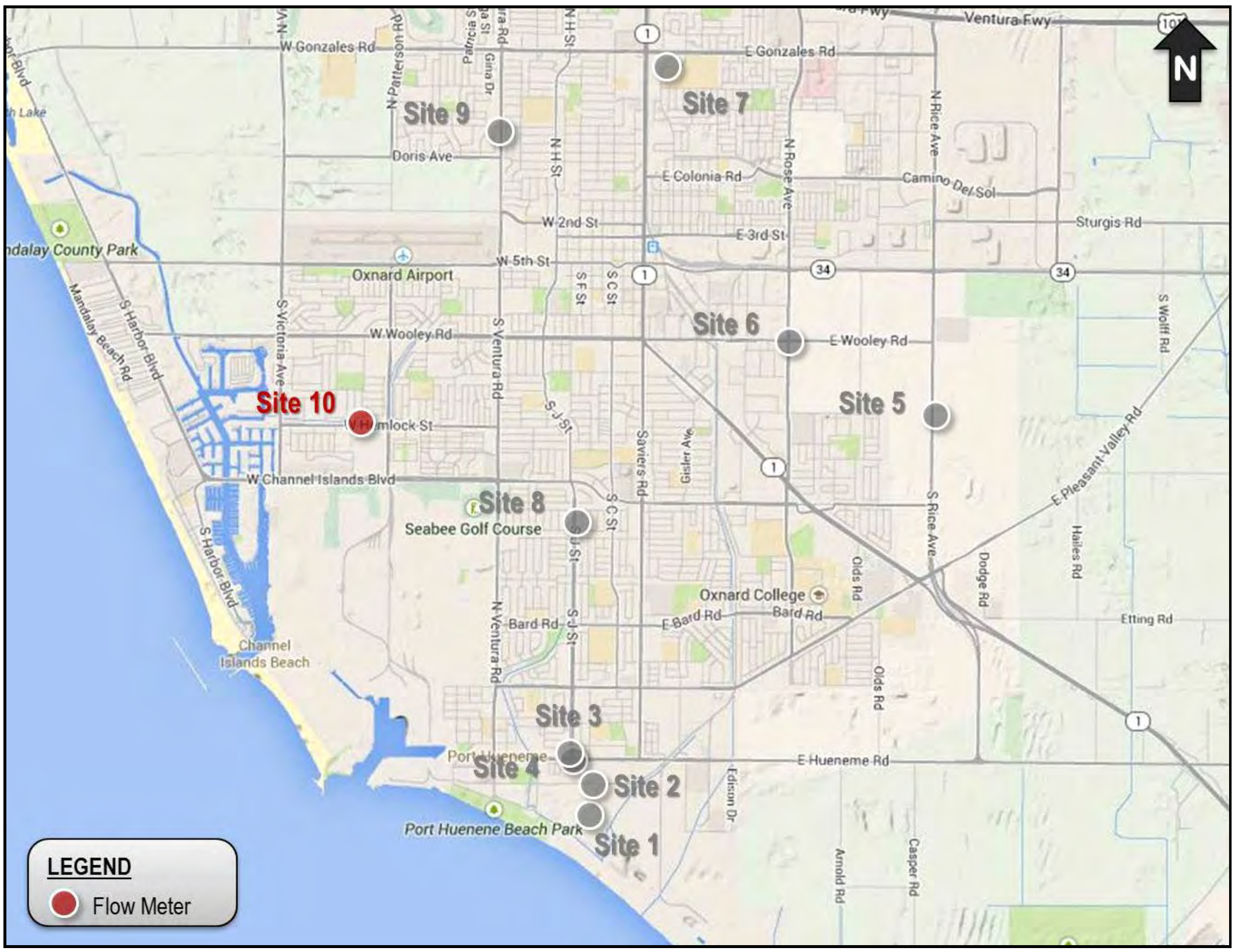
City of Oxnard

Sanitary Sewer Flow Monitoring
Temporary Monitoring: August, 2014

Monitoring Site: Site 10

Location: West of W Hemlock Street and Jetty Street

Data Summary Report



Vicinity Map: Site 10

SITE 10

Site Information

Location: West of W Hemlock Street and Jetty Street

Coordinates: 119.2116° W, 34.1812° N

Rim Elevation: 16 feet

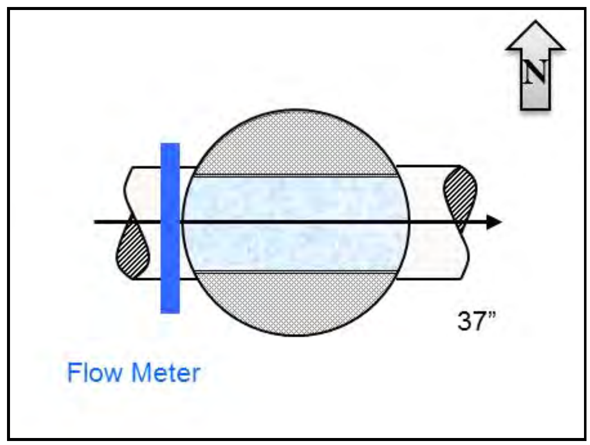
Pipe Diameter: 37 inches

Baseline Flow: 1.913 mgd

Peak Measured Flow: 3.460 mgd

Satellite Map

Sanitary Map



Flow Diagram


Street View


Plan View

SITE 10

Additional Site Photos

Effluent Pipe

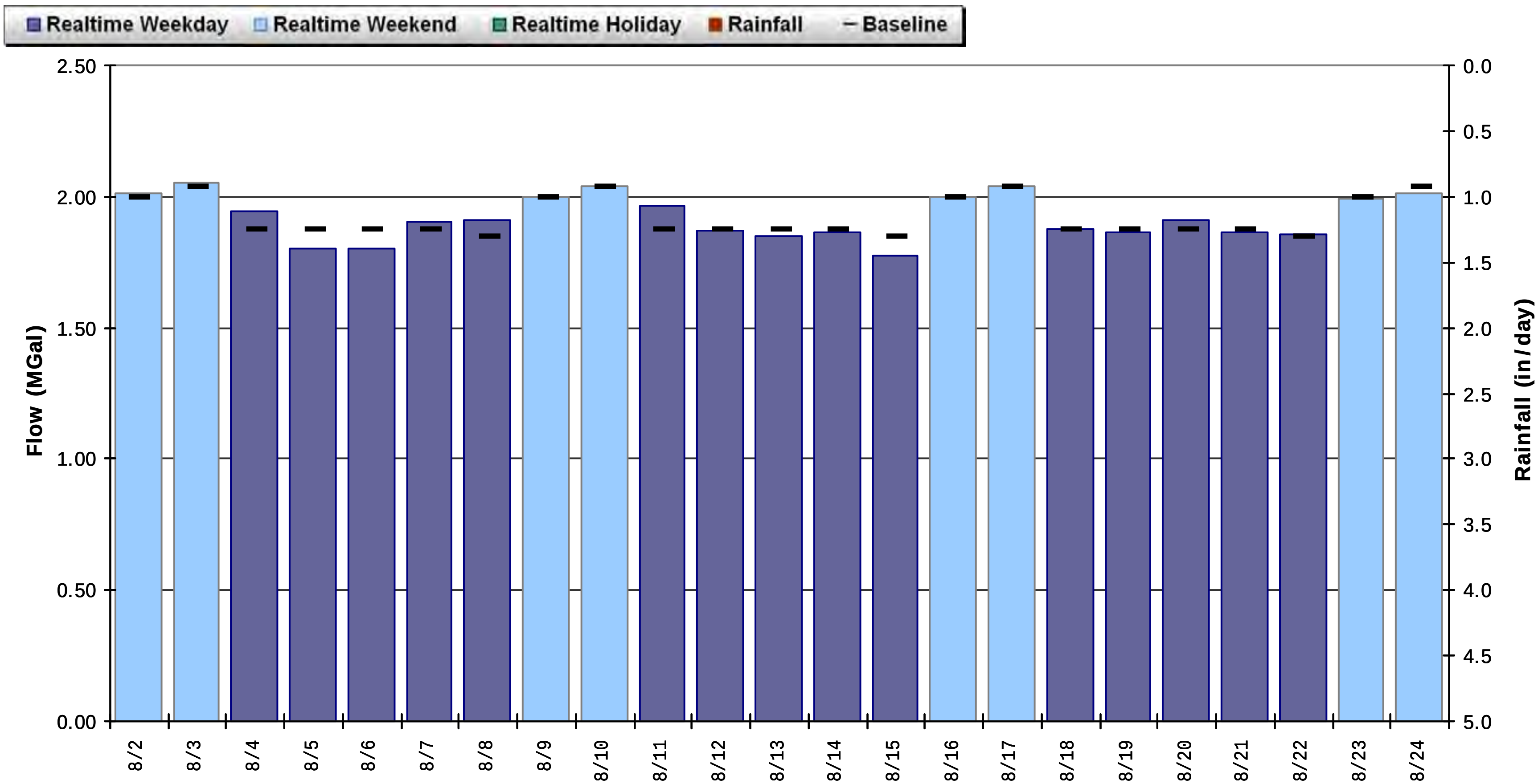
Influent Pipe

SITE 10

Period Flow Summary: Daily Flow Totals

Avg Period Flow: 1.922 MGal **Peak Daily Flow: 2.052 MGal** **Min Daily Flow: 1.776 MGal**

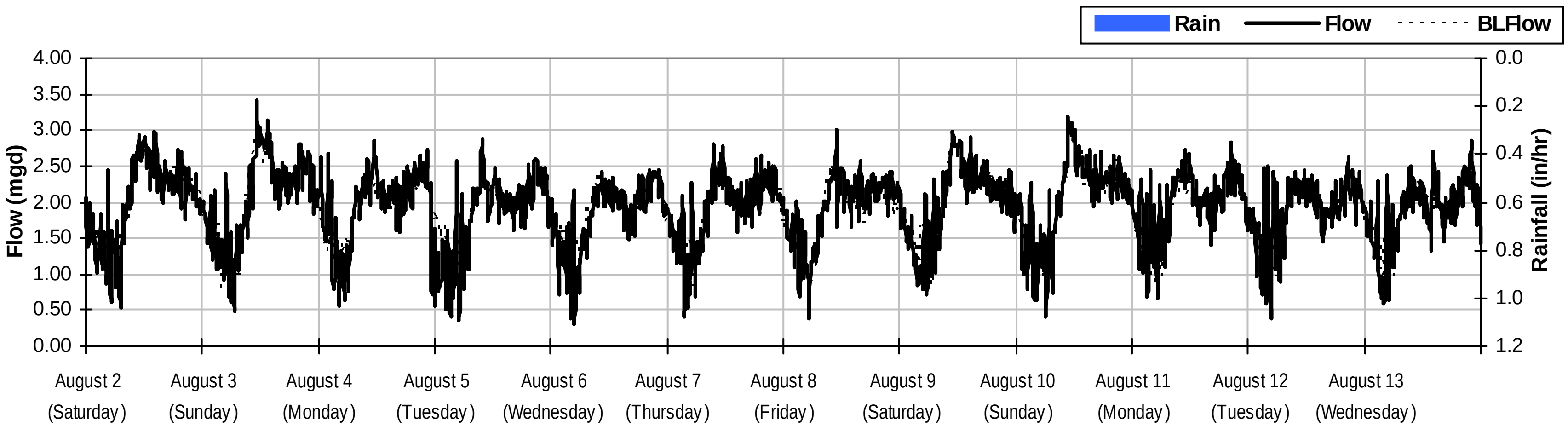
Total Monthly Rainfall: 0.00 inches

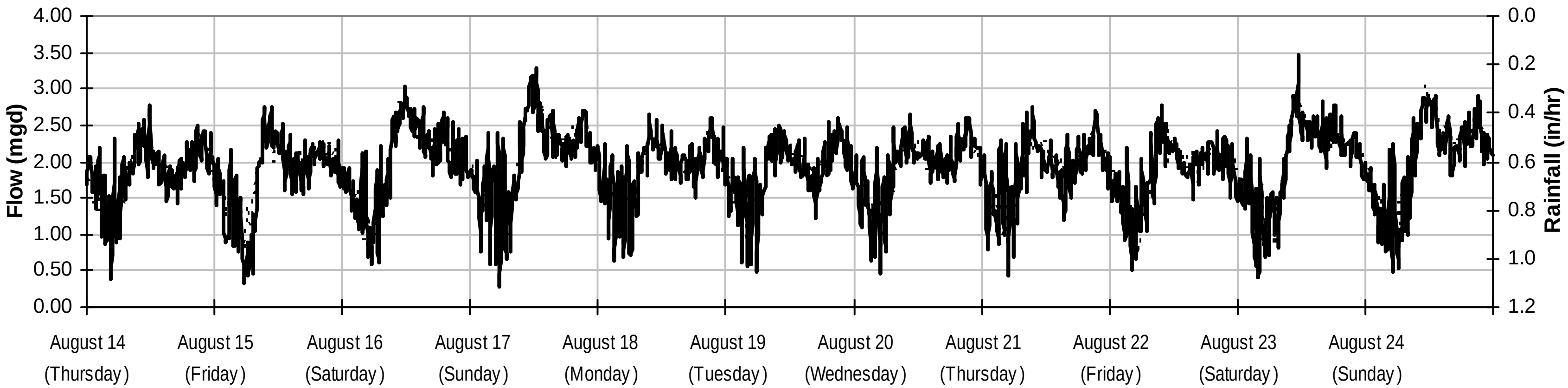


SITE 10

Flow Summary: 8/2/2014 to 8/24/2014

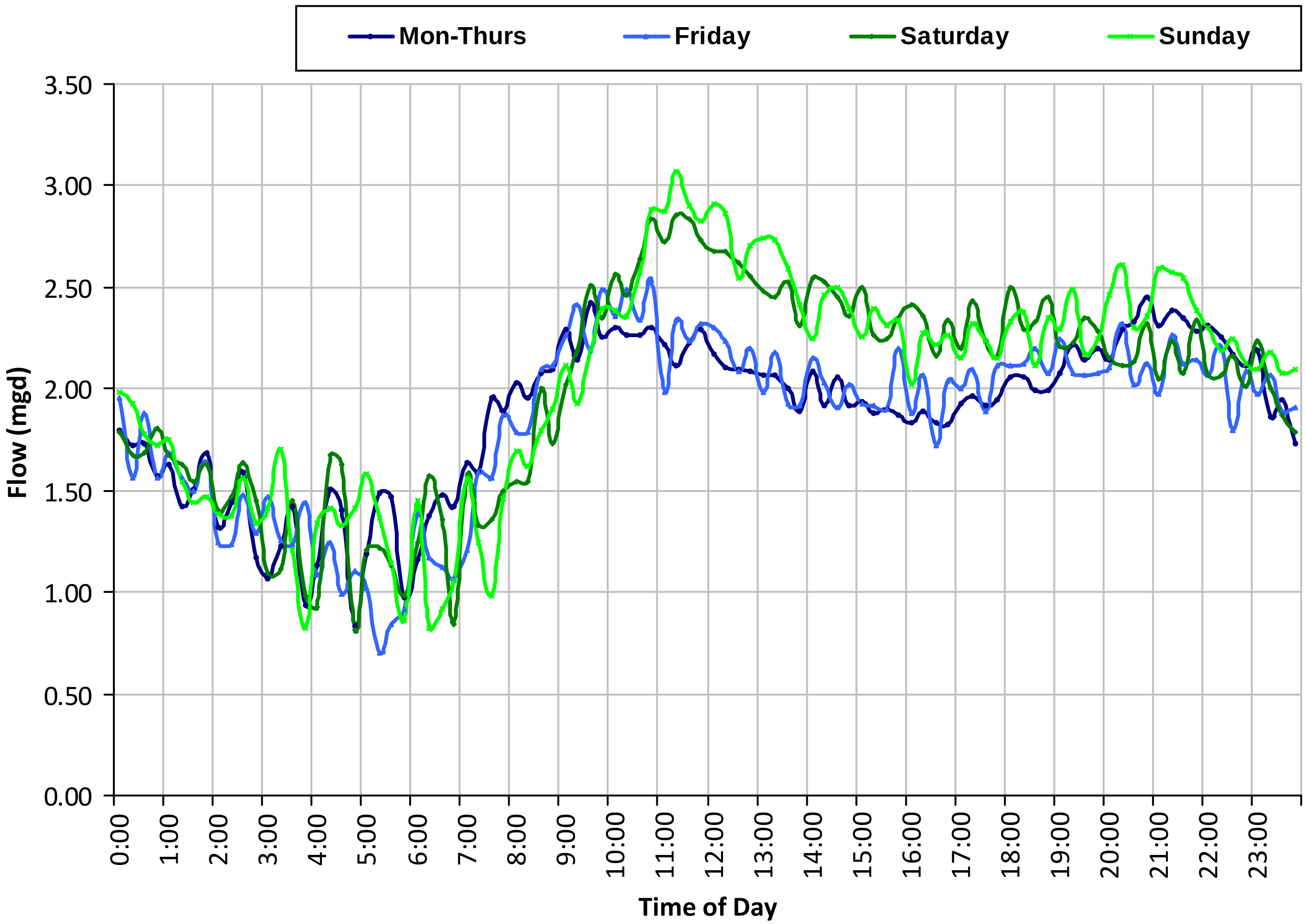
Total Period Rainfall: 0.00 inches **Avg Flow: 1.922 mgd** **Peak Flow: 3.460 mgd** **Min Flow: 0.288 mgd**





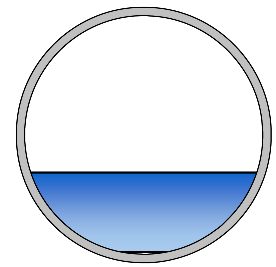
SITE 10

Baseline Flow Hydrographs



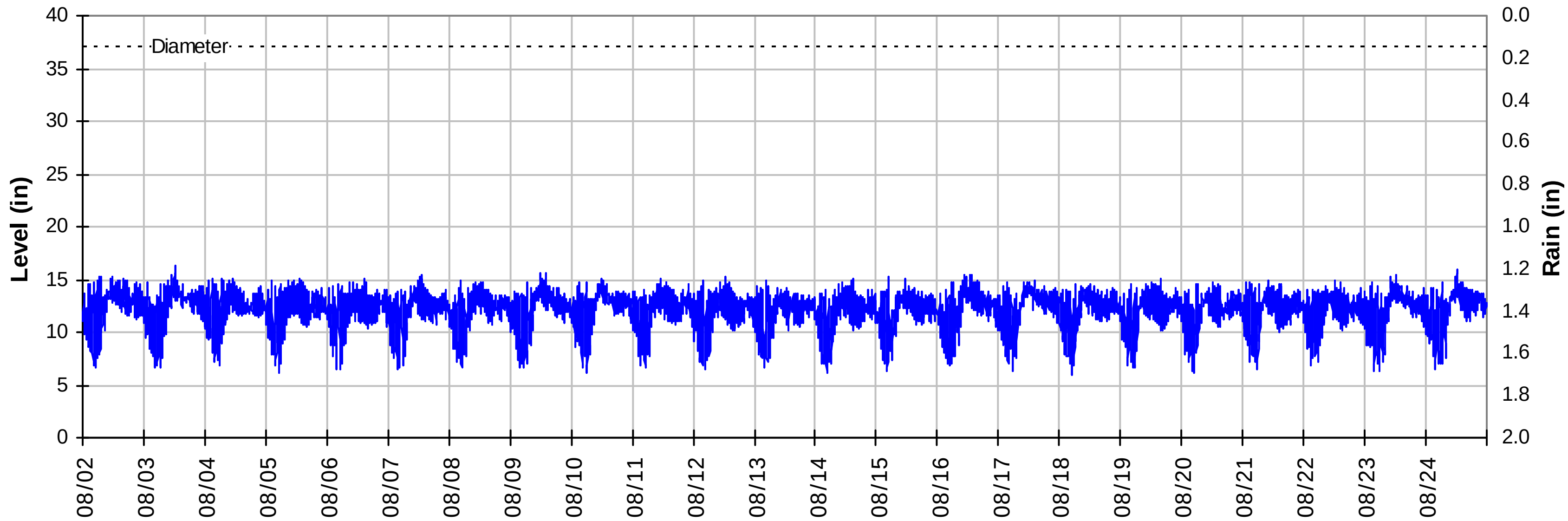
Baseline Flow:

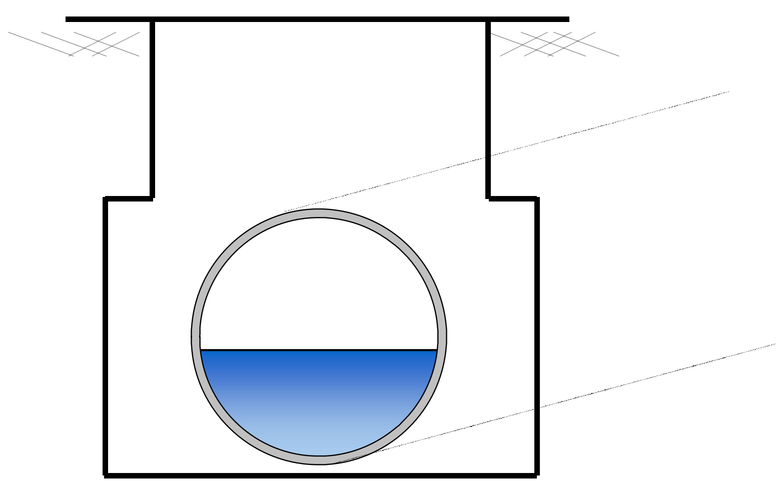
1.913 *mgd*



SITE 10
Site Capacity and Surcharge Summary

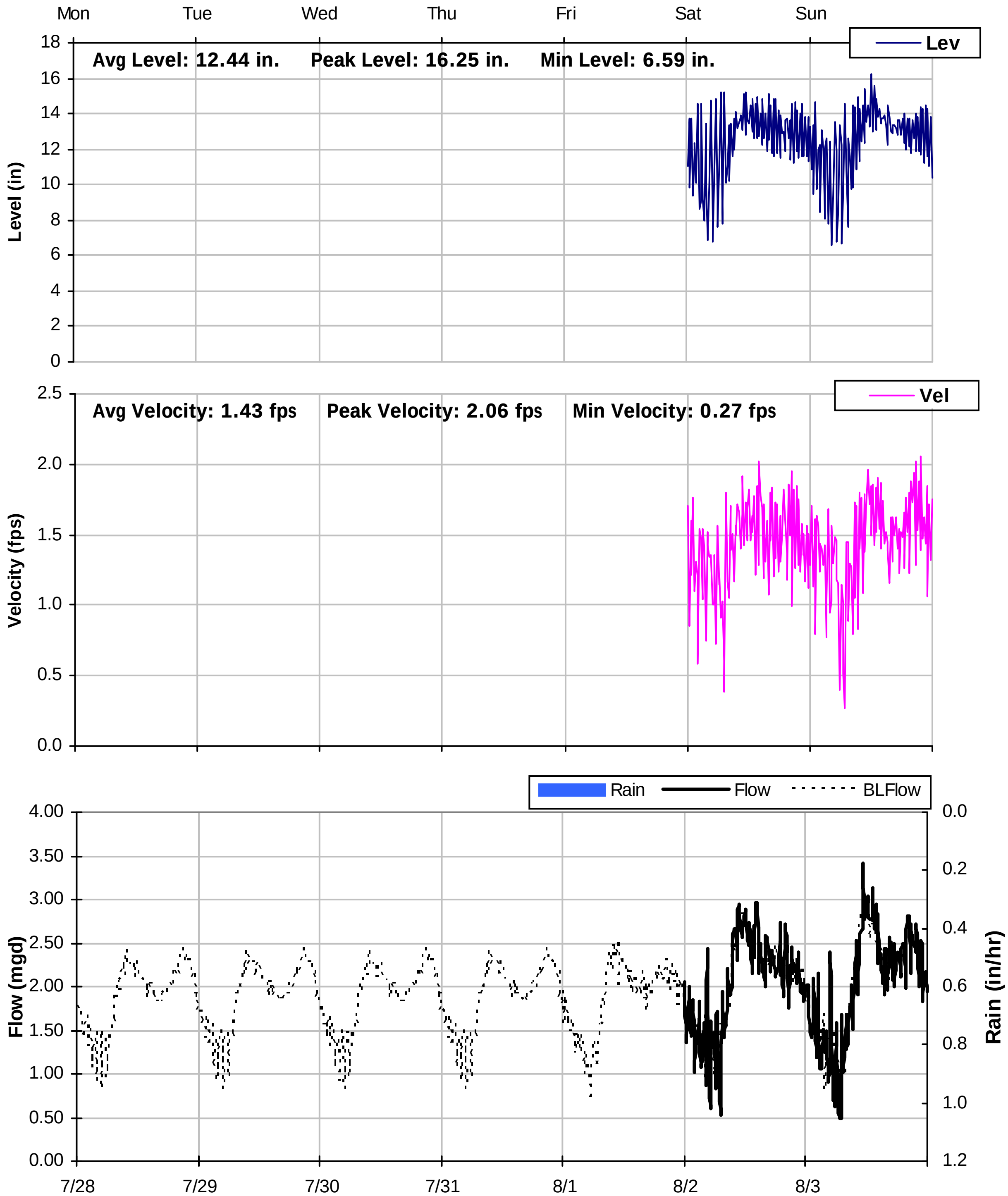
Realtime Flow Levels with Rainfall Data over Monitoring Period





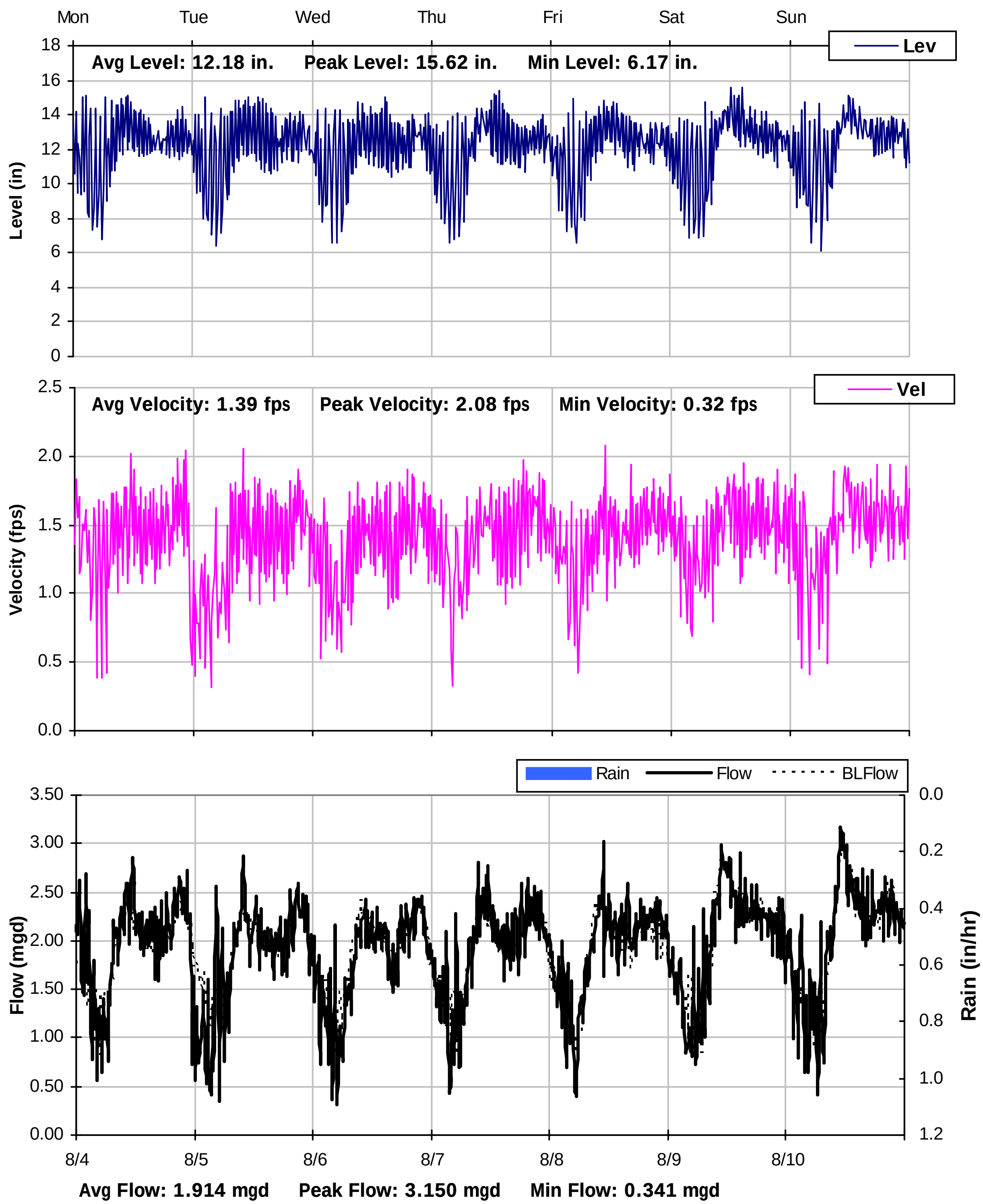
Pipe Diameter:	37	*inches*
Peak Measured Level:	16.3	*inches*
Peak d/D Ratio:	0.44	

SITE 10
Weekly Level, Velocity and Flow Hydrographs
7/28/2014 to 8/4/2014

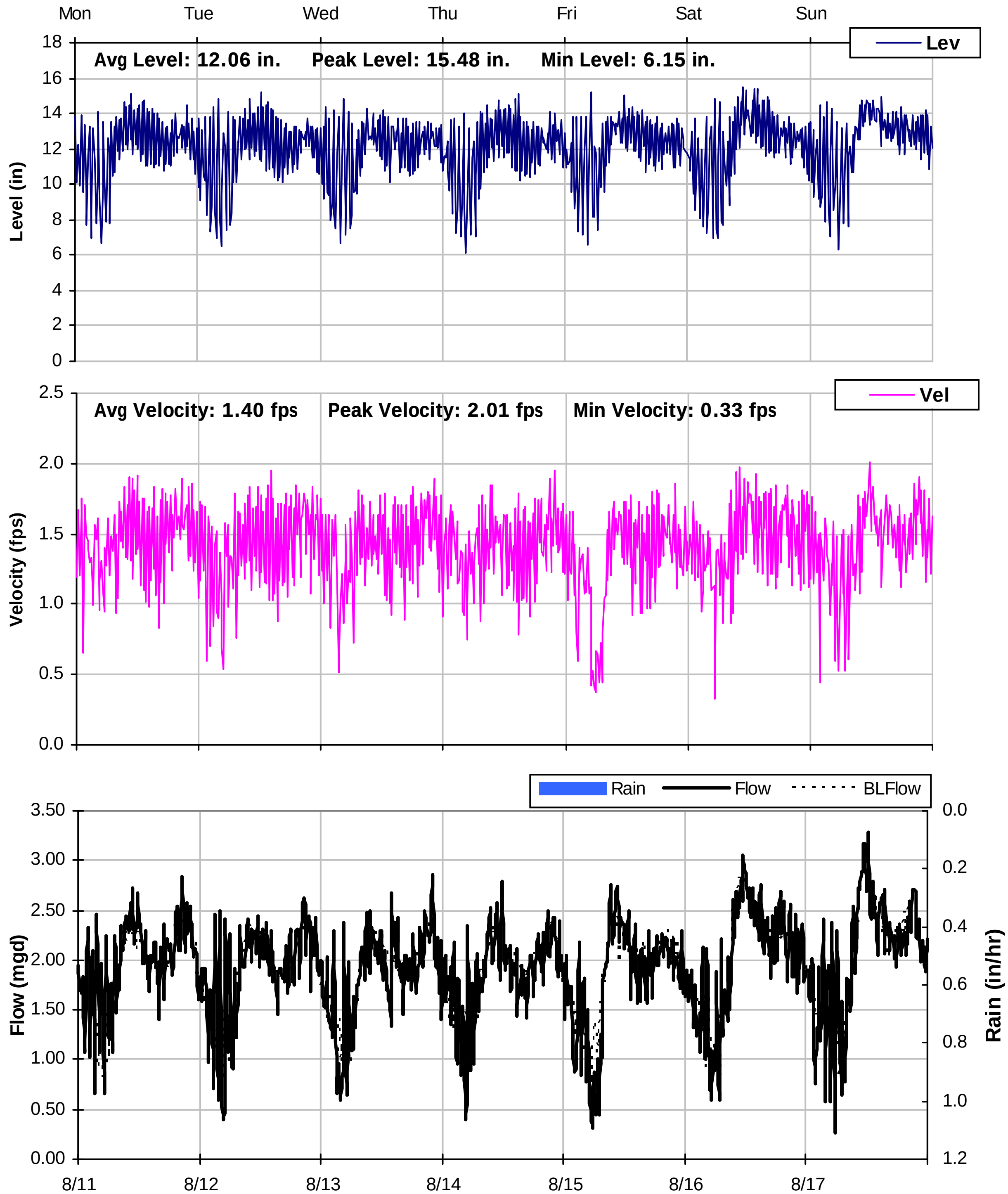


Avg Flow: 2.031 mgd **Peak Flow: 3.413 mgd** **Min Flow: 0.483 mgd**

SITE 10
Weekly Level, Velocity and Flow Hydrographs
8/4/2014 to 8/11/2014

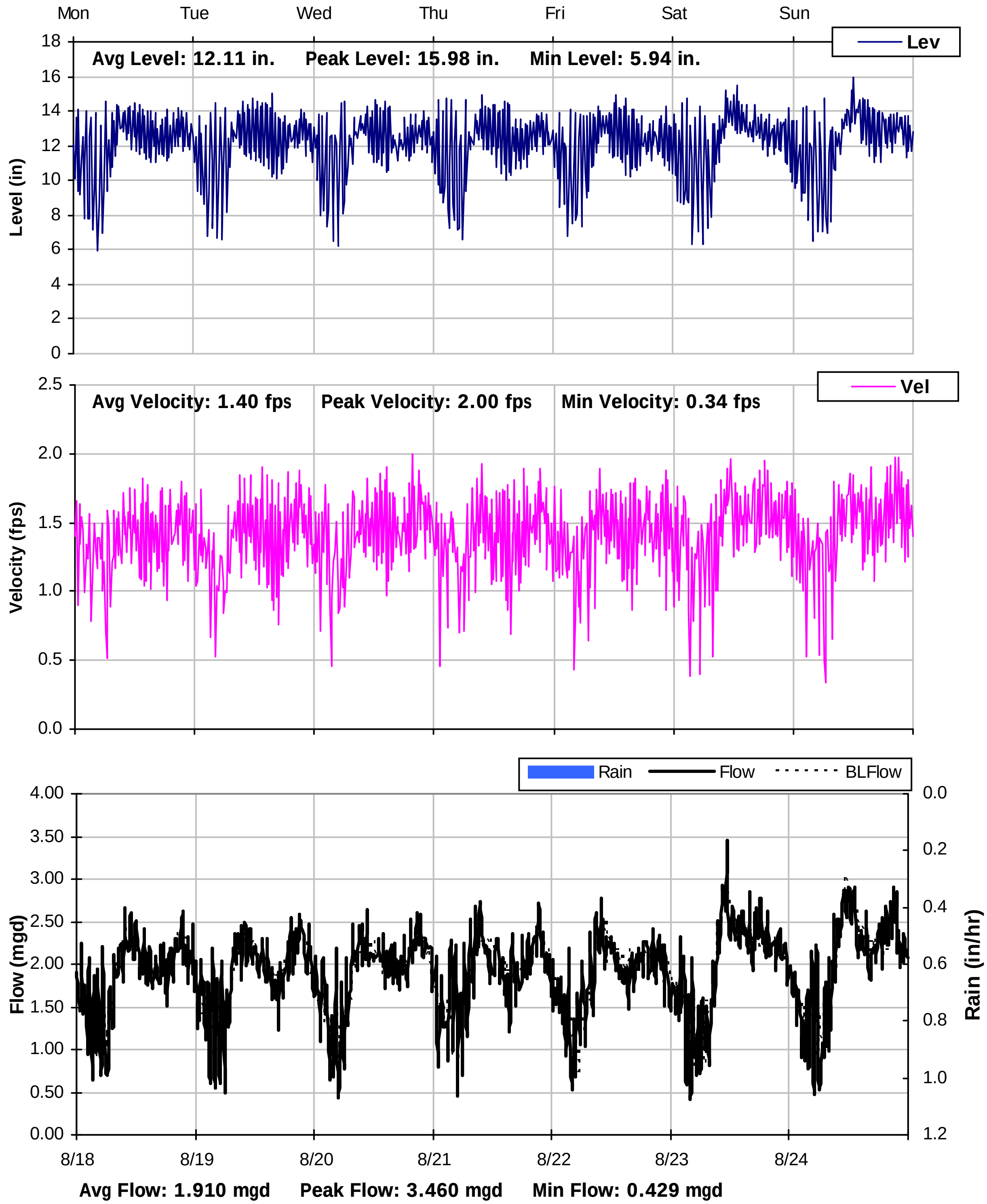


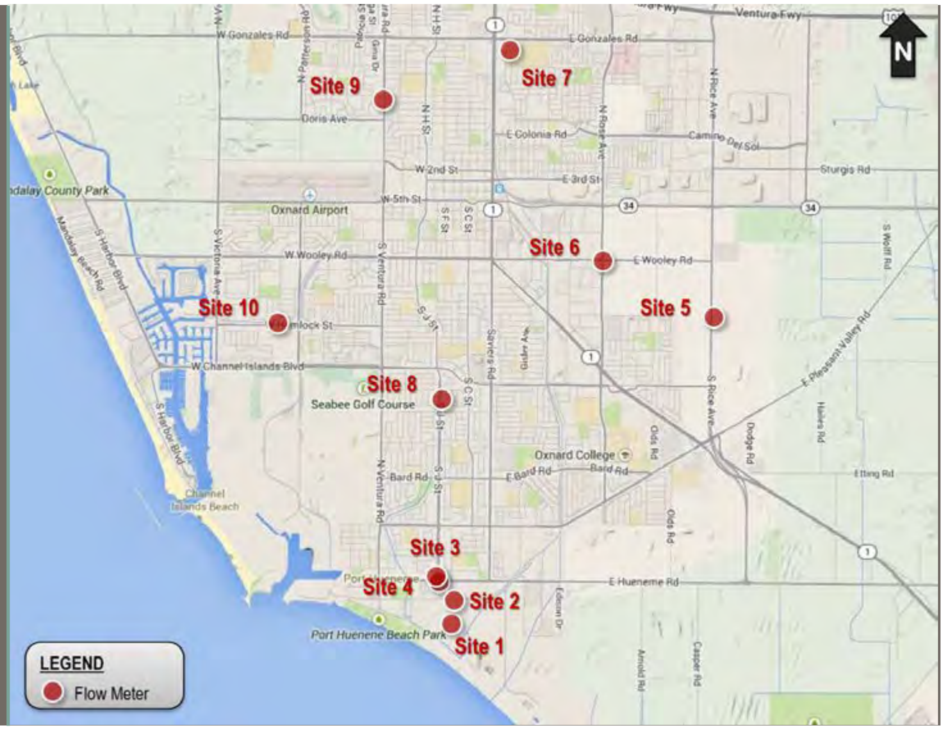
SITE 10
Weekly Level, Velocity and Flow Hydrographs
8/11/2014 to 8/18/2014



Avg Flow: 1.910 mgd **Peak Flow: 3.278 mgd** **Min Flow: 0.288 mgd**

SITE 10
Weekly Level, Velocity and Flow Hydrographs
8/18/2014 to 8/25/2014





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APPENDIX B – WET WEATHER SEWER FLOW MONITORING AND INFLOW / INFILTRATION STUDY

City of Oxnard
Sewer Flow Monitoring and Inflow / Infiltration Study

CITY OF
OXNARD
CALIFORNIA

May 2015

V&A

CITY OF OXNARD
SEWER FLOW MONITORING AND INFLOW / INFILTRATION STUDY



Prepared for: **Carollo Engineers**
89 Newbury Street, Suite 104
Danvers, MA 01923

Date: May 2015

Prepared by: V&A

V&A Project No. 14-0195

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

ABBREVIATIONS, TERMS AND DEFINITIONS USED IN THIS REPORT

Table i. Abbreviations

Abbreviation	Term
ADWF	average dry weather flow
CO	carbon monoxide
d/D	depth/diameter ratio
FM	flow monitor
H_2S	hydrogen sulfide
I/I	inflow and infiltration
LEL	lower explosive limit
mgd	million gallons per day
NOAA	National Oceanic and Atmospheric Administration
Q	flow rate
RDI	rainfall-dependent infiltration
RRI	rainfall-responsive infiltration
RG	rain gauge
SSO	sanitary sewer overflow
WEF	Water Environment Federation
WRCC	Western Regional Climate Center

Table ii. Terms and Definitions

Term	Definition
Average dry weather flow (ADWF)	Average flow rate or pattern from days without noticeable inflow or infiltration response. ADWF usage patterns for weekdays and weekends differ and must be computed separately. ADWF can be expressed as a numeric average or as a curve showing the variation in flow over a day. ADWF includes the influence of normal groundwater infiltration (not related to a rain event).
Basin	Sanitary sewer collection system upstream of a given location (often a flow meter), including all pipelines, inlets, and appurtenances. Also refers to the ground surface area near and enclosed by pipelines. A basin may refer to the entire collection system upstream from a flow meter or exclude separately monitored basins upstream.
Depth/diameter (*d/D*) ratio	Depth of water in a pipe as a fraction of the pipe's diameter. A measure of fullness of the pipe used in capacity analysis.
Infiltration and inflow	Infiltration and inflow (I/I) rates are calculated by subtracting the ADWF flow curve from the instantaneous flow measurements taken during and after a storm event. Flow in excess of the baseline consists of inflow, rainfall-responsive infiltration, and rainfall-dependent infiltration. **Total I/I** is the total sum in gallons of additional flow attributable to a storm event.
Infiltration, *groundwater*	Groundwater infiltration (**GWI**) is groundwater that enters the collection system through pipe defects. GWI depends on the depth of the groundwater table above the pipelines as well as the percentage of the system that is submerged. The variation of groundwater levels and subsequent groundwater infiltration rates is seasonal by nature. On a day-to-day basis, groundwater infiltration rates are relatively steady and will not fluctuate greatly.
Infiltration, *rainfall-dependent*	Rainfall-dependent infiltration (**RDI**) is similar to groundwater infiltration but occurs as a result of storm water. The storm water percolates into the soil, submerges more of the pipe system, and enters through pipe defects. RDI is the slowest component of storm-related infiltration and inflow, beginning gradually and often lasting 24 hours or longer. The response time depends on the soil permeability and saturation levels.
Infiltration, *rainfall-responsive*	Rainfall-responsive infiltration (**RRI**) is storm water that enters the collection system through pipe defects, but normally in sewers constructed close to the ground surface such as private laterals. RRI is independent of the groundwater table and reaches defective sewers via the pipe trench in which the sewer is constructed, particularly if the pipe is placed in impermeable soil and bedded and backfilled with a granular material. In this case, the pipe trench serves as a conduit similar to a French drain, conveying storm drainage to defective joints and other openings in the system.
Inflow	**Inflow** is defined as water discharged into the sewer system, including private sewer laterals, from **direct** connections such as downspouts, yard and area drains, holes in manhole covers, cross-connections from storm drains, or catch basins. Inflow creates a peak flow problem in the sewer system and often dictates the required capacity of downstream pipes and transport facilities to carry these peak instantaneous flows. Overflows are often attributable to high inflow rates.
Normalization	To run an "apples-to-apples" comparison amongst different basins, calculated metrics must be **normalized**. Individual basins will have different runoff areas, pipe lengths and sanitary flows. There are three common methods of normalization. Depending on the information available, one or all methods can be applied to a given project: • <u>Pipe Length:</u> The metric is divided by the length of pipe in the upstream

Term	Definition
	basin expressed in units of inch-diameter-mile (IDM). • Basin Area: The metric is divided by the estimated drainage area of the basin in acres. • ADWF: The metric is divided by the average dry weather sanitary flow (ADWF).
Normalization, *inflow*	The peak I/I flow rate is used to quantify inflow. Although the instantaneous flow monitoring data will typically show an inflow peak, the inflow response is measured from the I/I flow rate (in excess of baseline flow). This removes the effect of sanitary flow variations and measures only the I/I response: • Pipe Length: The peak I/I flow rate is divided by the length of pipe (IDM) in the upstream basin. The result is expressed in gallons per day (gpd) per IDM (gpd/IDM). • Basin Area: The peak I/I flow rate is divided by the geographic area of the upstream basin. The result is expressed in gpd per acre. • ADWF: The peak I/I flow rate is divided by the average dry weather flow (ADWF). This is a ratio and is expressed without units.
Normalization, *GWI*	The estimated GWI rates are compared to acceptable GWI rates, as defined by the Water Environment Federation, and are used to identify basins with high GWI: • Pipe Length: The GWI flow rate is divided by the length of pipe (IDM) in the upstream basin. The result is expressed in gallons per day (gpd) per IDM (gpd/IDM). • Basin Area: The GWI flow rate is divided by the geographic area of the upstream basin. The result is expressed in gpd per acre. • ADWF: The GWI flow rate is divided by the average dry weather flow (ADWF). This is a ratio and is expressed without units.
Normalization, *RDI*	The estimated RDI rates at a period 24 hours or more after the conclusion of a storm event are used to identify basins with high RDI: • Pipe Length: The RDI flow rate is divided by the length of pipe (IDM) in the upstream basin. The result is expressed in gallons per day (gpd) per IDM (gpd/IDM). • Basin Area: The RDI flow rate is divided by the geographic area of the upstream basin. The result is expressed in gpd per acre. • ADWF: The RDI flow rate is divided by the average dry weather flow (ADWF). This is a ratio and is expressed without units.
Normalization, *total I/I*	The estimated totalized I/I in gallons attributable to a particular storm event is used to identify basins with high total I/I. Because this is a totalized value rather than a rate and can be attributable solely to an individual storm event, the volume of the storm event is also taken into consideration. This allows for a comparison not only between basins but also between storm events: • Pipe Length: Total gallons of I/I is divided by the length of pipe (IDM) in the upstream basin and the rainfall total (inches) of the storm event. The result is expressed in gallons per IDM per inch-rain. • Basin Area (R-Value): Total gallons of I/I is divided by total gallons of rainfall

Term	Definition
	water that fell within the acreage of the basin area. This is a ratio and is expressed as a percentage. R-Value is described as "the percentage of rainfall that enters the collection system." Systems with R-Values less than 5%[1] are often considered to be performing well. • ADWF: Total gallons of I/I is divided by the ADWF and the rainfall total of the storm event. The result is expressed in million gallons per MGD of ADWF per inch of rain.
Peaking factor	Ratio of peak measured flow to average dry weather flow. This ratio expresses the degree of fluctuation in flow rate over the monitoring period and is used in capacity analysis.
Surcharge	When the flow level is higher than the crown of the pipe, then the pipeline is said to be in a **surcharged** condition. The pipeline is surcharged when the *d/D* ratio is greater than 1.0.
Weekend/weekday ratio	The ratio of weekend ADWFs to weekday ADWFs. In residential areas, this ratio is typically slightly higher than 1.0. In business districts, depending on the type of service, this ratio can be significantly less than 1.0.

[1] Keefe, P.N. "Test Basins for I/I Reduction and SSO Elimination." 1998 WEF Wet Weather Specialty Conference, Cleveland.

ES EXECUTIVE SUMMARY

Scope and Purpose

V&A Consulting Engineers (V&A) has completed sanitary sewer flow monitoring within the City of Oxnard (City) under the wet weather conditions. During this study, the flow monitoring was performed from December 9, 2014 to February 25, 2015 at ten open-channel flow monitoring sites. The monitored sites were the same as the dry weather study except Site 4A. The dry weather study was performed in August, 2014 and the report was submitted in October, 2014.

The main purpose of this study was to establish the baseline sanitary flows and quantify the inflow/infiltration. The City can utilize the data for sewer hydraulic modeling analysis and sewer rehabilitation/replacement verification.

Site Flow Monitoring and Capacity Results

Table ES-1 summarizes the flow monitoring and I/I results for the flow monitoring sites. It should be noted that the flow rate and sewer capacity information is presented on a site-by-site basis.

Table ES-1. Capacity Analysis Summary

Monitoring Site	ADWF (mgd)	Peak Measured Flow (mgd)	Peaking Factor	d/D Ratio	Peak I/I Rate (mgd)	Peak I/I per ADWF
Site 1	4.823	8.312	1.7	0.48	3.468	0.7
Site 2	2.194	6.002	2.7	0.59	3.242	1.5
Site 3	6.988	14.352	2.1	0.40	5.545	0.8
Site 4A	3.153	5.729	1.8	0.70	4.512	1.4
Site 5	1.408	3.074	2.2	0.37	2.044	1.5
Site 6	1.197	2.292	1.9	0.46	1.081	0.9
Site 7	0.333	0.620	1.9	0.25	0.248	0.7
Site 8	1.638	4.540	2.8	0.57	3.725	2.3
Site 9	2.306	4.053	1.8	0.23	1.884	0.8
Site 10	2.128	4.024	1.9	0.40	1.052	0.5

The flow monitoring and I/I analyses show that:

1. **Inflow and Infiltration:** Most of the I/I within the collection system comes from INFLOW. There was negligible rain dependent infiltration observed during this flow monitoring study.
2. **Capacity:** The capacity analysis in this study shows that the sewer system is in good condition on a capacity basis during this monitoring study.

Recommendations

V&A advises that future I/I reduction plans consider the following recommendations if I/I is a concern to the City:

1. **Determine I/I Reduction Program:** The City should examine its I/I reduction needs to determine their strategy and goals for a future I/I reduction program.
   a. If peak flows, sanitary sewer overflows, and pipeline capacity issues are of greater concern, then priority can be given to investigate and reduce sources of inflow within the basins with the higher inflow/ADWF ratios. This would appear to be the greatest concern for the City collection system.
   b. If infiltration and general pipeline deterioration are of greater concern, then the program can be weighted to investigate and reduce sources of infiltration within the basins with the higher RDI/ADWF ratios. Infiltration does not appear to be an issues for the City collection system.
2. **I/I Investigation Methods:** Potential I/I investigation methods include the following:
   a. smoke testing
   b. mini-basin flow monitoring
   c. CCTV inspection
3. **I/I Reduction Cost Effective Analysis:** The City should conduct a study to determine which is more cost-effective: (1) locating the sources of inflow/infiltration and systematically rehabilitating or replacing the faulty pipelines; or (2) continued treatment of the additional rainfall dependent I/I flow.

1.0 INTRODUCTION

1.1 Introduction

V&A Consulting Engineers (V&A) has completed sanitary sewer flow monitoring within the City of Oxnard (City) under wet weather conditions. During this study, the flow monitoring was performed from December 9, 2014 to February 25, 2015 at ten open-channel flow monitoring sites. The monitored sites were the same as the dry weather study except Site 4A. The dry weather study was performed in August, 2014 and the report was submitted in October, 2014.

The main purpose of this study was to establish the baseline sanitary flows and quantify the inflow/infiltration. The City can utilize the data for sewer hydraulic modeling analysis and sewer rehabilitation/replacement verification. The flow monitoring locations are listed in Table 1-1. It should be noted that the flow rate and sewer capacity information is presented on a site-by-site basis.

Table 1-1. List of Flow Monitoring Sites

Monitoring Site	Measured Pipe Diameter (in)	Location
Site 1	41.5	McWane Boulevard, east of Perkins Road
Site 2	36	Magellan Avenue
Site 3	60	J Street and E Port Hueneme Road
Site 4A*	33	J Street and W Hueneme Road
Site 5	36	S Rice Avenue and East of Emerson Avenue
Site 6	24	S Rose Avenue and E Wooley Road
Site 7	24	E Gonzales Road and Bahia Drive
Site 8	27	J Street, between Spruce Street and Teakwood Street
Site 9	42	N Ventura Road, between Devonshire Drive and Doris Avenue
Site 10	37	West of W Hemlock Street and Jetty Street

*Site 4A was installed one manhole upstream from Site 4 in the dry weather study as the new site had a better hydraulic condition for flow monitoring.

The rainfall data was obtained from Ventura County Watershed Protection District Hydrologic Data Server and the sites are listed in Table 1-2. The flow monitoring sites and rainfall recording sites are shown together in Figure 1-1.

Table 1-2. List of Rainfall Recording Sites

Monitoring Site	Latitude (°)	Longitude (°)
Oxnard WWTP	34.142	-119.187
Oxnard Airport	34.202	-119.208
Oxnard Civic Center	34.200	-119.180
El Rio-UWCD Spreading Grounds	34.239	-119.153
Oxnard NWS	34.207	-119.137

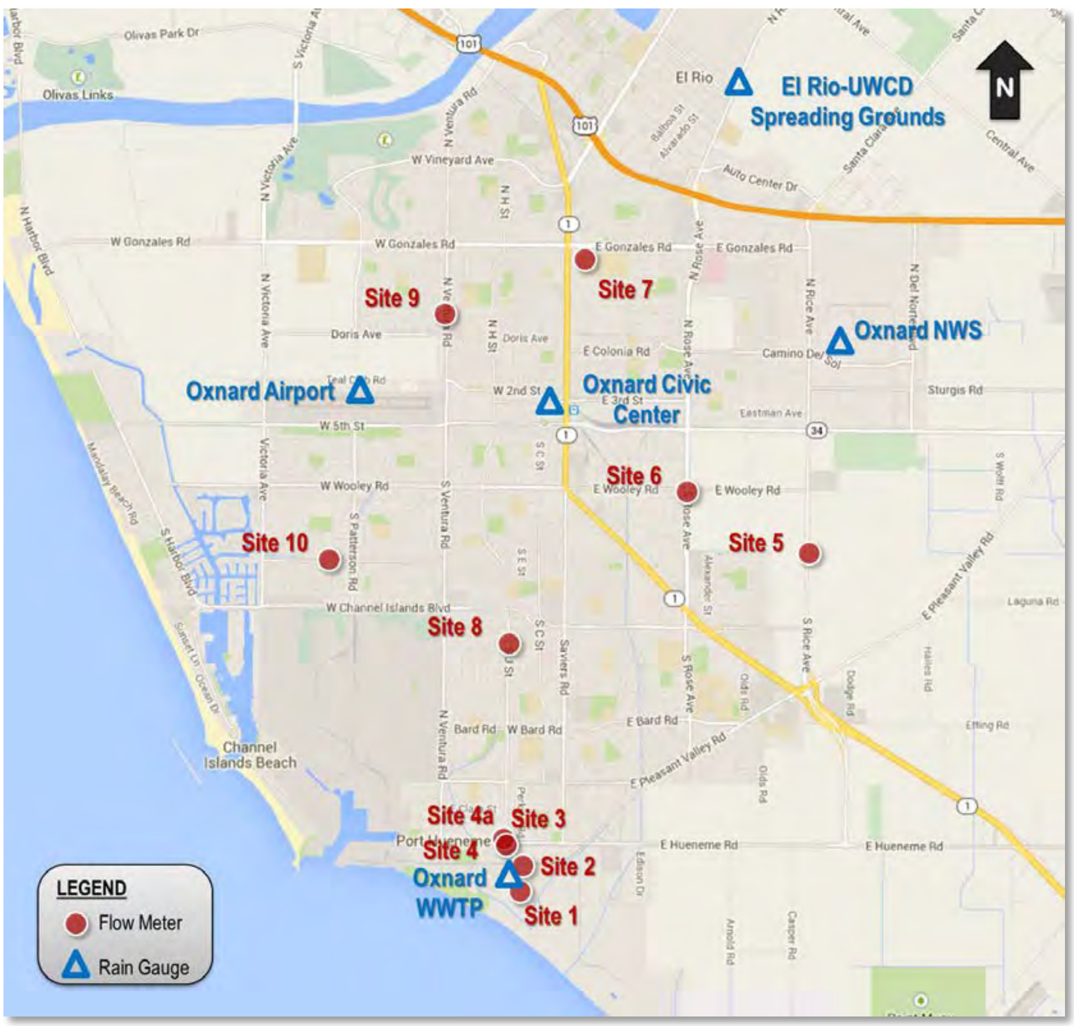


Figure 1-1. Locations of Flow/Rainfall Monitoring Sites

2.0 METHODS AND PROCEDURES

2.1 Confined Space Entry

A confined space (Photo 2-1) is defined as any space that is large enough and so configured that a person can bodily enter and perform assigned work, has limited or restricted means for entry or exit and is not designed for continuous employee occupancy. In general, the atmosphere must be constantly monitored for sufficient levels of oxygen (19.5% to 23.5%), and the absence of hydrogen sulfide (H_2S) gas, carbon monoxide (CO) gas, and lower explosive limit (LEL) levels. A typical confined space entry crew has members with OSHA-defined responsibilities of Entrant, Attendant and Supervisor. The Entrant is the individual performing the work. He or she is equipped with the necessary personal protective equipment needed to perform the job safely, including a personal four-gas monitor (Photo 2-2). If it is not possible to maintain line-of-sight with the Entrant, then more Entrants are required until line-of-sight can be maintained. The Attendant is responsible for maintaining contact with the Entrants to monitor the atmosphere using another four-gas monitor and maintaining records of all Entrants, if there are more than one. The Supervisor is responsible for developing the safe work plan for the job at hand prior to entering.

Photo 2-1. Confined Space Entry

Photo 2-2. Typical Personal Four-Gas Monitor

2.2 Flow Meter Installation

Teledyne Isco 2150 meters were installed by V&A in the sewer lines listed in Table 1-1. Isco 2150 meters use submerged sensors with a pressure transducer to collect depth readings and an ultrasonic Doppler sensor to determine the average fluid velocity. The ultrasonic sensor emits high-frequency sound waves, which are reflected by air bubbles and suspended particles in the flow. The sensor receives the reflected signal and determines the Doppler frequency shift, which indicates the estimated average flow velocity. The sensor is typically mounted at a manhole inlet to take advantage of smoother upstream flow conditions. The sensor may be offset to one side to lessen the chances of fouling and sedimentation where these problems are expected to occur. Manual level and velocity measurements were taken during installation of the flow meters and again when they were removed and were compared to simultaneous level and velocity readings from the flow meters to ensure proper calibration and accuracy. The pipe diameter was also verified in order to accurately calculate the flow cross-section. The continuous depth and velocity readings were recorded by the flow meters on 5-minute intervals. Figure 2-1 shows a typical installation for a flow meter with a submerged sensor.

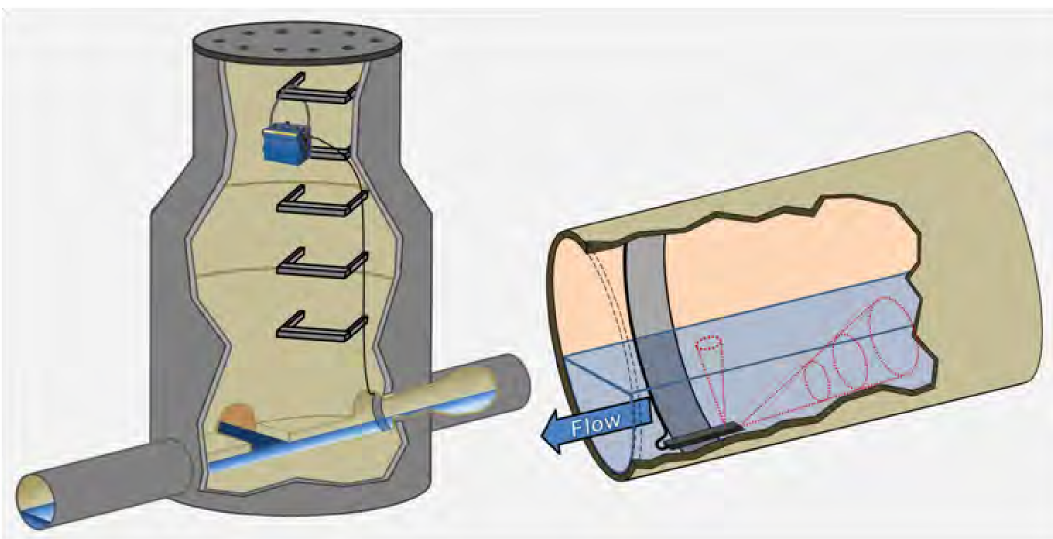


Figure 2-1. Typical Installation for Flow Meter with Submerged Sensor

2.3 Flow Calculation

Data retrieved from the flow meter was placed into a spreadsheet program for analysis. Data analysis includes data comparison to field calibration measurements, as well as necessary geometric adjustments as required for sediment (sediment reduces the pipe's wetted cross-sectional area available to carry flow). Area-velocity flow metering uses the continuity equation,

$$Q = v \cdot A = v \cdot (A_T - A_S)$$

where Q : volume flow rate
v: average velocity as determined by the ultrasonic sensor
A: cross-sectional area available to carry flow
A_T: total cross-sectional area with both wastewater and sediment
A_S: cross-sectional area of sediment.

For circular pipe,

$$A_T = \left[\frac{D^2}{4}\cos^{-1}\left(1-\frac{2d_W}{D}\right)\right]-\left[\left(\frac{D}{2}-d_W\right)\left(\frac{D}{2}\right)\sin\left(\cos^{-1}\left(1-\frac{2d_W}{D}\right)\right)\right]$$

$$A_S = \left[\frac{D^2}{4}\cos^{-1}\left(1-\frac{2d_S}{D}\right)\right]-\left[\left(\frac{D}{2}-d_S\right)\left(\frac{D}{2}\right)\sin\left(\cos^{-1}\left(1-\frac{2d_S}{D}\right)\right)\right]$$

where d_W: distance between wastewater surface level and pipe invert
d_S: depth of sediment
D: pipe diameter

2.4 Inflow / Infiltration Analysis: Definitions and Identification

Inflow and infiltration (I/I) consists of storm water and groundwater that enter the sewer system through pipe defects and improper storm drainage connections and is defined as follows:

2.4.1 Definition and Typical Sources

- Inflow: Storm water inflow is defined as water discharged into the sewer system, including private sewer laterals, from direct connections such as downspouts, yard and area drains, holes in manhole covers, cross-connections from storm drains, or catch basins.
- Infiltration: Infiltration is defined as water entering the sanitary sewer system through defects in pipes, pipe joints, and manhole walls, which may include cracks, offset joints, root intrusion points, and broken pipes.

Figure 2-2 illustrates the possible sources and components of I/I.

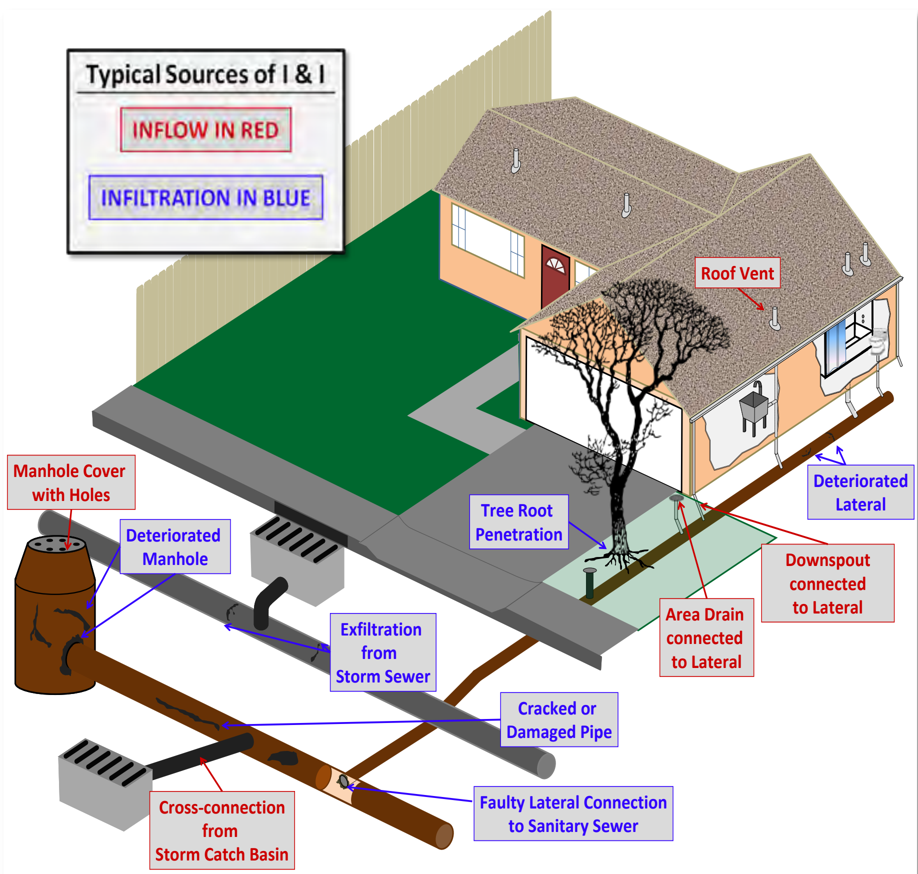


Figure 2-2. Typical Sources of Infiltration and Inflow

2.4.2 Infiltration Components

Infiltration can be further subdivided into components as follows:

- Groundwater Infiltration: Groundwater infiltration depends on the depth of the groundwater table above the pipelines as well as the percentage of the system submerged. The variation of groundwater levels and subsequent groundwater infiltration rates is seasonal by nature. On a day-to-day basis, groundwater infiltration rates are relatively steady and will not fluctuate greatly.
- Rainfall-Dependent Infiltration: This component occurs as a result of storm water and enters the sewer system through pipe defects, as with groundwater infiltration. The storm water first percolates directly into the soil and then migrates to an infiltration point. Typically, the time of concentration for rainfall-related infiltration may be 24 hours or longer, but this depends on the soil permeability and saturation levels.
- Rainfall-Responsive Infiltration is storm water which enters the collection system indirectly through pipe defects, but normally in sewers constructed close to the ground surface such as private laterals. Rainfall-responsive infiltration is independent of the groundwater table and reaches defective sewers via the pipe trench in which the sewer is constructed, particularly if the pipe is placed in impermeable soil and bedded and backfilled with a granular material. In this case, the pipe trench serves as a conduit similar to a French drain, conveying storm drainage to defective joints and other openings in the system. This type of infiltration can have a quick response and graphically can look very similar to inflow.

2.4.3 Impact and Cost of Source Detection and Removal

- **Inflow:**
  - Impact: This component of I/I creates a peak flow problem in the sewer system and often dictates the required capacity of downstream pipes and transport facilities to carry these peak instantaneous flows. Because the response and magnitude of inflow is tied closely to the intensity of the storm event, the short-term peak instantaneous flows may result in surcharging and overflows within a collection system. Severe inflow may result in sewage dilution, resulting in upsetting the biological treatment (secondary treatment) at the treatment facility.
  - Cost of Source Identification and Removal: Inflow locations are usually less difficult to find and less expensive to correct. These sources include direct and indirect cross-connections with storm drainage systems, roof downspouts, and various types of surface drains. Generally, the costs to identify and remove sources of inflow are low compared to potential benefits to public health and safety or the costs of building new facilities to convey and treat the resulting peak flows.

- **Infiltration:**
  - Impact: Infiltration typically creates long-term annual volumetric problems. The major impact is the cost of pumping and treating the additional volume of water, and of paying for treatment (for municipalities that are billed strictly on flow volume).
  - Cost of Source Detection and Removal: Infiltration sources are usually harder to find and more expensive to correct than inflow sources. Infiltration sources include defects in deteriorated sewer pipes or manholes that may be widespread throughout a sanitary sewer system.

2.4.4 Graphical Identification of I/I

Inflow is usually recognized graphically by large-magnitude, short-duration spikes immediately following a rain event. Infiltration is often recognized graphically by a gradual increase in flow after a wet-weather event. The increased flow typically sustains for a period after rainfall has stopped and then gradually drops off as soils become less saturated and as groundwater levels recede to normal levels. Realtime flows were plotted against ADWF to analyze the I/I response to rainfall events. Figure 2-3 illustrates a sample of how this analysis is conducted and some of the measurements that are used to distinguish infiltration and inflow. Similar graphs were generated for the individual flow monitoring sites and can be found in *Appendix A*.

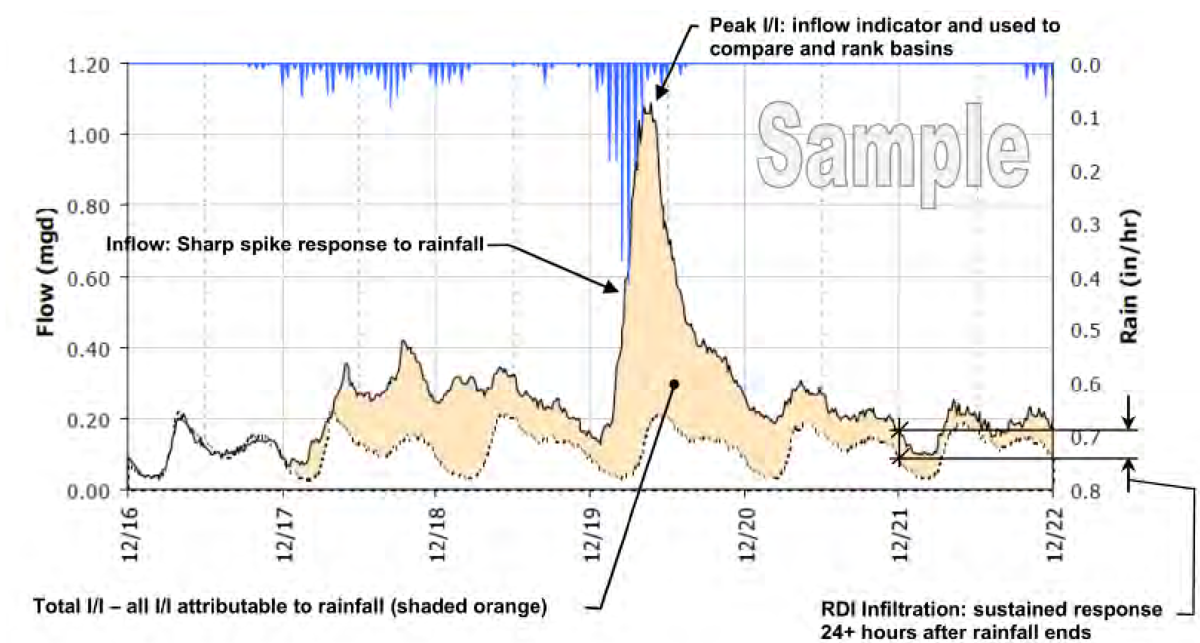


Figure 2-3. Sample Infiltration and Inflow Isolation Graph

Figure 2-4 shows sample graphs indicating the typical graphical response patterns for inflow and infiltration in a more detailed version.

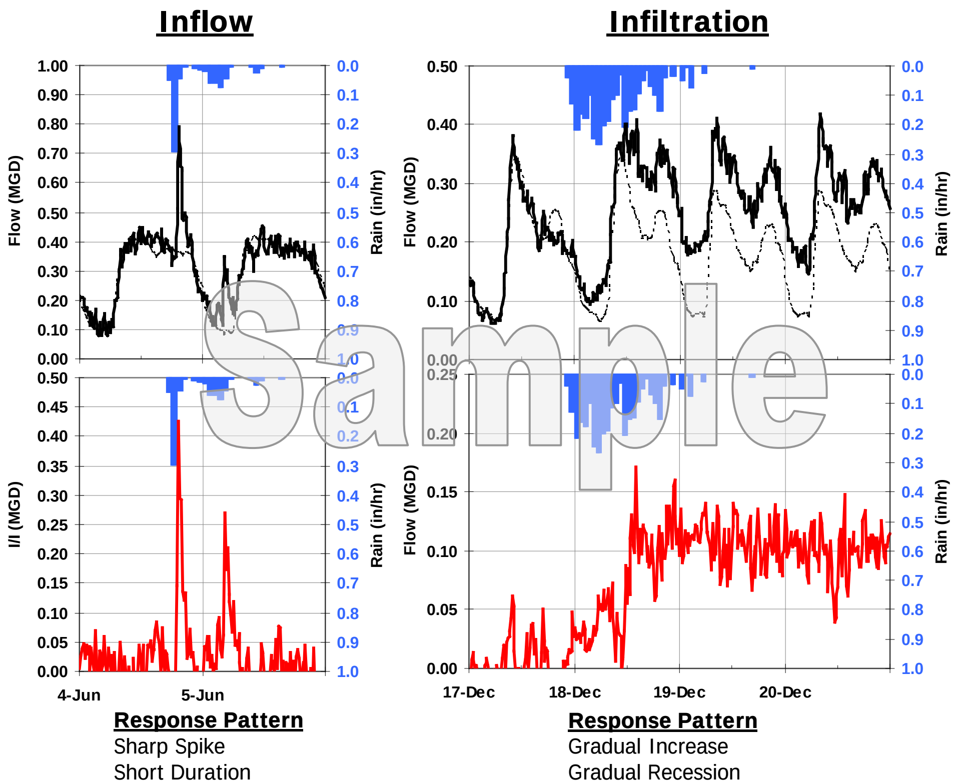


Figure 2-4. Inflow and Infiltration: Graphical Response Patterns

2.4.5 Analysis Methods

In this study, after differentiating I/I flows from ADWF flows, the peak inflow and RDI were normalized to ADWF for an "apples-to-apples" comparison amongst the different sites.

3.0 RESULTS AND ANALYSIS

3.1 Rainfall Monitoring

3.1.1 Flow Study Rainfall Data

The rainfall data was obtained from five locations from Ventura County Watershed Protection District Hydrologic Data Server and the sites are previously listed in Table 1-2 and shown in Figure 1-1.

There were several rainfall events during the flow monitoring period. Two notable rainfall events were defined and selected from all the five locations. For illustration purpose, Figure 3-1 shows the two rainfall events and other small rainfall events recorded at Oxnard Civic Center. The total rainfall over period was 5.24 inches. Rainfall Event 1 and Event 2 are 2.55 inches and 1.70 inches, respectively.

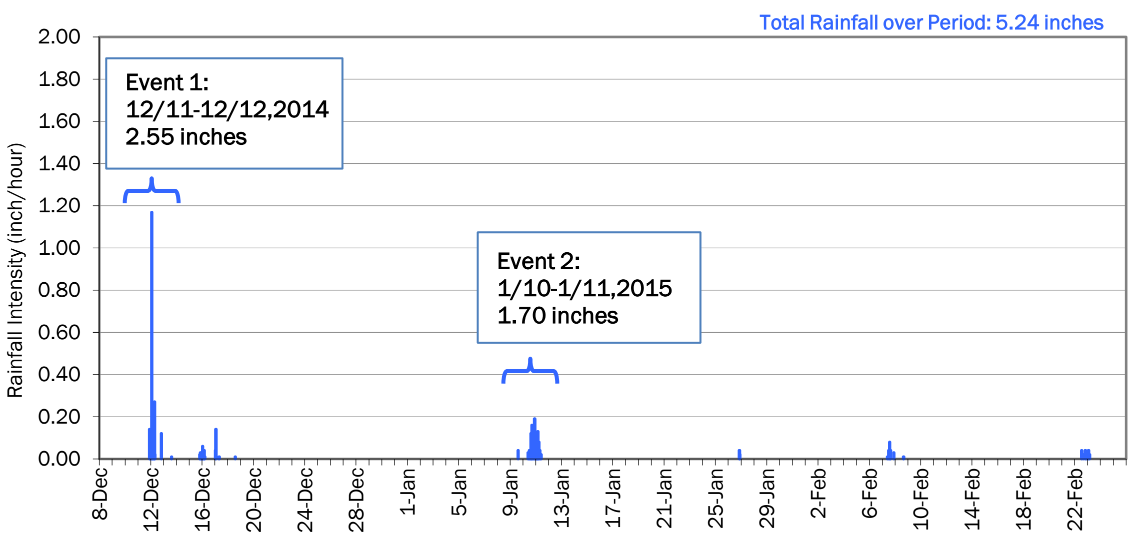


Figure 3-1. Rainfall Events Recorded at Oxnard Civic Center

The rainfall recorded at all the locations are listed in Table 3-1.

Table 3-1. Rainfall Recorded for the Two Rainfall Events

Monitoring Site	Event 1 Precipitation (in.)	Event 2 Precipitation (in.)	Total Precipitation (in.)
Oxnard WWTP	2.10	1.46	4.66
Oxnard Airport	2.10	1.60	4.70
Oxnard Civic Center	2.55	1.70	5.24
El Rio-UWCD Spreading Grounds	1.89	2.11	5.08
Oxnard NWS	2.50	2.26	6.05

Figure 3-2 shows the rainfall accumulation during the monitoring period, as well as the historical average rainfall in the City during this project duration. The historical data was taken from the WRCC (Station 046569 at Oxnard Civic Center[2]). The cumulative precipitation was approximately 38% lower than the historical precipitation for the time period shown.

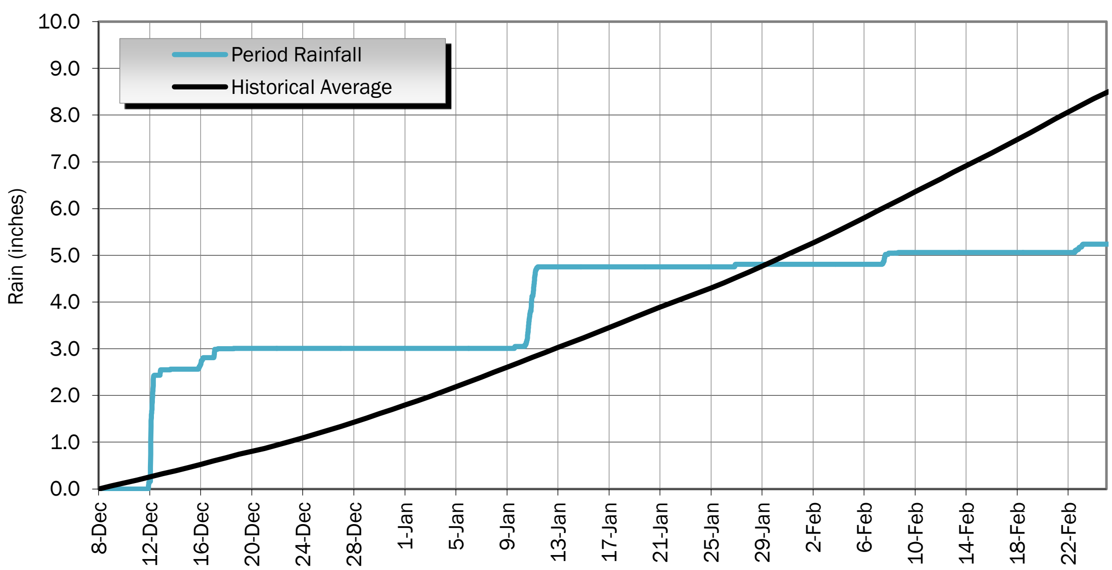


Figure 3-2. Rainfall Accumulation at Oxnard Civic Center

[2] http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?caoxna+sca

3.1.2 Regional Rainfall Event Classification

It is important to classify the relative size of a major storm event that occurs over the course of a flow monitoring period[3]. Rainfall events are classified by intensity and duration. Based on historical data, frequency contour maps for storm events of given intensity and duration have been developed by the NOAA for Southern California (Figure 3-3).

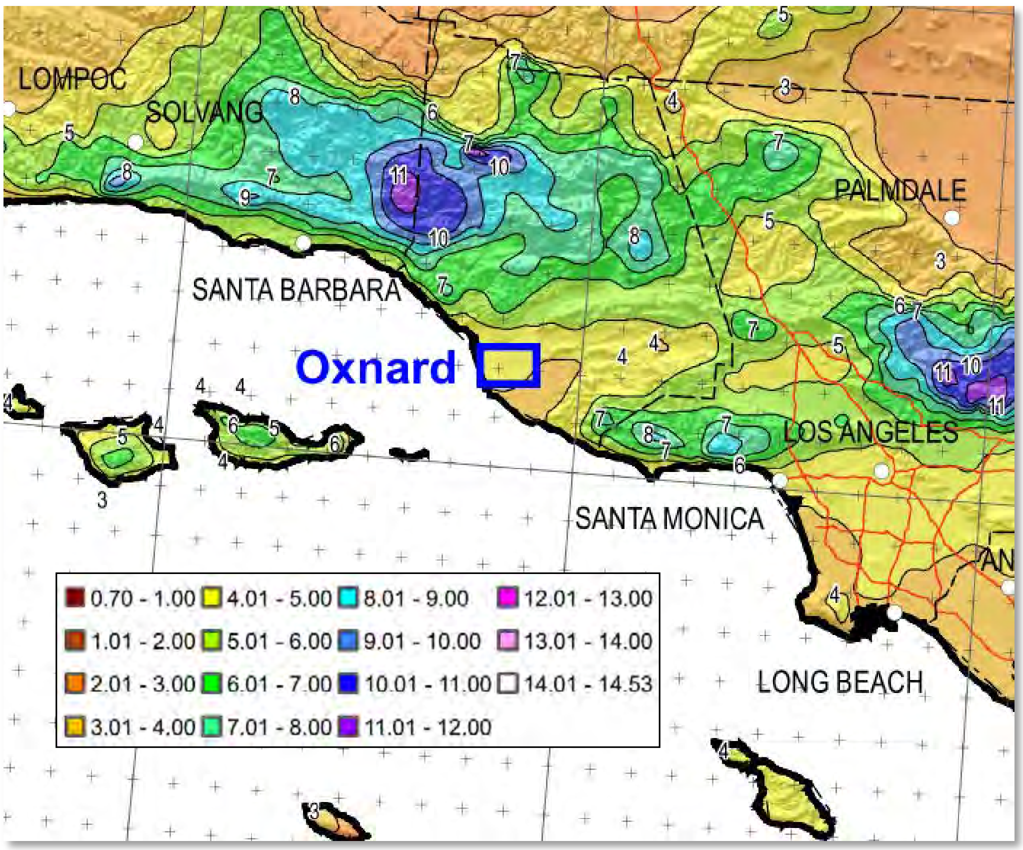


Figure 3-3. NOAA Southern California Rainfall Frequency Map

For example, the NOAA Rainfall Frequency Atlas[4] classifies a 10-year, 24-hour storm event at Oxnard as 4.3 inches. This means that in any given year, at this specific location, there is a 10% chance that 4.3 inches of rain will fall in any 24-hour period.

From the NOAA frequency maps, for a specific latitude and longitude, the rainfall densities for period durations ranging from 5 minutes to 60 days are known for rain events ranging from 1-year to 1000-year intensities. These can be plotted to develop a rain event frequency map specific to each rainfall

[3] Sanitary sewers are often designed to withstand I/I contribution to sanitary flows for specific-sized "design" storm events.
[4] NOAA Western U.S. Precipitation Frequency Maps Atlas 2, 1973: http://www.wrcc.dri.edu/pcpnfreq.html

monitoring site. Superimposing the peak measured densities for the rainfall events on the rain event frequency plot determines the classification of the rainfall event.

Figure 3-4 shows the classification curves for Rainfall Events 1 and 2 at Oxnard Civic Center. It can be seen from the figure that Event 2 was a less than a 1-year event for all durations. Event 1 was greater than a 5-year event for a 6-hour duration. If longer durations are considered, the event was a three-year event for a 12-hour duration and a 1-year event for a 2-day duration.

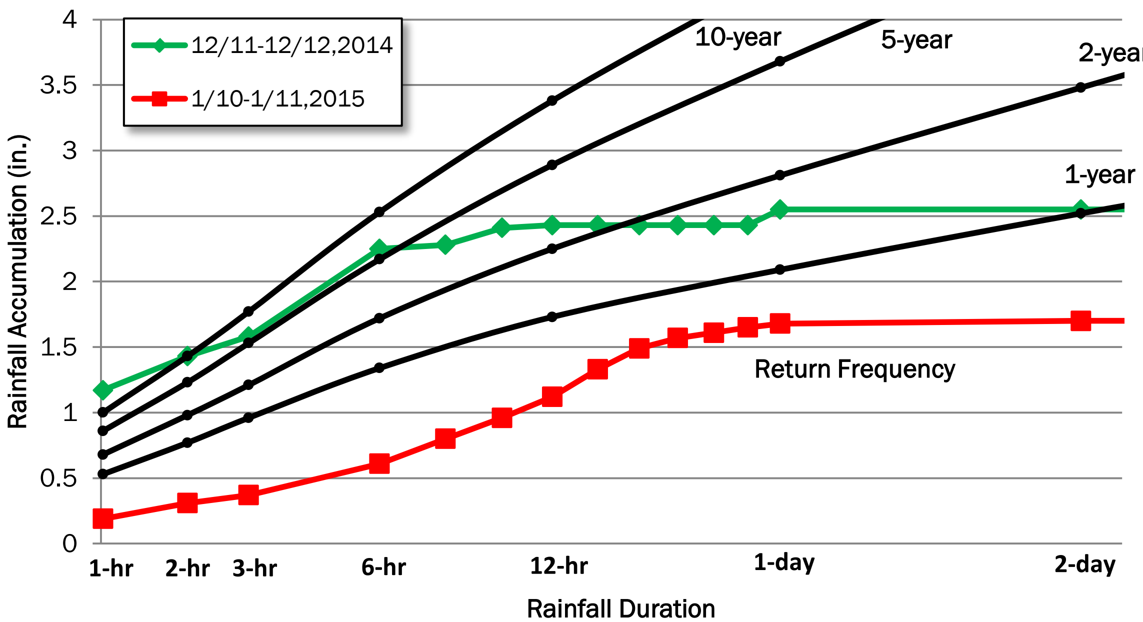


Figure 3-4. Rainfall Event Classification at Oxnard Civic Center

3.2 Flow Monitoring

3.2.1 Baseline Flow Analysis

The baseline flows used in this study to calculate inflow and infiltration were taken from "Dry Days" from January 20 through February 12, 2015 when RDI had the least impact. Similar to the dry weather study, four distinct average dry weather flow curves were established for each site location:

- Mondays – Thursdays
- Fridays
- Saturdays
- Sundays

Flows for many sites differ on Friday evenings compared to Mondays through Thursdays. Starting around 7 pm, the flows are often decreased (compared to Monday through Thursday). Similarly, flow patterns for Saturday and Sunday were also separated due to their unique evening flow pattern. This type of differentiation can be important when determining I/I response, especially if a rain event occurs on a Friday, Saturday or Sunday evening.

Figure 3-5 illustrates a sample of varying flow patterns within a typical dry week. Graphs of the ADWF (called *Baseline* in this study) flow patterns for each site can be found in *Appendix A*.

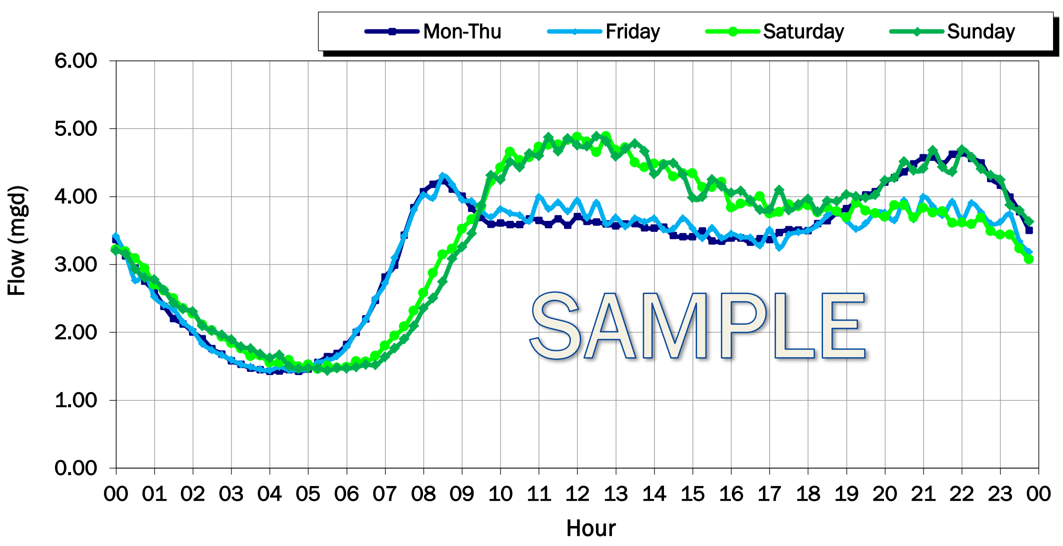


Figure 3-5. Sample ADWF Diurnal Flow Patterns

The overall average dry weather flow (ADWF) was calculated per the following equation:

$$ADWF = \left(ADWF_{Mon-Thu} \times \frac{4}{7}\right) + \left(ADWF_{Fri} \times \frac{1}{7}\right) + \left(ADWF_{Sat} \times \frac{1}{7}\right) + \left(ADWF_{Sun} \times \frac{1}{7}\right),$$

Table 3-2 summarizes the baseline flow data measured during this study. The baseline flows compare well with the dry weather study except Site 2 and Site 4.

- **Site 2:** The flow patterns measured at this site are not indicative of residential flow contribution, but more industrial or retail flows. If the service area is mostly industrial, then flows may be expected to be sporadic.

  Both level and velocity dropped on January 17, 2015 but the general hydraulic condition stayed consistent and diagnostic and calibration data confirm the drop in flows to be correct. V&A believes the data submitted for both the dry weather and wet weather studies to be reliable data.

  V&A took care to consider the relative baseline flows at the time of the storm events when running the I/I analysis for this site.

- **Site 4A:** Site 4, which was monitored during the dry weather study, had inconsistent hydraulics, showing strange backflow conditions. No evidence of backflow was found during the wet weather study. Additionally Site 4 had turbulent conditions and was not an ideal site to capture accurate flow monitoring data. V&A consulted with the City and a decision was made to relocate Site 4 to a location with suitable hydraulic conditions to ensure data accuracy and repeatability. Data from Site 4 from the dry weather study is considered invalid. An additional meter was installed one manhole upstream from Site 4, labeled "Site 4A".

Table 3-2. Baseline Flow Summary

Monitoring Site	Sediment (in.)	Monday-Thursday ADWF (mgd)	Friday ADWF (mgd)	Saturday ADWF (mgd)	Sunday ADWF (mgd)	Overall ADWF (mgd)	Dry Weather ADWF (mgd)
Site 1	4	5.005	4.814	4.510	4.417	4.823	5.142
Site 2	-	2.262	2.316	2.145	1.844	2.194	2.702
Site 3	-	6.828	6.695	7.440	7.465	6.988	7.134
Site 4A	4	3.131	2.978	3.219	3.351	3.153	4.301
Site 5	-	1.509	1.448	1.216	1.157	1.408	1.341
Site 6	-	1.264	1.232	1.034	1.054	1.197	1.351
Site 7	-	0.332	0.327	0.336	0.342	0.333	0.311
Site 8	-	1.647	1.509	1.660	1.704	1.638	1.840
Site 9	-	2.299	2.216	2.329	2.402	2.306	2.041
Site 10	-	2.077	2.085	2.198	2.301	2.128	1.913

3.2.2 Peak Measured Flows and Pipeline Capacity Analysis

Peak measured flows and the flow level (depth) at peak flow times are important factors to consider in order to understand the capacity of the flow monitoring system. The peak flows and flow levels reported are from the peak measurements taken across the entirety of the flow monitoring period and may or may not correspond to a simultaneous event for all sites. There were several instances of backflow conditions due to capacity constraints and the inability of the local collection system to handle peak wet weather flows.

The following capacity analysis terms are defined as follows:

- d/D Ratio: The d/D ratio is the peak measured depth of flow (d) divided by the pipe diameter (D). A d/D ratio of 0.75 is a common maximum threshold value used for pipe design. The d/D ratio for each site was computed based on the maximum depth of flow for the flow monitoring study.
- Peaking Factor: Peaking factor is defined as the peak measured flow divided by the average dry weather flow (ADWF). A peaking factor threshold value of 3.0 is commonly used for sanitary sewer design; however, it is noted that this value is variable and subject to attenuation (see previous section) and the size of the upstream collector area. The District should follow its own standards and criteria when examining peaking factors.

Table 3-3 summarizes the peak recorded flows, levels, *d/D* ratios, and peaking factors per site during the flow monitoring period. Capacity analysis data is presented on a site-by-site basis and represents the hydraulic conditions only at the point site locations. Hydraulic conditions in other areas of the collection system will differ.

Table 3-3. Capacity Analysis Summary

Site	ADWF (mgd)	Peak Measured Flow (mgd)	Peaking Factor	Diameter (in)	Peak Level (in)	*d/D* Ratio	Level Surcharged above Crown (ft)
Site 1	4.823	8.312	1.7	41.5	20.0	0.48	-
Site 2	2.194	6.002	2.7	36	21.2	0.59	-
Site 3	6.988	14.352	2.1	60	24.1	0.40	-
Site 4A	3.153	5.729	1.8	33	23.1	0.70	-
Site 5	1.408	3.074	2.2	36	13.5	0.37	-
Site 6	1.197	2.292	1.9	24	11.0	0.46	-
Site 7	0.333	0.620	1.9	24	5.9	0.25	-
Site 8	1.638	4.540	2.8	27	15.5	0.57	-
Site 9	2.306	4.053	1.8	42	9.5	0.23	-
Site 10	2.128	4.024	1.9	37	14.9	0.40	-

The following capacity analysis results are noted:

- d/D Ratio: All sites had d/D ratios lower than the typical design threshold. No surcharging was found.
- Peaking Factor: All sites had peaking factors lower than the typical design threshold limits

Figure 3-6 and Figure 3-7 summarizes the site-by-site d/D ratios and peaking factors, respectively in descending order.

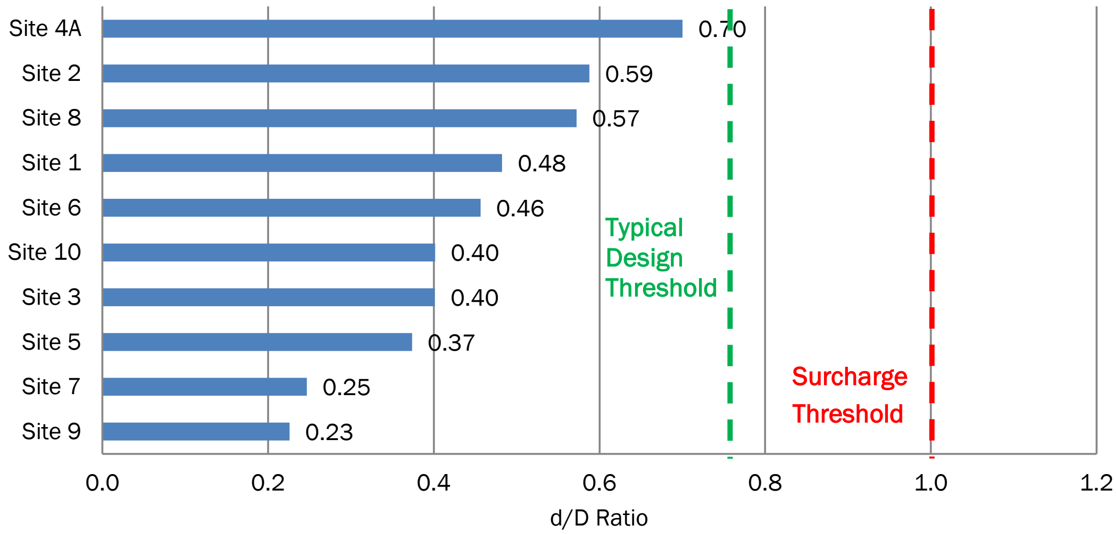


Figure 3-6. Capacity Summary: d/D Ratios

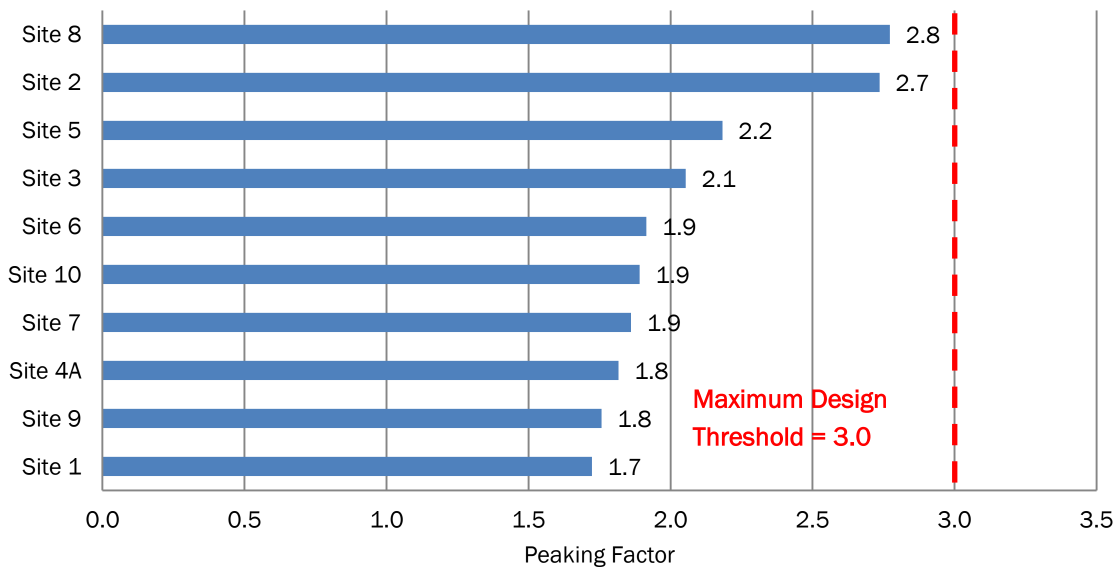


Figure 3-7. Capacity Summary: Peaking Factors

3.3 Inflow and Infiltration: Results

3.3.1 Inflow Results Summary

Inflow is storm water discharged into the sewer system through direct connections such as downspouts, area drains, cross-connections to catch basins, etc. These sources transport rain water directly into the sewer system and the corresponding flow rates are tied closely to the intensity of the storm. This component of I/I often causes a peak flow problem in the sewer system and often dictates the required capacity of downstream pipes and transport facilities to carry these peak instantaneous flows.

Inflow results were taken from Rainfall Event 1 (December 11 to 12, 2014). This is because this rainfall event is the most intensive short-term rainfall event. Table 3-4 summarizes the peak measured I/I flows and inflow analysis results for the storm events that occurred during the monitoring period.

Table 3-4. Inflow Analysis Summary

Monitoring Site	ADWF (mgd)	Peak I/I Rate (mgd)	Peak I/I per ADWF
Site 1	4.823	3.468	0.7
Site 2	2.194	3.242	1.5
Site 3	6.988	5.545	0.8
Site 4A	3.153	4.512	1.4
Site 5	1.408	2.044	1.5
Site 6	1.197	1.081	0.9
Site 7	0.333	0.248	0.7
Site 8	1.638	3.725	2.3
Site 9	2.306	1.884	0.8
Site 10	2.128	1.052	0.5

Figure 3-8 shows the summary of the inflow analysis in descending order. Site 8 had the highest Peak I/I per ADWF of 2.3. The other sites had ratios of 1.5 or less.

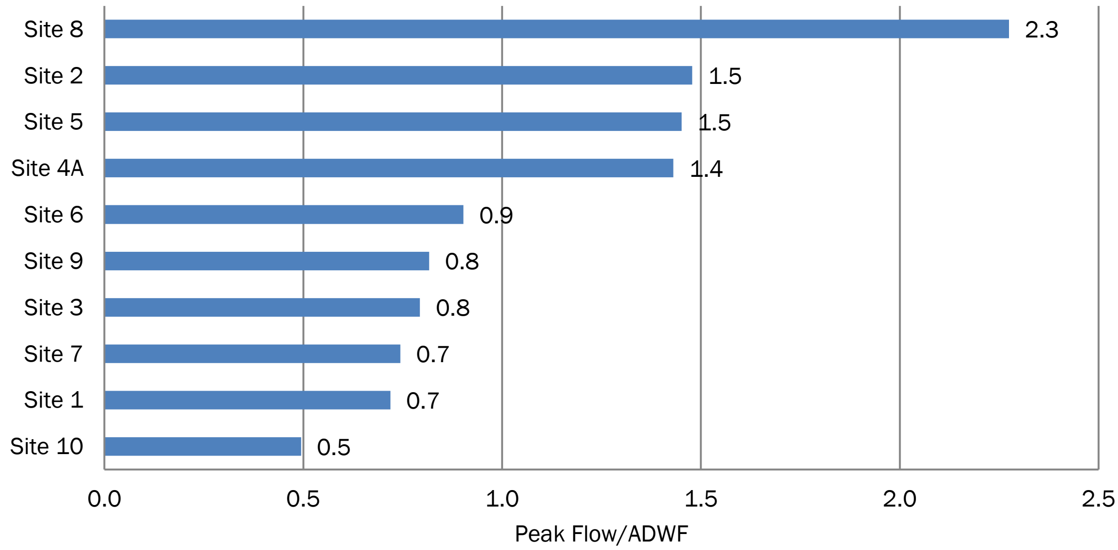


Figure 3-8. Inflow Analysis Summary – Peak I/I to ADWF

3.3.2 Infiltration Results Summary

Infiltration is defined as water entering the sanitary sewer system through defects in pipes, pipe joints, and manhole walls, which may include cracks, offset joints, root intrusion points, and broken pipes. Increased flows into the sanitary sewer system are usually tied to groundwater levels and soil saturation levels. Infiltration sources transport rain water into the system *indirectly*; flow levels in the sanitary system increase gradually, are typically sustained for a period after rainfall has stopped, and then gradually decrease as soils become less saturated and as groundwater levels recede to normal. Infiltration typically creates long-term annual volumetric problems. The major impact is the cost of pumping and treating the additional volume of water, and of paying for treatment (for municipalities that are billed strictly on flow volume).

The rain dependent infiltration rates for the monitoring sites in Oxnard were minimal or negligible and an RDI analysis could not be performed. For example, Figure 3-9 illustrates this I/I response graphic for Site 4 for Event 2. RDI analysis would typically be run 24-hours after the conclusion of the rainfall event; however, within 8 hours or so, the flow rates had returned to baseline levels. This was typical for all of the monitoring sites. For this study, rain dependent infiltration was considered negligible; generally, rain dependent infiltration does not appear to be an issue within the collection system.

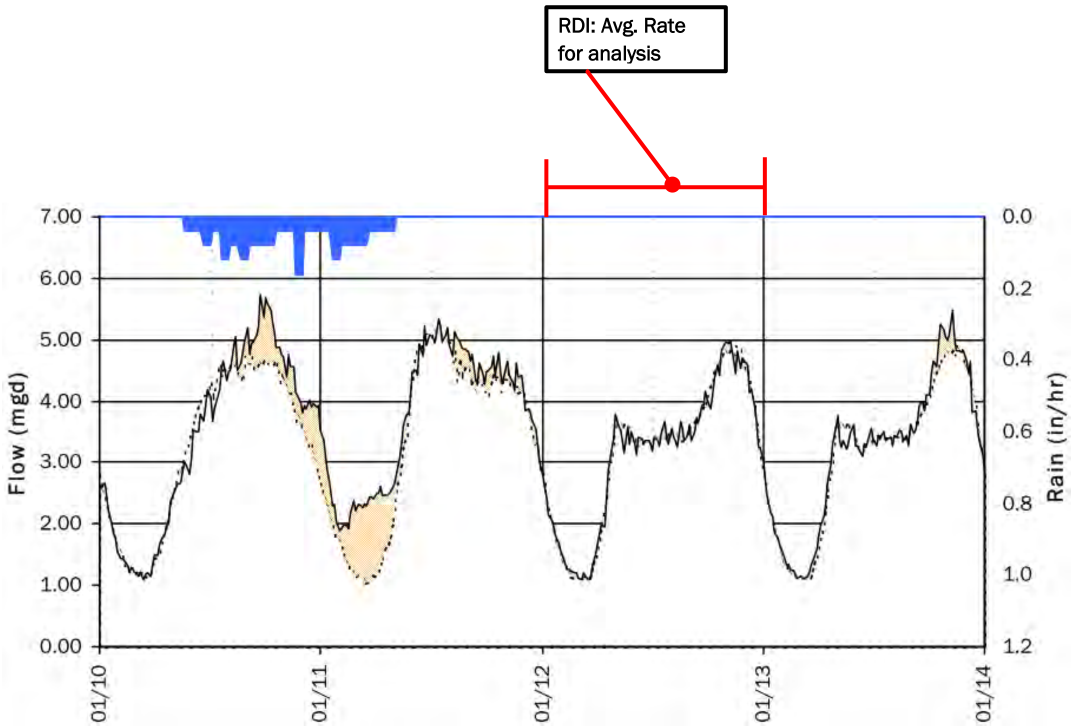


Figure 3-9. RDI Measurement, Site 1

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

The flow monitoring and I/I analyses show that:

3. **Inflow and Infiltration:** Most of the I/I within the collection system comes from INFLOW. There was negligible rain dependent infiltration observed during this flow monitoring study.
4. **Capacity:** The capacity analysis in this study shows that the sewer system is in good condition on a capacity basis during this monitoring study.

4.2 Recommendations

V&A advises that future I/I reduction plans consider the following recommendations if I/I is a concern to the City:

4. **Determine I/I Reduction Program:** The City should examine its I/I reduction needs to determine their strategy and goals for a future I/I reduction program.
    a. If peak flows, sanitary sewer overflows, and pipeline capacity issues are of greater concern, then priority can be given to investigate and reduce sources of inflow within the basins with the higher inflow/ADWF ratios. This would appear to be the greatest concern for the City collection system.
    b. If infiltration and general pipeline deterioration are of greater concern, then the program can be weighted to investigate and reduce sources of infiltration within the basins with the higher RDI/ADWF ratios. Infiltration does not appear to be an issues for the City collection system.
5. **I/I Investigation Methods:** Potential I/I investigation methods include the following:
    a. smoke testing
    b. mini-basin flow monitoring
    c. CCTV inspection
6. **I/I Reduction Cost Effective Analysis:** The City should conduct a study to determine which is more cost-effective: (1) locating the sources of inflow/infiltration and systematically rehabilitating or replacing the faulty pipelines; or (2) continued treatment of the additional rainfall dependent I/I flow.

APPENDIX A. FLOW MONITORING SITES: DATA, GRAPHS, INFORMATION

City of Oxnard

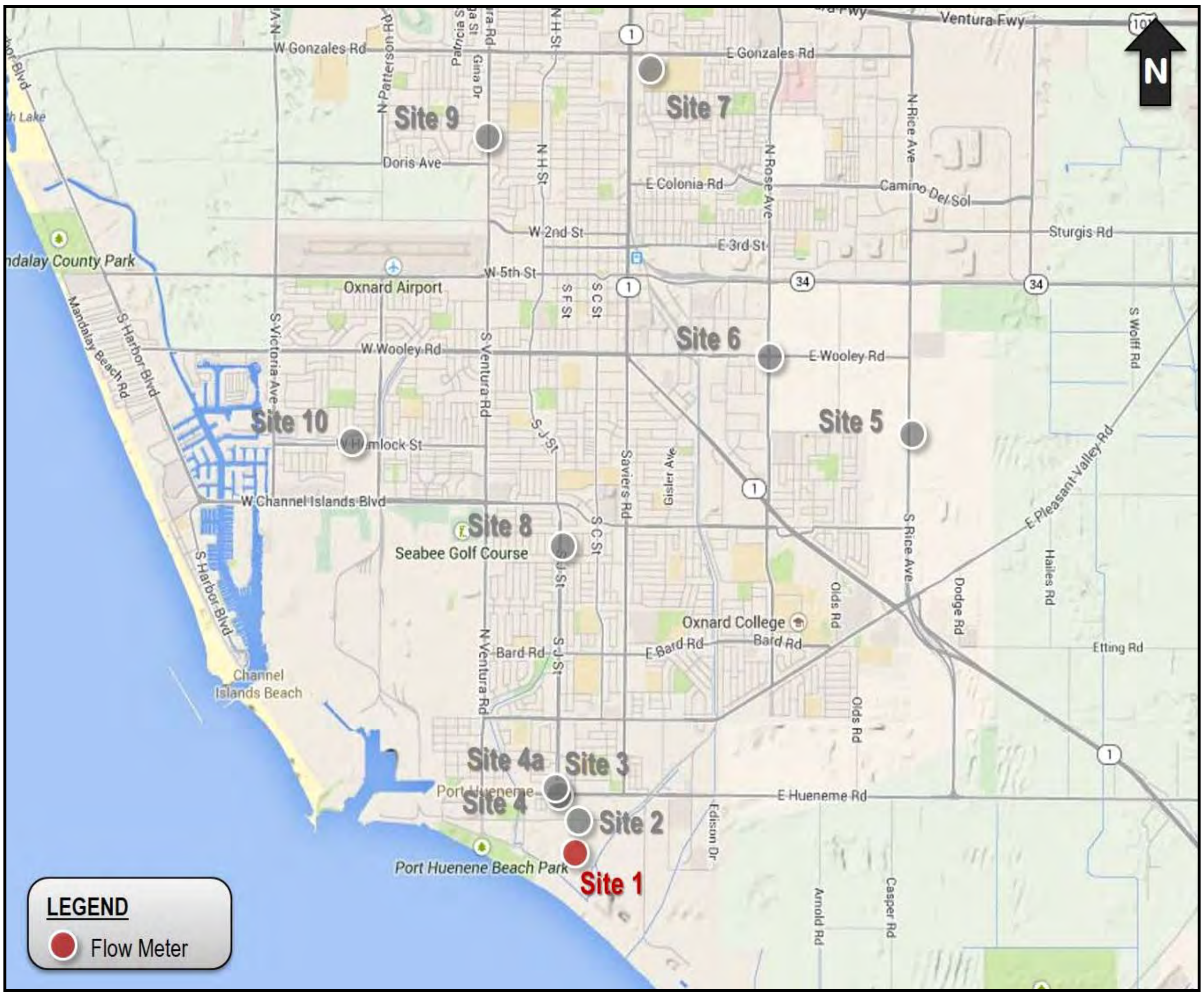
Sanitary Sewer Flow Monitoring

Temporary Monitoring: December, 2014 through February, 2015

Monitoring Site: Site 1

Location: McWane Boulevard, east of Perkins Road

Data Summary Report



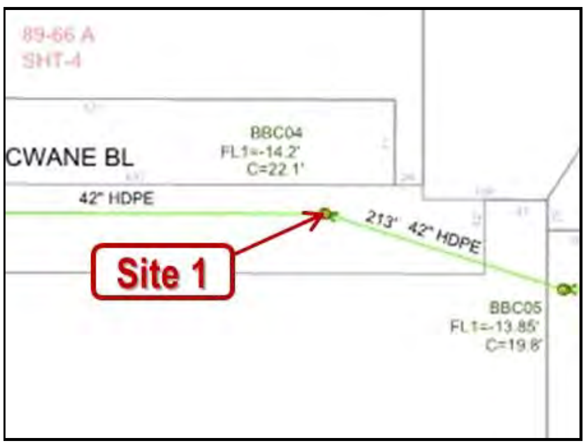
Vicinity Map: Site 1

SITE 1

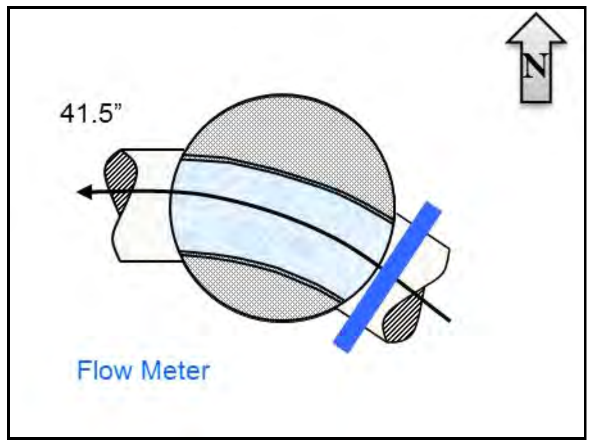
Site Information

Location:	McWane Boulevard, east of Perkins Road
Coordinates:	119.1833° W, 34.1401° N
Rim Elevation:	10 feet
Pipe Diameter:	41.5 inches
Baseline Flow:	4.823 mgd
Peak Measured Flow:	8.312 mgd

Satellite Map



Sanitary Map



Flow Diagram

Street View

Plan View

SITE 1

Additional Site Photos

Effluent Pipe

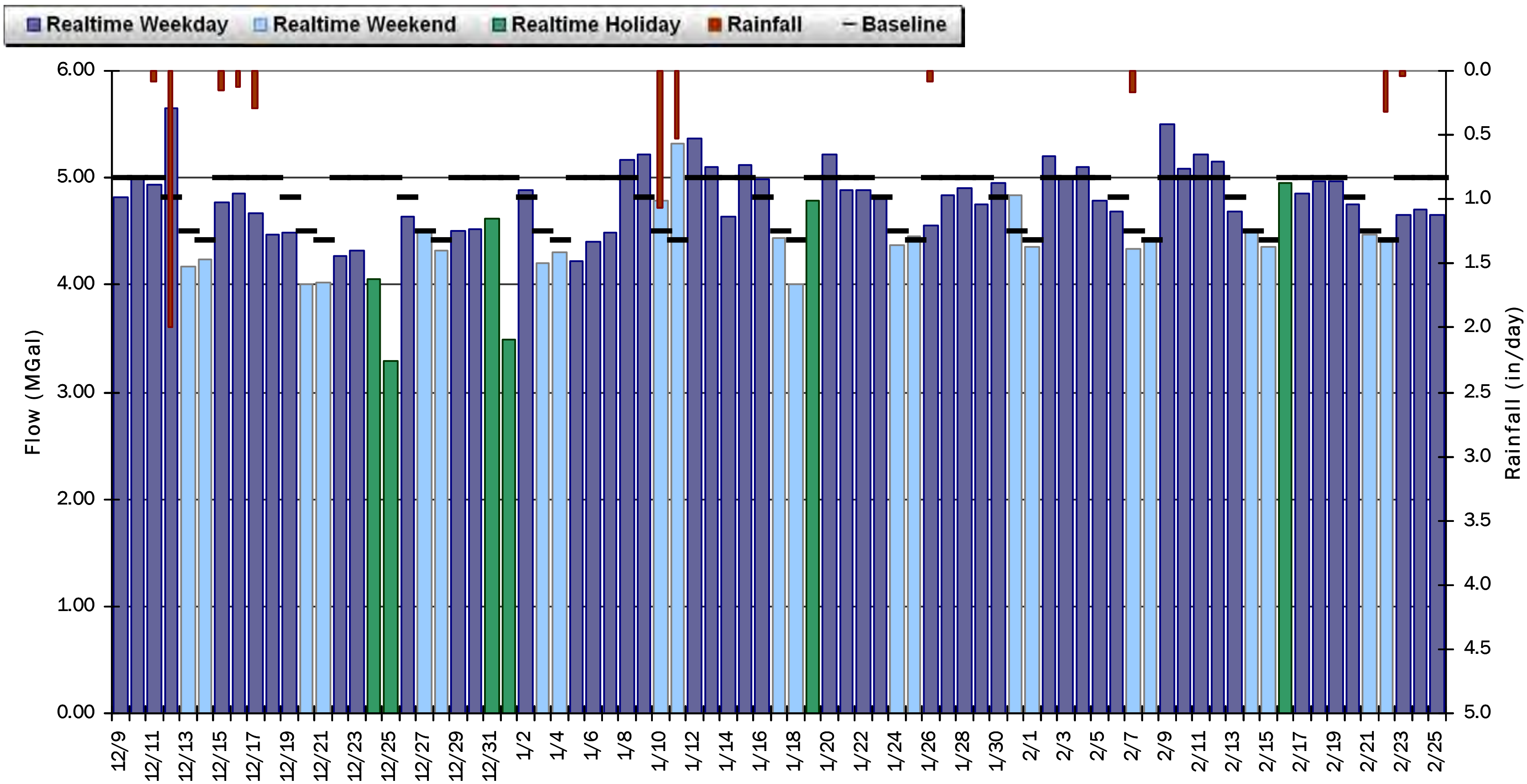
Influent Pipe

SITE 1

Period Flow Summary: Daily Flow Totals

Avg Period Flow: 4.675 MGal **Peak Daily Flow: 5.646 MGal** **Min Daily Flow: 3.287 MGal**

Total Period Rainfall: 4.84 inches

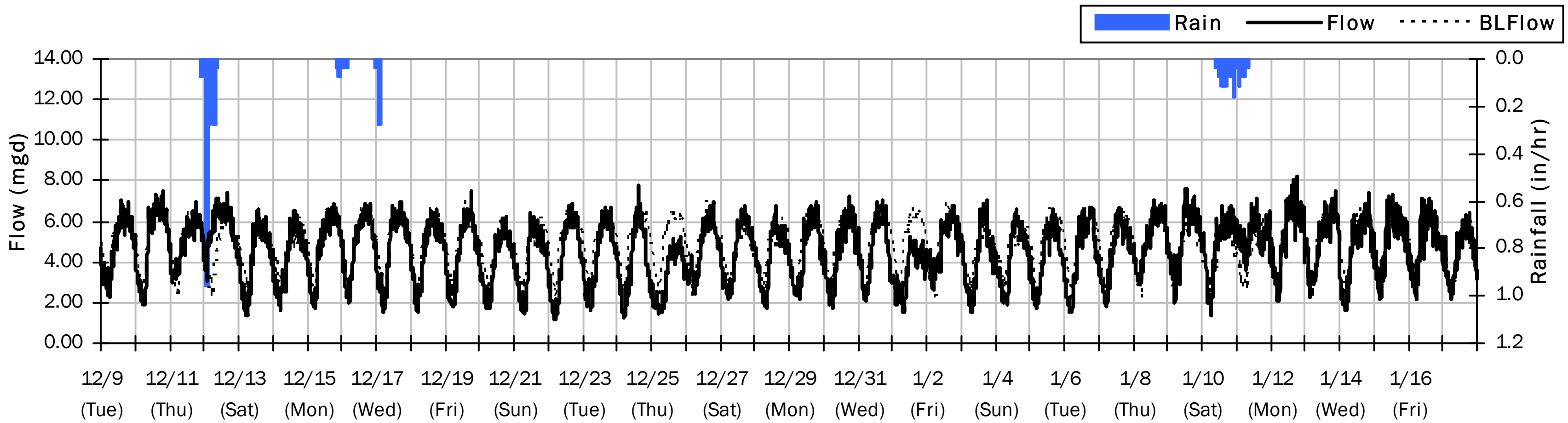


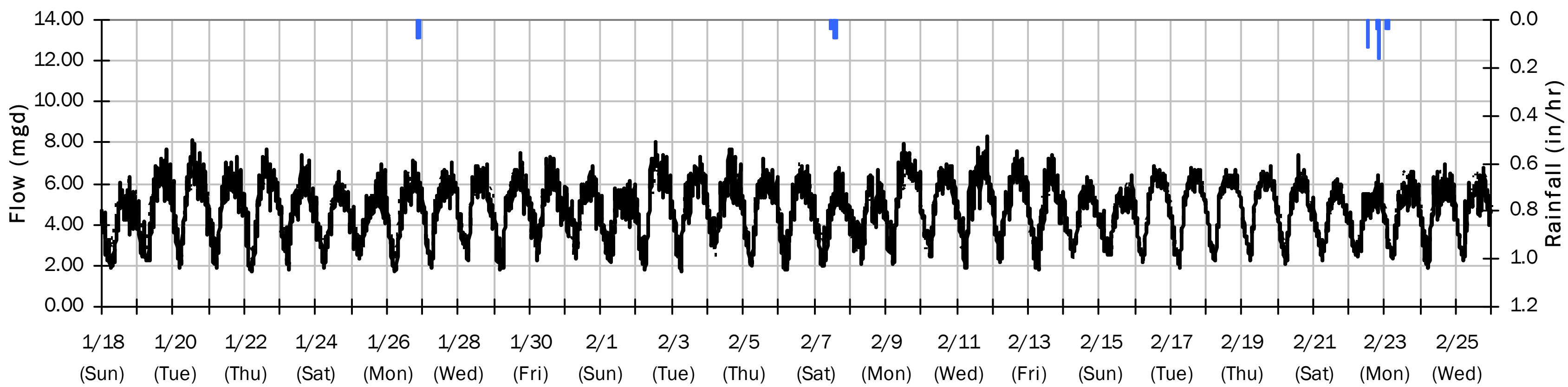
SITE 1

Flow Summary: 12/9/2014 to 2/25/2015

Total Period Rainfall: 4.84 inches

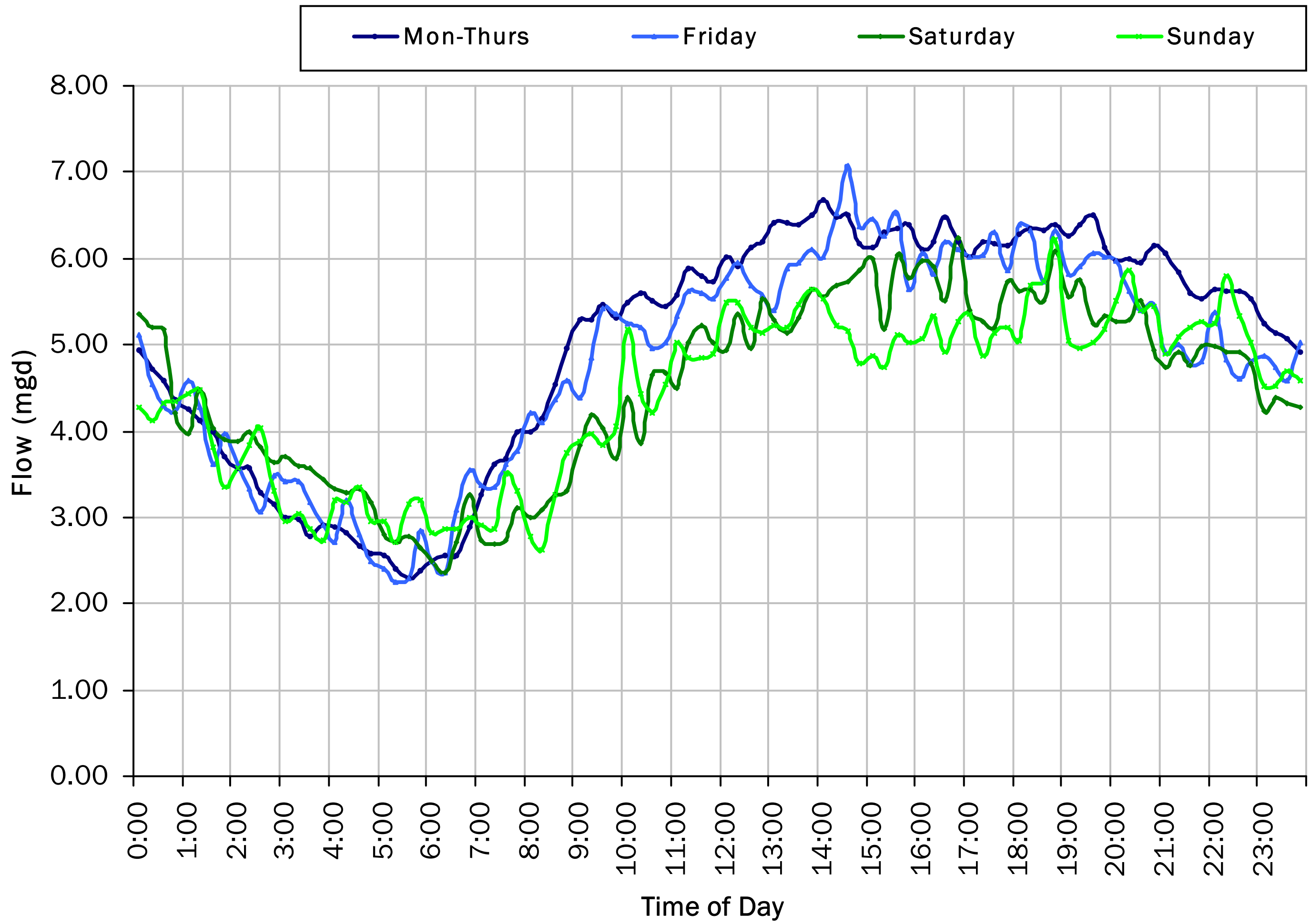
Avg Flow: 4.675 mgd Peak Flow: 8.312 mgd Min Flow: 1.176 mgd





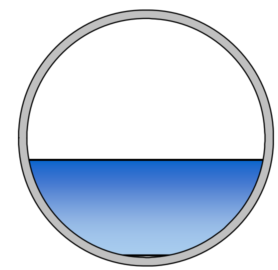
SITE 1

Baseline Flow Hydrographs



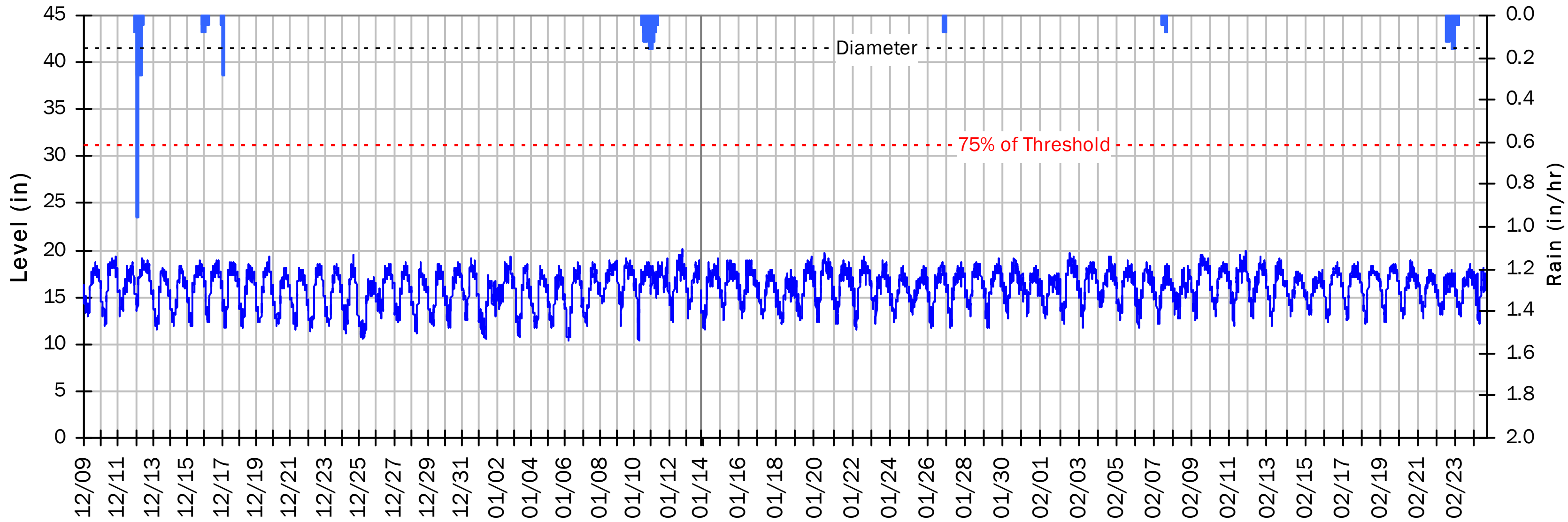
Baseline Flow:

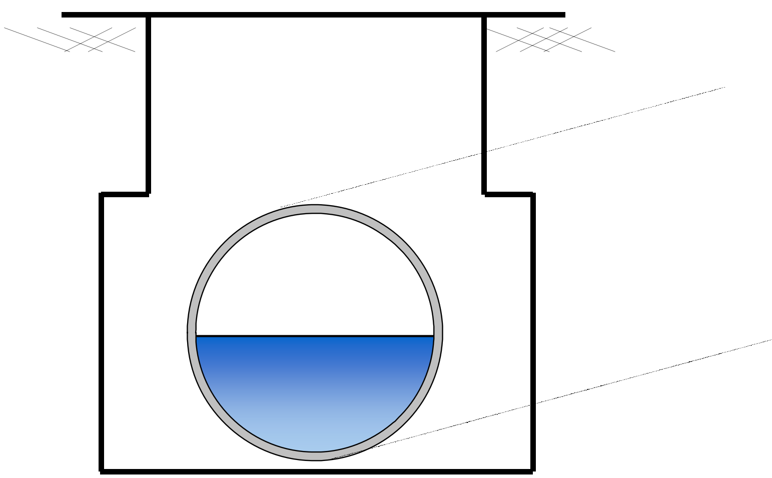
4.82 *mgd*



SITE 1
Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Monitoring Period

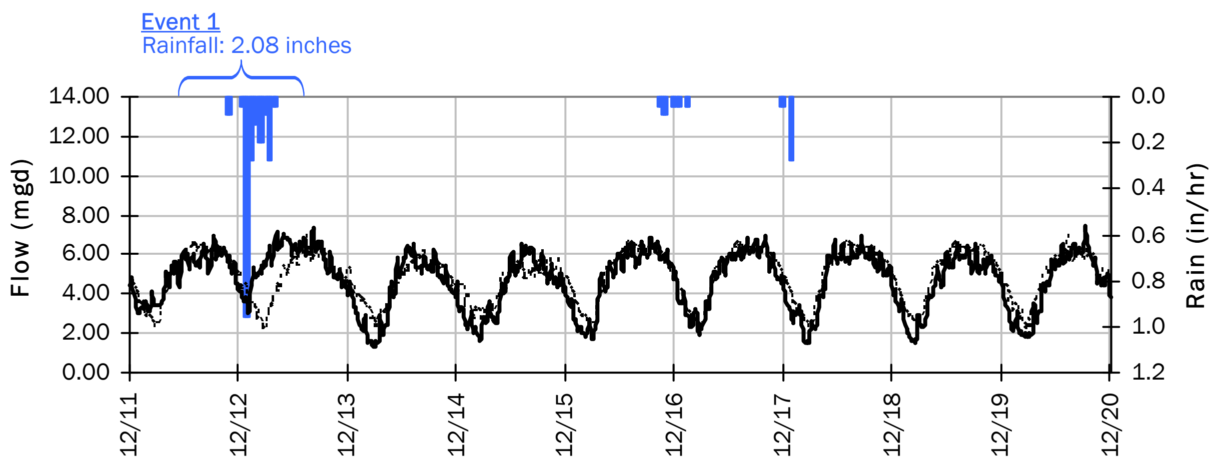




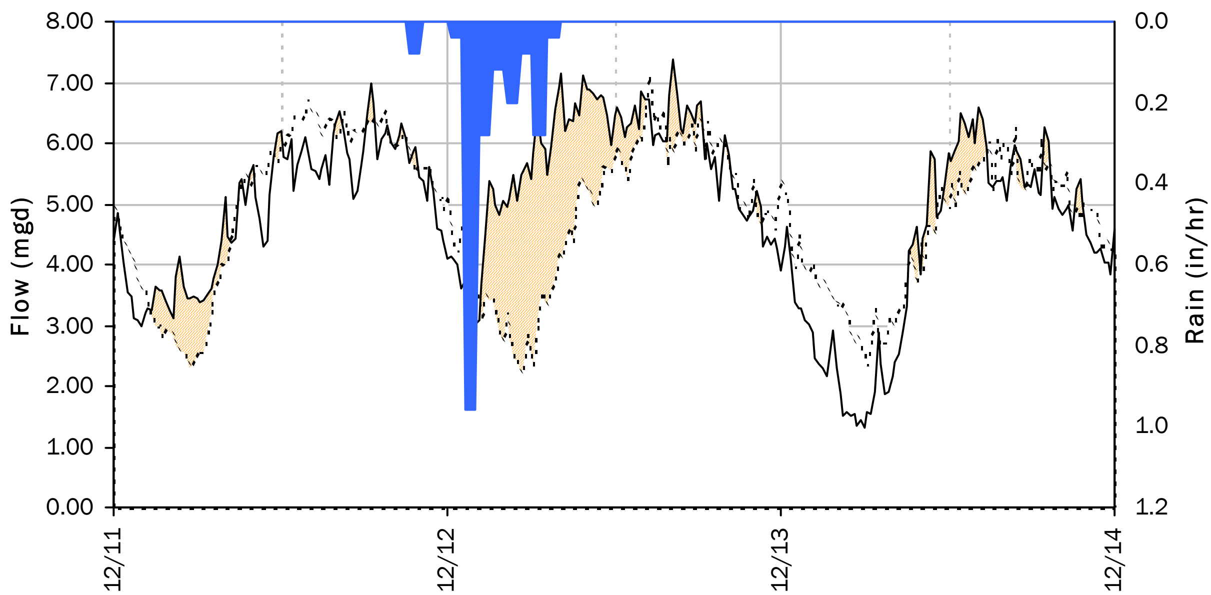
Pipe Diameter:	41.5 *inches*
Peak Measured Level:	20.0 *inches*
Peak d/D Ratio:	0.48

SITE 1
I/I Summary: Event 1

Baseline and Realtime Flows with Rainfall Data over Monitoring Period



Event 1 Detail Graph

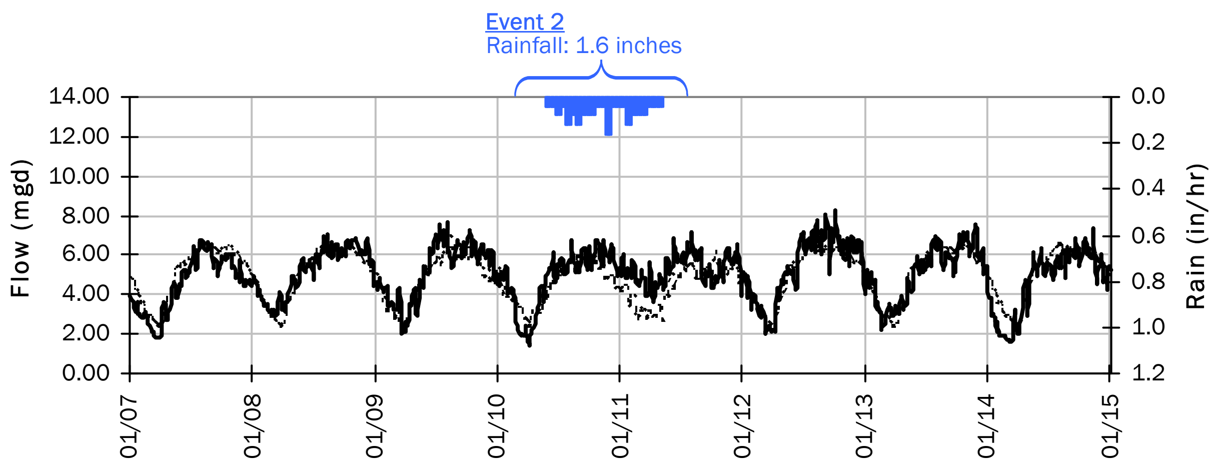


Storm Event I/I Analysis (Rain = 2.08 inches)

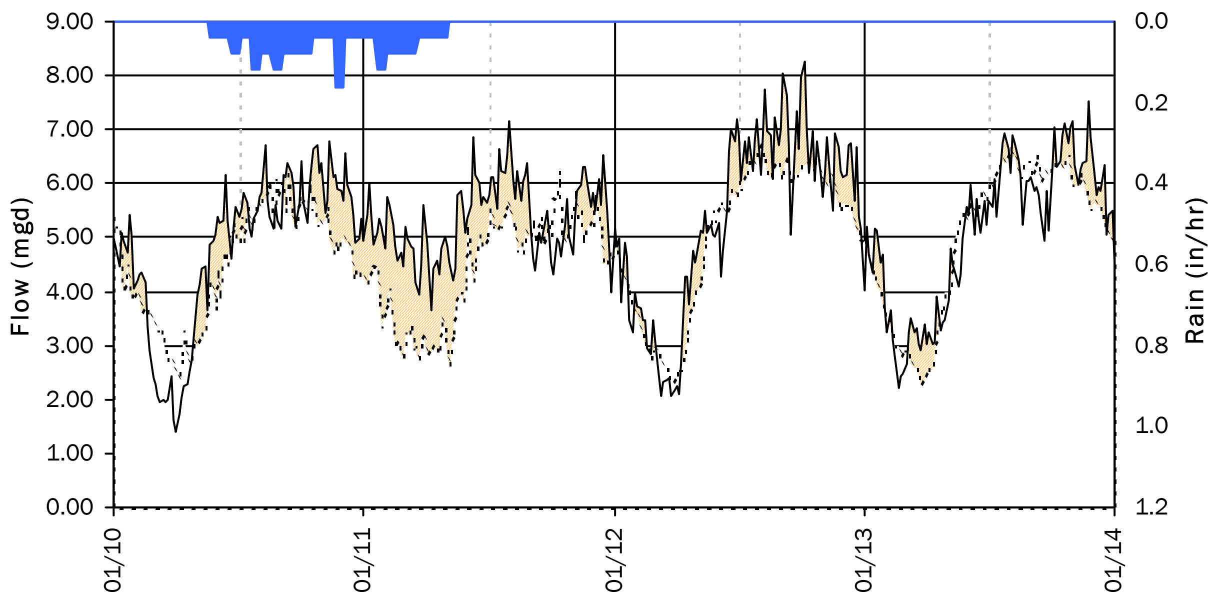
Capacity		Inflow / Infiltration	
Peak Flow:	7.38 *mgd*	Peak I/I Rate:	3.47 *mgd*
PF:	1.53	Total I/I:	474,000 *gallons*
Peak Level:	19.20 *in*		
d/D Ratio:	0.46		

SITE 1
I/I Summary: Event 2

Baseline and Realtime Flows with Rainfall Data over Monitoring Period



Event 2 Detail Graph



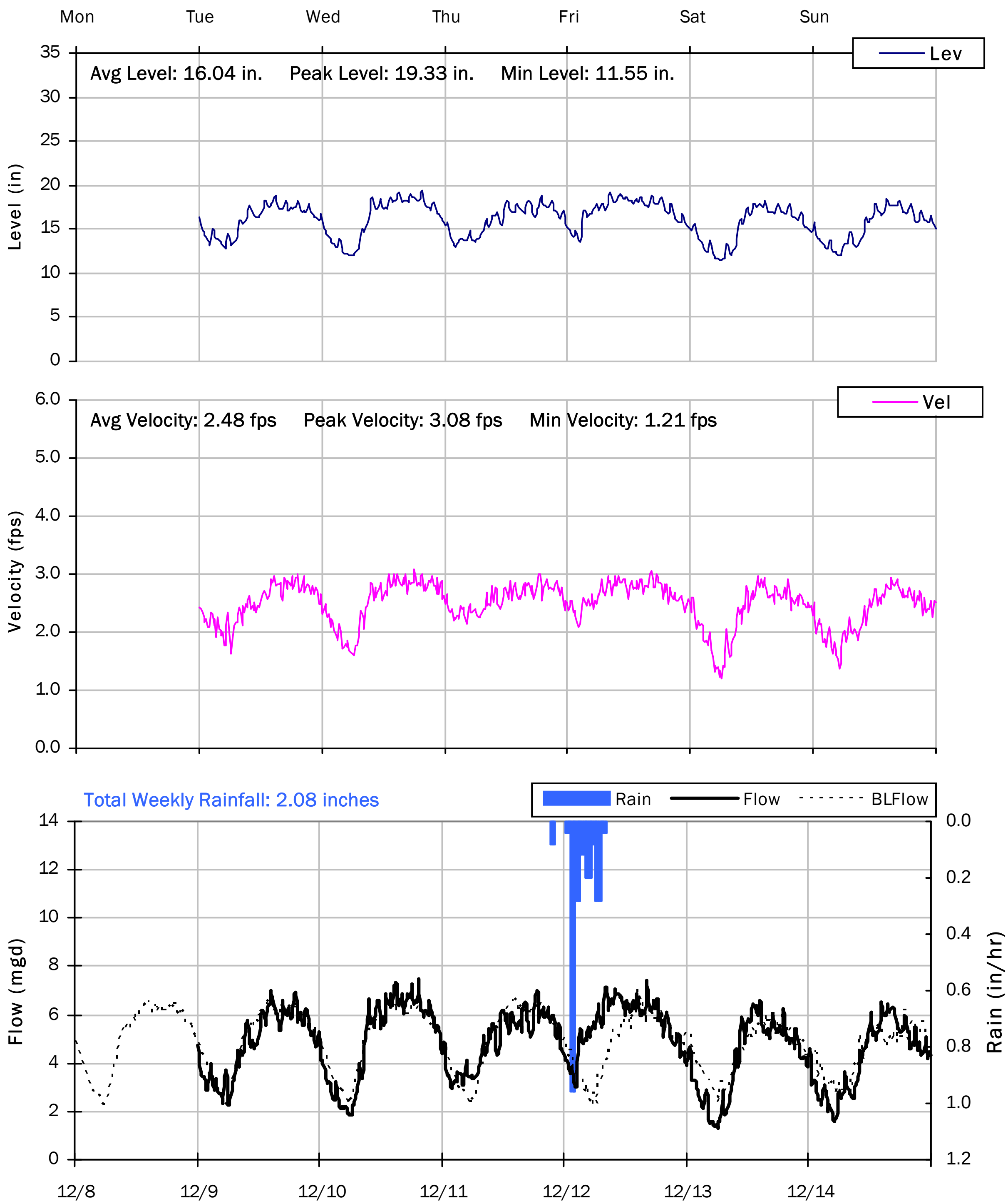
Storm Event I/I Analysis (Rain = 1.60 inches)

Capacity		Inflow / Infiltration	
Peak Flow:	8.26 *mgd*	Peak I/I Rate:	2.64 *mgd*
PF:	1.71	Total I/I:	1,543,000 *gallons*
Peak Level:	20.02 *in*		
d/D Ratio:	0.48		

SITE 1

Weekly Level, Velocity and Flow Hydrographs

12/8/2014 to 12/15/2014

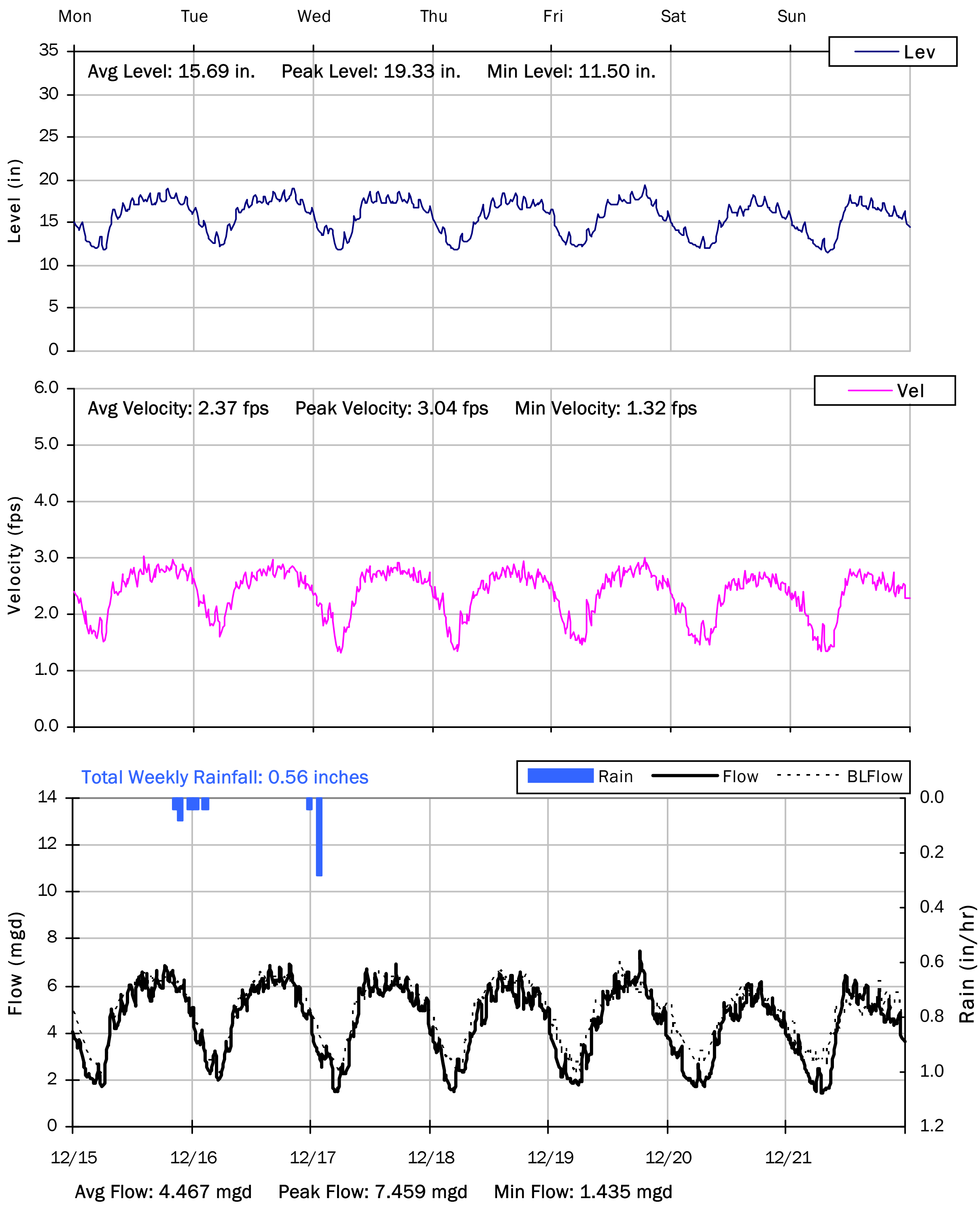


Avg Flow: 4.805 mgd Peak Flow: 7.480 mgd Min Flow: 1.319 mgd

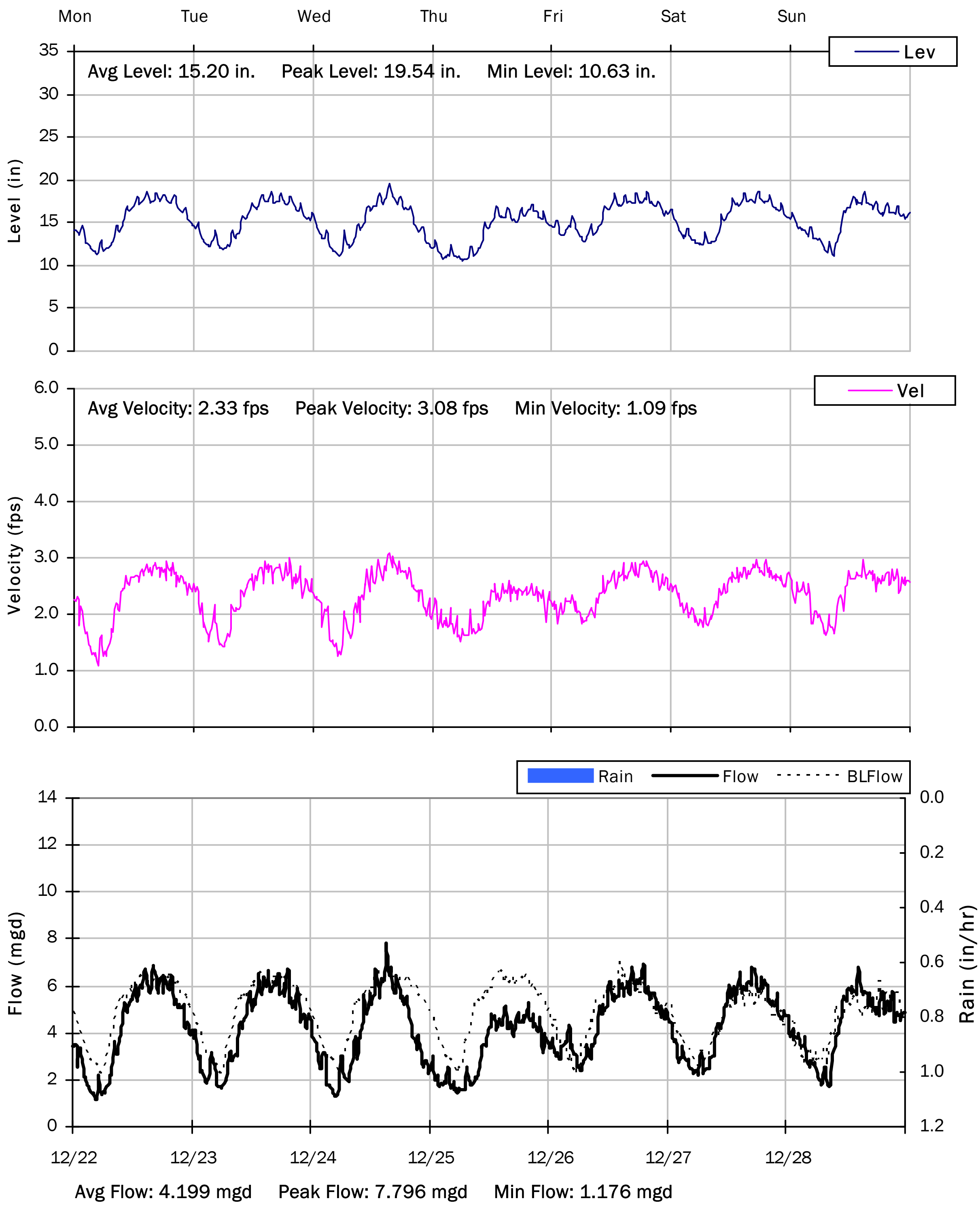
SITE 1

Weekly Level, Velocity and Flow Hydrographs

12/15/2014 to 12/22/2014



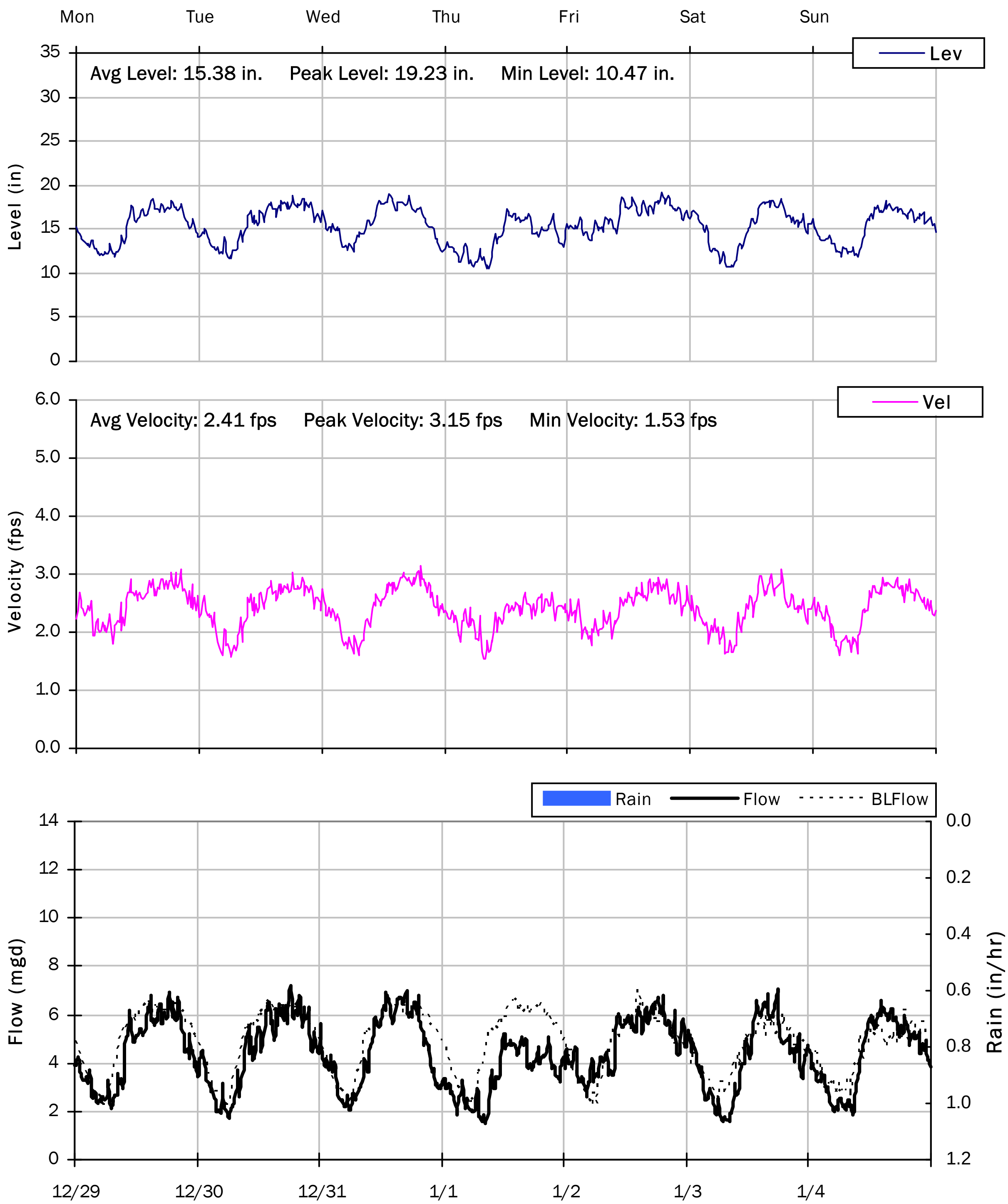
SITE 1
Weekly Level, Velocity and Flow Hydrographs
12/22/2014 to 12/29/2014



SITE 1

Weekly Level, Velocity and Flow Hydrographs

12/29/2014 to 1/5/2015

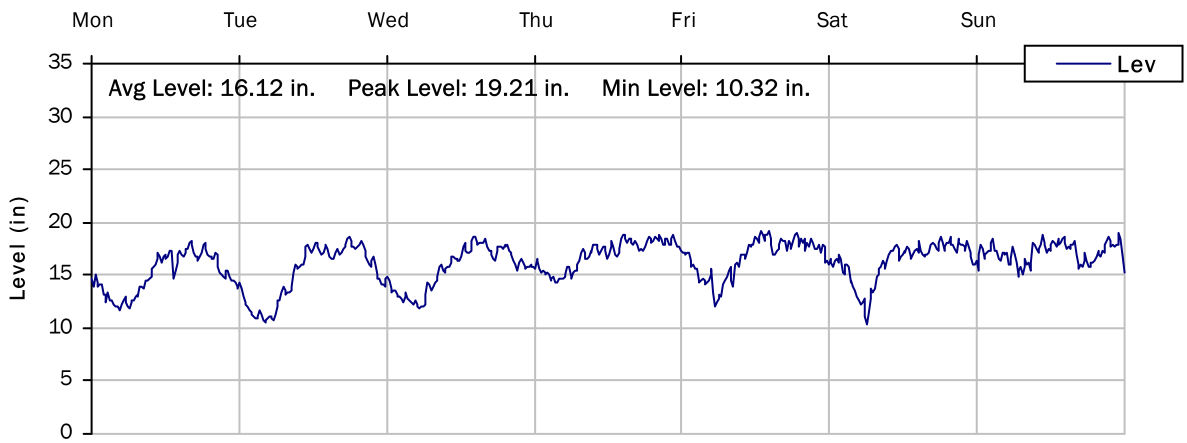


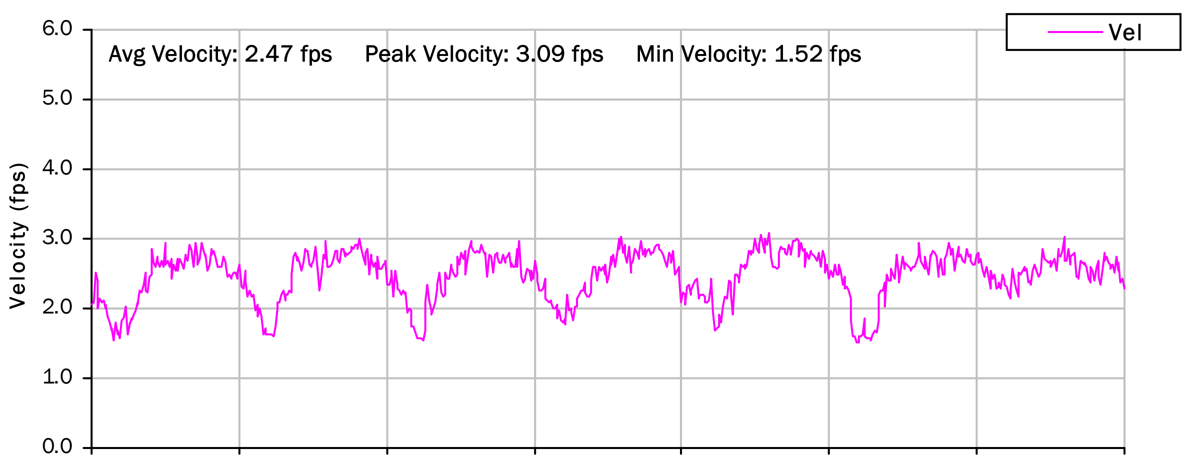
Avg Flow: 4.363 mgd Peak Flow: 7.224 mgd Min Flow: 1.521 mgd

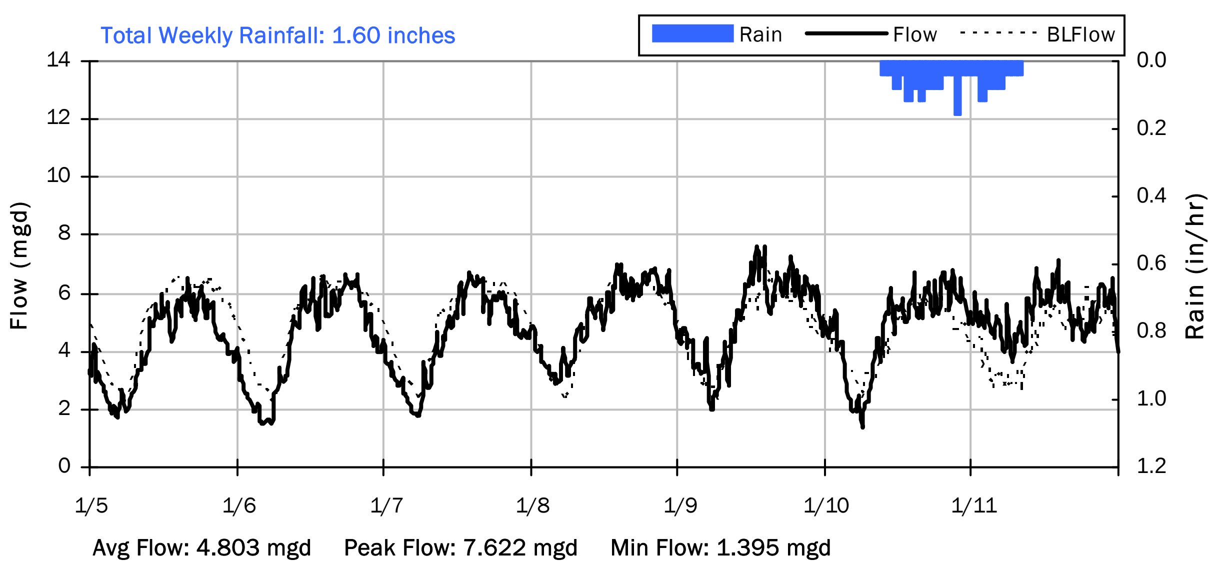
SITE 1

Weekly Level, Velocity and Flow Hydrographs

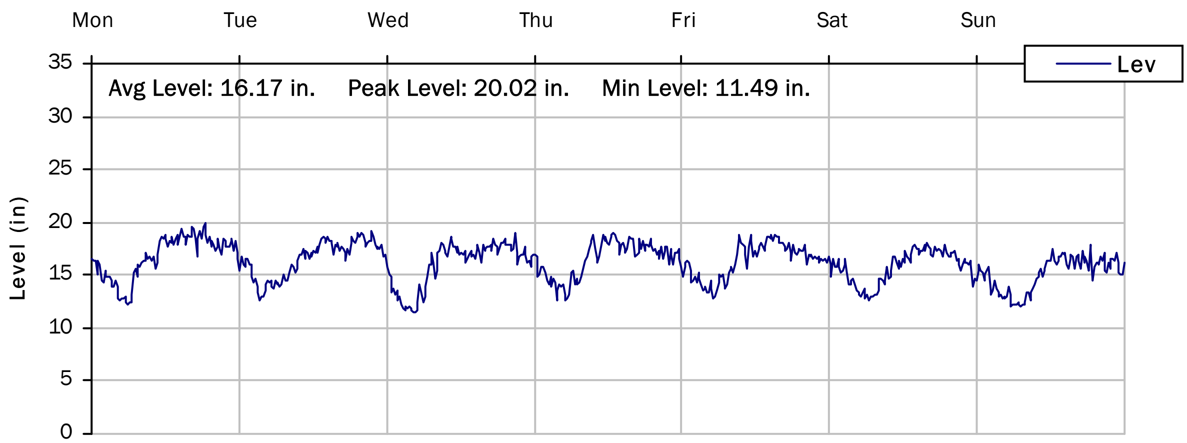
1/5/2015 to 1/12/2015

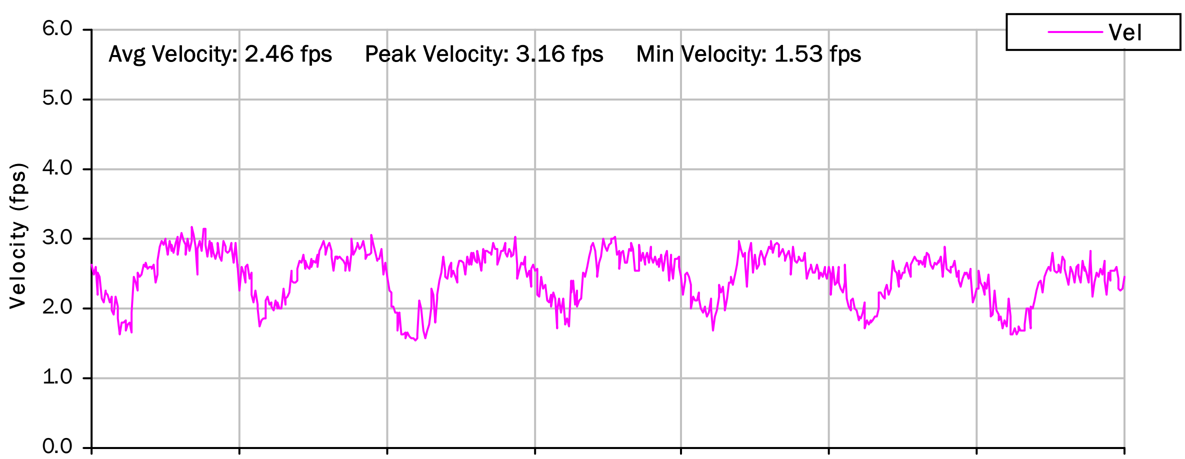


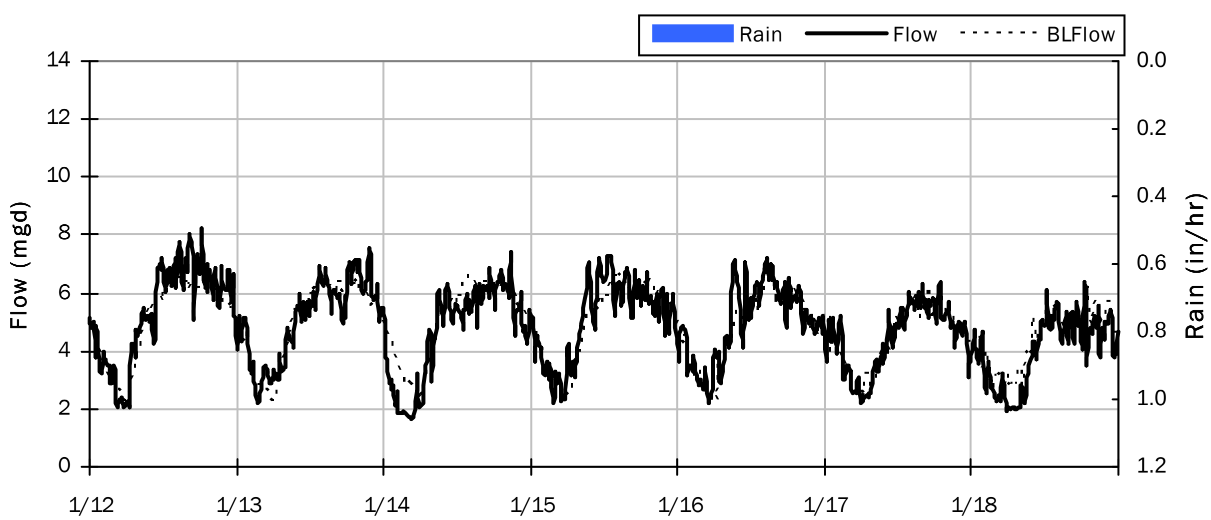




SITE 1
Weekly Level, Velocity and Flow Hydrographs
1/12/2015 to 1/19/2015





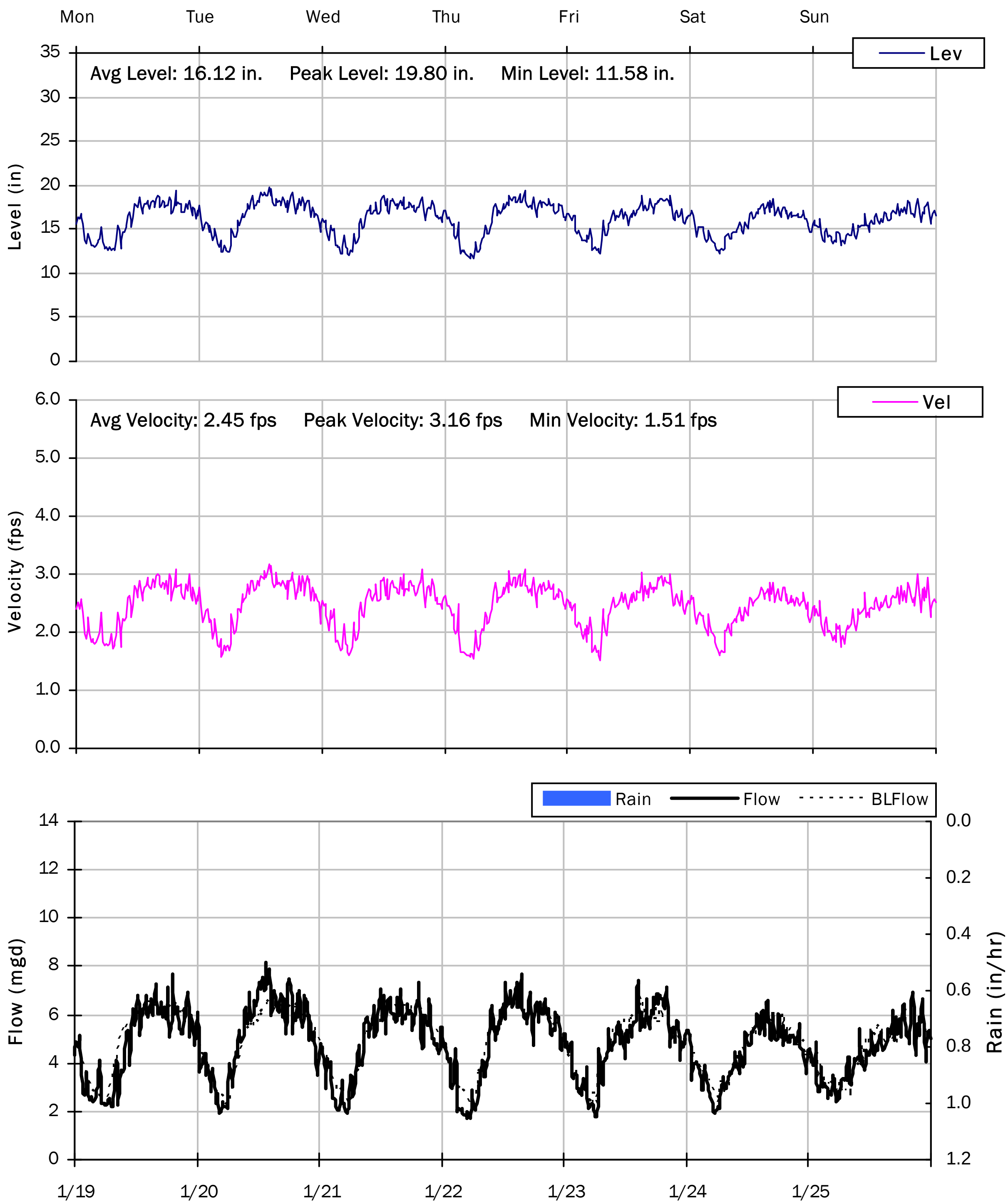


Avg Flow: 4.811 mgd   Peak Flow: 8.263 mgd   Min Flow: 1.661 mgd

SITE 1

Weekly Level, Velocity and Flow Hydrographs

1/19/2015 to 1/26/2015

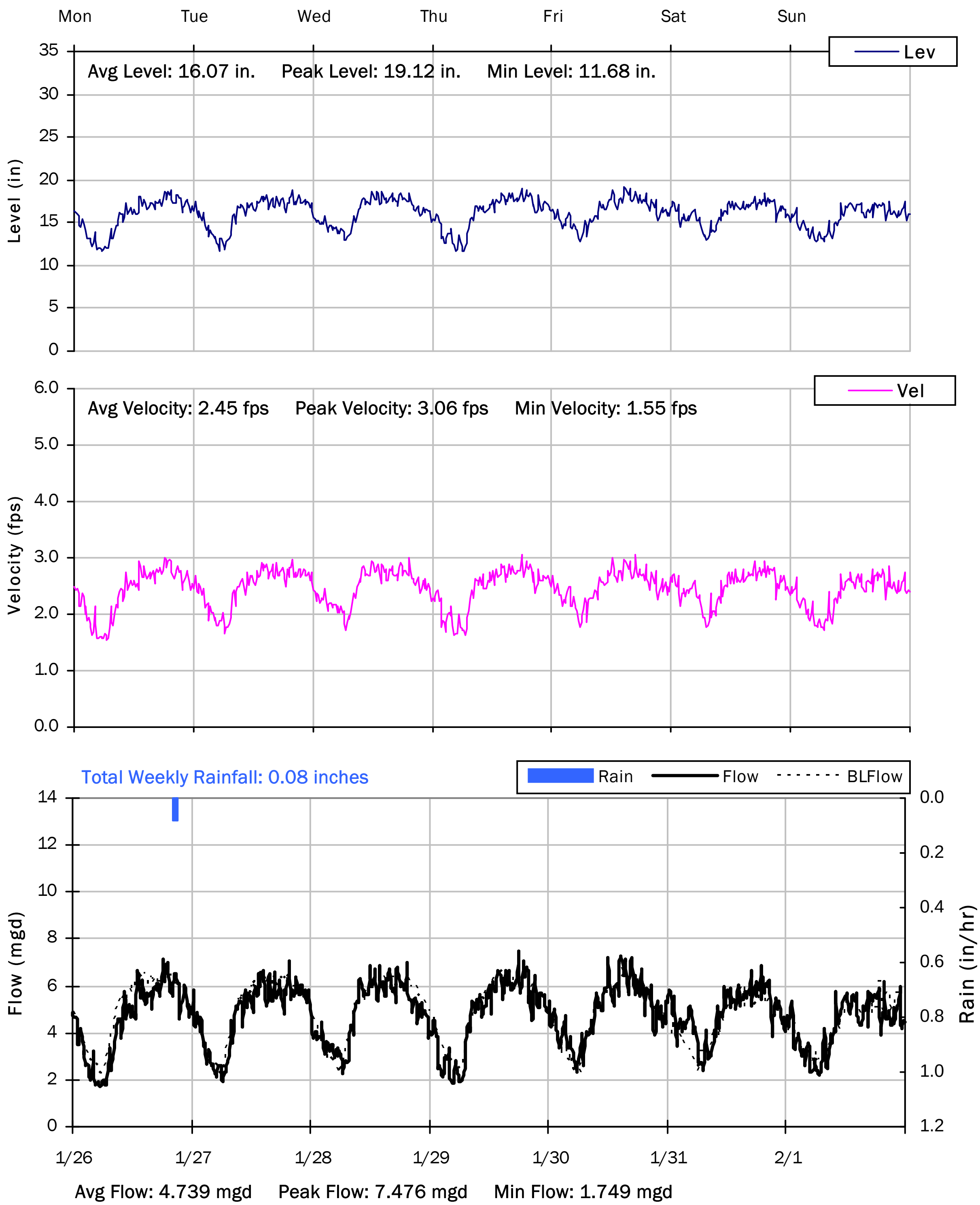


Avg Flow: 4.771 mgd Peak Flow: 8.150 mgd Min Flow: 1.723 mgd

SITE 1

Weekly Level, Velocity and Flow Hydrographs

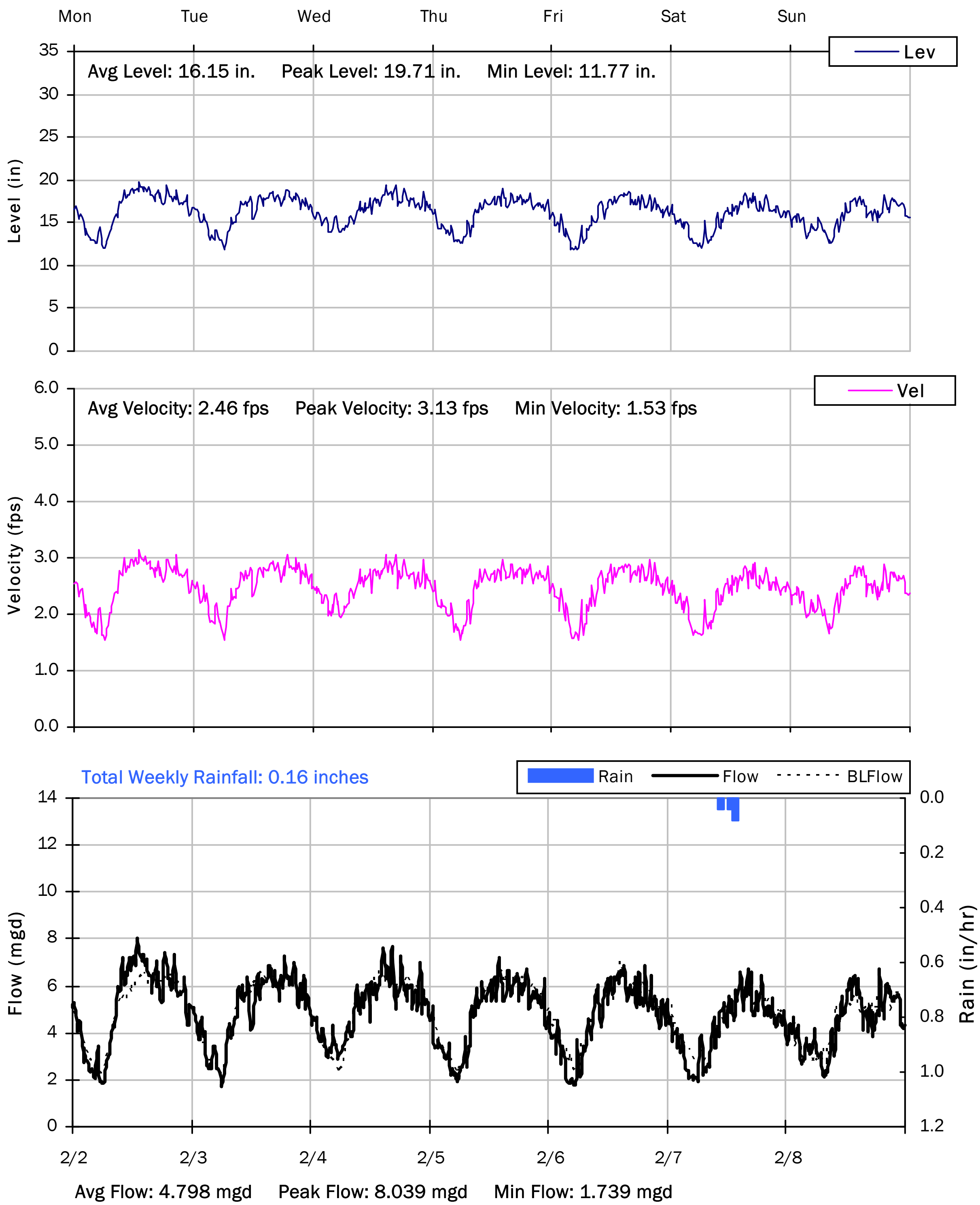
1/26/2015 to 2/2/2015



SITE 1

Weekly Level, Velocity and Flow Hydrographs

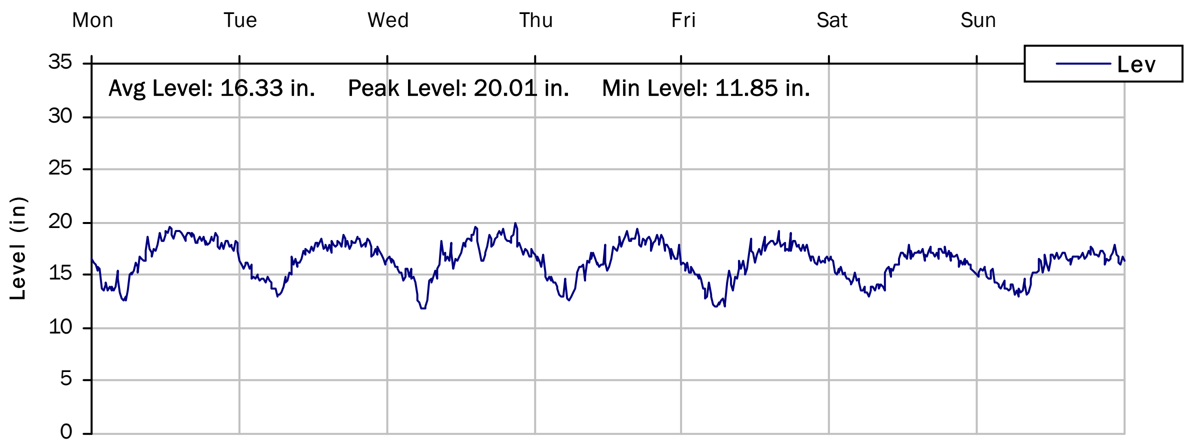
2/2/2015 to 2/9/2015

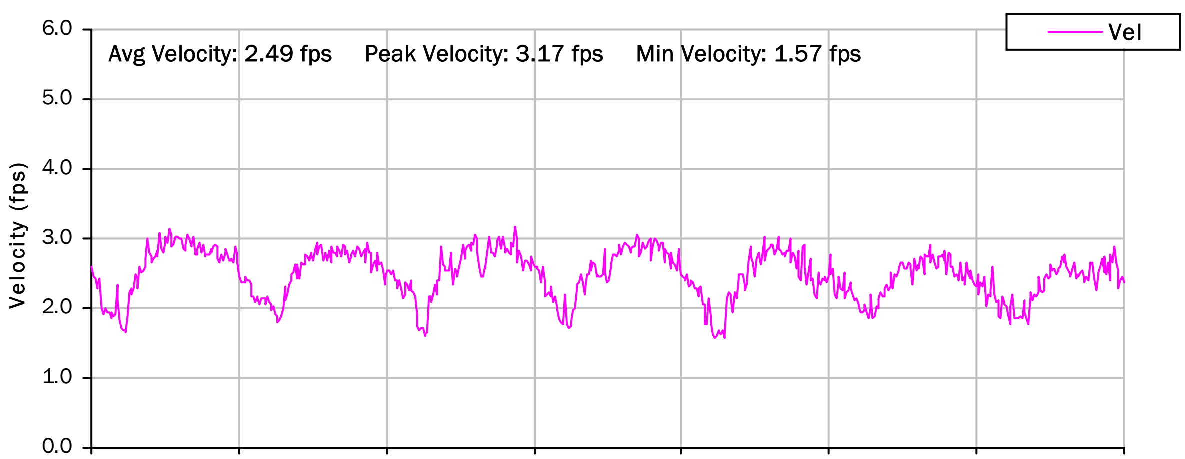


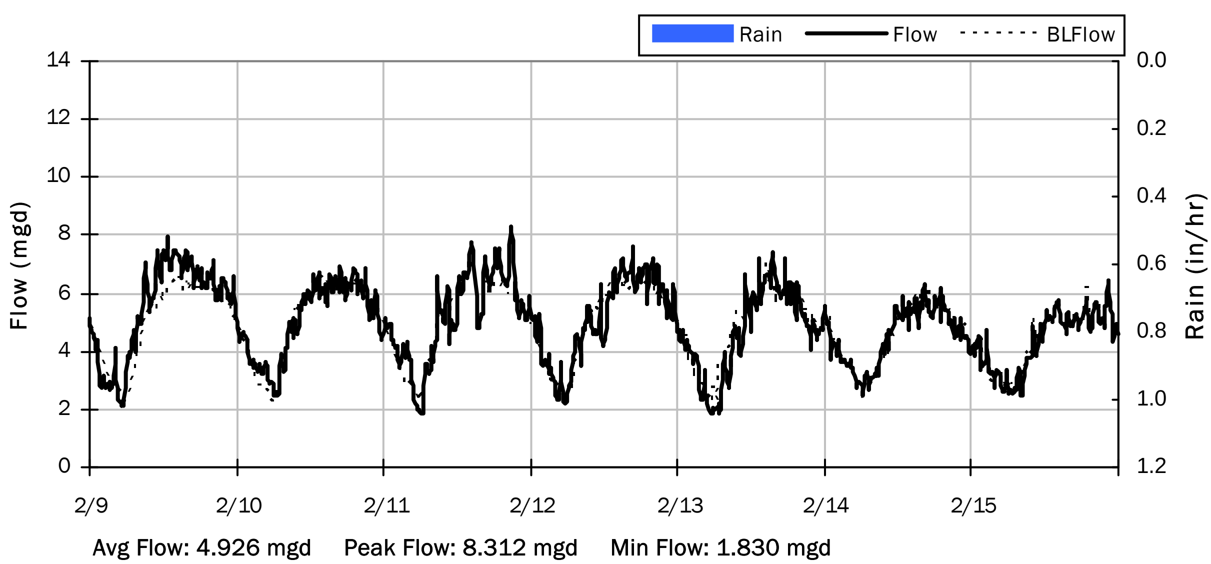
SITE 1

Weekly Level, Velocity and Flow Hydrographs

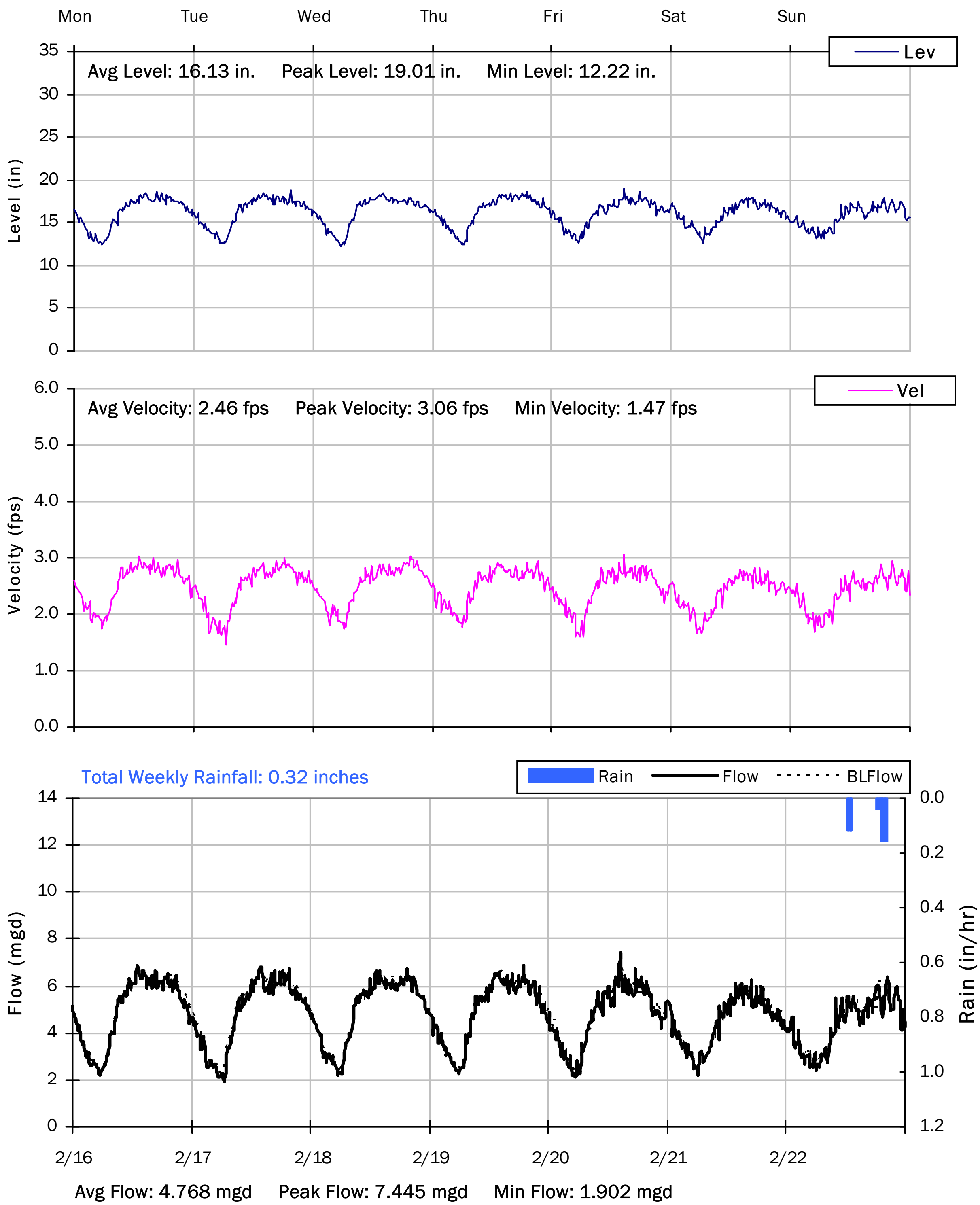
2/9/2015 to 2/16/2015







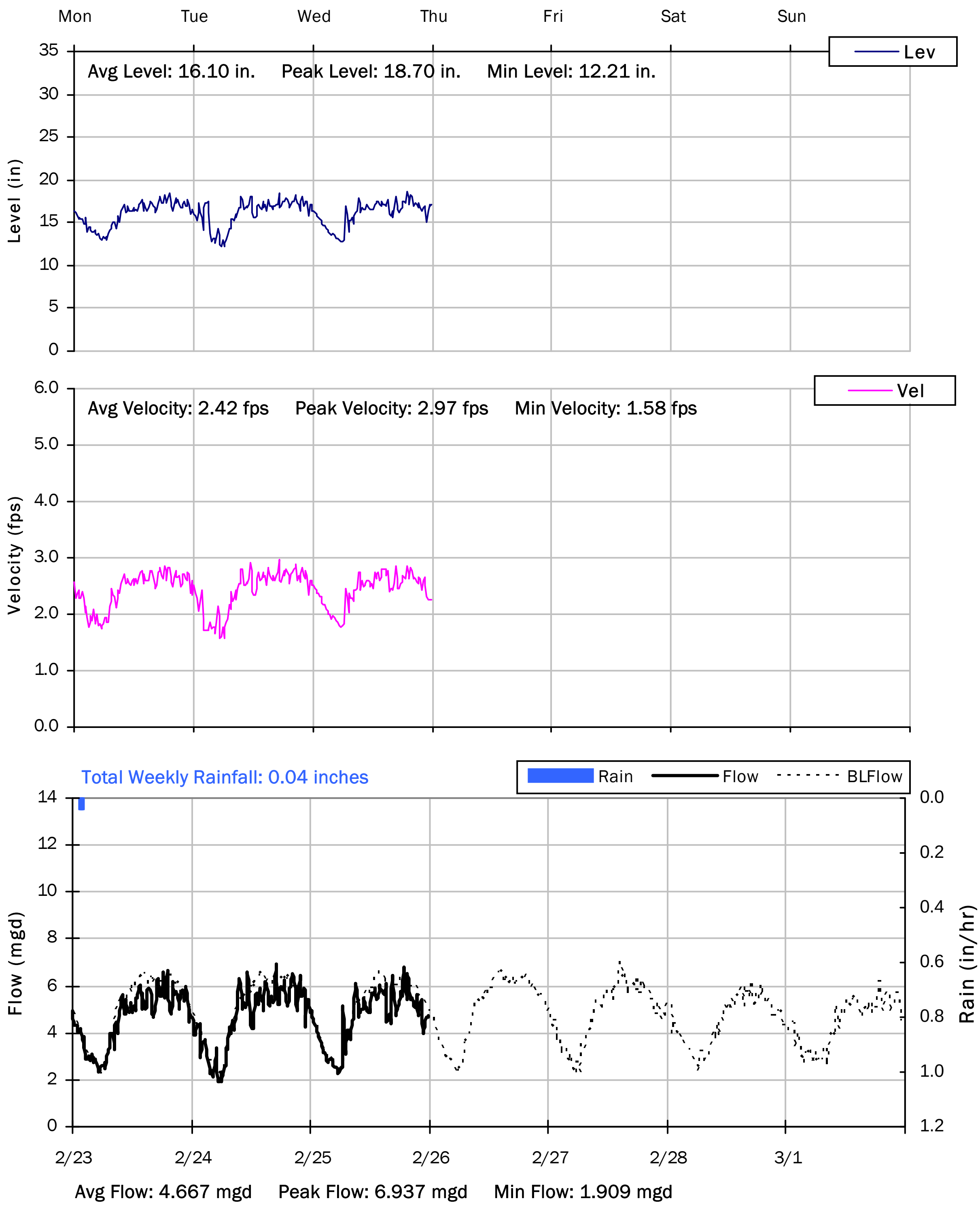
SITE 1
Weekly Level, Velocity and Flow Hydrographs
2/16/2015 to 2/23/2015



SITE 1

Weekly Level, Velocity and Flow Hydrographs

2/23/2015 to 3/2/2015



City of Oxnard

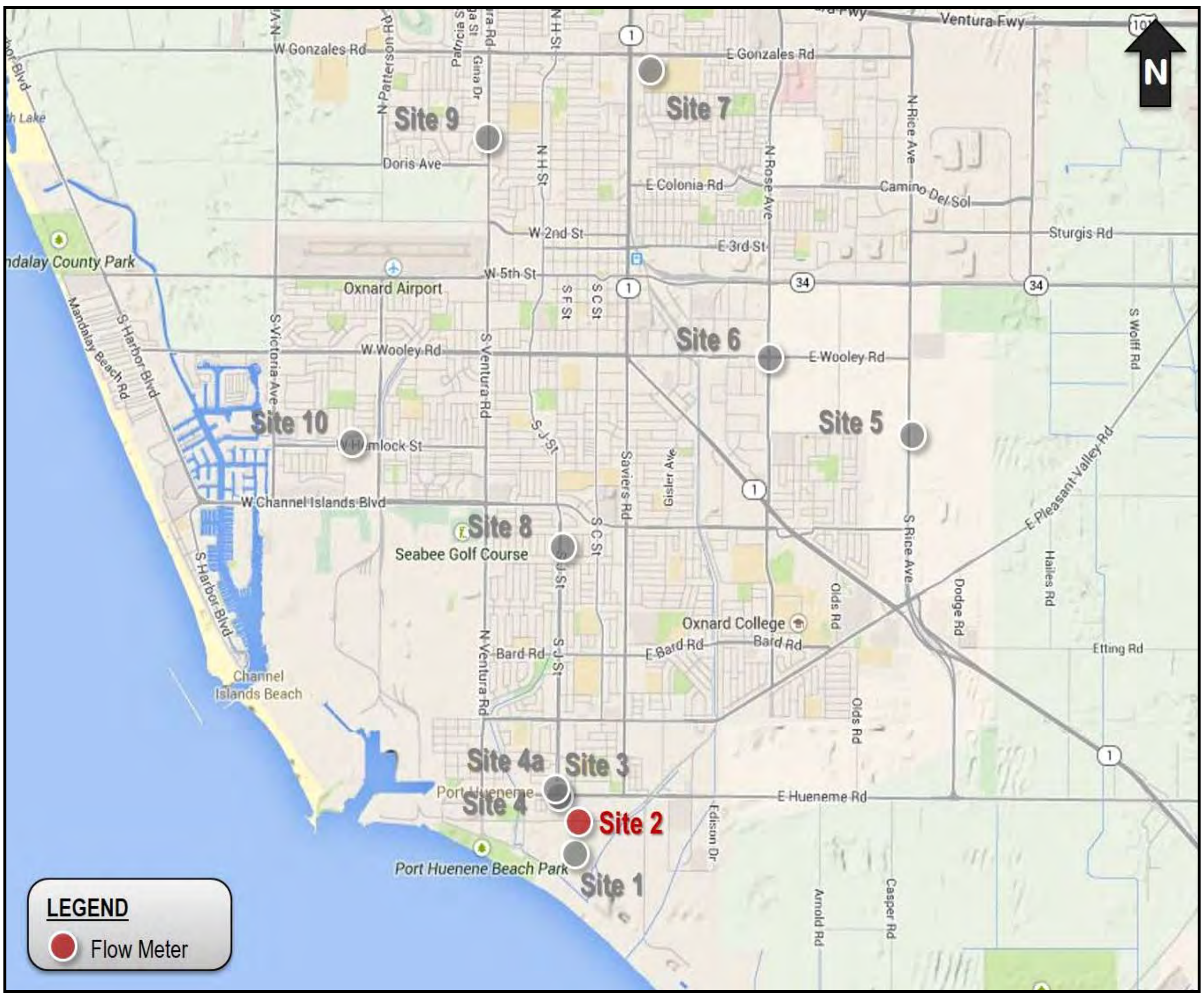
Sanitary Sewer Flow Monitoring

Temporary Monitoring: December, 2014 through February, 2015

Monitoring Site: Site 2

Location: Magellan Avenue

Data Summary Report



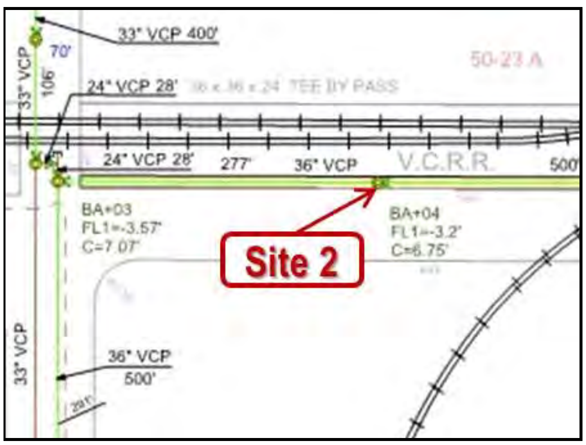
Vicinity Map: Site 2

SITE 2

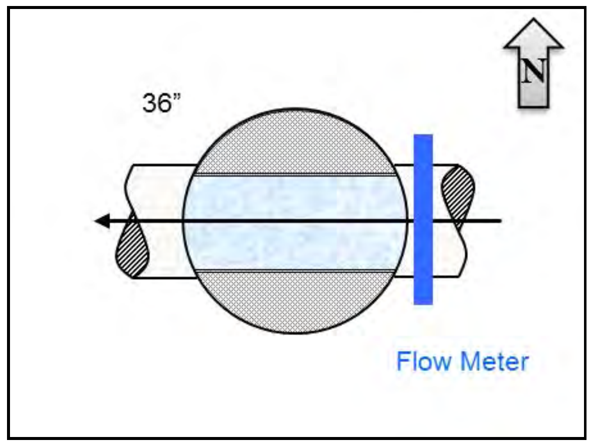
Site Information

Location:	Magellan Avenue
Coordinates:	119.1830° W, 34.1448° N
Rim Elevation:	13 feet
Pipe Diameter:	36 inches
Baseline Flow:	2.194 mgd
Peak Measured Flow:	6.002 mgd

Satellite Map



Sanitary Map



Flow Diagram

Street View

Plan View

SITE 2

Additional Site Photos

Effluent Pipe

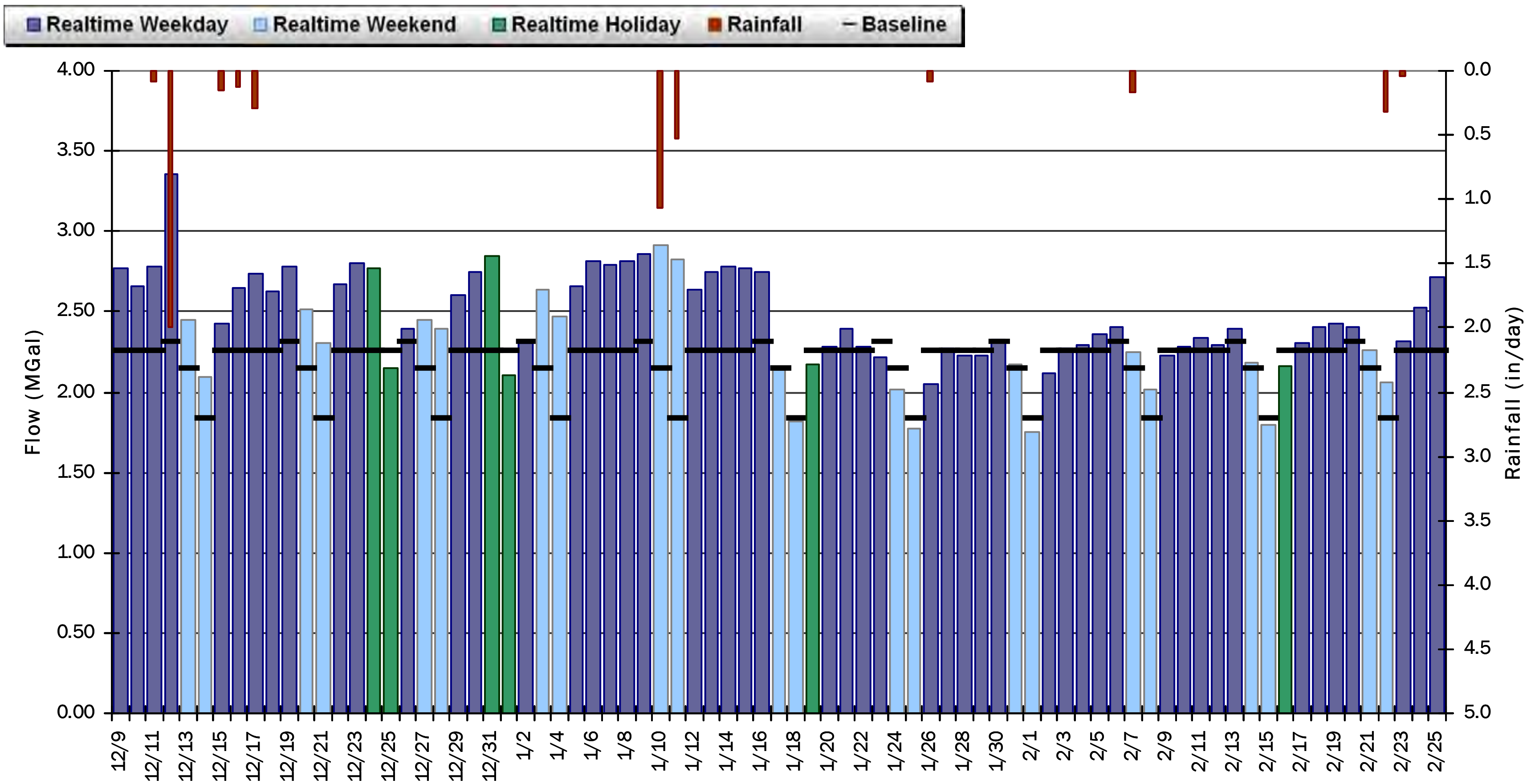
Influent Pipe

SITE 2

Period Flow Summary: Daily Flow Totals

Avg Period Flow: 2.428 MGal **Peak Daily Flow: 3.359 MGal** **Min Daily Flow: 1.751 MGal**

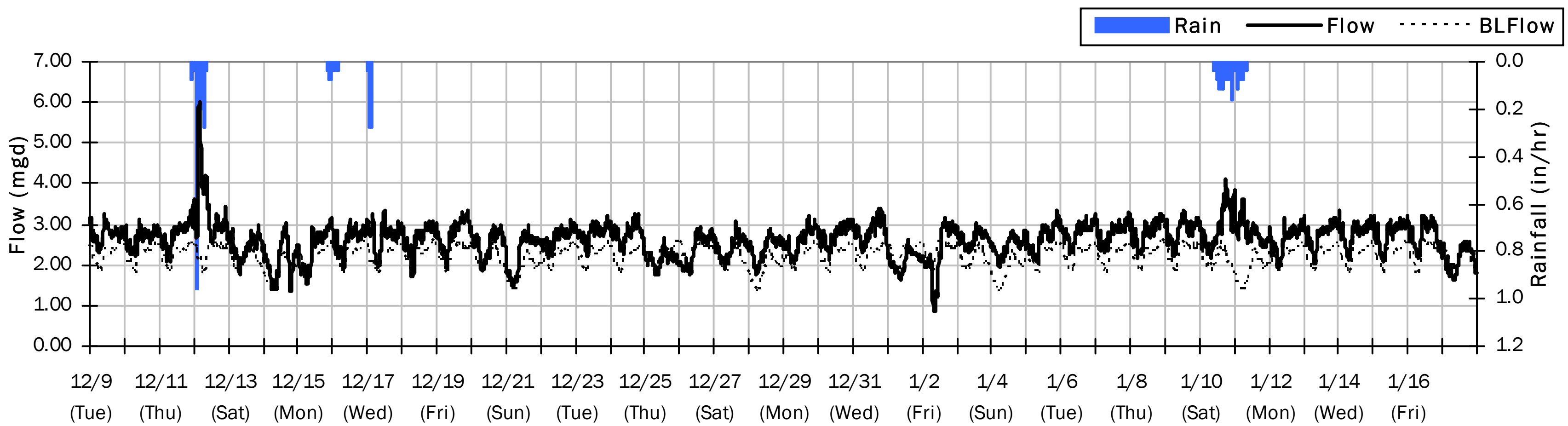
Total Period Rainfall: 4.84 inches

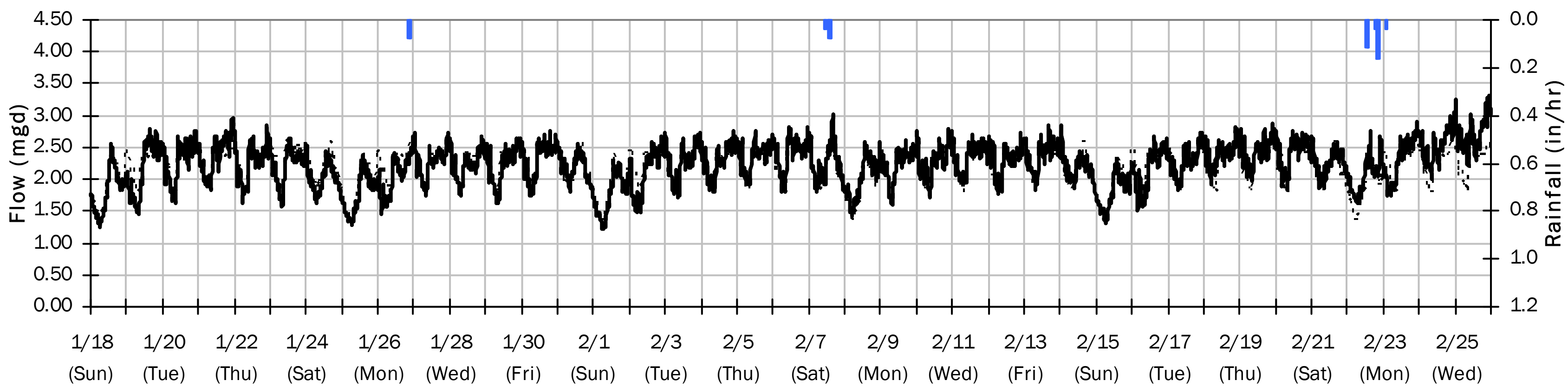


SITE 2

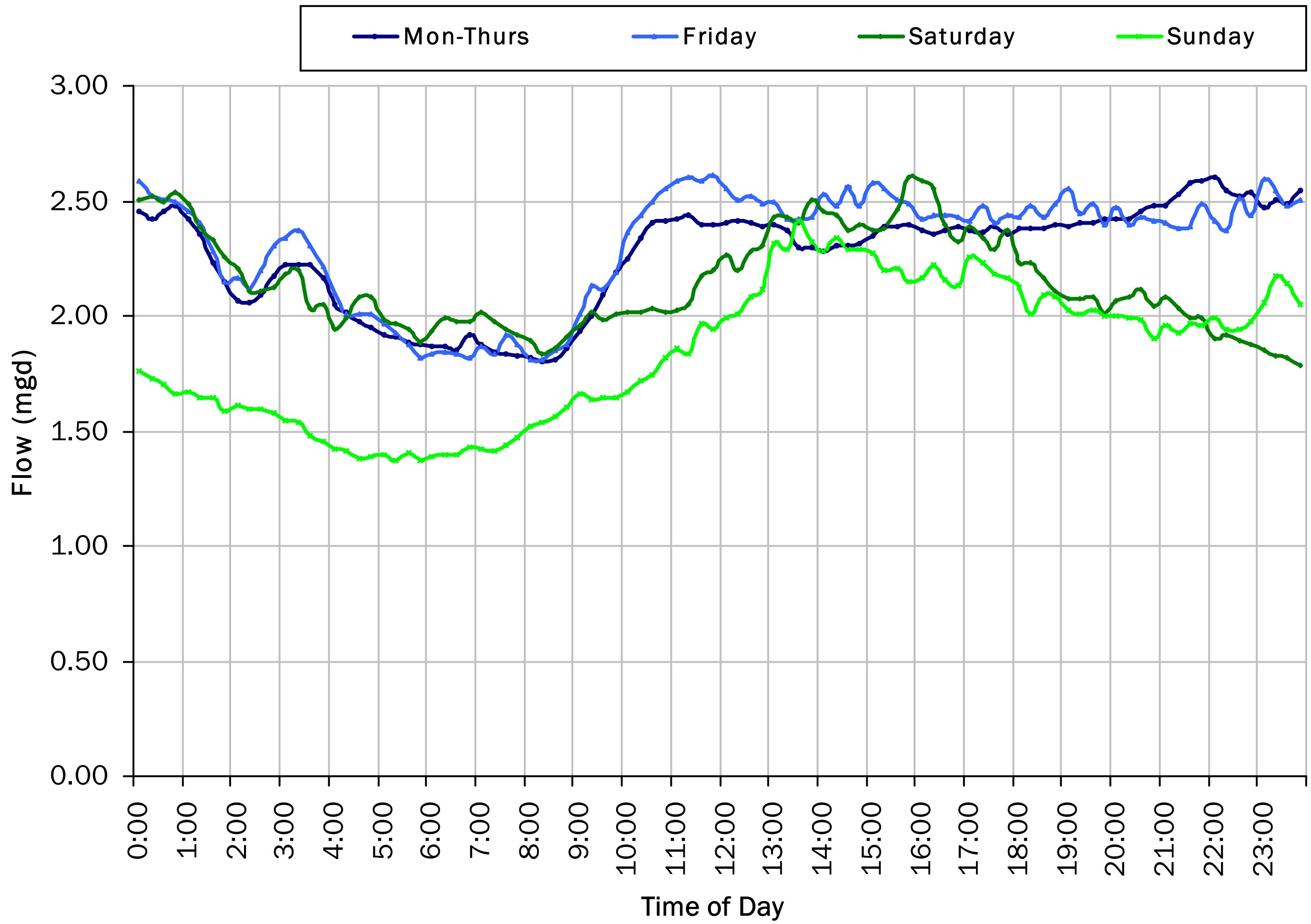
Flow Summary: 12/9/2014 to 2/25/2015

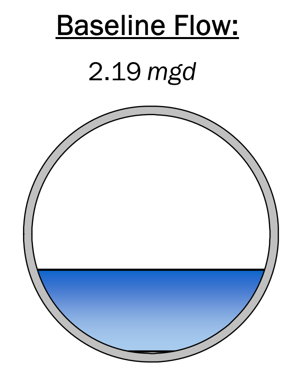
Total Period Rainfall: 4.84 inches   Avg Flow: 2.428 mgd   Peak Flow: 6.002 mgd   Min Flow: 0.853 mgd





SITE 2
Baseline Flow Hydrographs

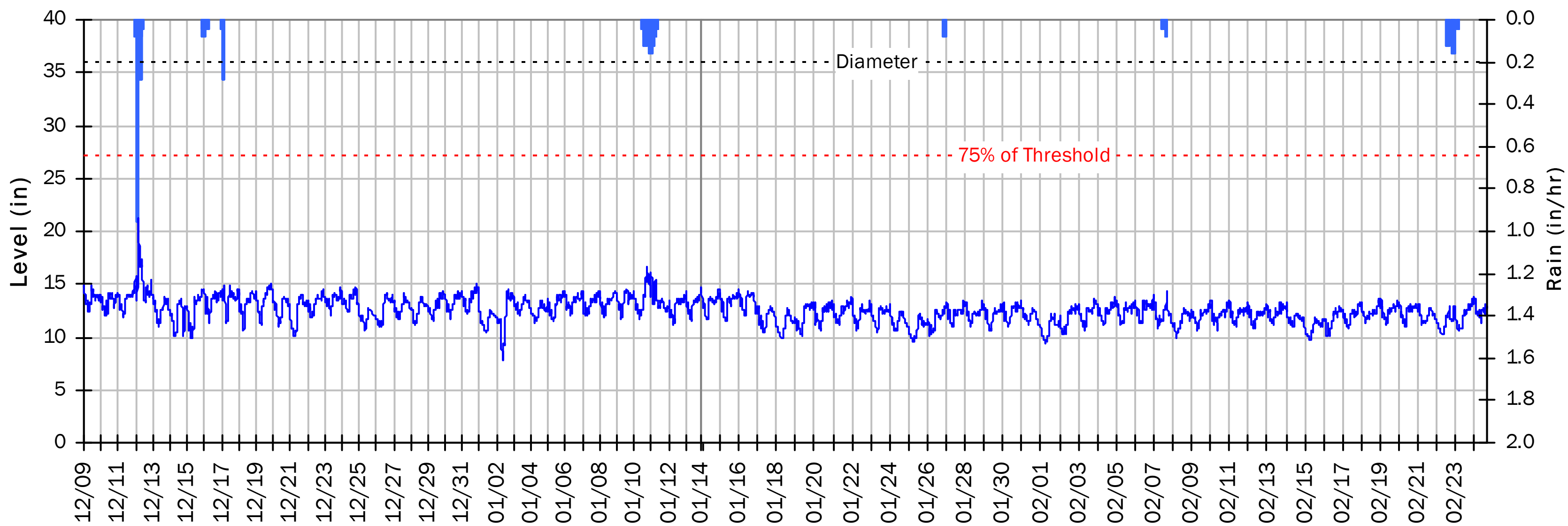


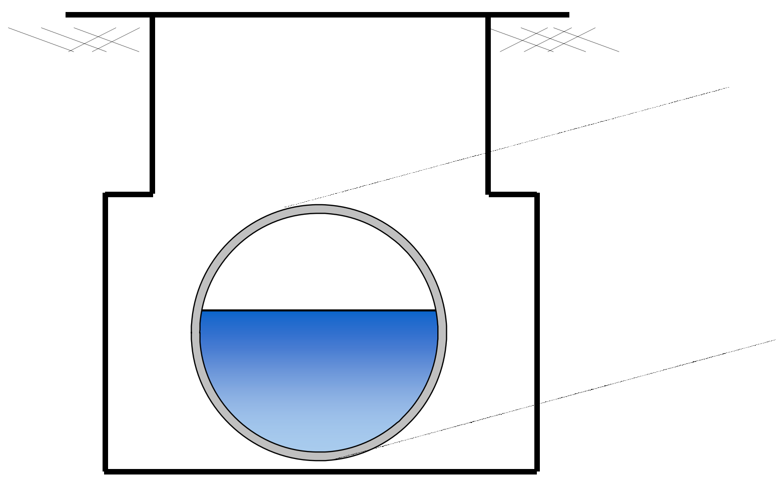


SITE 2

Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Monitoring Period





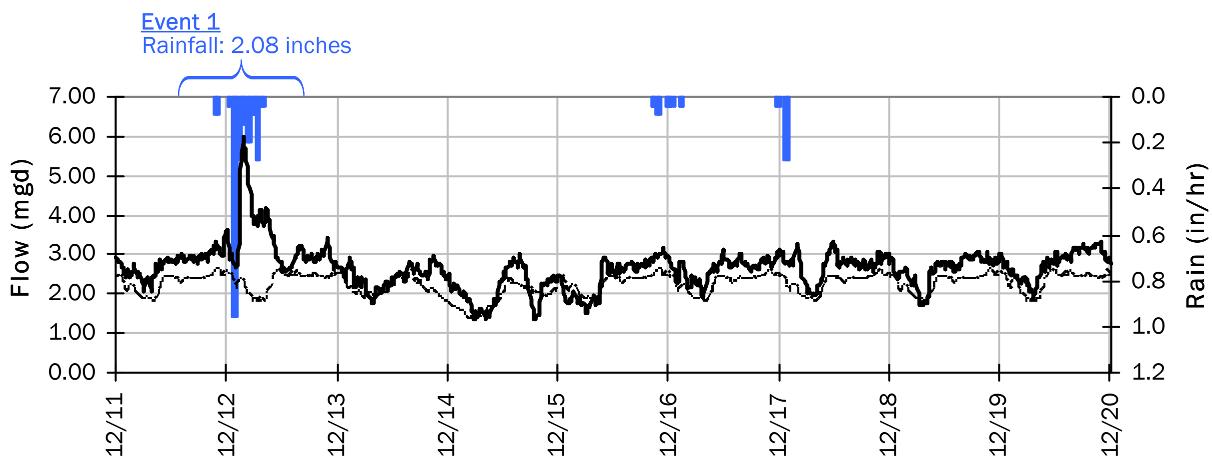
Pipe Diameter: 36 *inches*

Peak Measured Level: 21.2 *inches*

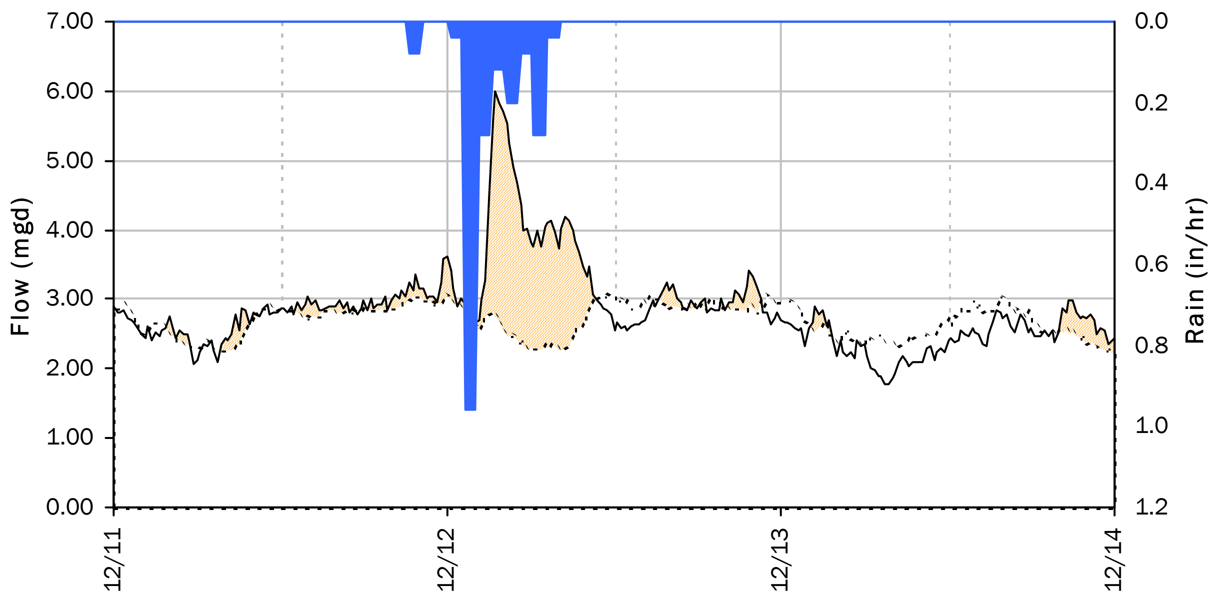
Peak d/D Ratio: 0.59

SITE 2
I/I Summary: Event 1

Baseline and Realtime Flows with Rainfall Data over Monitoring Period



Event 1 Detail Graph

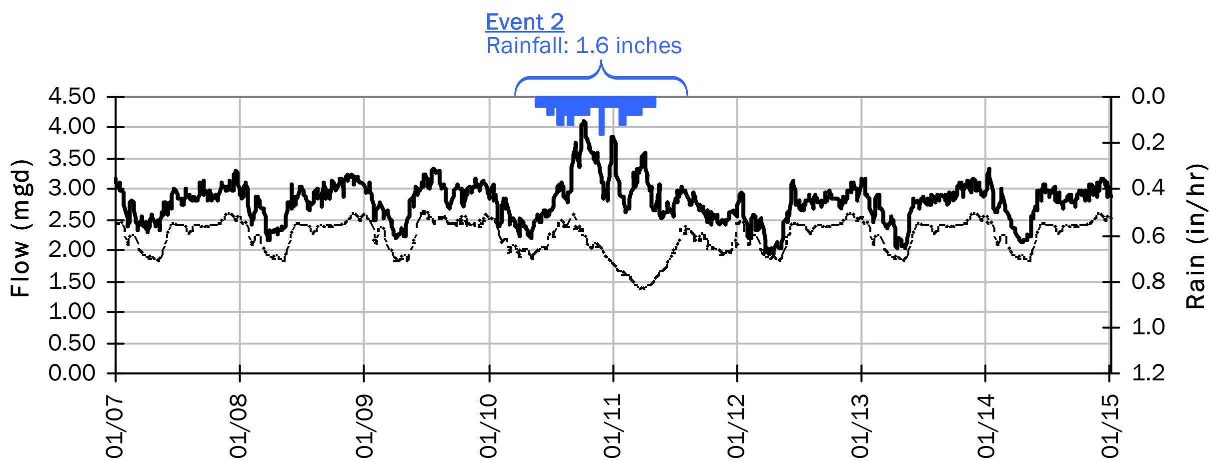


Storm Event I/I Analysis (Rain = 2.08 inches)

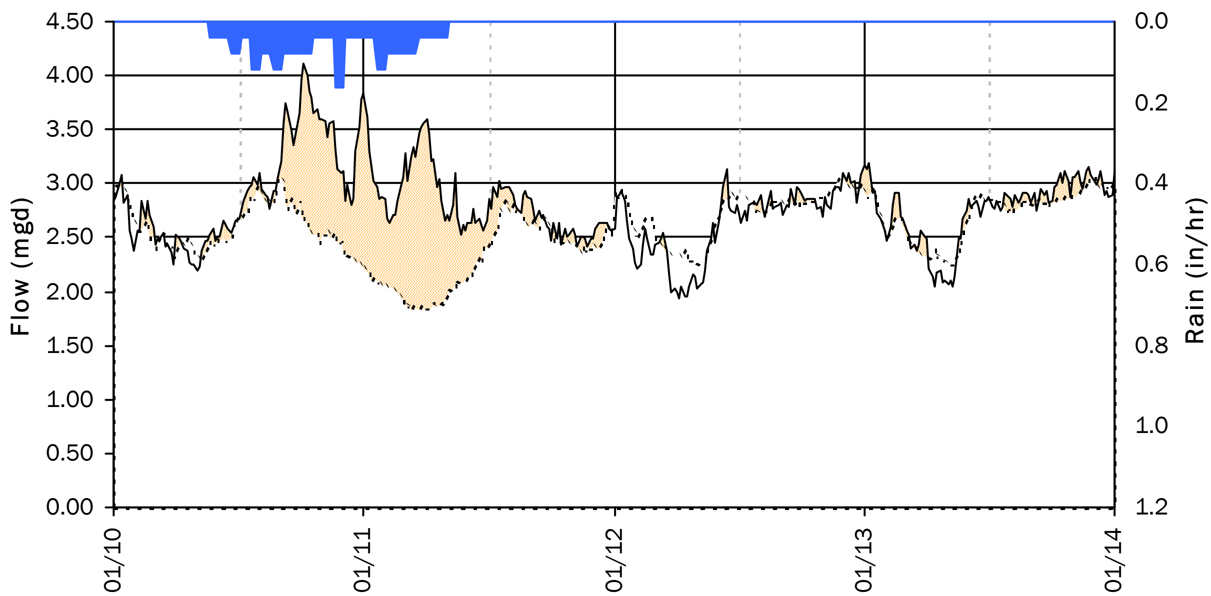
Capacity		Inflow / Infiltration	
Peak Flow:	6.00 *mgd*	Peak I/I Rate:	3.24 *mgd*
PF:	2.74	Total I/I:	460,000 *gallons*
Peak Level:	21.16 *in*		
d/D Ratio:	0.59		

SITE 2
I/I Summary: Event 2

Baseline and Realtime Flows with Rainfall Data over Monitoring Period



Event 2 Detail Graph



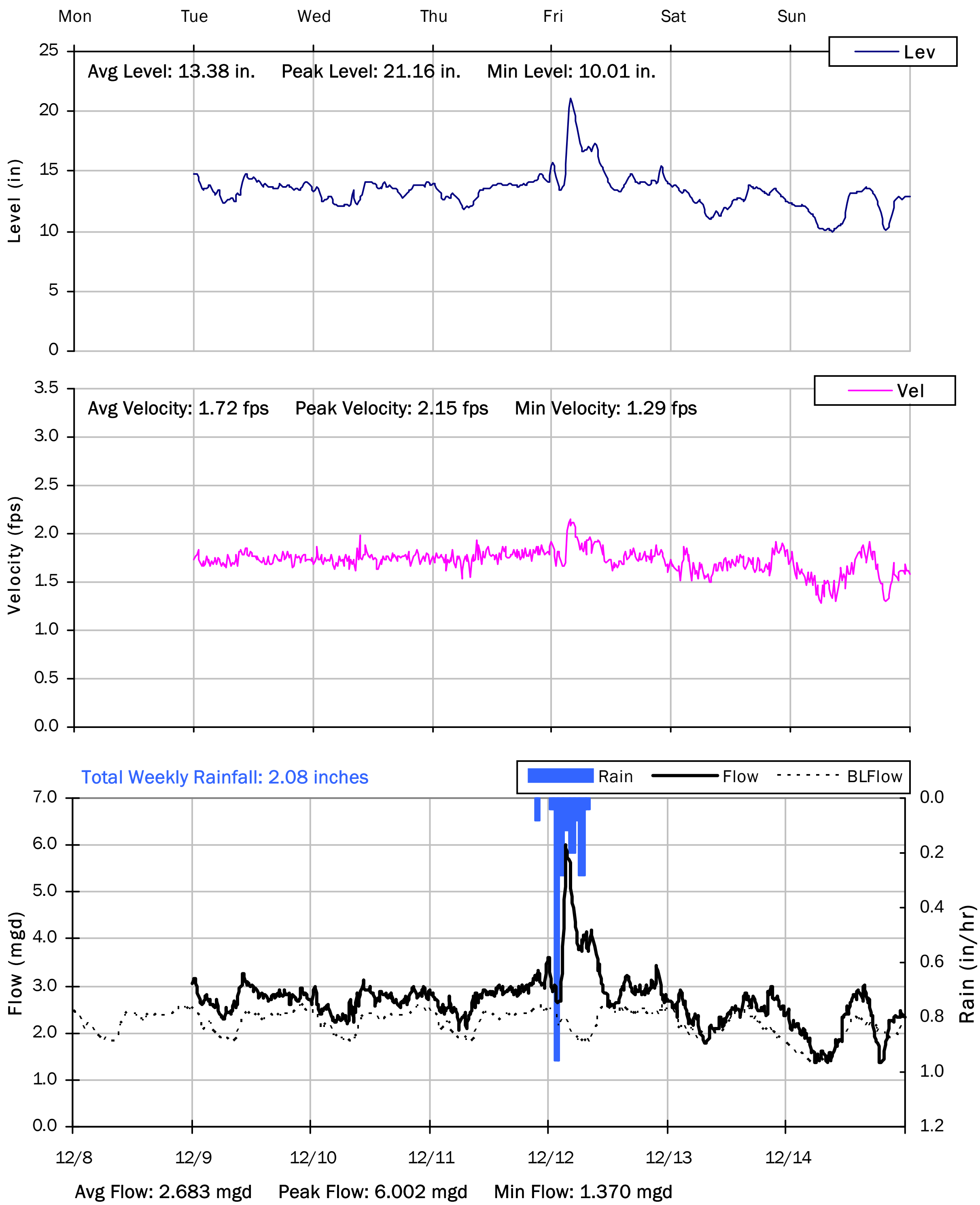
Storm Event I/I Analysis (Rain = 1.60 inches)

Capacity		Inflow / Infiltration	
Peak Flow:	4.11 *mgd*	Peak I/I Rate:	1.76 *mgd*
PF:	1.87	Total I/I:	788,000 *gallons*
Peak Level:	16.68 *in*		
d/D Ratio:	0.46		

SITE 2

Weekly Level, Velocity and Flow Hydrographs

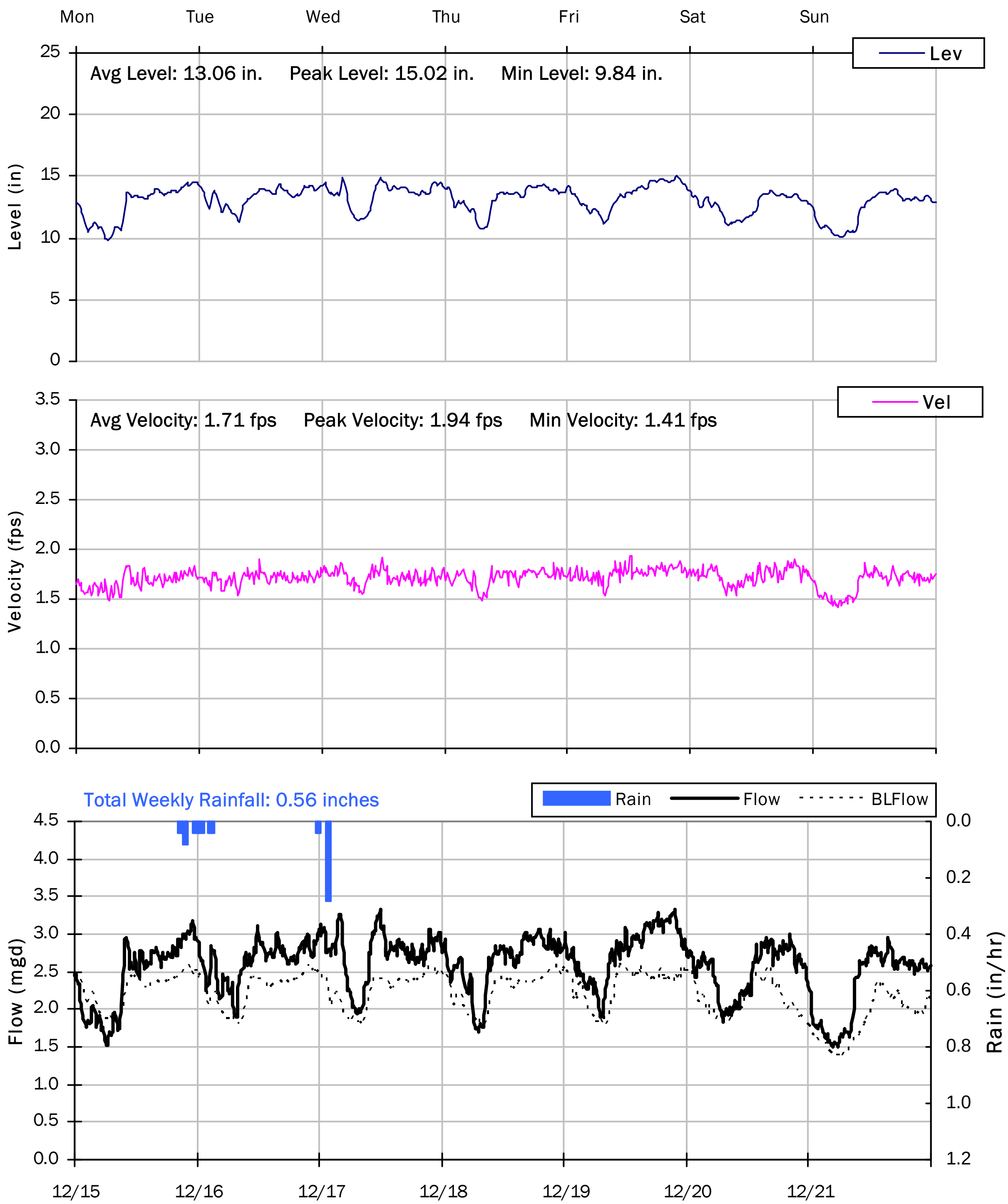
12/8/2014 to 12/15/2014



SITE 2

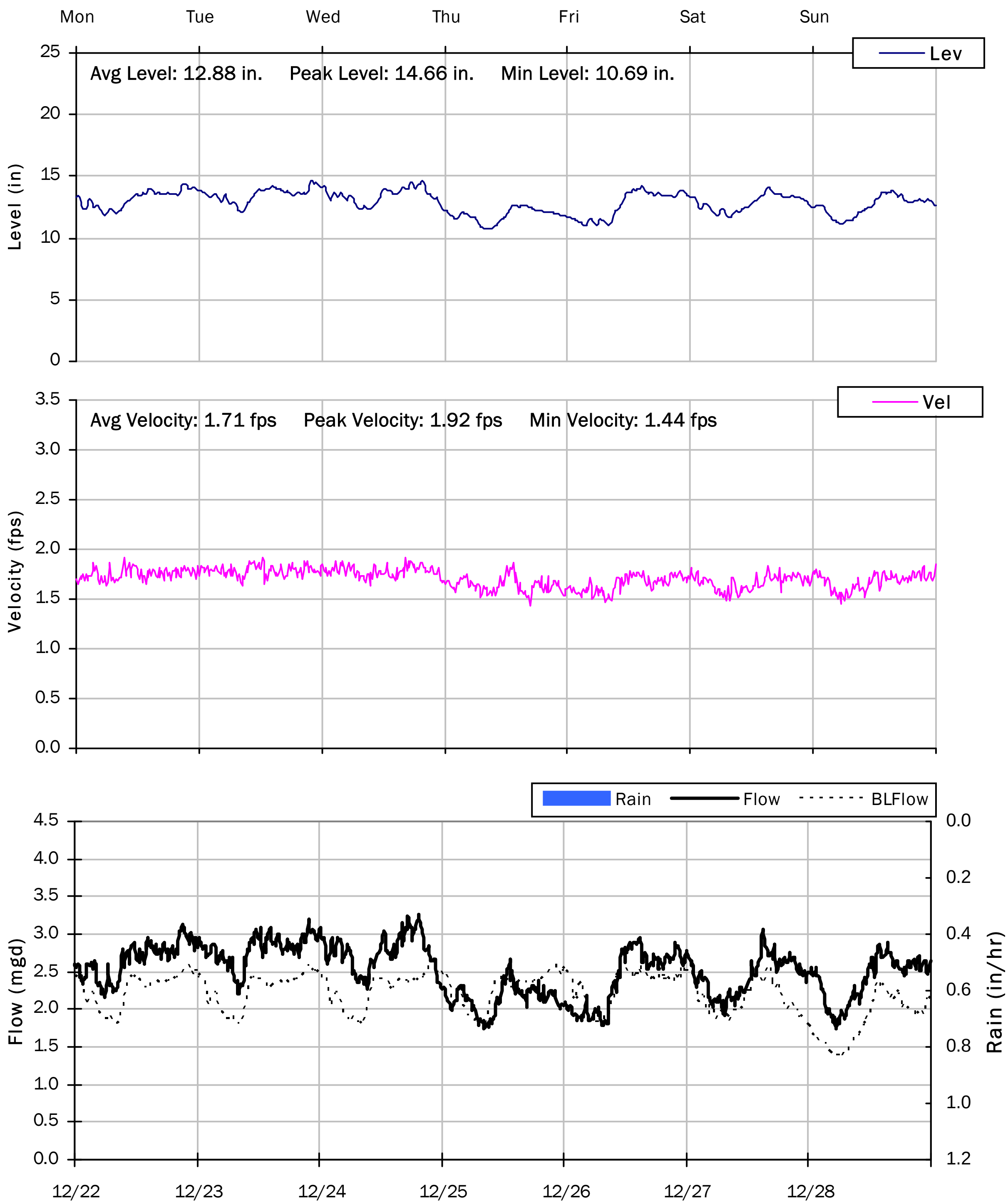
Weekly Level, Velocity and Flow Hydrographs

12/15/2014 to 12/22/2014



Avg Flow: 2.577 mgd Peak Flow: 3.339 mgd Min Flow: 1.490 mgd

SITE 2
Weekly Level, Velocity and Flow Hydrographs
12/22/2014 to 12/29/2014

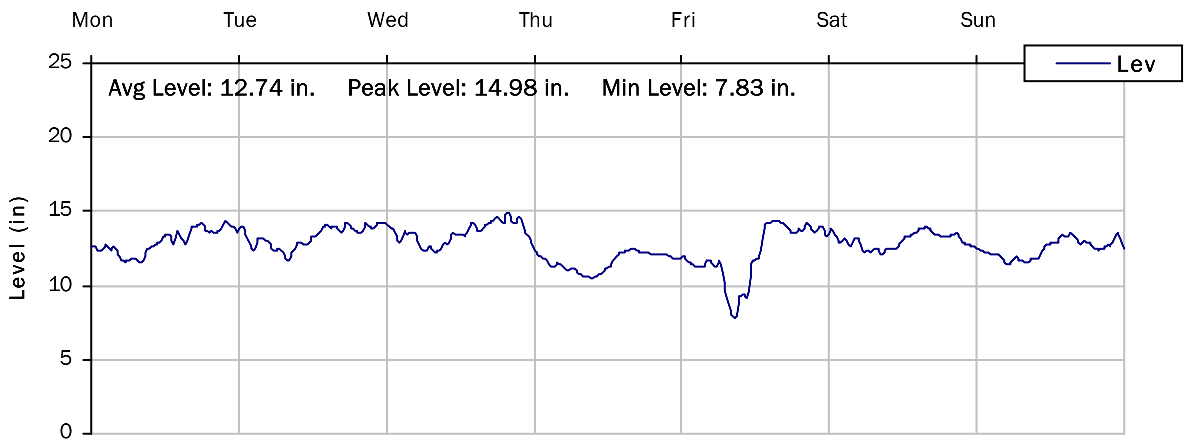


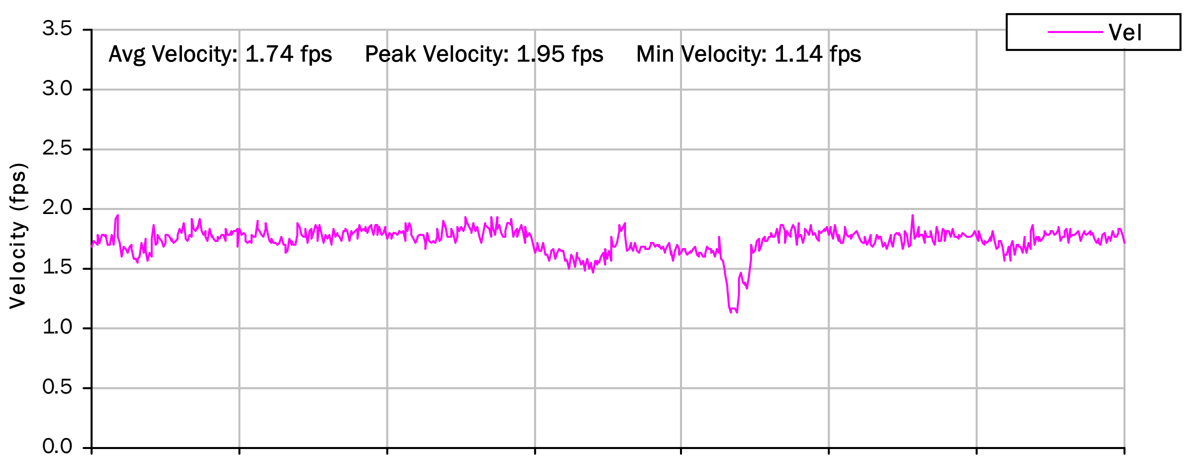
Avg Flow: 2.518 mgd Peak Flow: 3.270 mgd Min Flow: 1.743 mgd

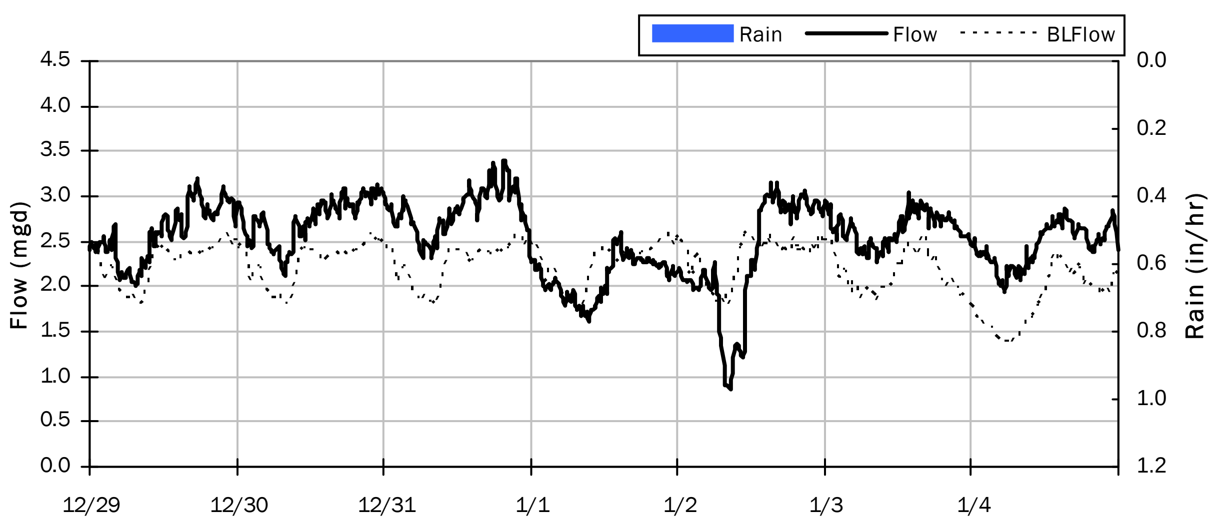
SITE 2

Weekly Level, Velocity and Flow Hydrographs

12/29/2014 to 1/5/2015

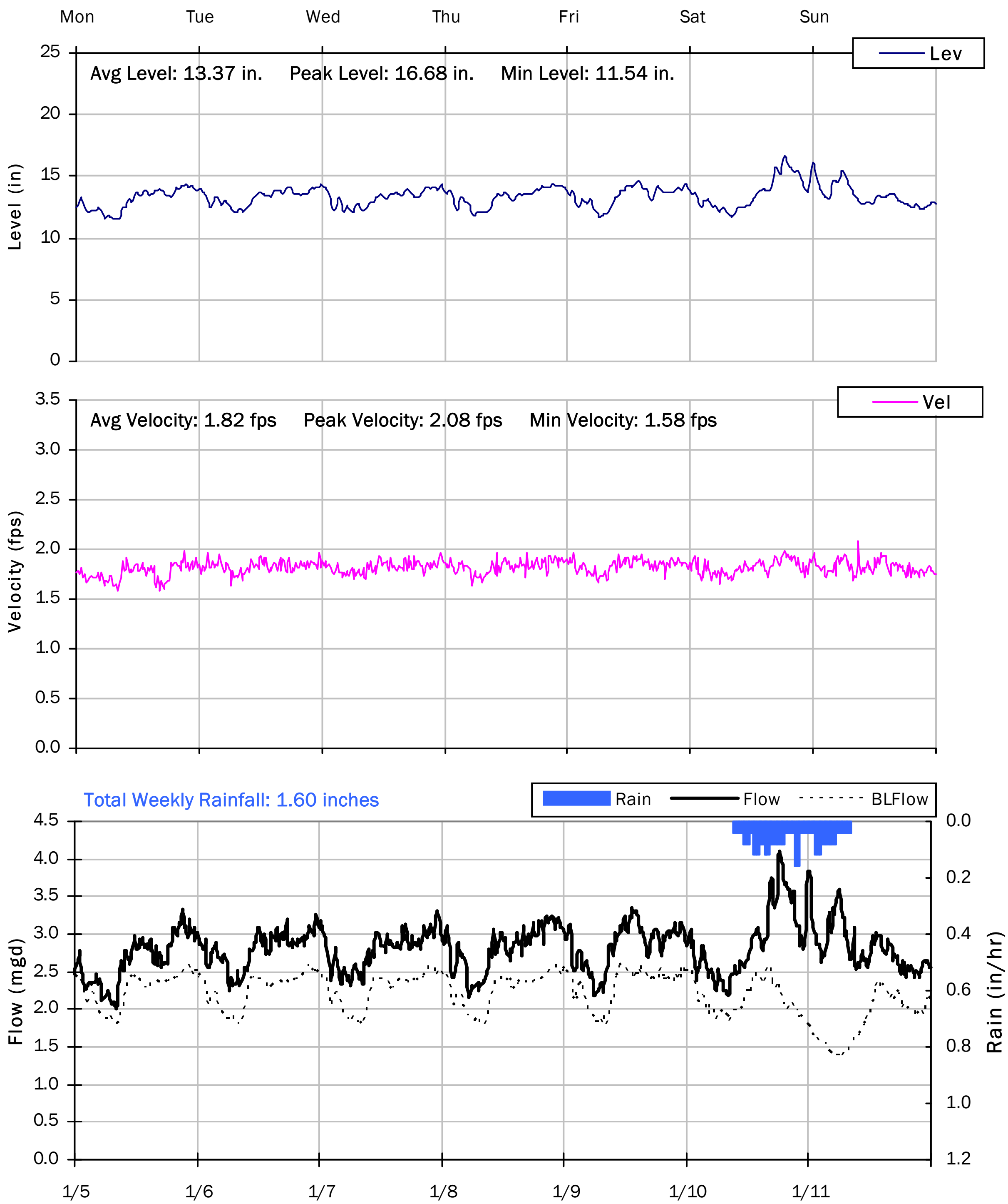






Avg Flow: 2.530 mgd   Peak Flow: 3.402 mgd   Min Flow: 0.853 mgd

SITE 2
Weekly Level, Velocity and Flow Hydrographs
1/5/2015 to 1/12/2015

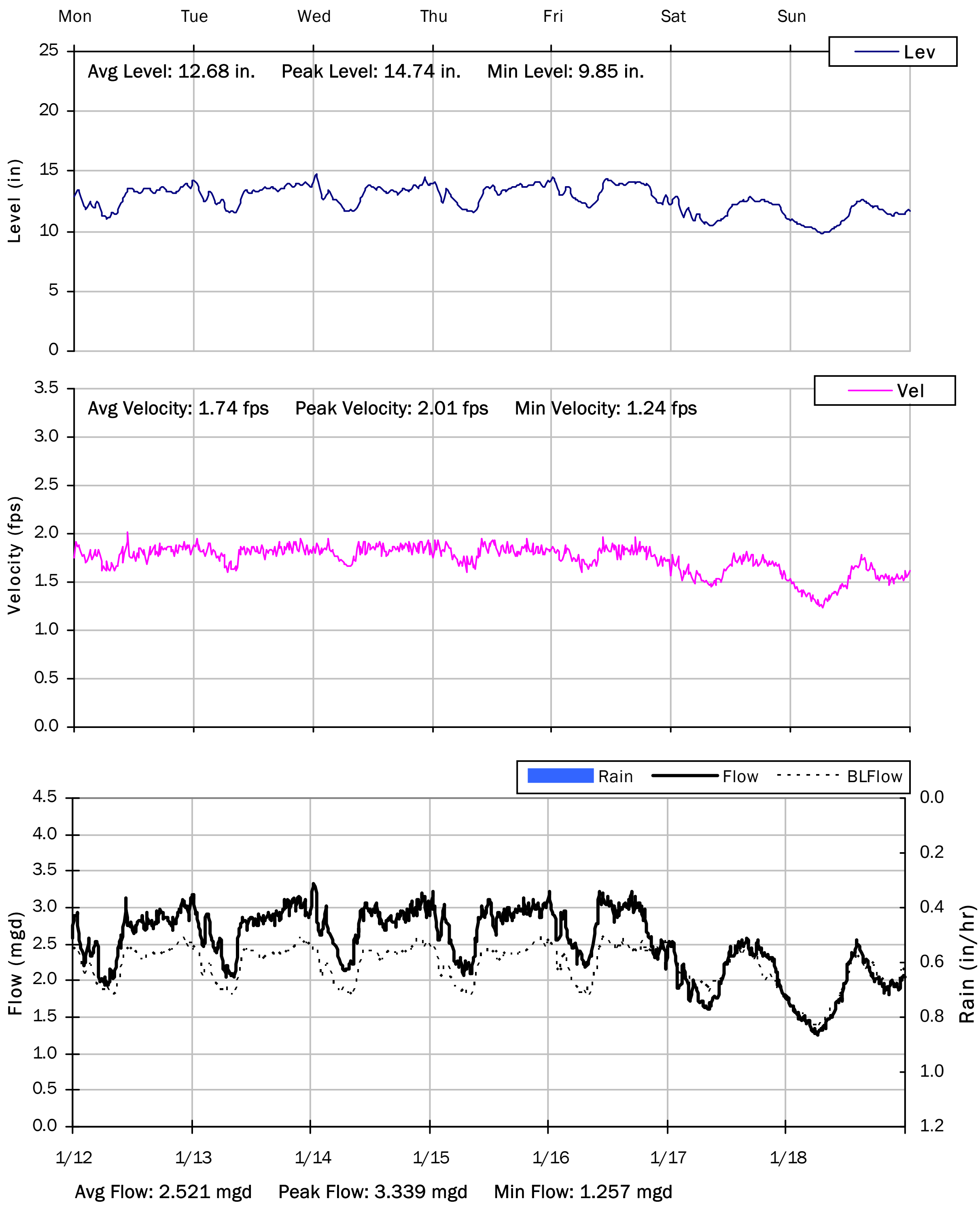


Avg Flow: 2.812 mgd Peak Flow: 4.107 mgd Min Flow: 2.012 mgd

SITE 2

Weekly Level, Velocity and Flow Hydrographs

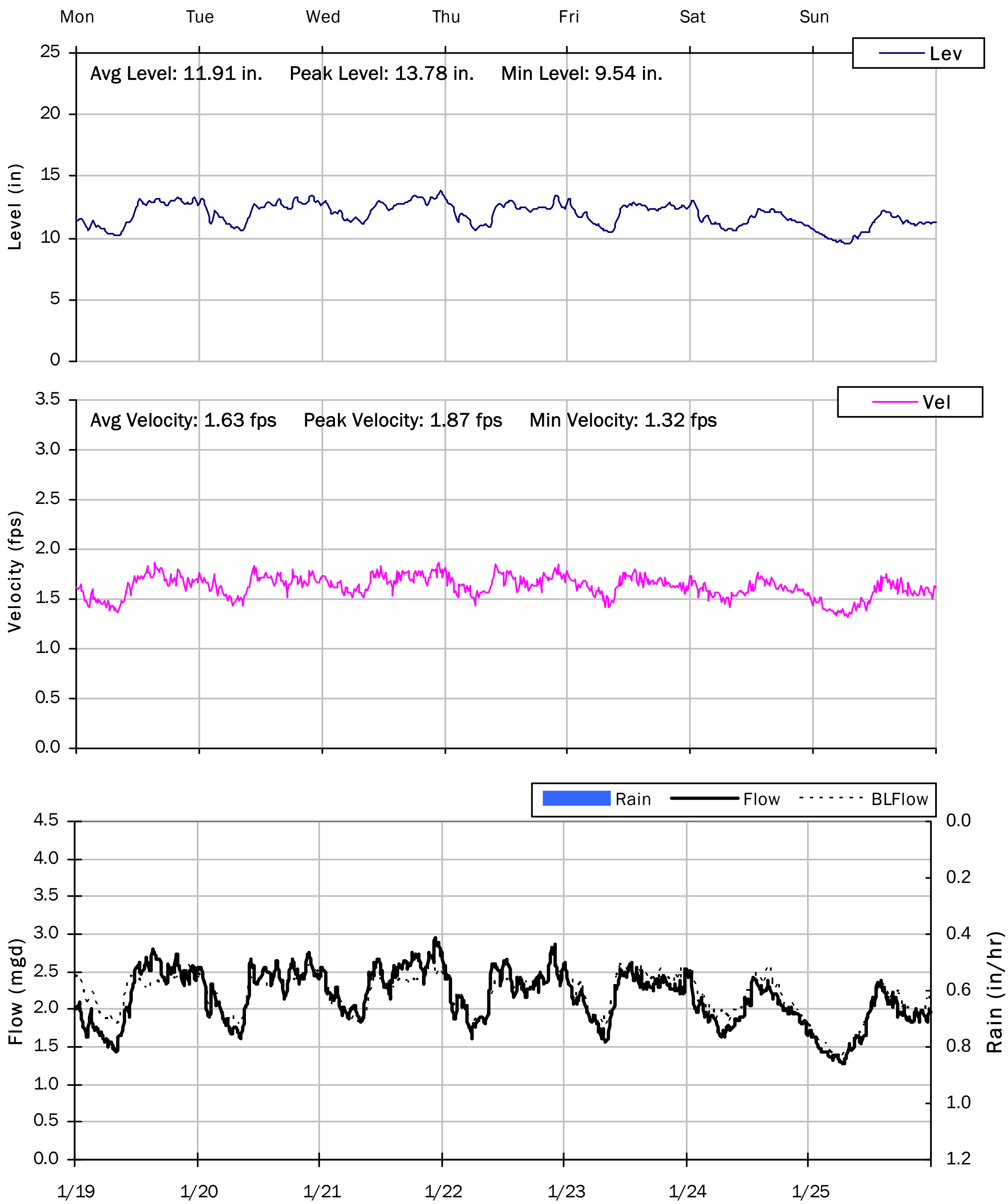
1/12/2015 to 1/19/2015



SITE 2

Weekly Level, Velocity and Flow Hydrographs

1/19/2015 to 1/26/2015

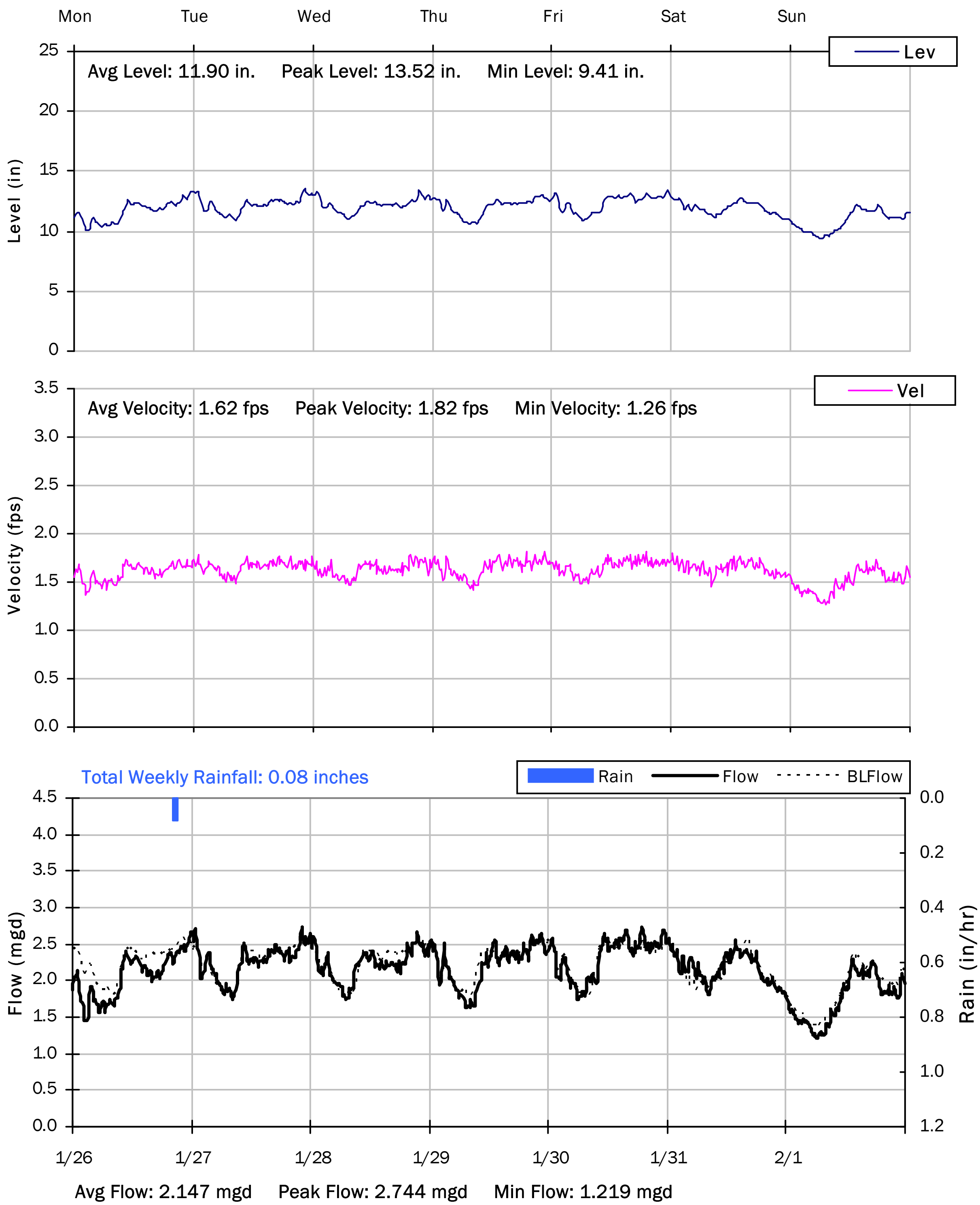


Avg Flow: 2.161 mgd   Peak Flow: 2.960 mgd   Min Flow: 1.284 mgd

SITE 2

Weekly Level, Velocity and Flow Hydrographs

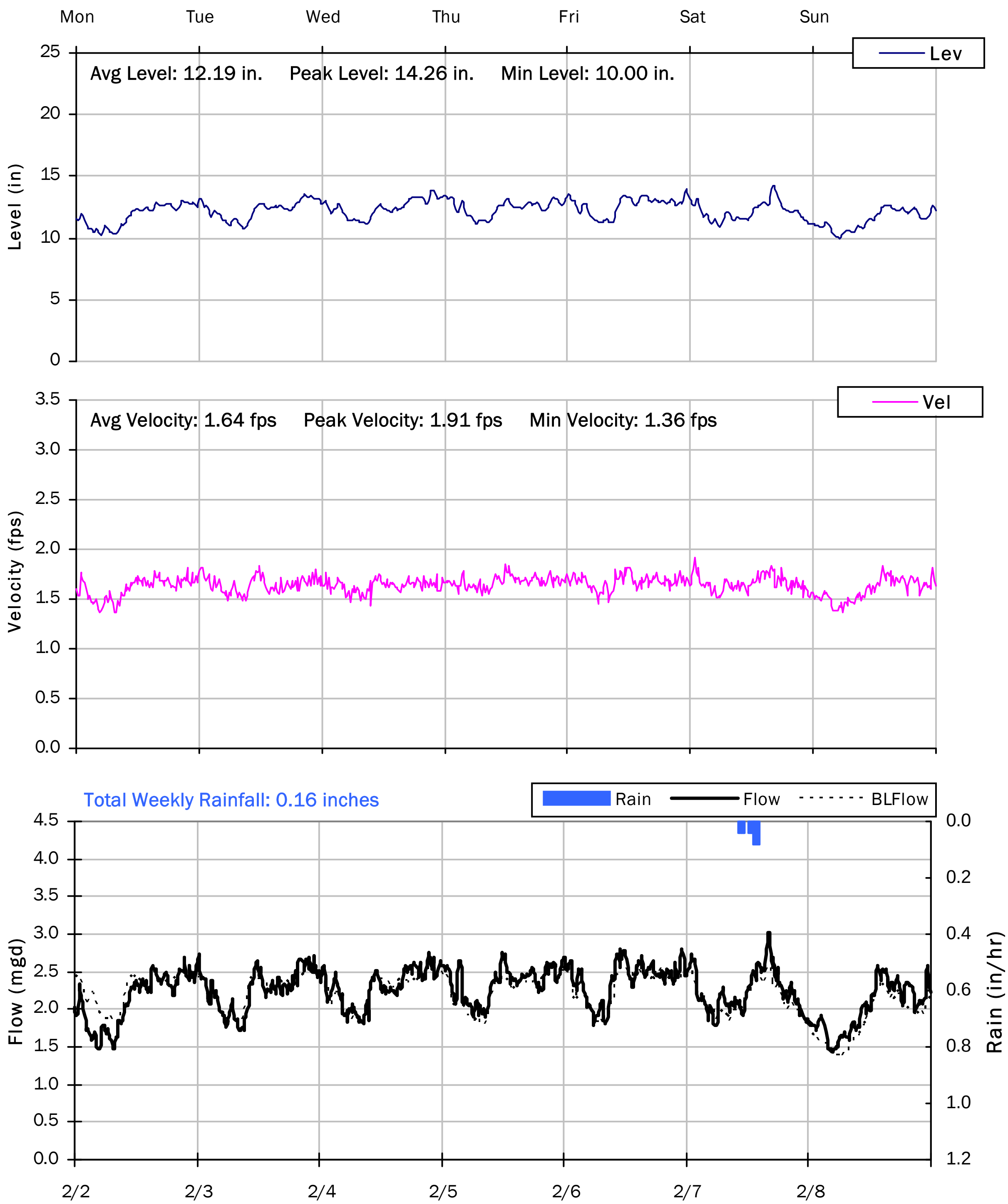
1/26/2015 to 2/2/2015



SITE 2

Weekly Level, Velocity and Flow Hydrographs

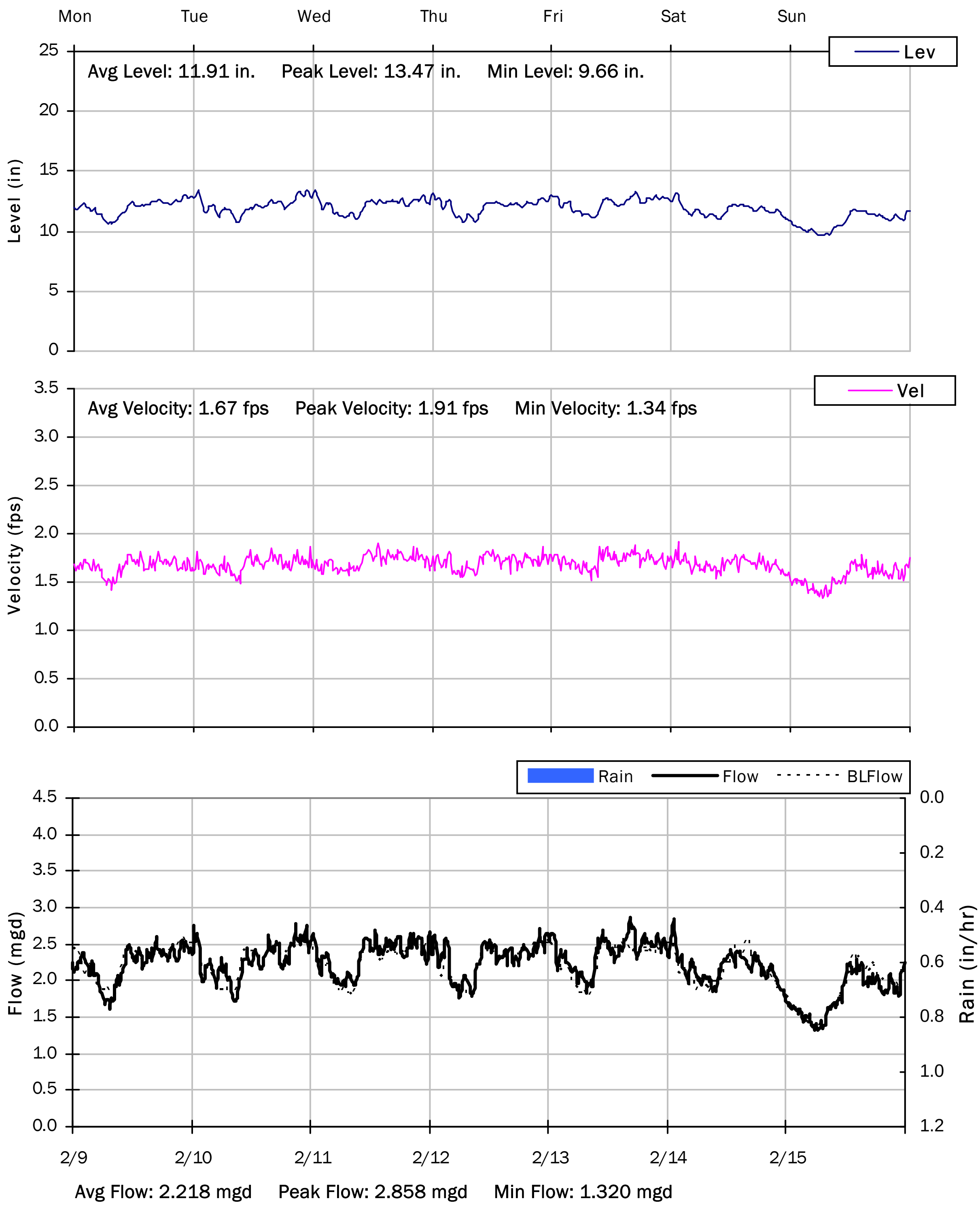
2/2/2015 to 2/9/2015



Avg Flow: 2.245 mgd Peak Flow: 3.027 mgd Min Flow: 1.432 mgd

SITE 2

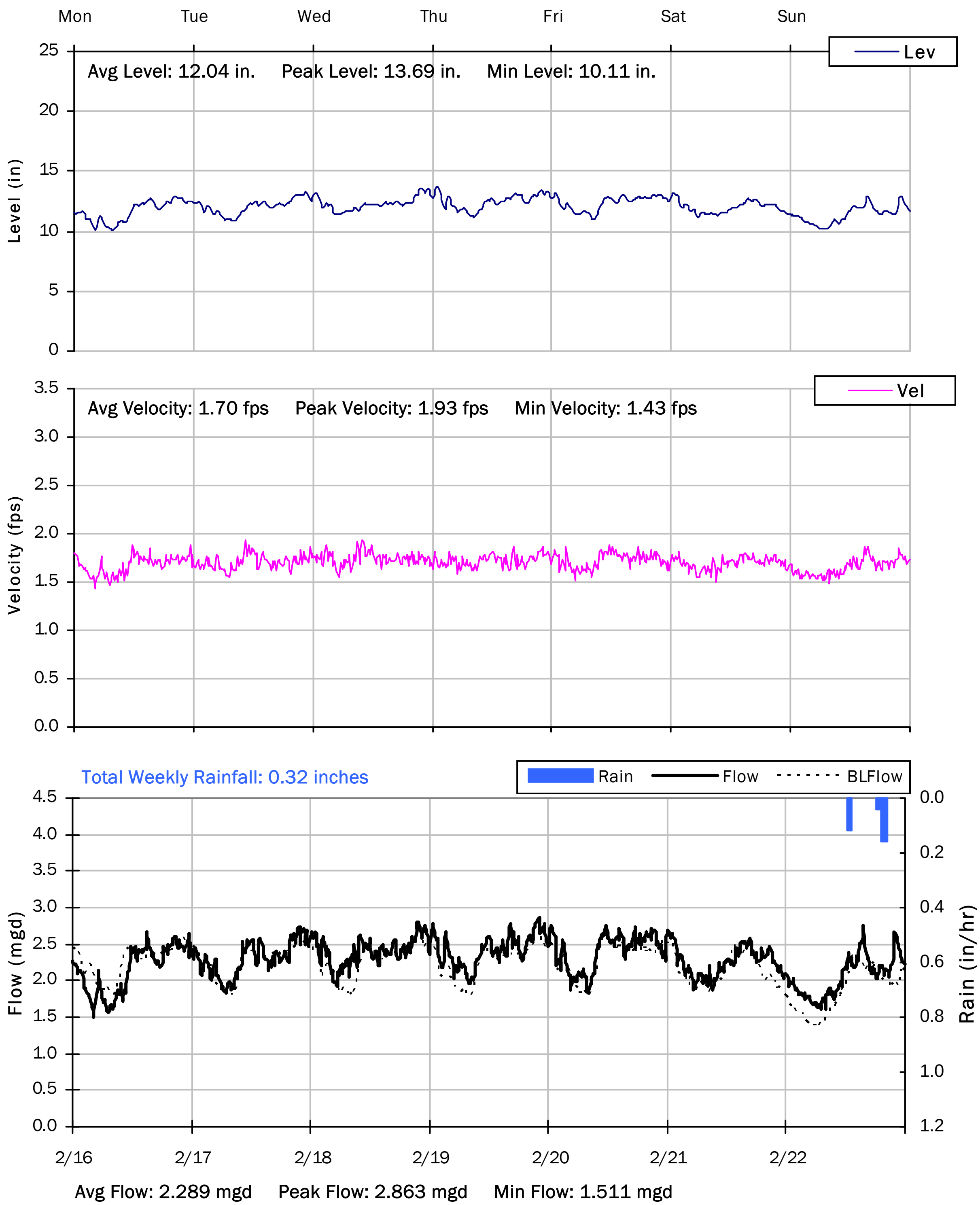
Weekly Level, Velocity and Flow Hydrographs
2/9/2015 to 2/16/2015



SITE 2

Weekly Level, Velocity and Flow Hydrographs

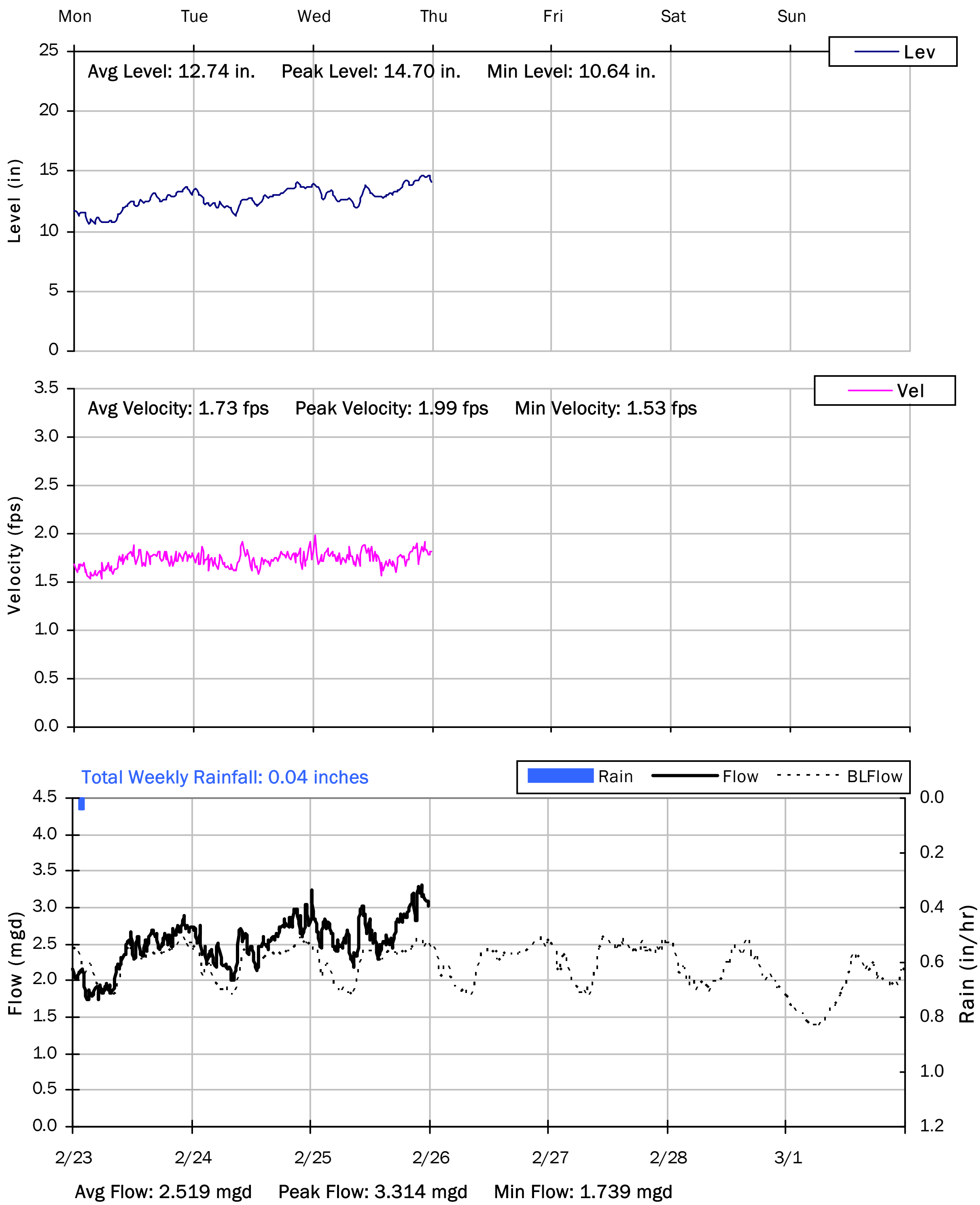
2/16/2015 to 2/23/2015



SITE 2

Weekly Level, Velocity and Flow Hydrographs

2/23/2015 to 3/2/2015



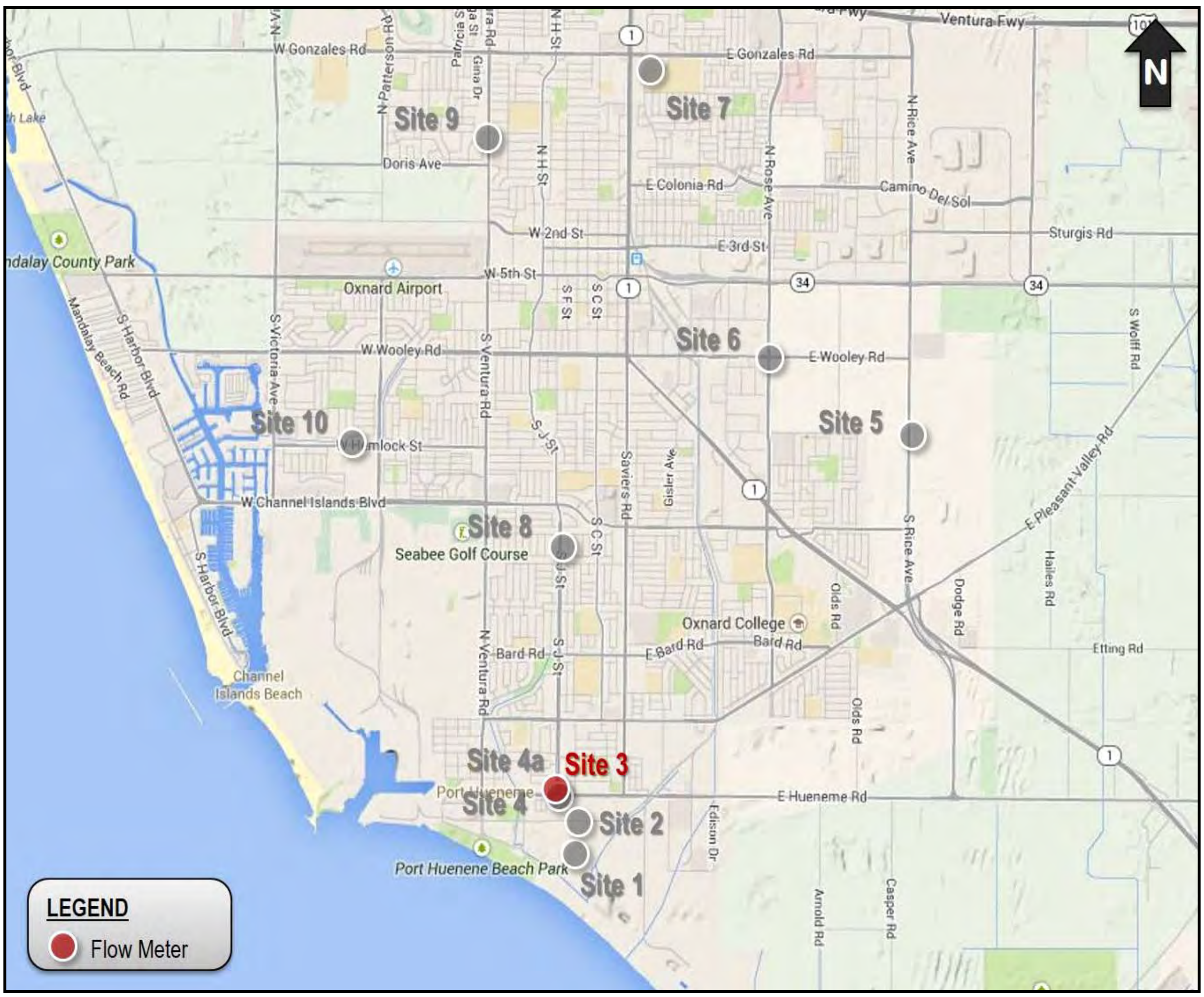
City of Oxnard

Sanitary Sewer Flow Monitoring
Temporary Monitoring: December, 2014 through February, 2015

Monitoring Site: Site 3

Location: J Street and E Port Hueneme Road

Data Summary Report



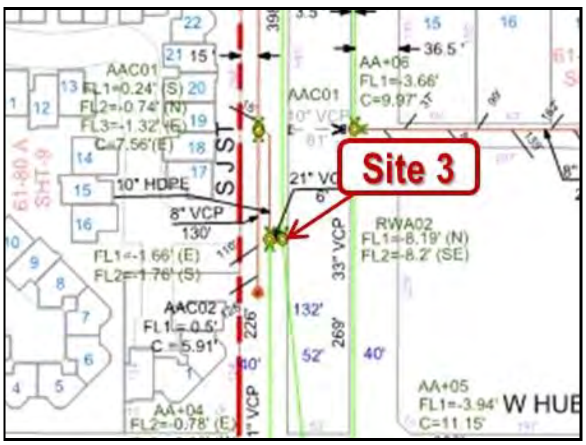
Vicinity Map: Site 3

SITE 3

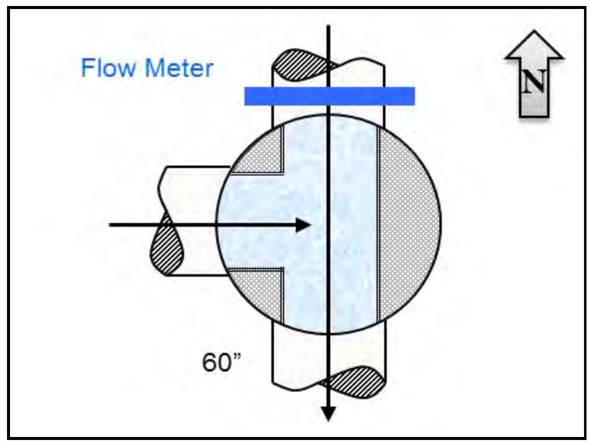
Site Information

Location:	J Street and E Port Hueneme Road
Coordinates:	119.1862° W, 34.1481° N
Rim Elevation:	13 feet
Pipe Diameter:	60 inches
Baseline Flow:	6.988 mgd
Peak Measured Flow:	14.352 mgd

Satellite Map



Sanitary Map



Flow Diagram


Street View


Plan View

SITE 3

Additional Site Photos

Effluent Pipe

Influent Pipe

SITE 3

Additional Site Photos

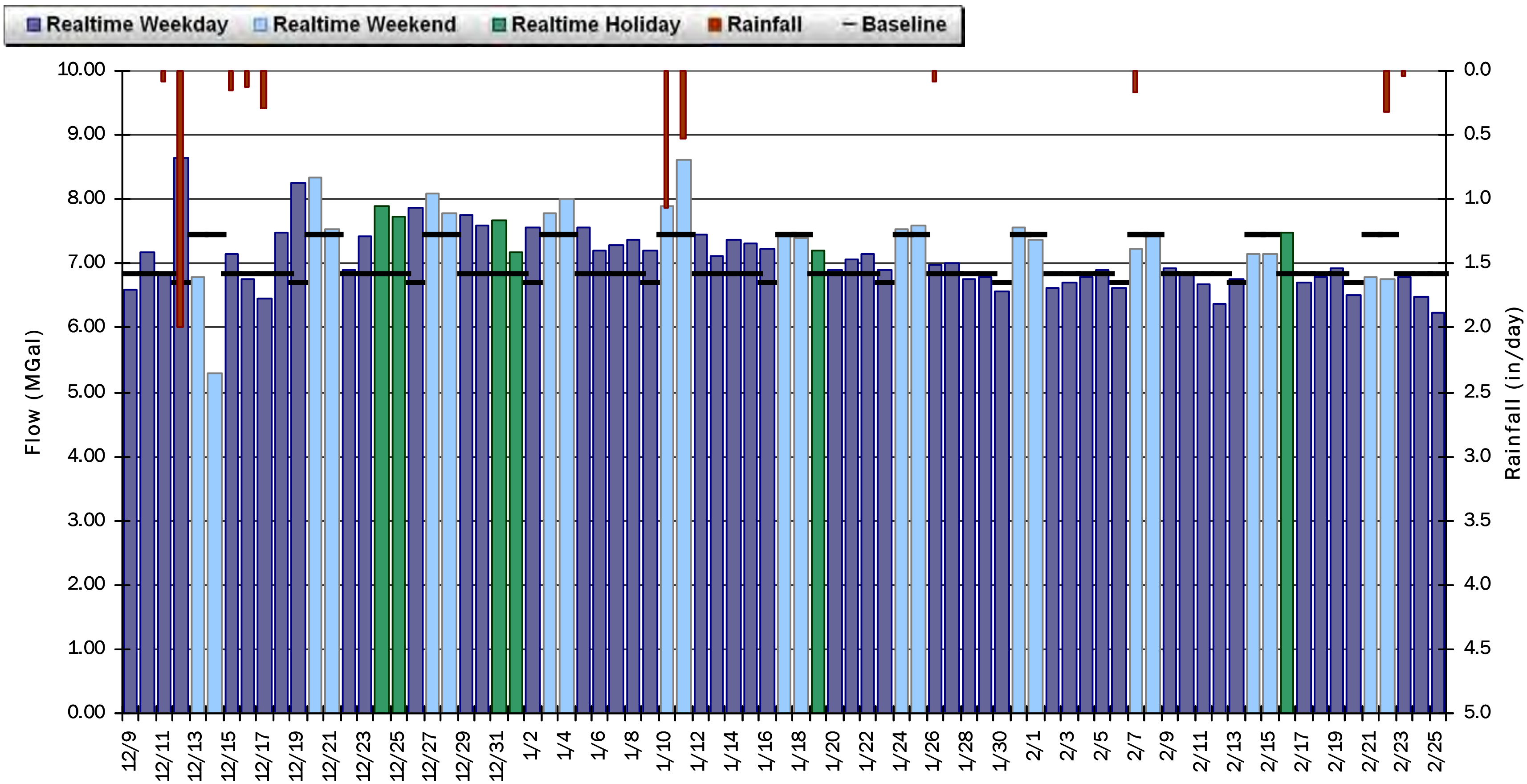
Lateral Pipe

SITE 3

Period Flow Summary: Daily Flow Totals

Avg Period Flow: 7.189 MGal **Peak Daily Flow: 8.648 MGal** **Min Daily Flow: 5.294 MGal**

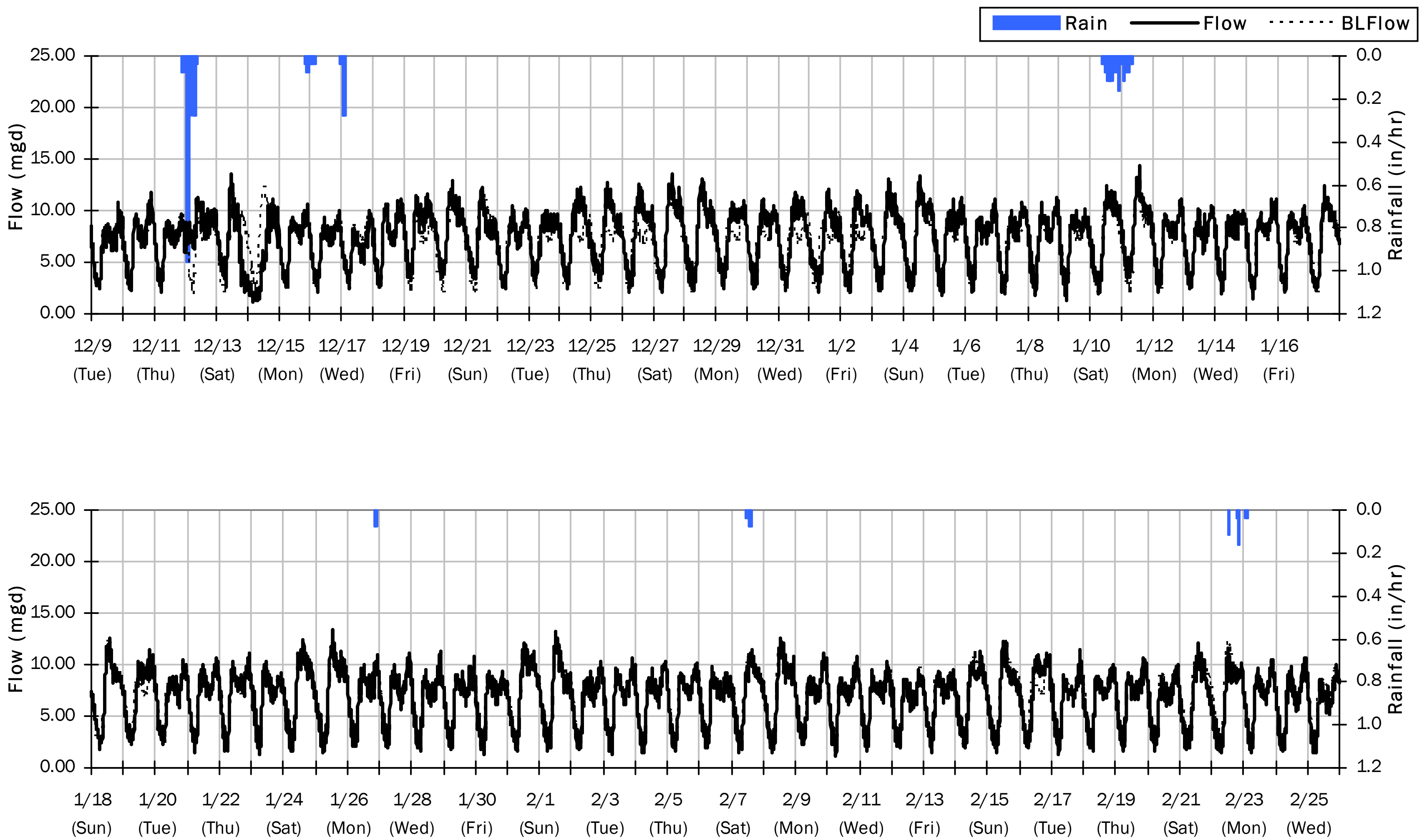
Total Period Rainfall: 4.84 inches



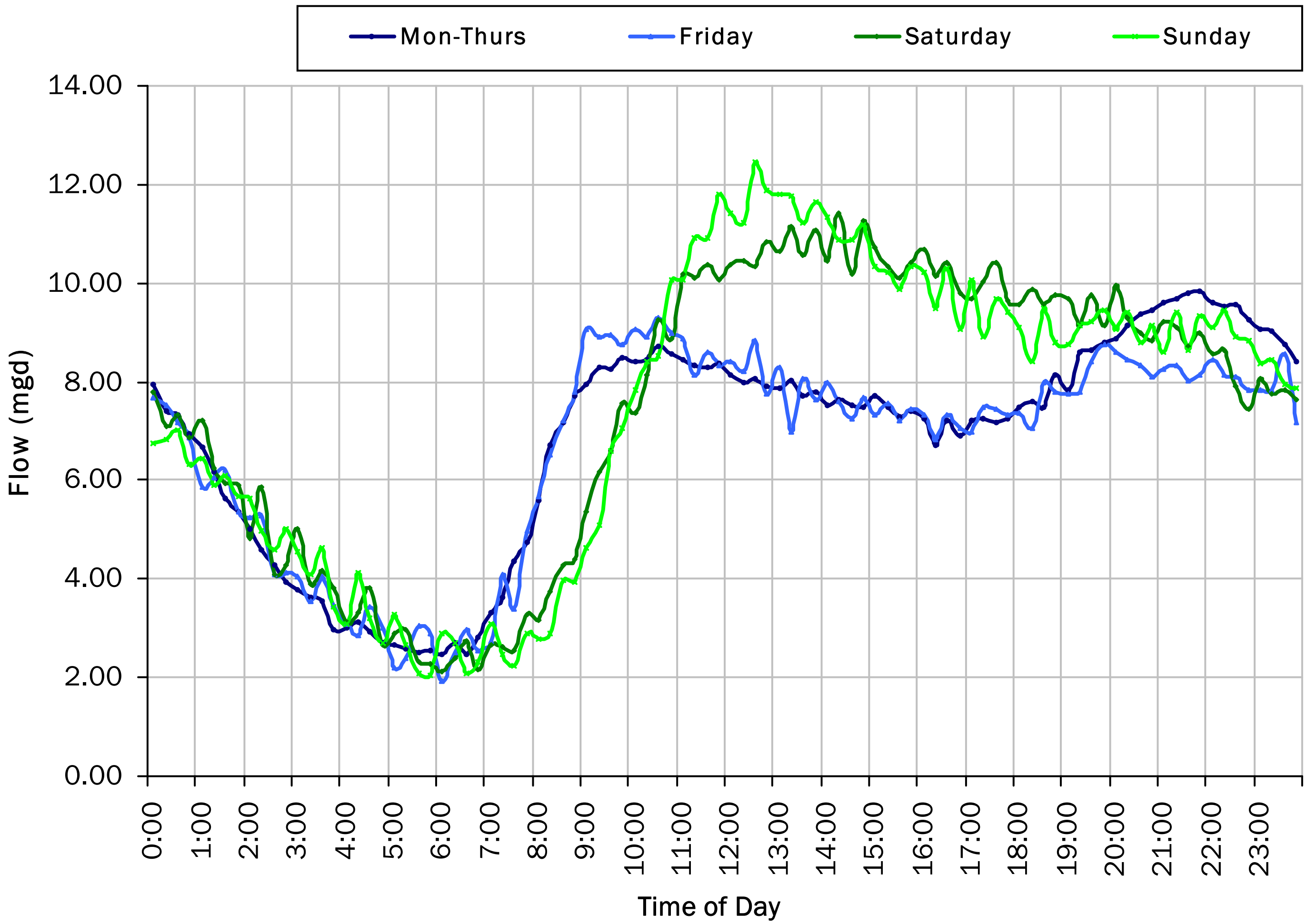
SITE 3

Flow Summary: 12/9/2014 to 2/25/2015

Total Period Rainfall: 4.84 inches   Avg Flow: 7.189 mgd   Peak Flow: 14.352 mgd   Min Flow: 1.162 mgd

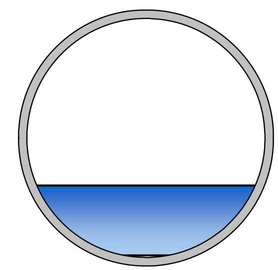


SITE 3
Baseline Flow Hydrographs



Baseline Flow:

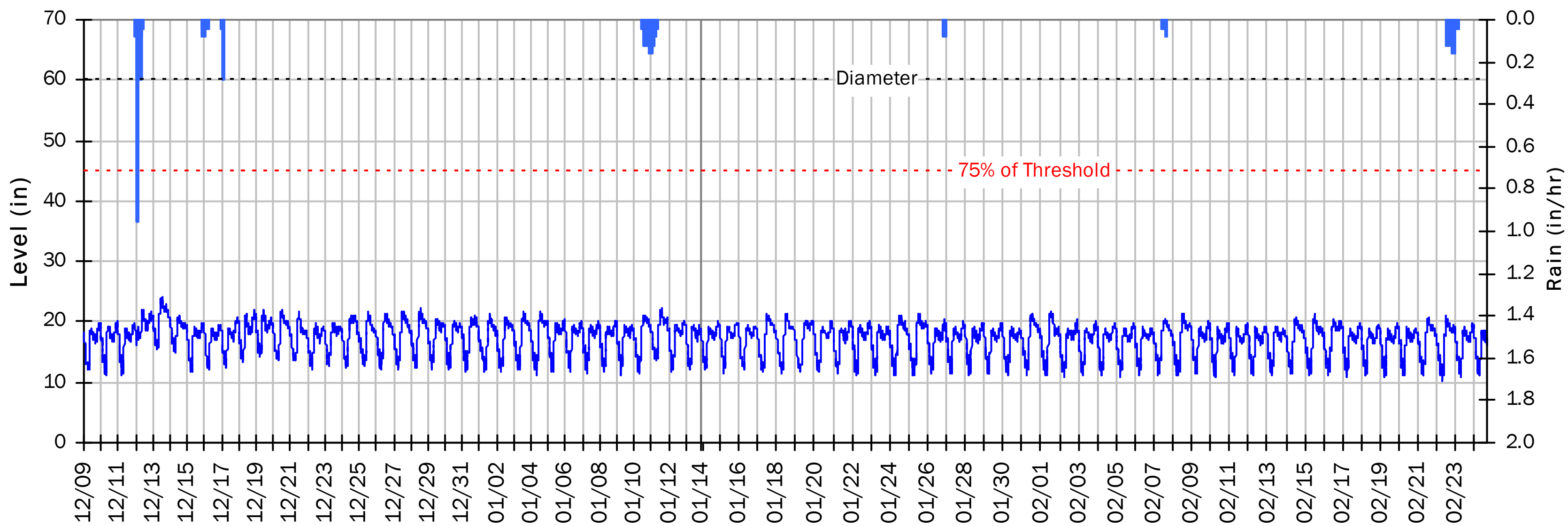
6.99 *mgd*

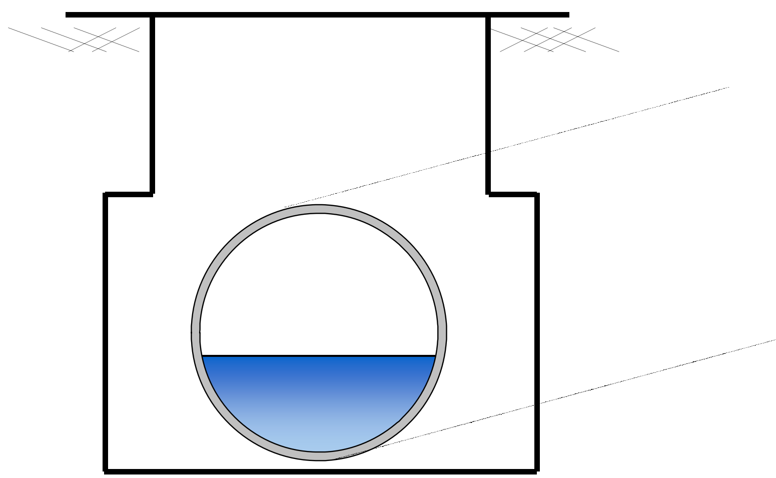


SITE 3

Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Monitoring Period





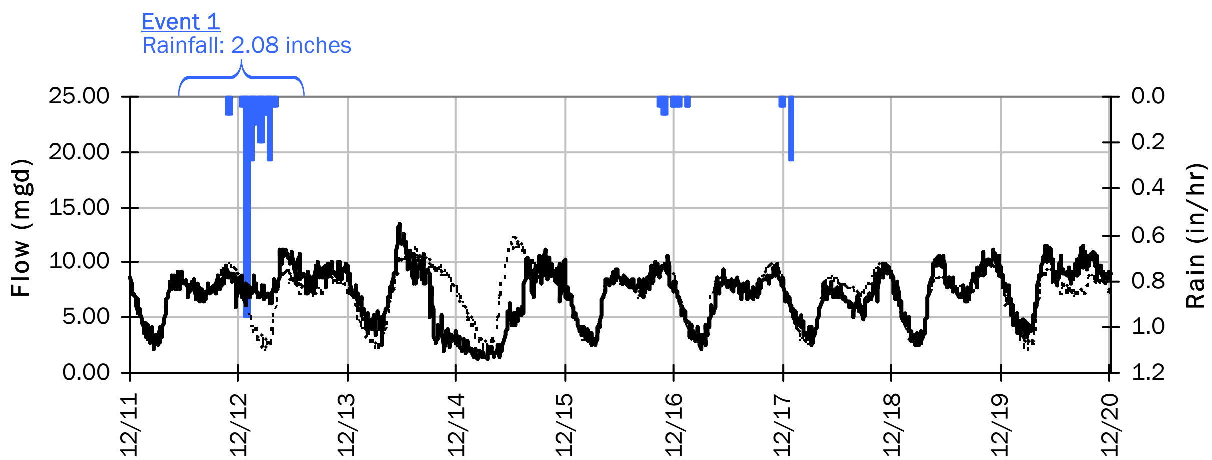
Pipe Diameter: 60 *inches*

Peak Measured Level: 24.1 *inches*

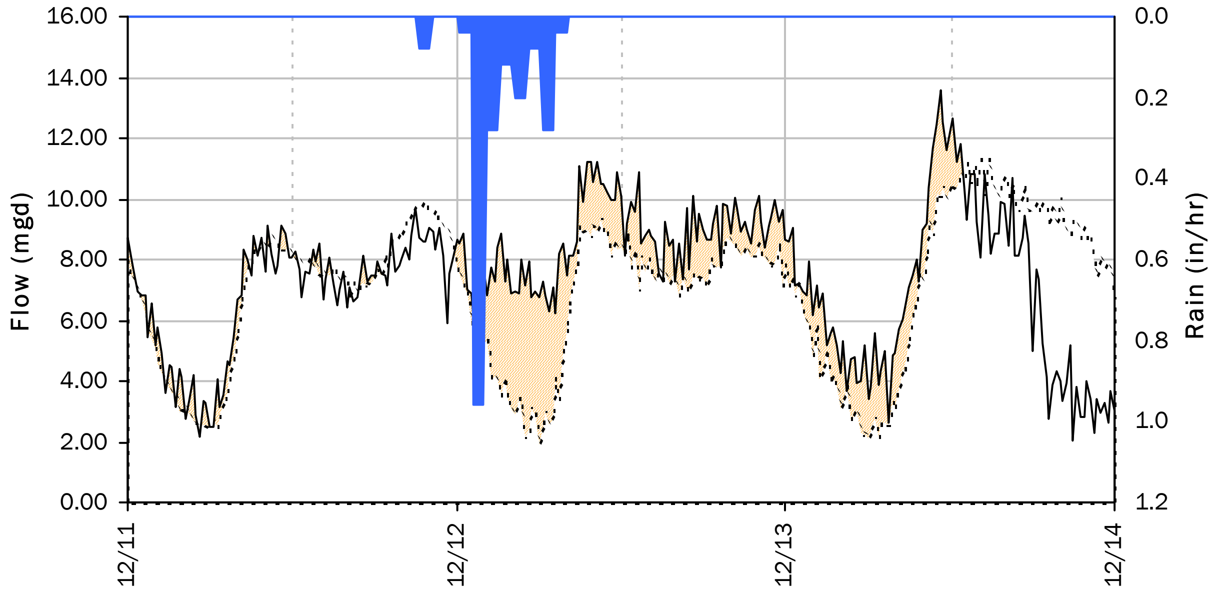
Peak d/D Ratio: 0.40

SITE 3
I/I Summary: Event 1

Baseline and Realtime Flows with Rainfall Data over Monitoring Period



Event 1 Detail Graph

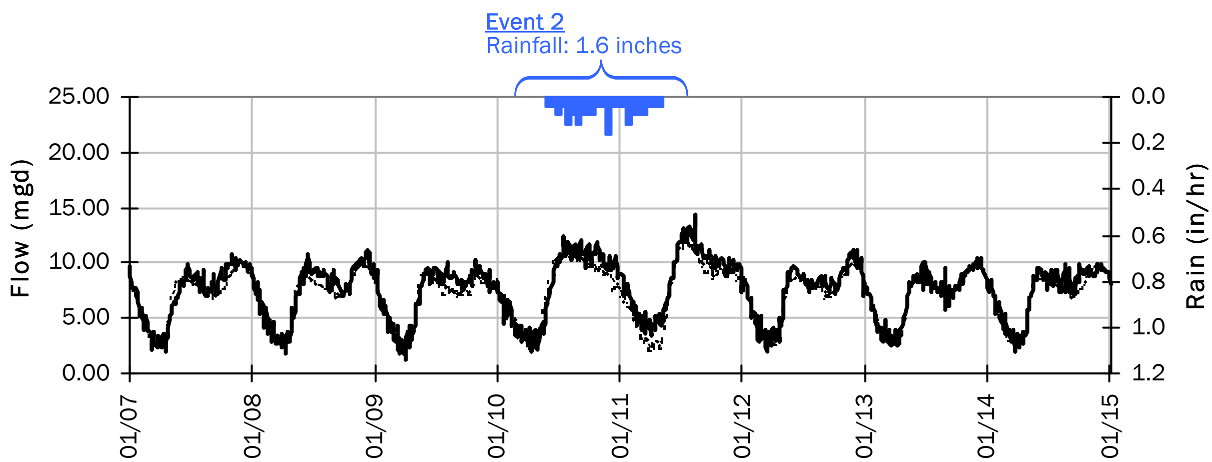


Storm Event I/I Analysis (Rain = 2.08 inches)

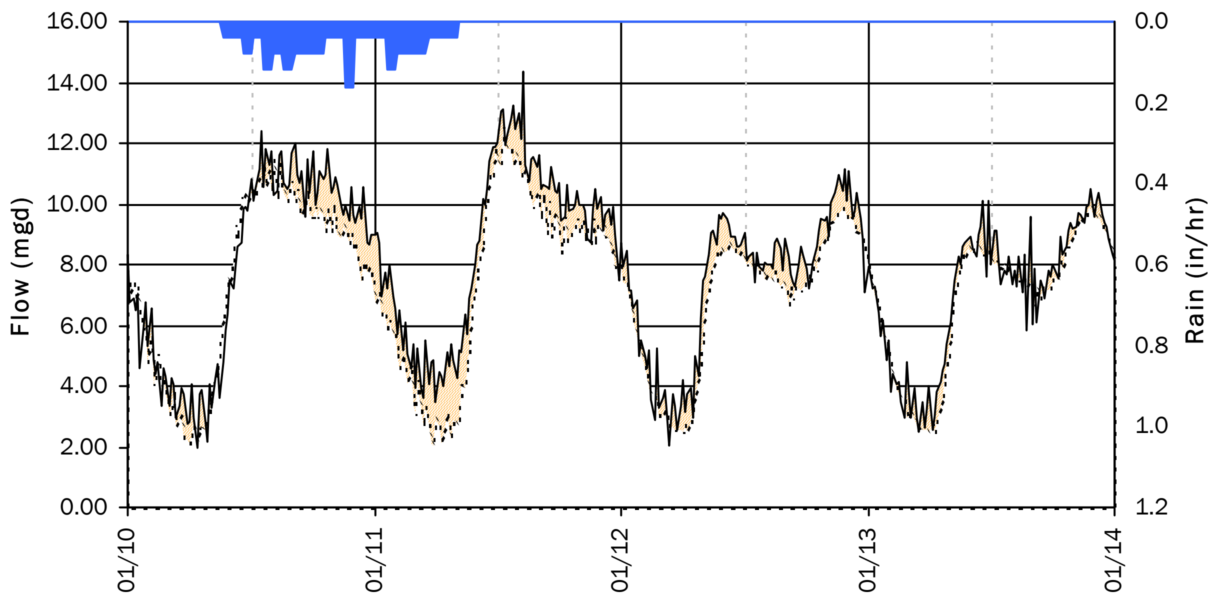
Capacity			Inflow / Infiltration		
Peak Flow:	13.55	*mgd*	Peak I/I Rate:	5.55	*mgd*
PF:	1.94		Total I/I:	1,174,000	*gallons*
Peak Level:	24.08	*in*			
d/D Ratio:	0.40				

SITE 3
I/I Summary: Event 2

Baseline and Realtime Flows with Rainfall Data over Monitoring Period



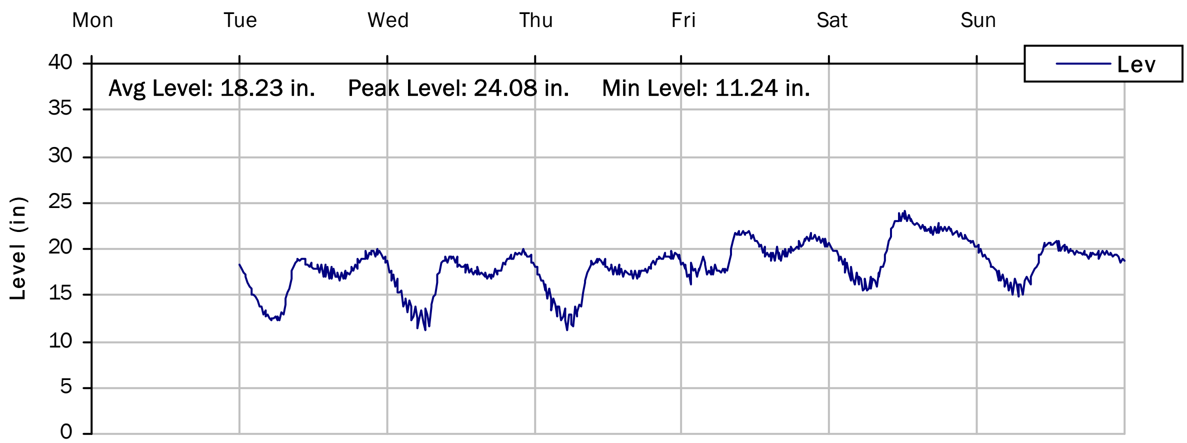
Event 2 Detail Graph

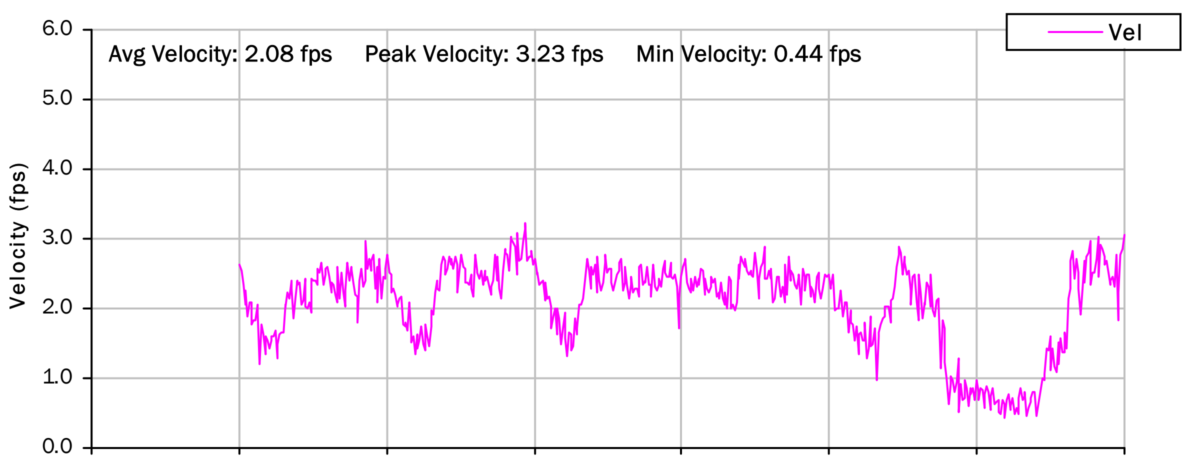


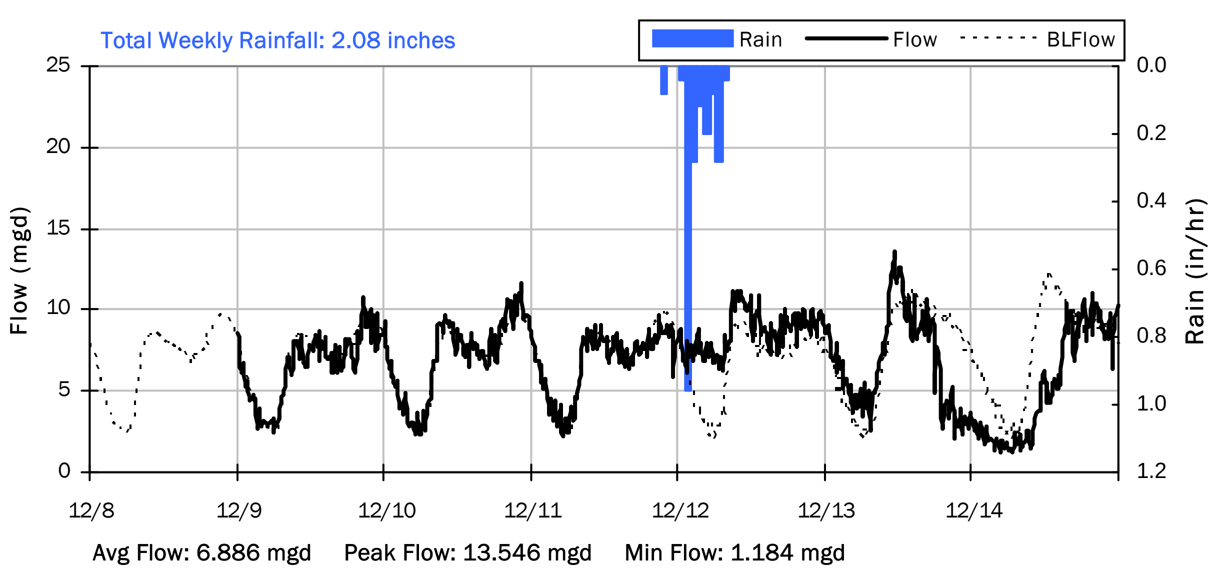
Storm Event I/I Analysis (Rain = 1.60 inches)

Capacity		Inflow / Infiltration	
Peak Flow:	14.35 *mgd*	Peak I/I Rate:	3.46 *mgd*
PF:	2.05	Total I/I:	2,227,000 *gallons*
Peak Level:	22.27 *in*		
d/D Ratio:	0.37		

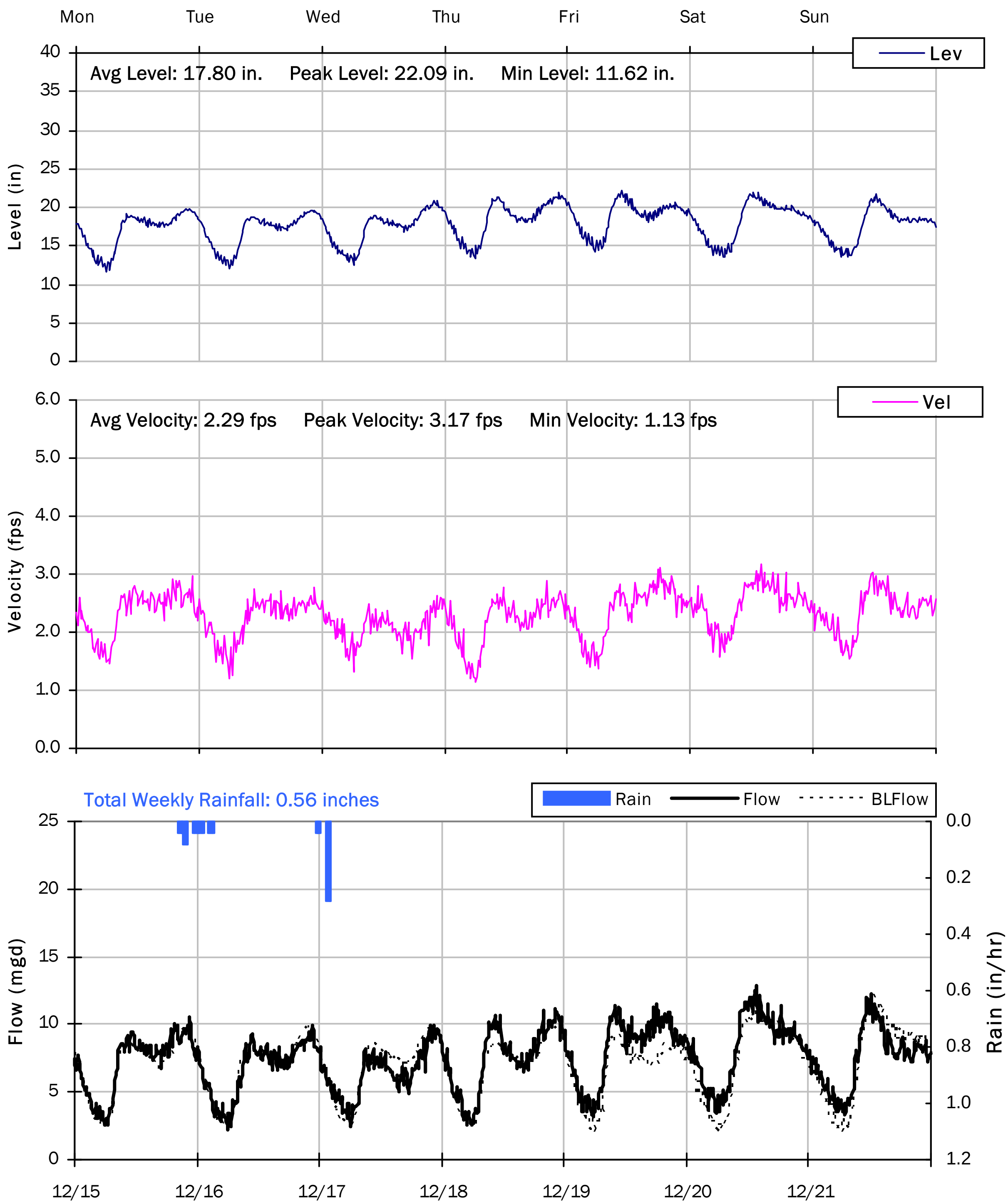
SITE 3
Weekly Level, Velocity and Flow Hydrographs
12/8/2014 to 12/15/2014







SITE 3
Weekly Level, Velocity and Flow Hydrographs
12/15/2014 to 12/22/2014

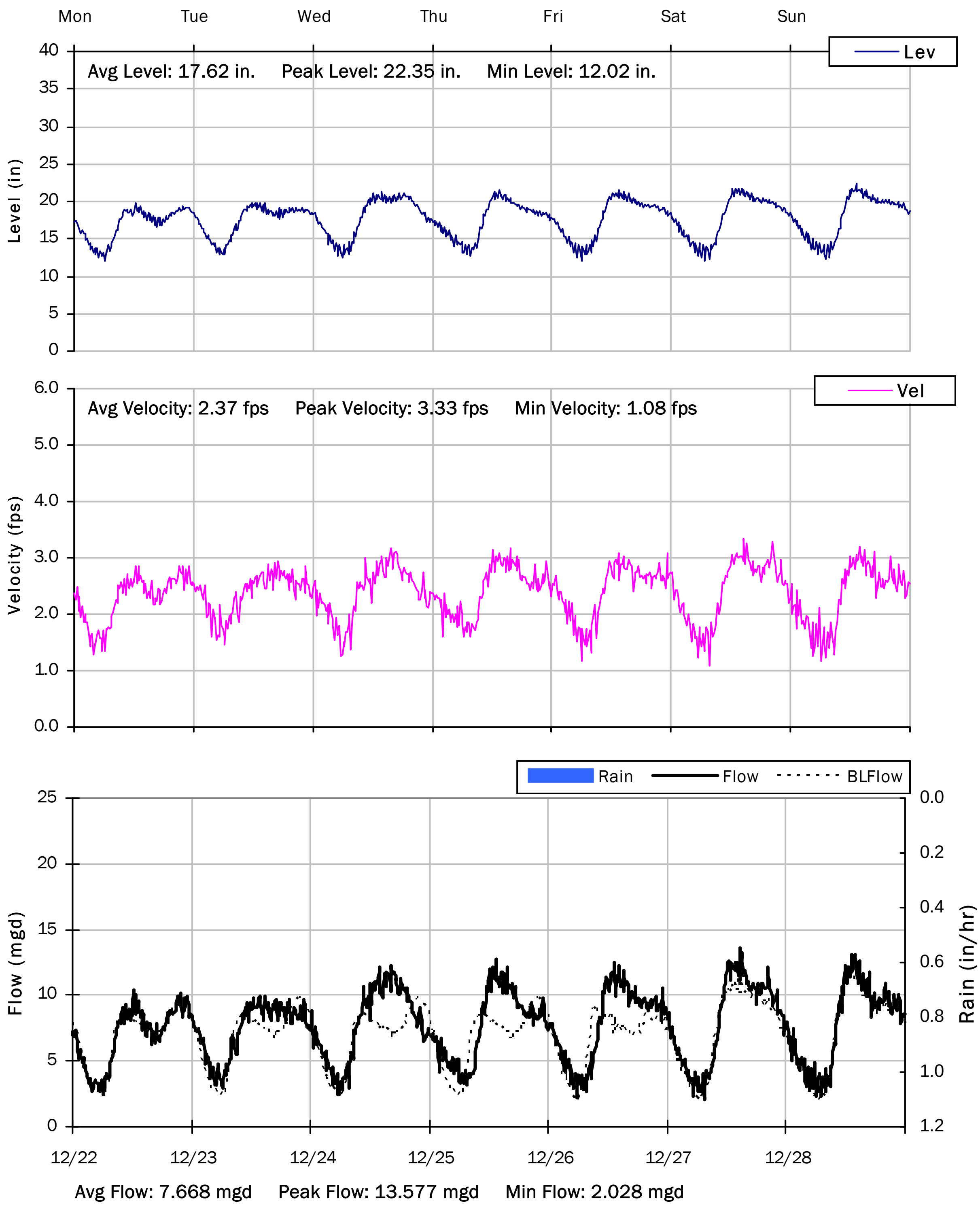


Avg Flow: 7.426 mgd
Peak Flow: 12.844 mgd
Min Flow: 2.171 mgd

SITE 3

Weekly Level, Velocity and Flow Hydrographs

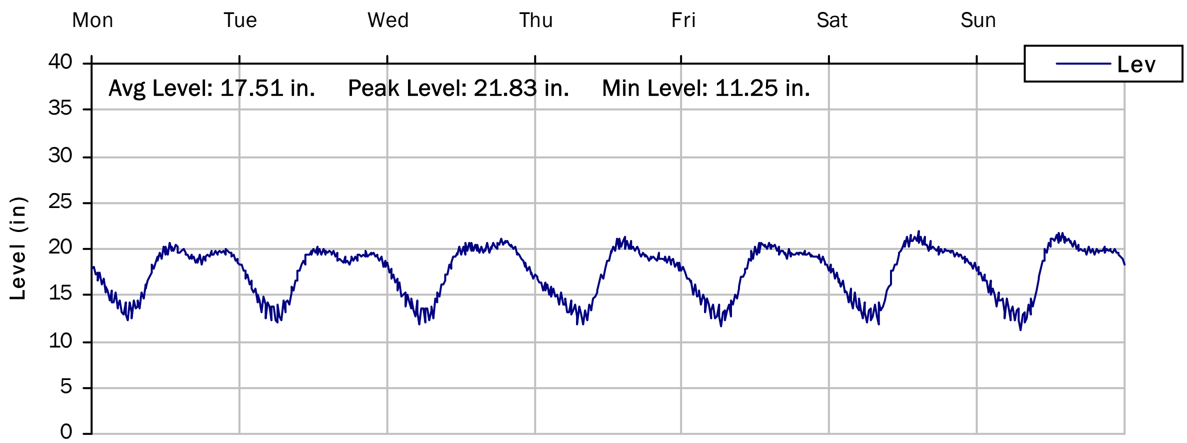
12/22/2014 to 12/29/2014

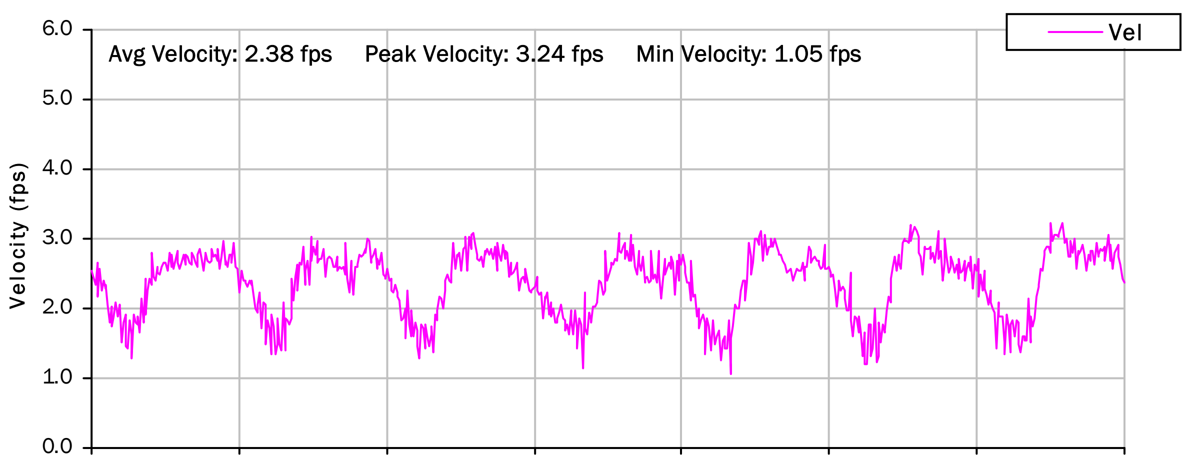


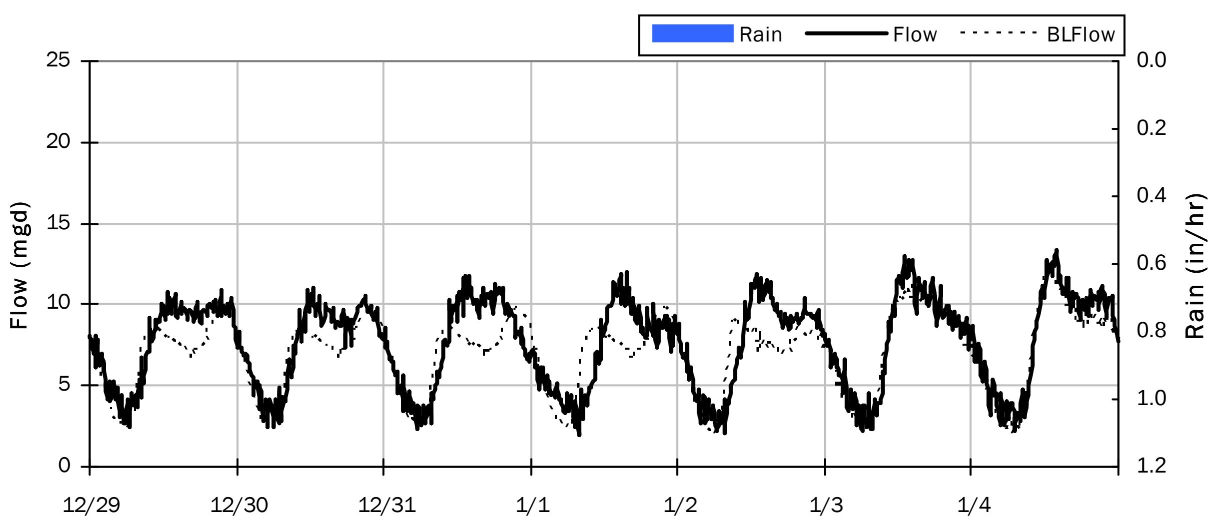
SITE 3

Weekly Level, Velocity and Flow Hydrographs

12/29/2014 to 1/5/2015





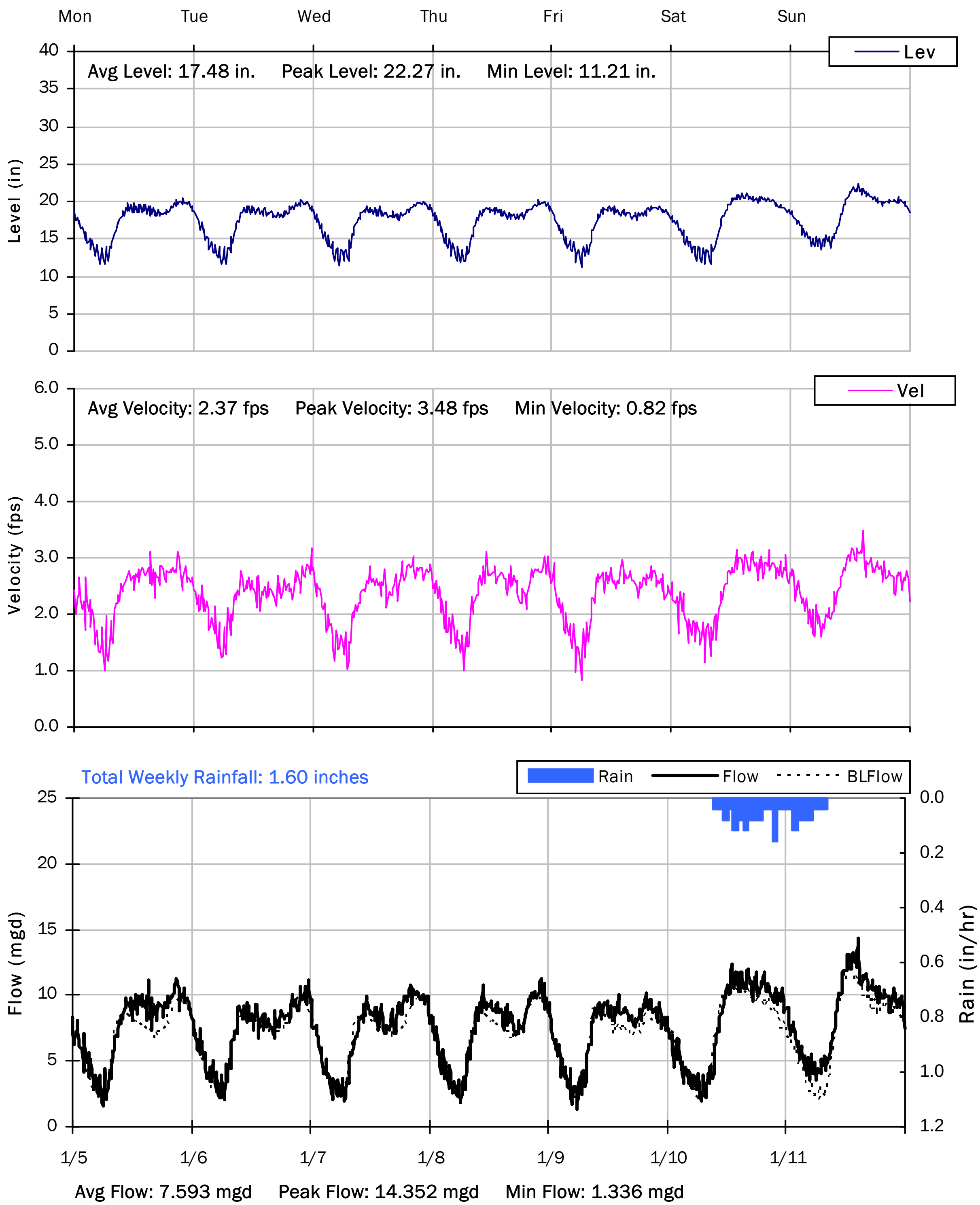


Avg Flow: 7.647 mgd Peak Flow: 13.378 mgd Min Flow: 2.020 mgd

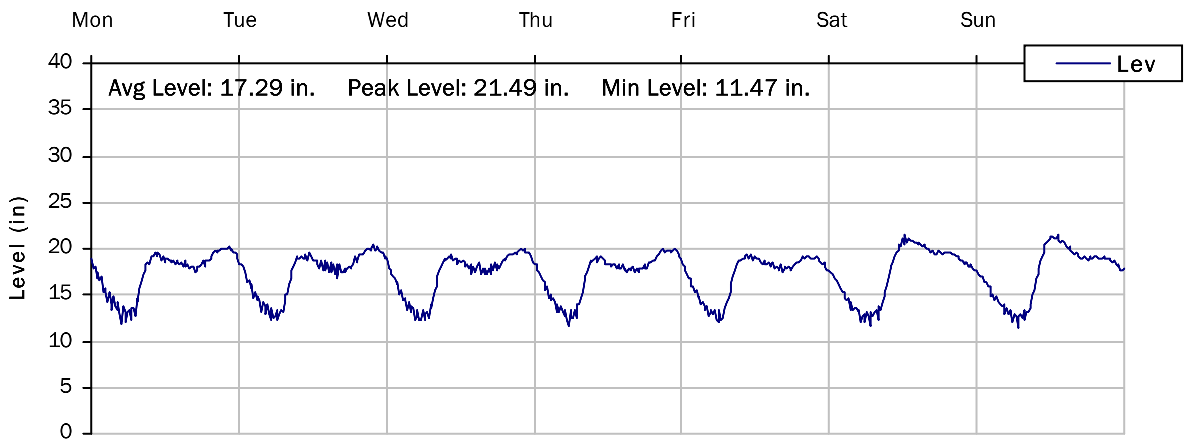
SITE 3

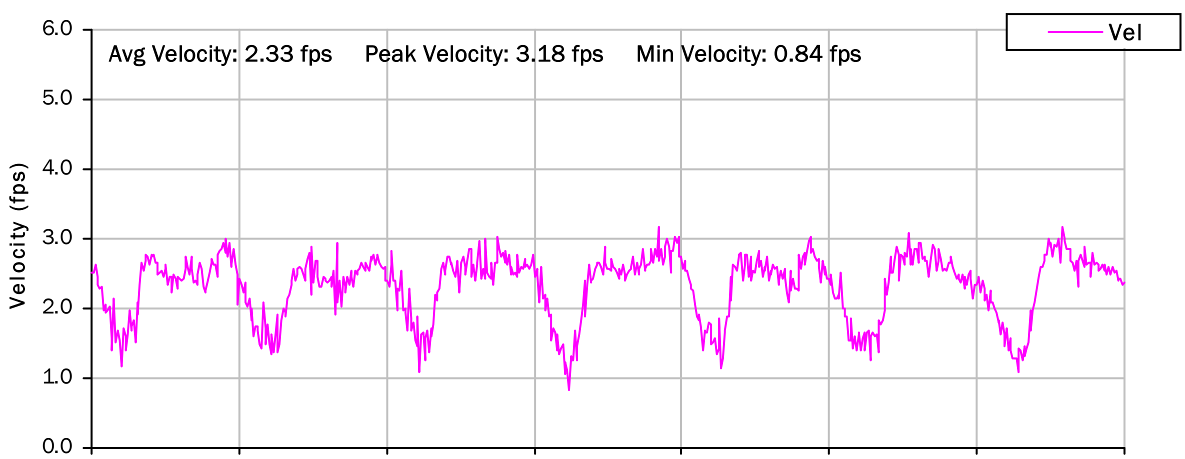
Weekly Level, Velocity and Flow Hydrographs

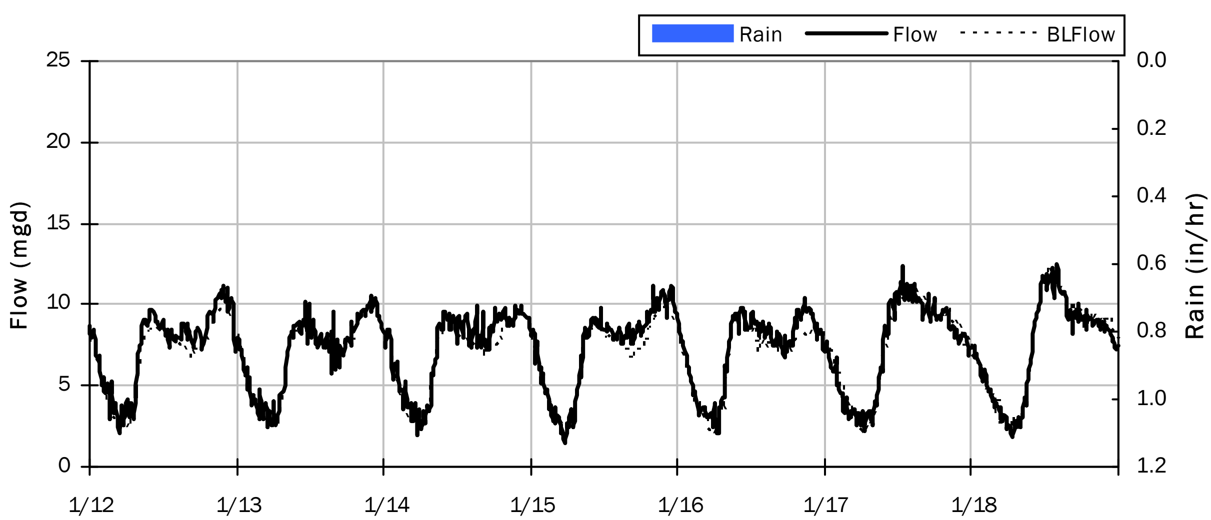
1/5/2015 to 1/12/2015



SITE 3
Weekly Level, Velocity and Flow Hydrographs
1/12/2015 to 1/19/2015

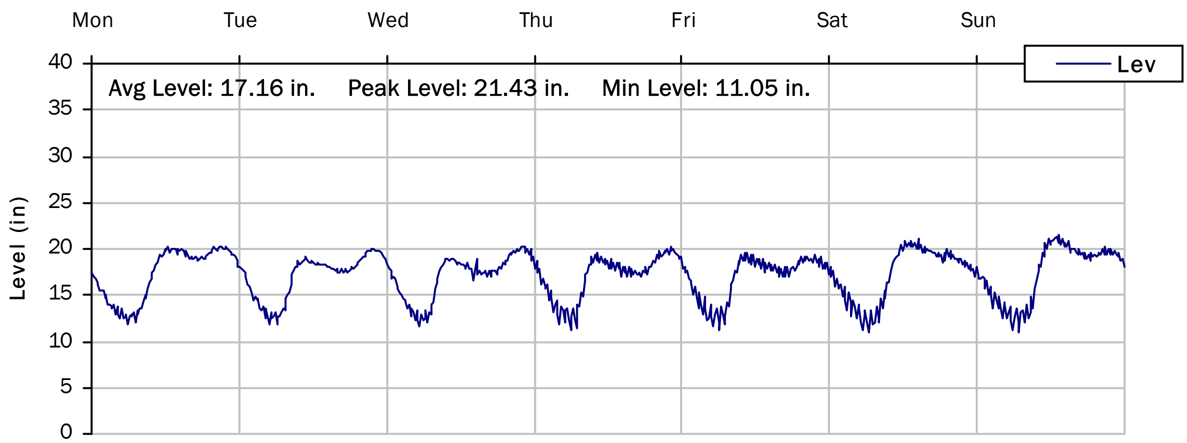


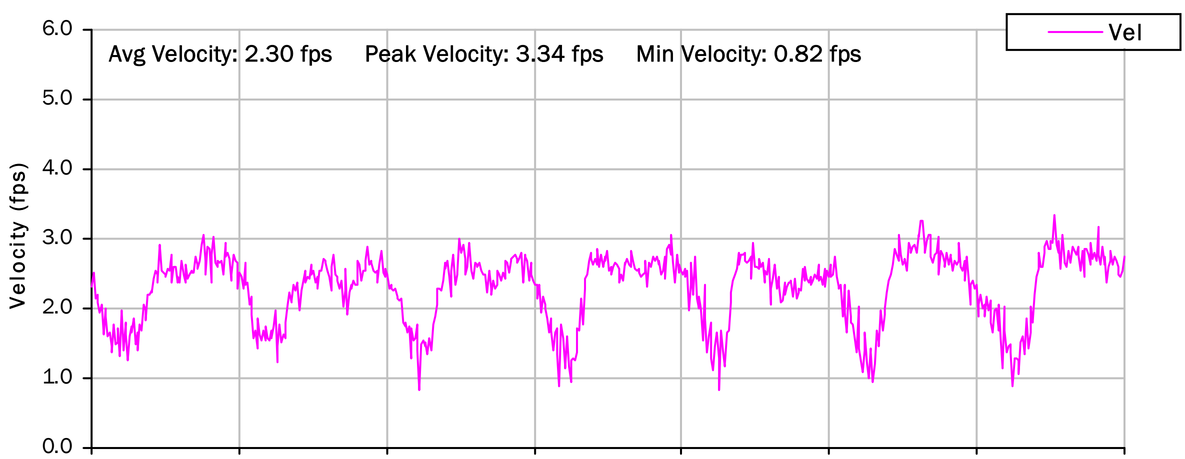


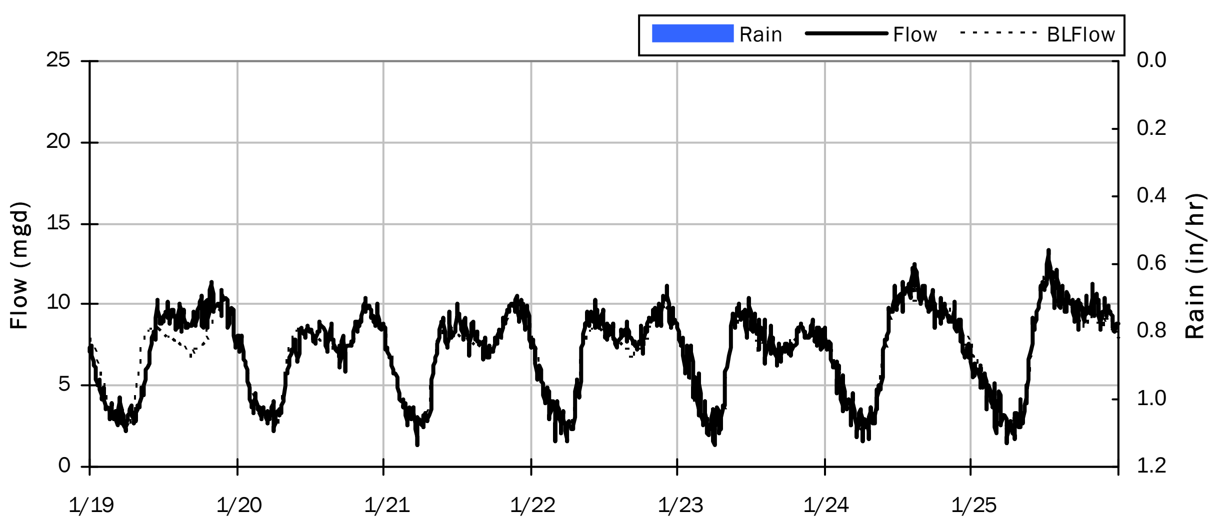


Avg Flow: 7.328 mgd Peak Flow: 12.548 mgd Min Flow: 1.435 mgd

SITE 3
Weekly Level, Velocity and Flow Hydrographs
1/19/2015 to 1/26/2015

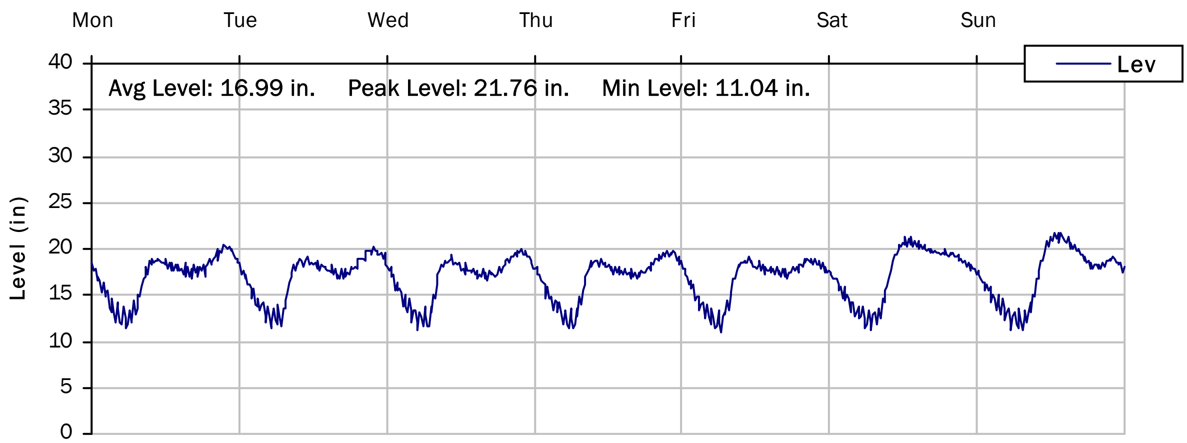


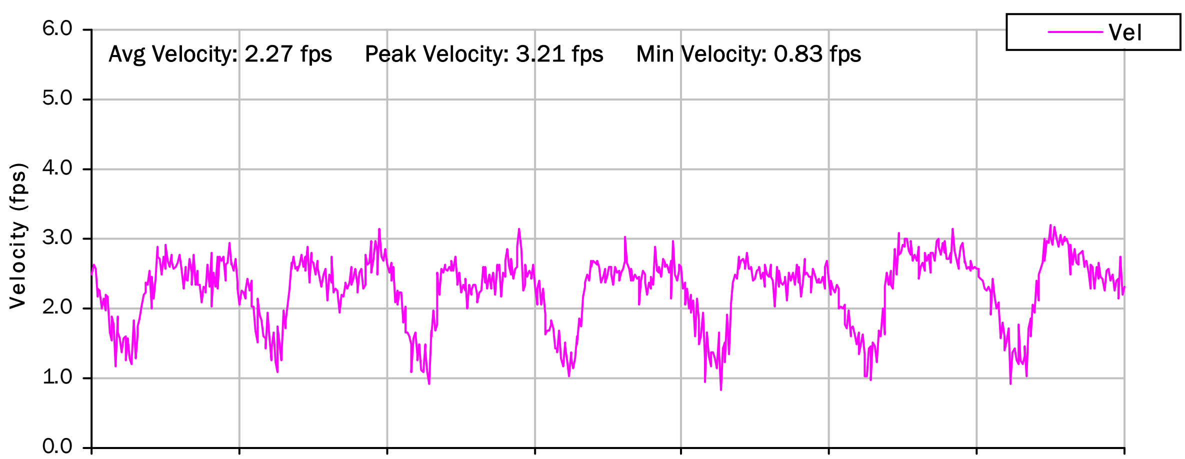


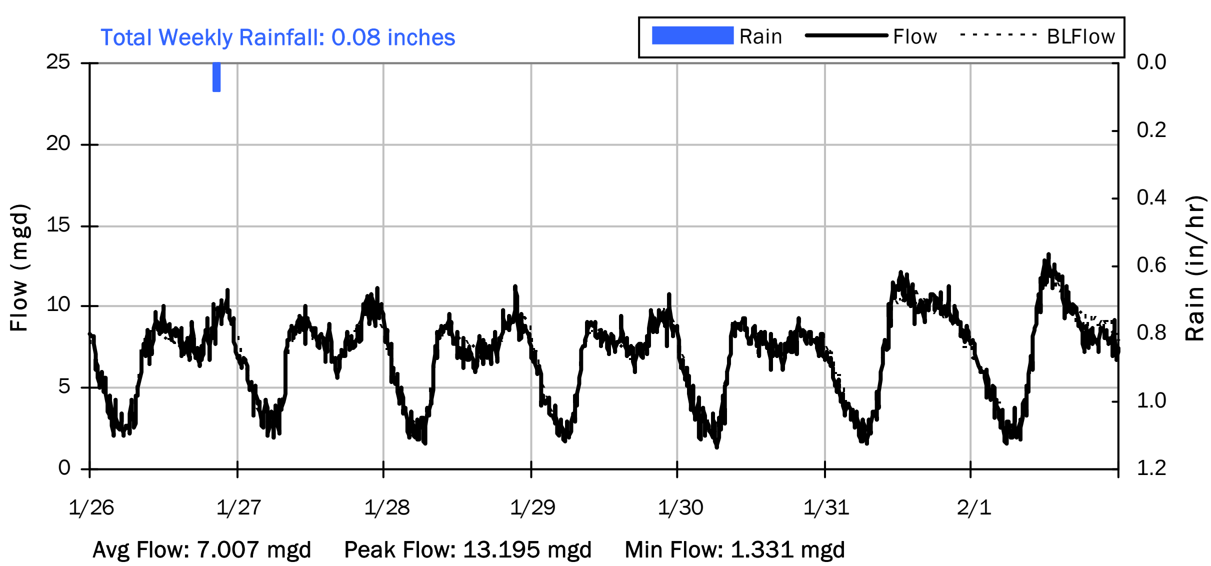


Avg Flow: 7.191 mgd Peak Flow: 13.318 mgd Min Flow: 1.363 mgd

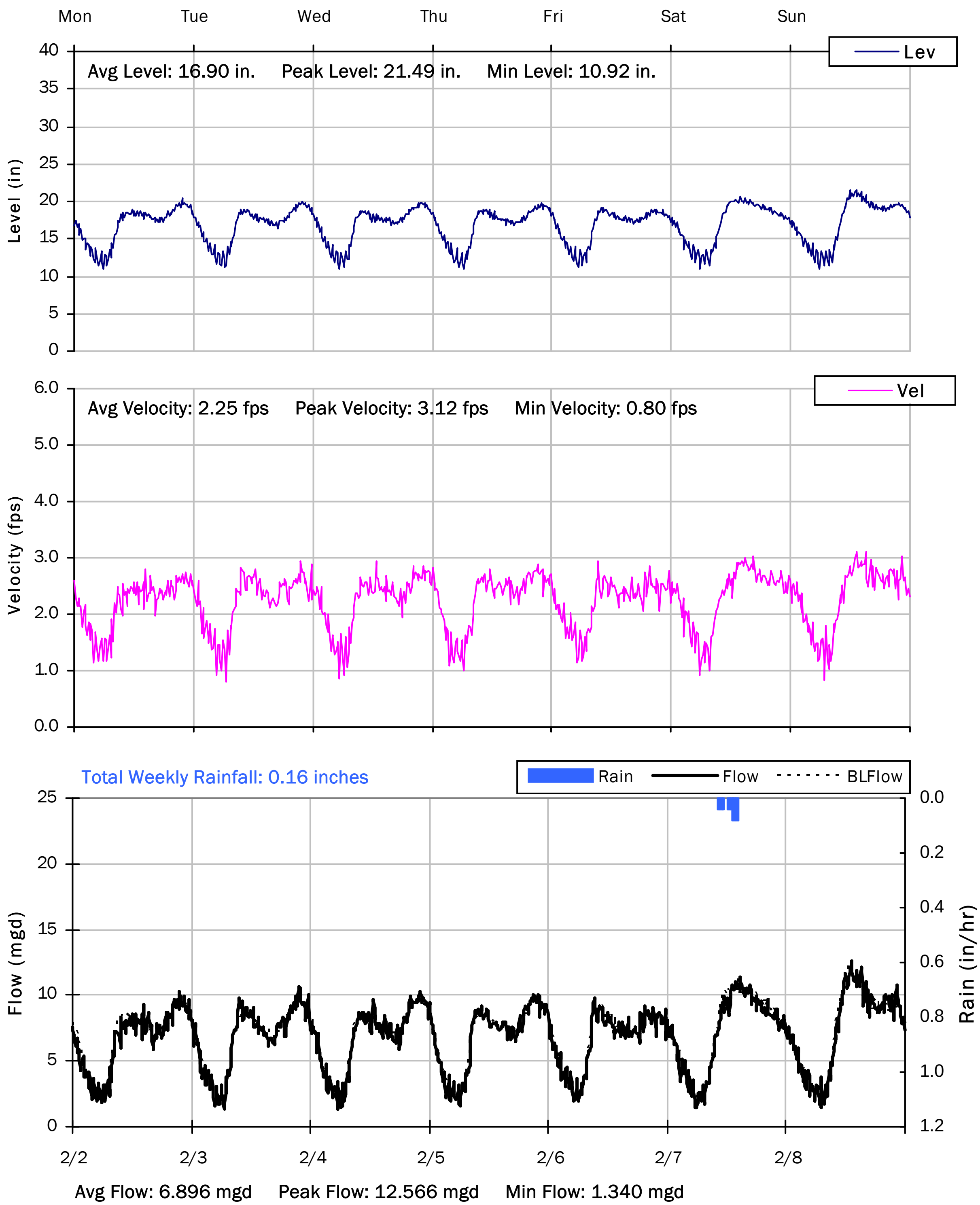
SITE 3
Weekly Level, Velocity and Flow Hydrographs
1/26/2015 to 2/2/2015







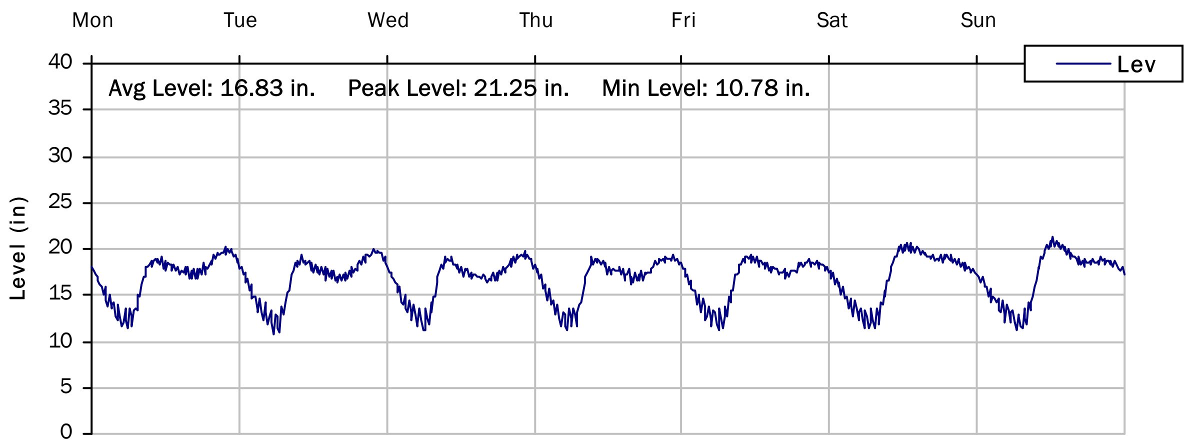
SITE 3
Weekly Level, Velocity and Flow Hydrographs
2/2/2015 to 2/9/2015

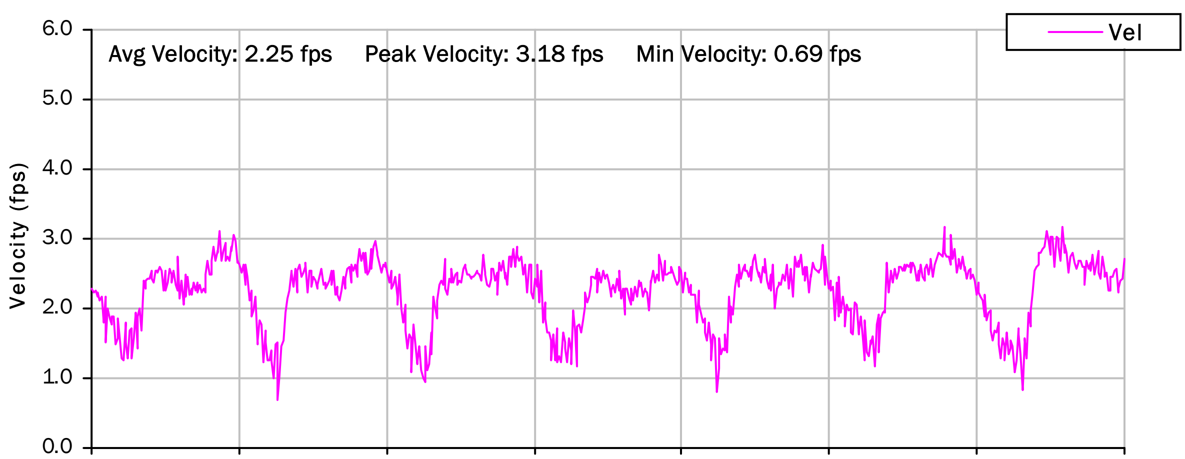


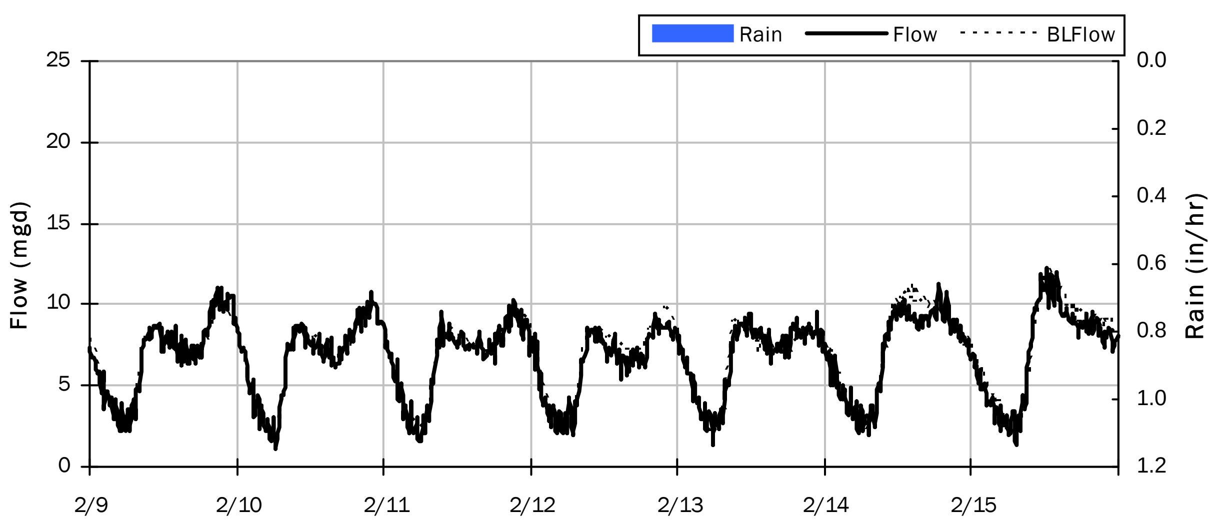
SITE 3

Weekly Level, Velocity and Flow Hydrographs

2/9/2015 to 2/16/2015





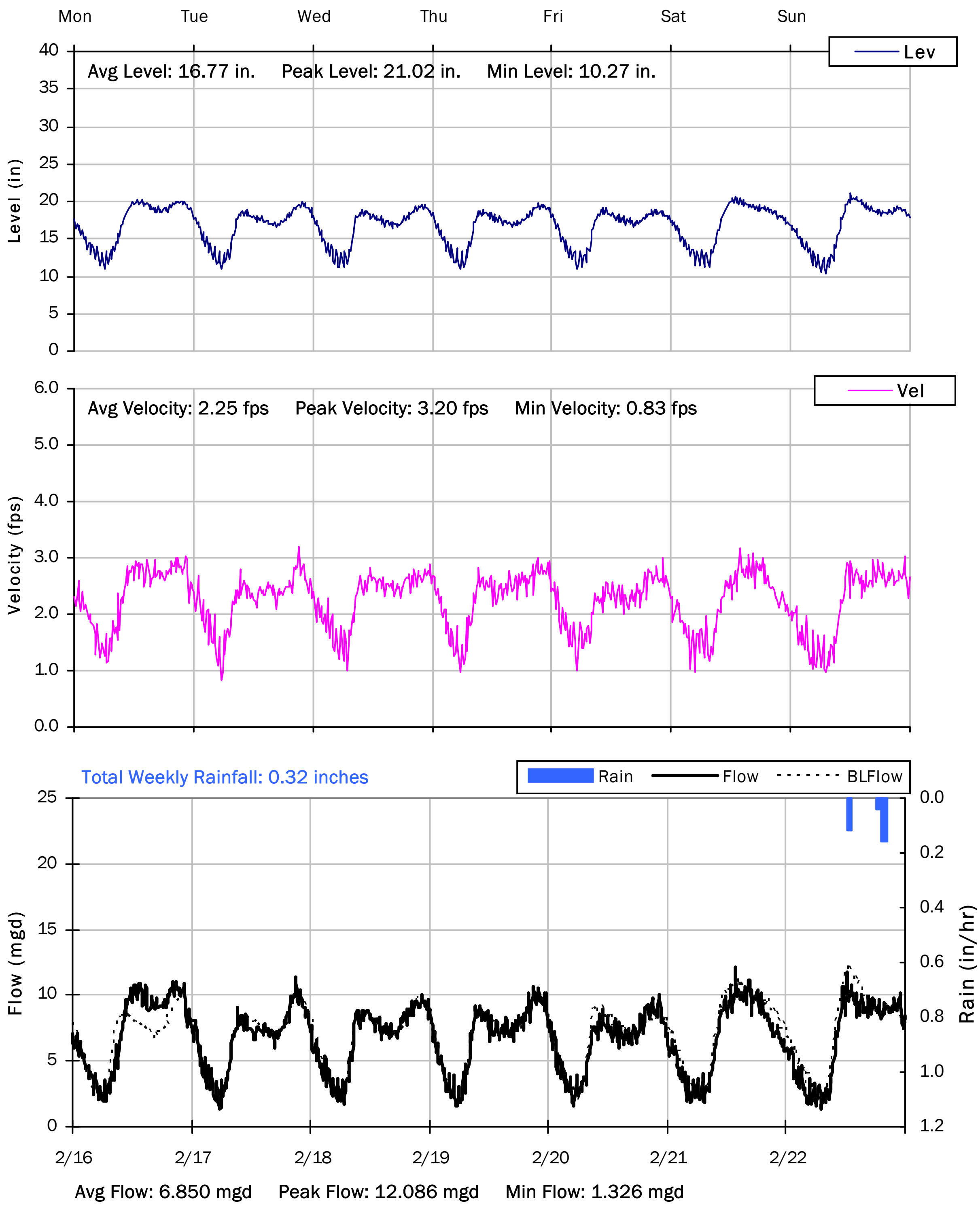


Avg Flow: 6.836 mgd   Peak Flow: 12.235 mgd   Min Flow: 1.162 mgd

SITE 3

Weekly Level, Velocity and Flow Hydrographs

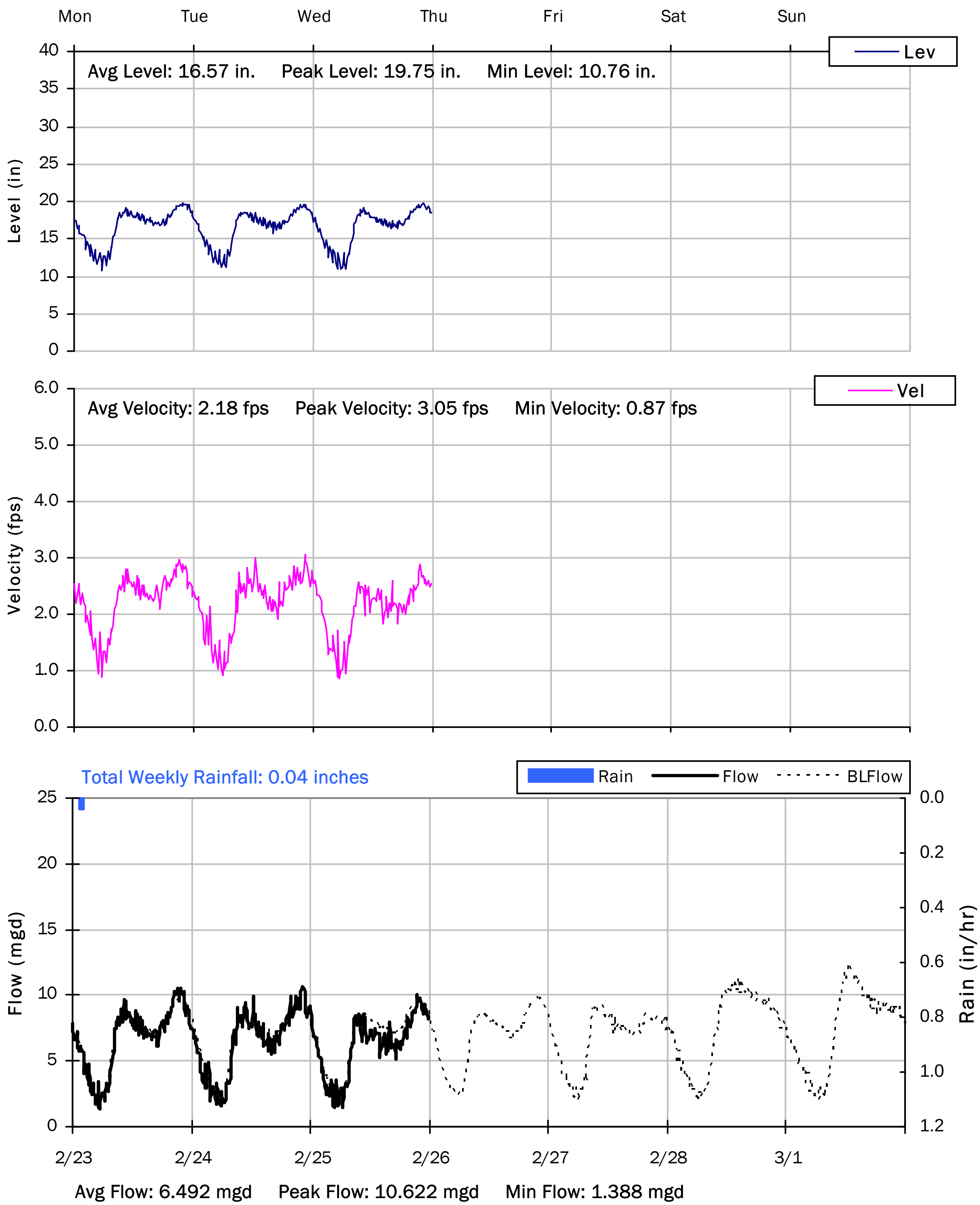
2/16/2015 to 2/23/2015



SITE 3

Weekly Level, Velocity and Flow Hydrographs

2/23/2015 to 3/2/2015



City of Oxnard

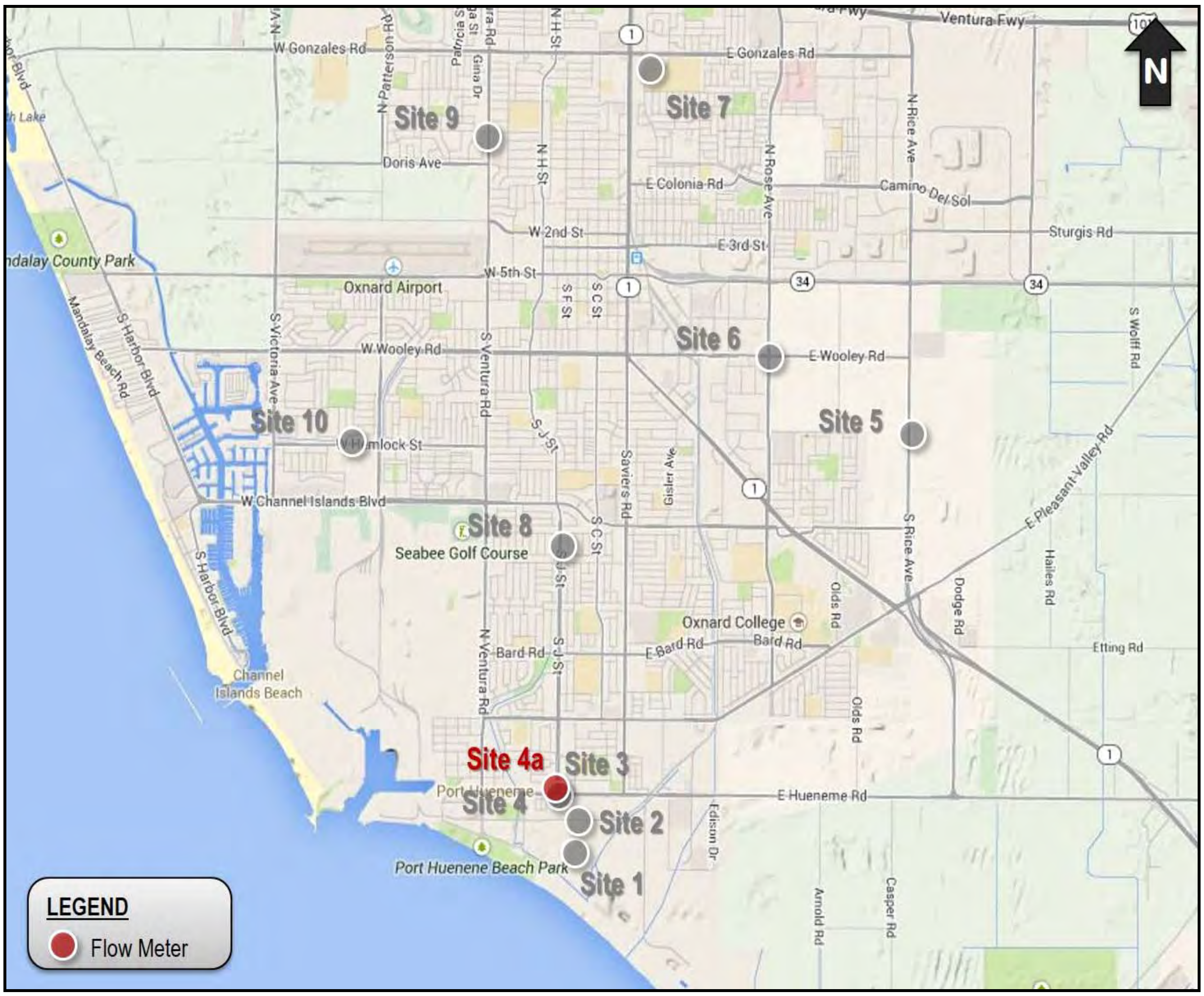
Sanitary Sewer Flow Monitoring

Temporary Monitoring: December, 2014 through February, 2015

Monitoring Site: Site 4A

Location: Northbound J Street south of Cuesta Del Mar Drive

Data Summary Report



Vicinity Map: Site 4A

SITE 4A

Site Information

Location: Northbound J Street south of Cuesta Del Mar Drive

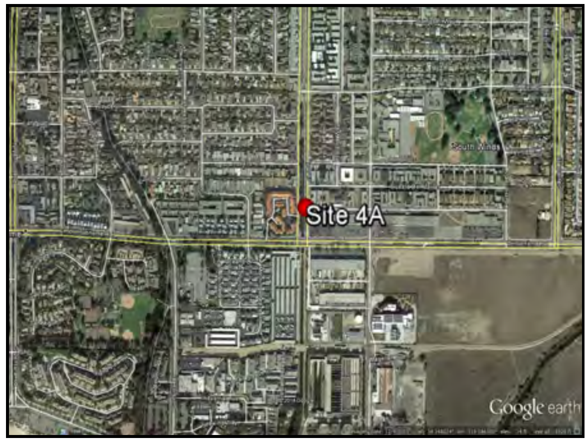
Coordinates: 119.1860° W, 34.1483° N

Rim Elevation: 13 feet

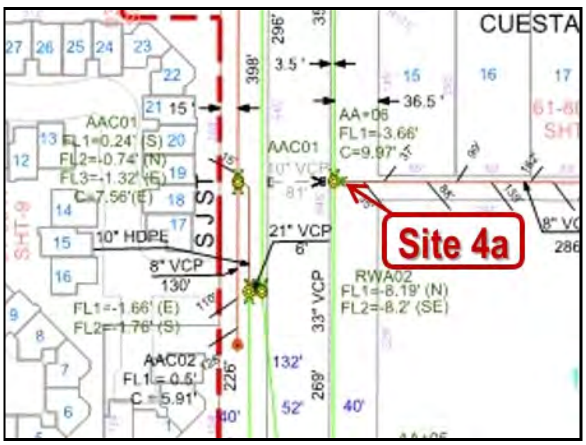
Pipe Diameter: 33 inches

Baseline Flow: 3.153 mgd

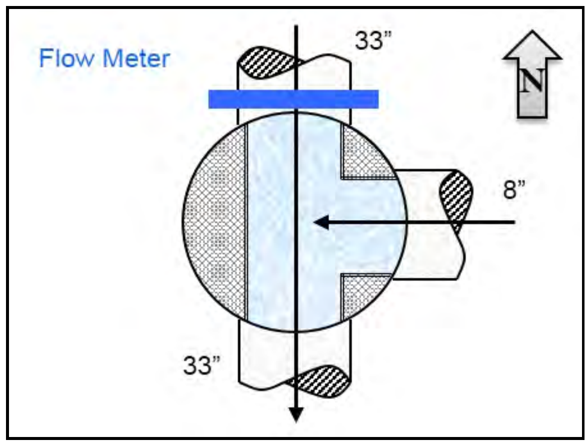
Peak Measured Flow: 5.729 mgd



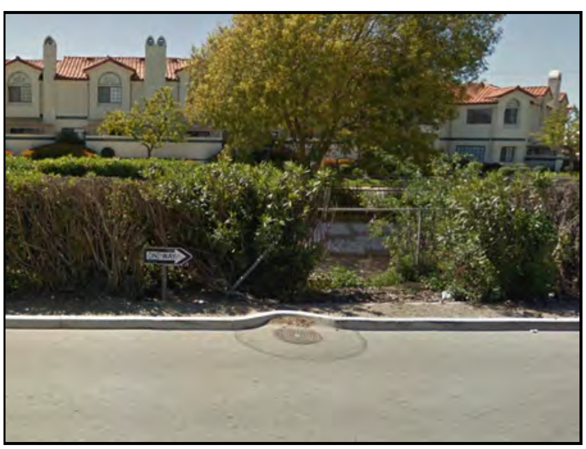
Satellite Map



Sanitary Map



Flow Diagram

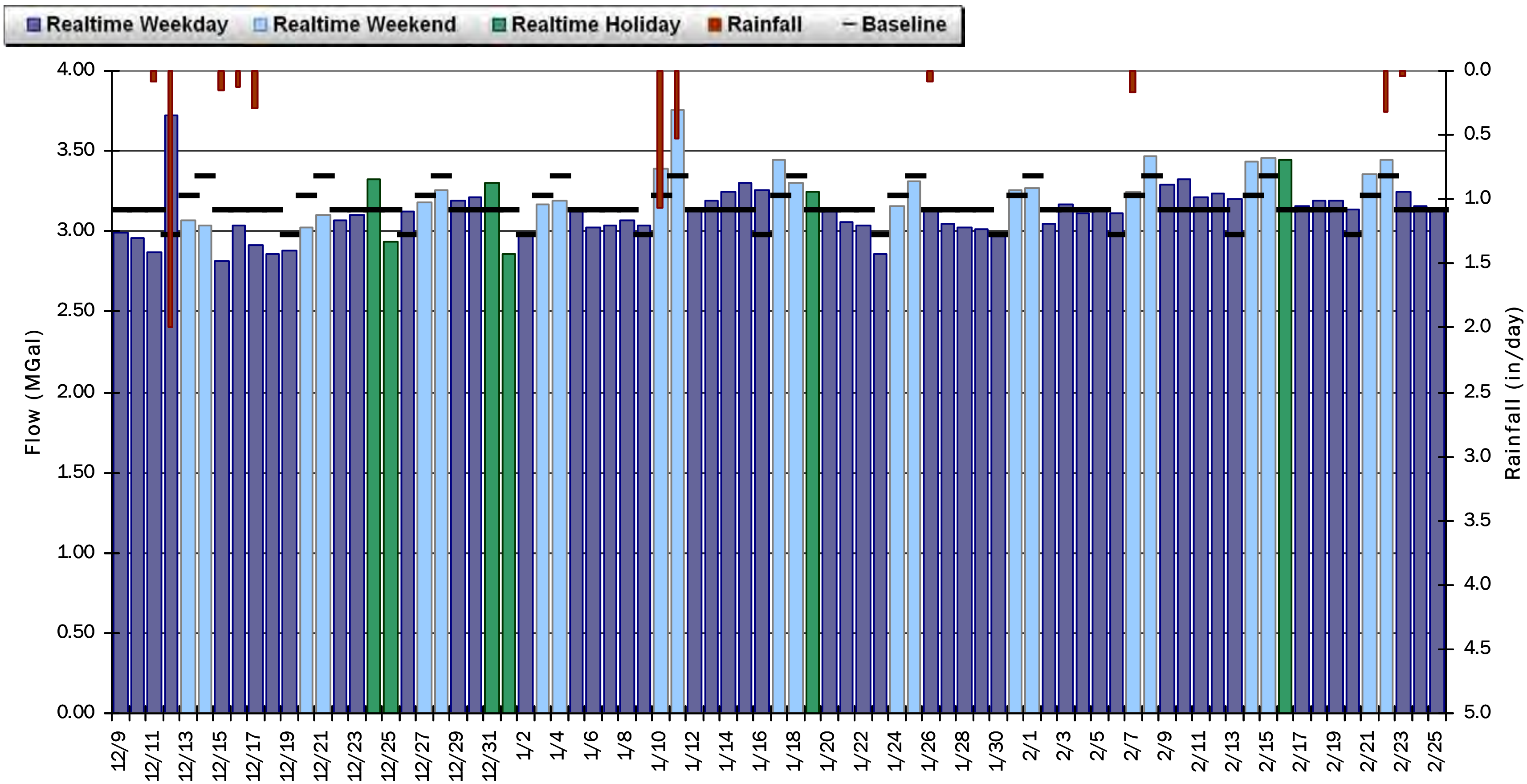

Street View

SITE 4A

Period Flow Summary: Daily Flow Totals

Avg Period Flow: 3.164 MGal **Peak Daily Flow: 3.753 MGal** **Min Daily Flow: 2.815 MGal**

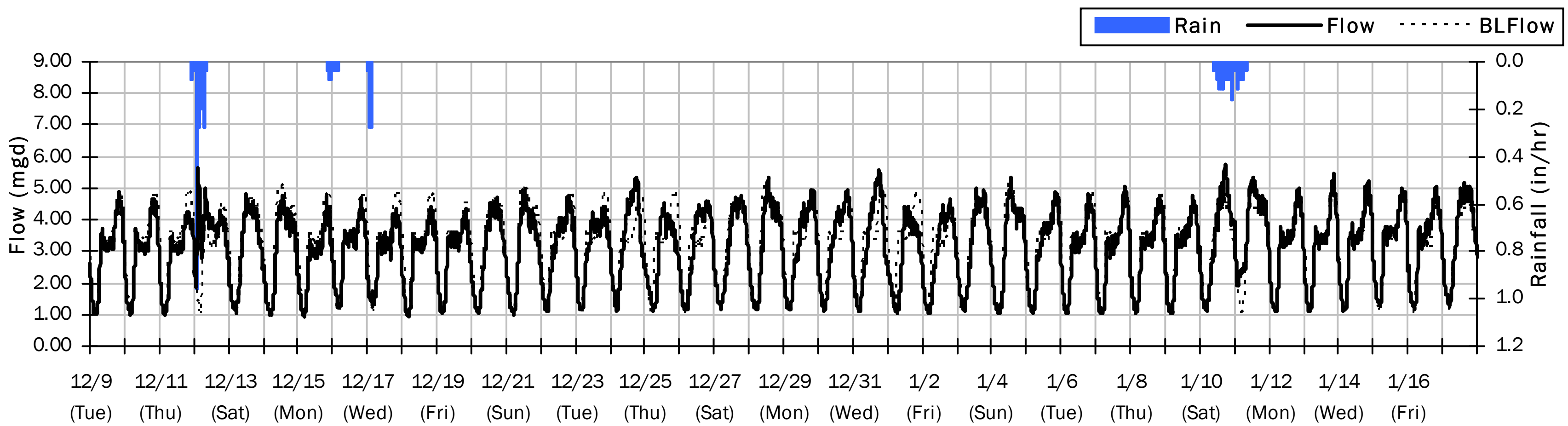
Total Period Rainfall: 4.84 inches

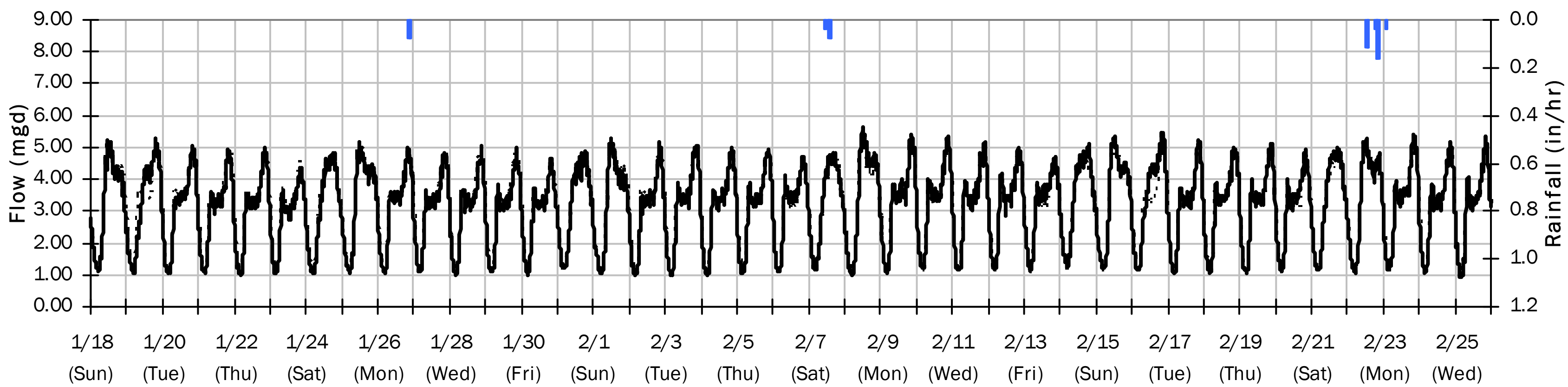


SITE 4A

Flow Summary: 12/9/2014 to 2/25/2015

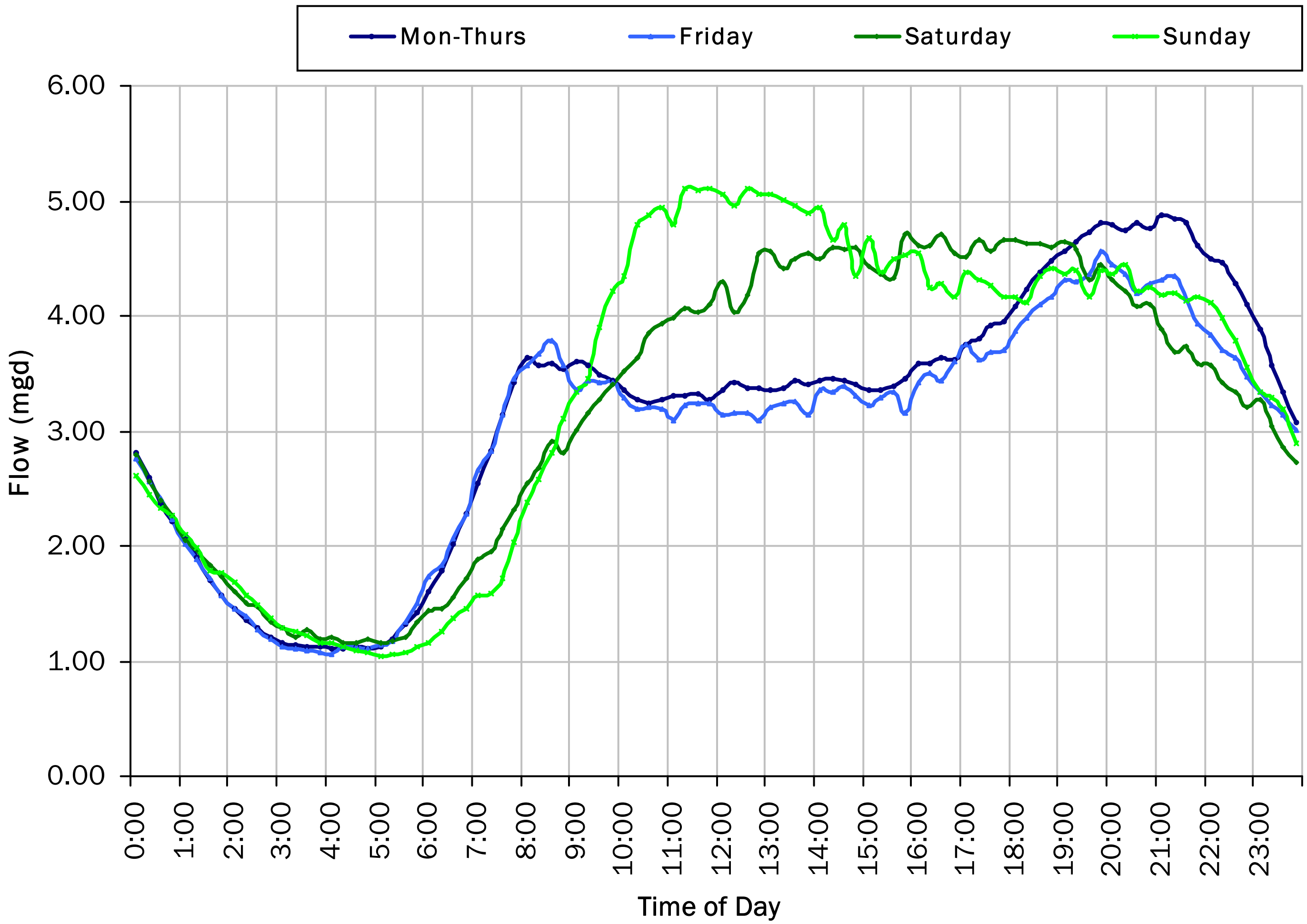
Total Period Rainfall: 4.84 inches   Avg Flow: 3.164 mgd   Peak Flow: 5.729 mgd   Min Flow: 0.906 mgd





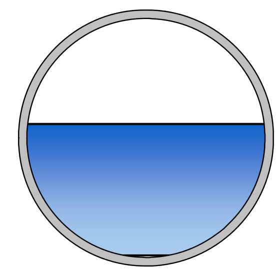
SITE 4A

Baseline Flow Hydrographs



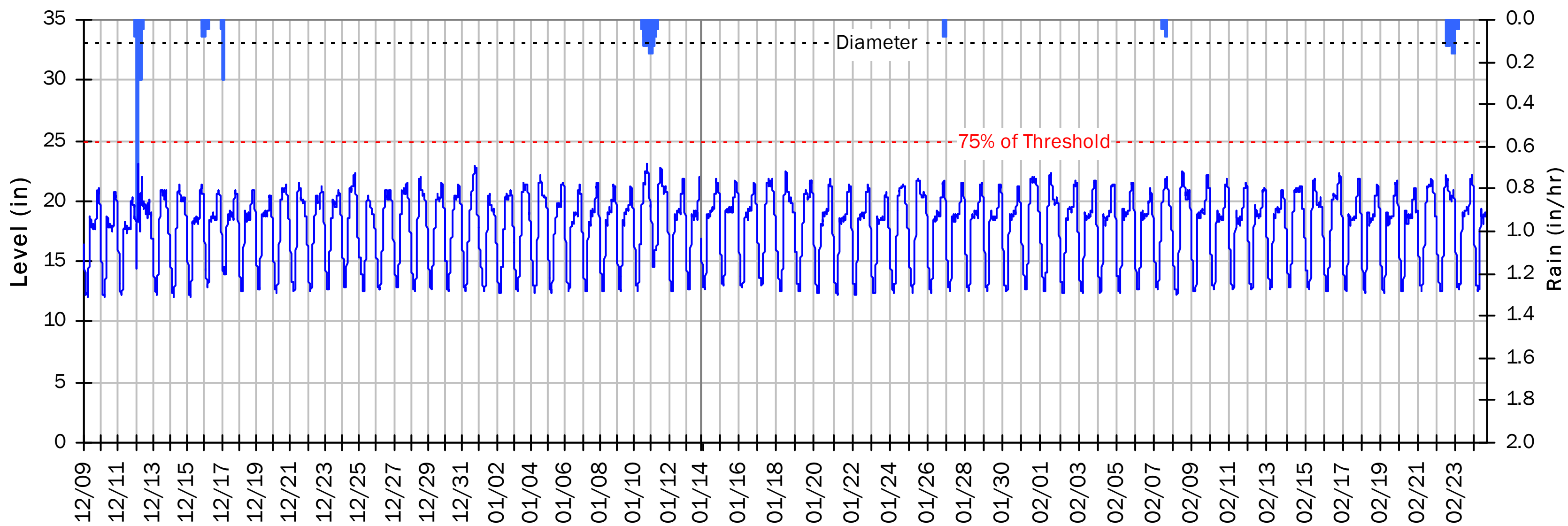
Baseline Flow:

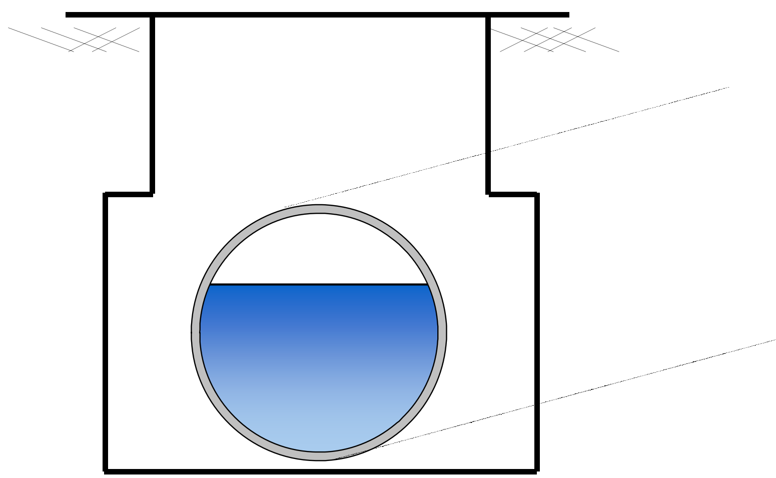
3.15 *mgd*



SITE 4A
Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Monitoring Period

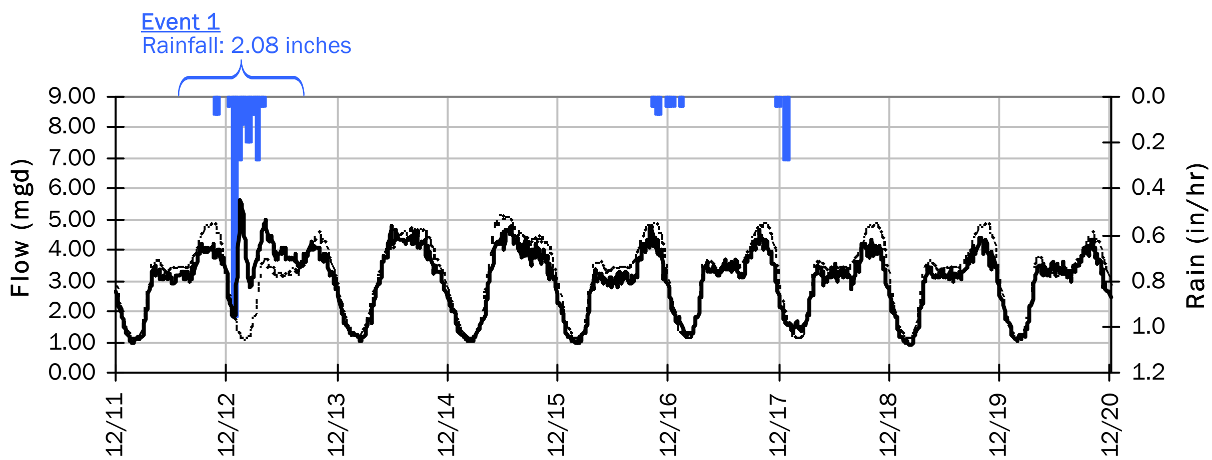




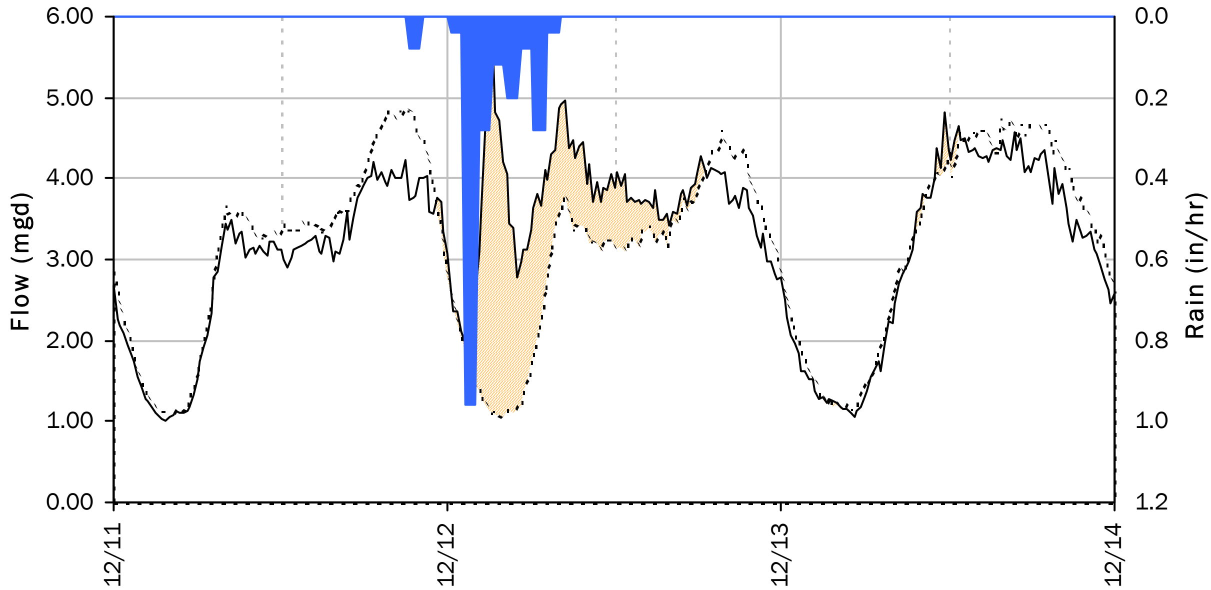
Pipe Diameter:	33	*inches*
Peak Measured Level:	23.1	*inches*
Peak d/D Ratio:	0.70	

SITE 4A
I/I Summary: Event 1

Baseline and Realtime Flows with Rainfall Data over Monitoring Period



Event 1 Detail Graph

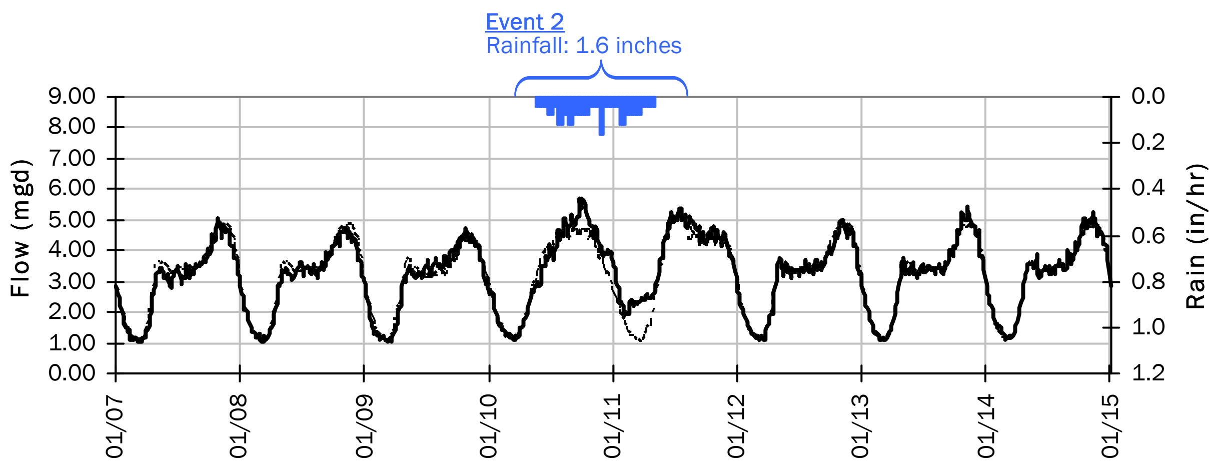


Storm Event I/I Analysis (Rain = 2.08 inches)

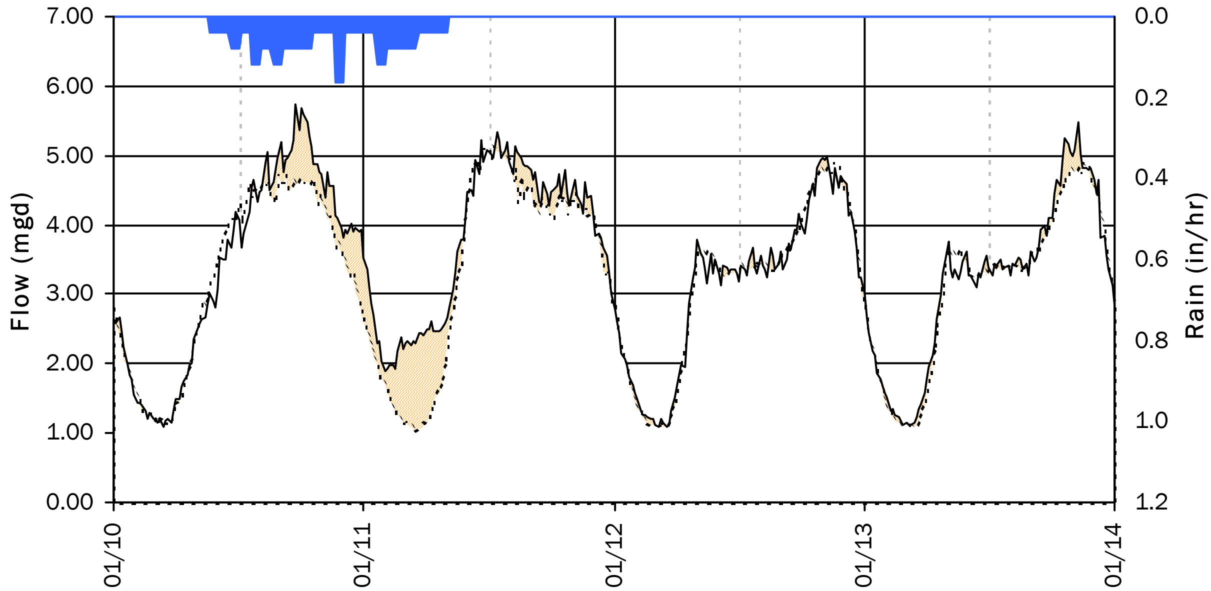
Capacity		Inflow / Infiltration	
Peak Flow:	5.63 *mgd*	Peak I/I Rate:	4.51 *mgd*
PF:	1.79	Total I/I:	577,000 *gallons*
Peak Level:	23.04 *in*		
d/D Ratio:	0.70		

SITE 4A
I/I Summary: Event 2

Baseline and Realtime Flows with Rainfall Data over Monitoring Period



Event 2 Detail Graph



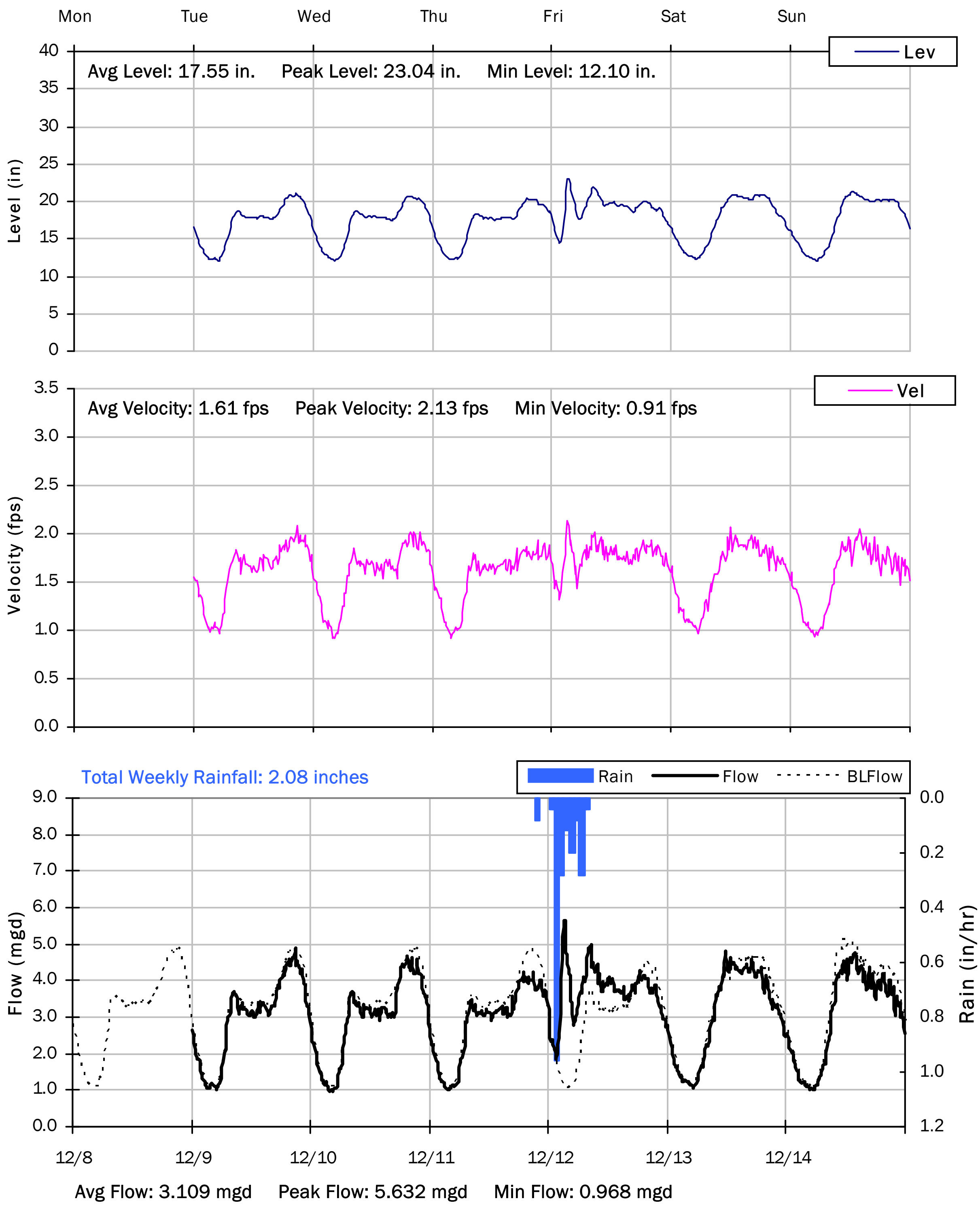
Storm Event I/I Analysis (Rain = 1.60 inches)

Capacity		Inflow / Infiltration	
Peak Flow:	5.73 *mgd*	Peak I/I Rate:	1.37 *mgd*
PF:	1.82	Total I/I:	571,000 *gallons*
Peak Level:	23.11 *in*		
d/D Ratio:	0.70		

SITE 4A

Weekly Level, Velocity and Flow Hydrographs

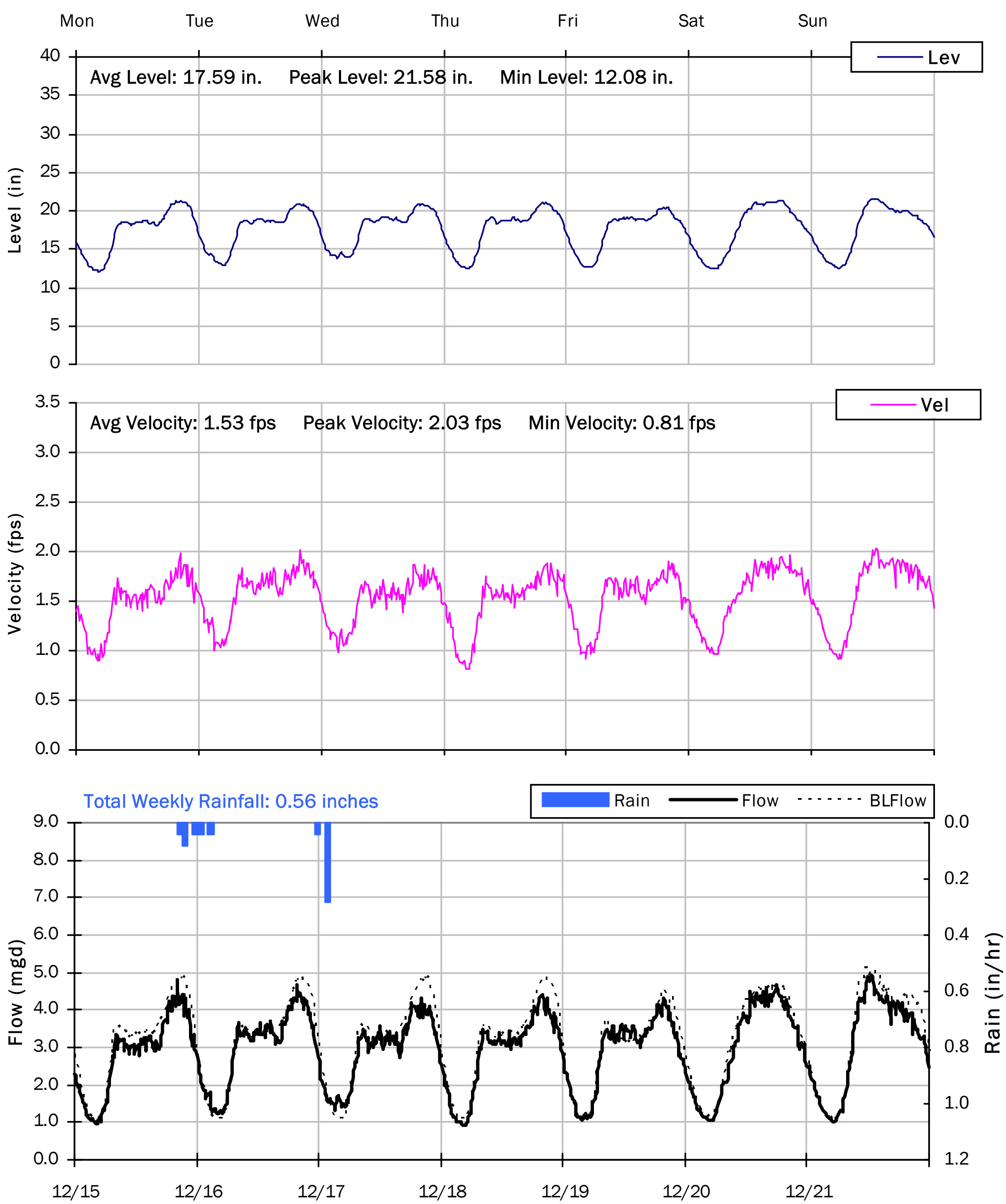
12/8/2014 to 12/15/2014



SITE 4A

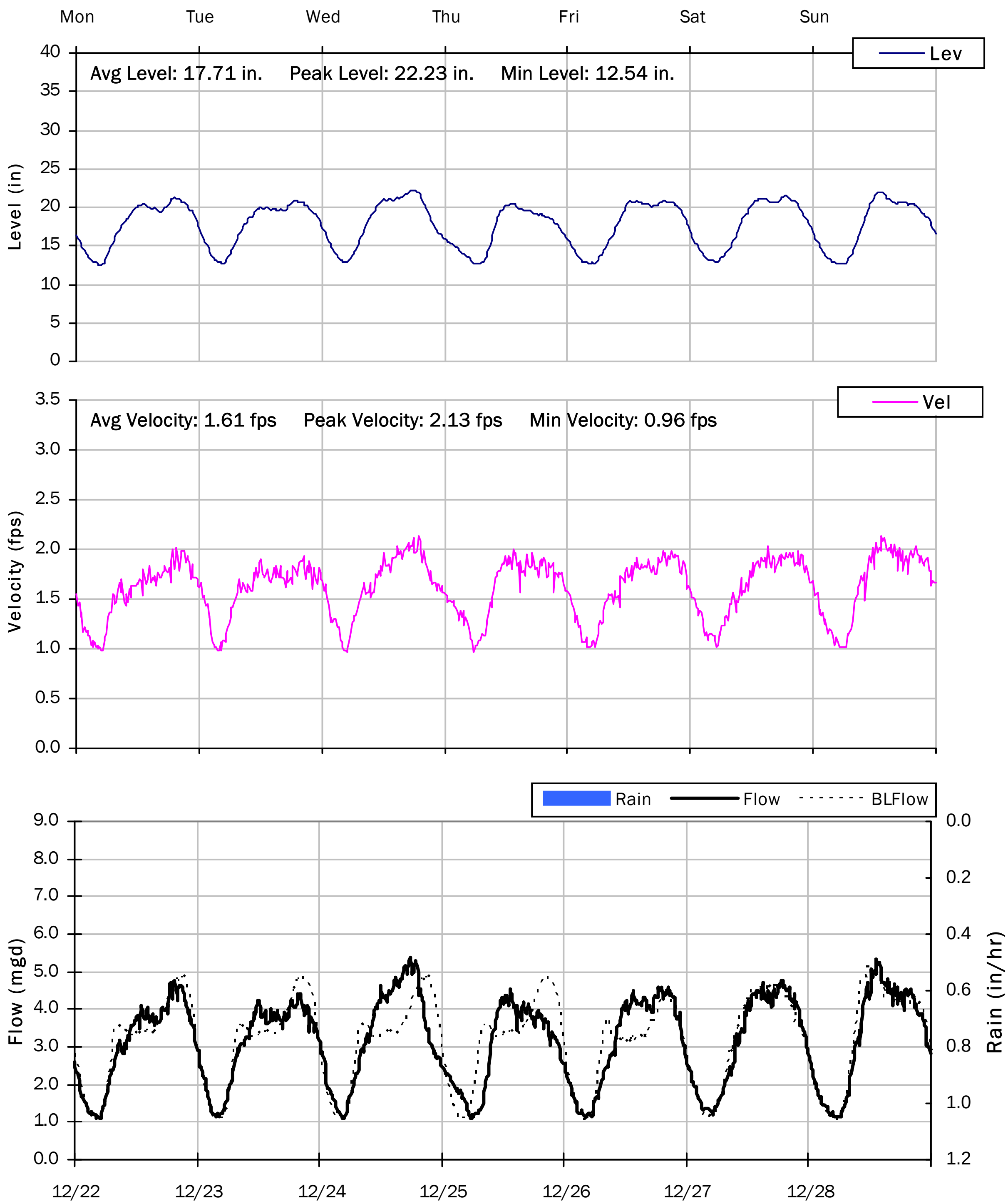
Weekly Level, Velocity and Flow Hydrographs

12/15/2014 to 12/22/2014



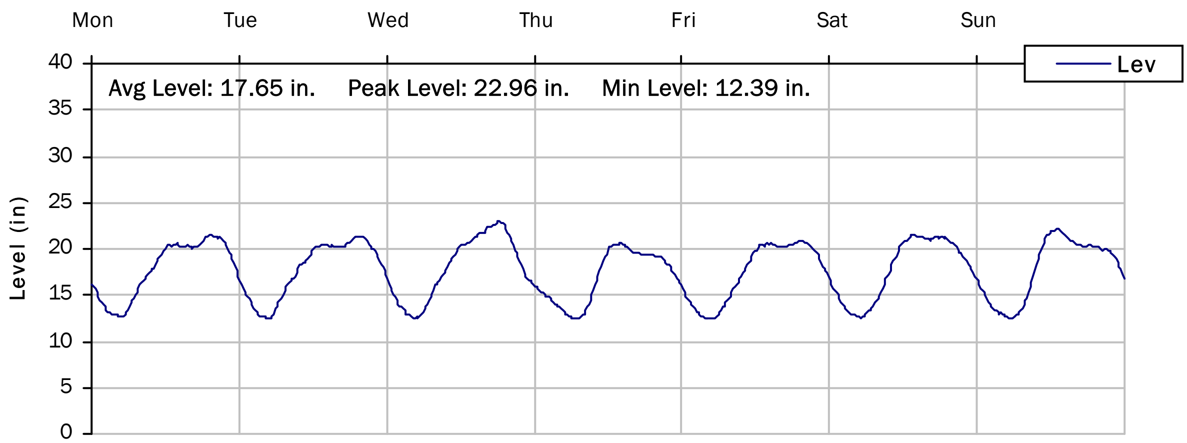
Avg Flow: 2.948 mgd Peak Flow: 4.960 mgd Min Flow: 0.906 mgd

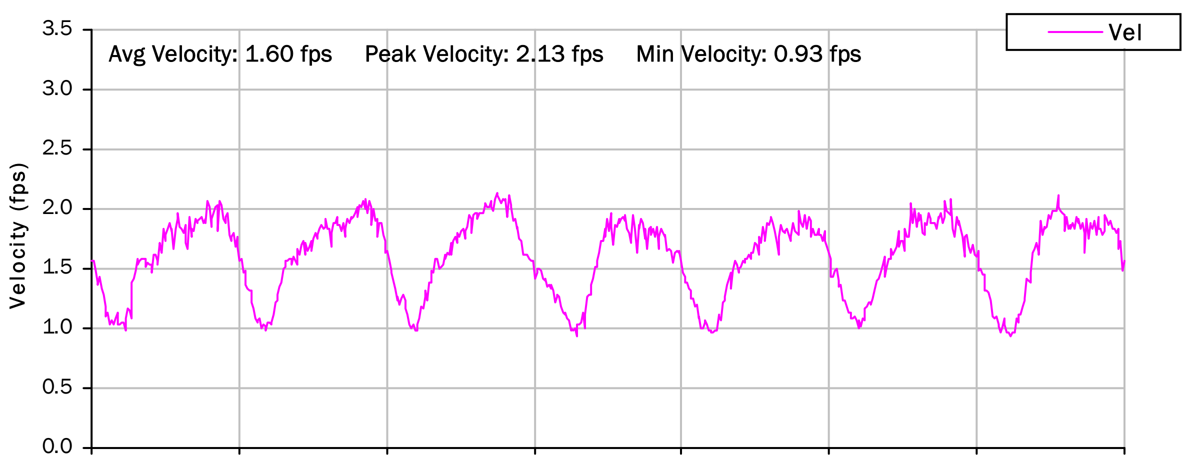
SITE 4A
Weekly Level, Velocity and Flow Hydrographs
12/22/2014 to 12/29/2014

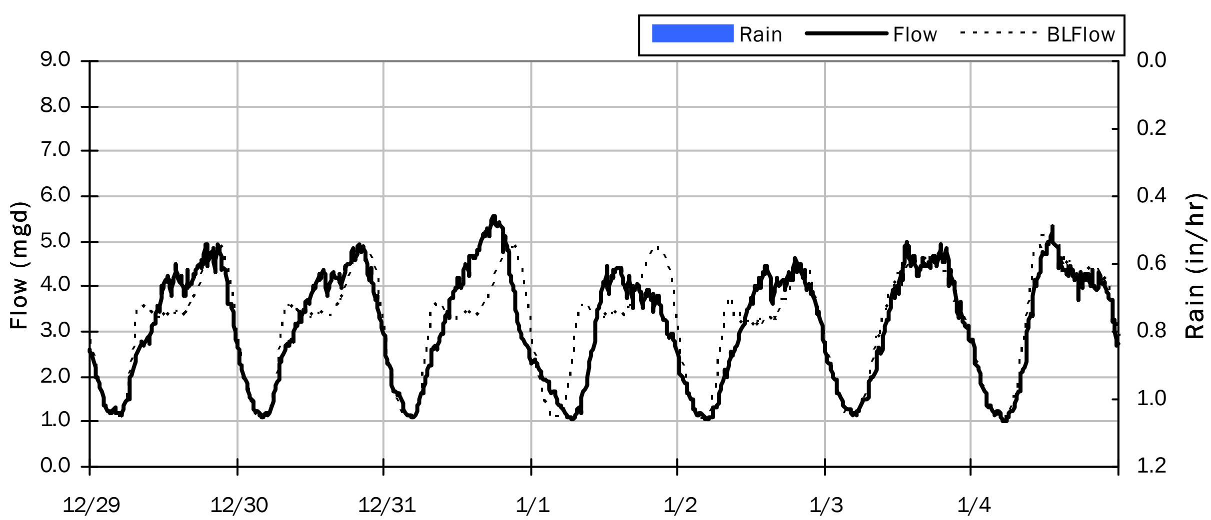


Avg Flow: 3.145 mgd Peak Flow: 5.364 mgd Min Flow: 1.100 mgd

SITE 4A
Weekly Level, Velocity and Flow Hydrographs
12/29/2014 to 1/5/2015

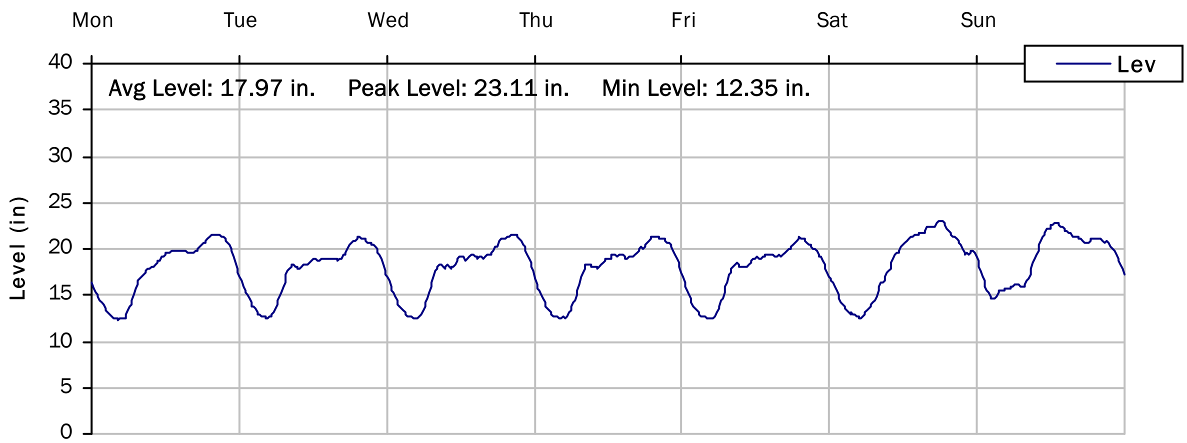


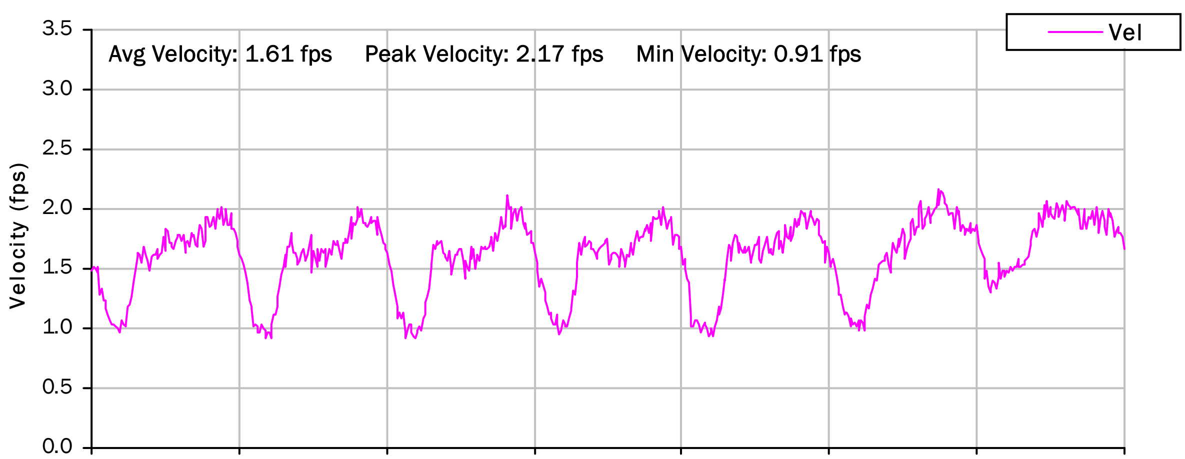


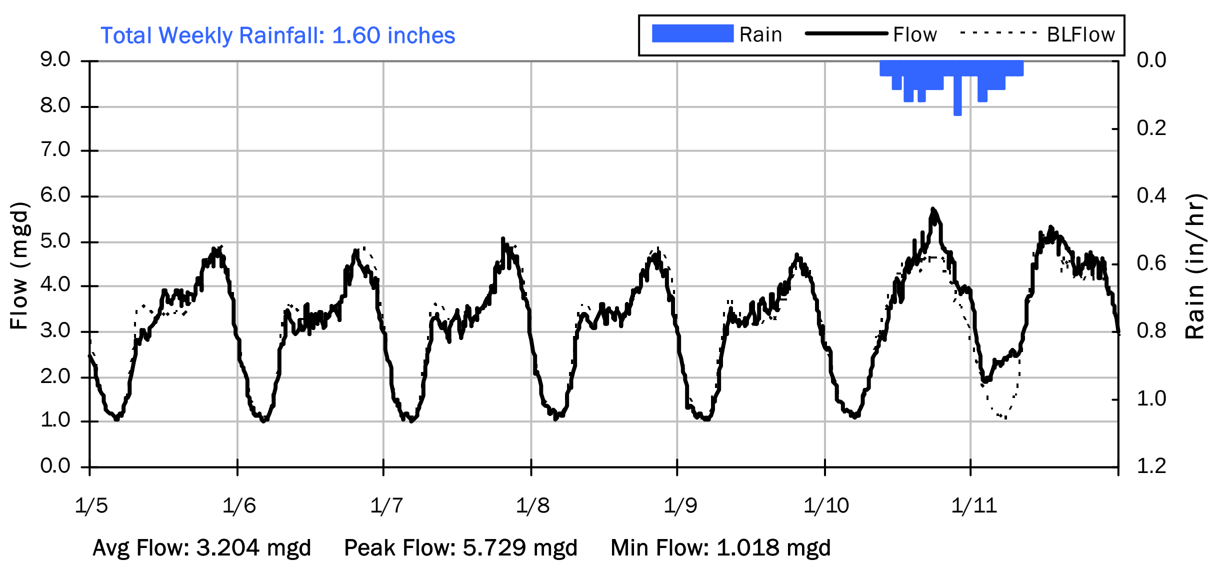


Avg Flow: 3.132 mgd Peak Flow: 5.569 mgd Min Flow: 1.031 mgd

SITE 4A
Weekly Level, Velocity and Flow Hydrographs
1/5/2015 to 1/12/2015



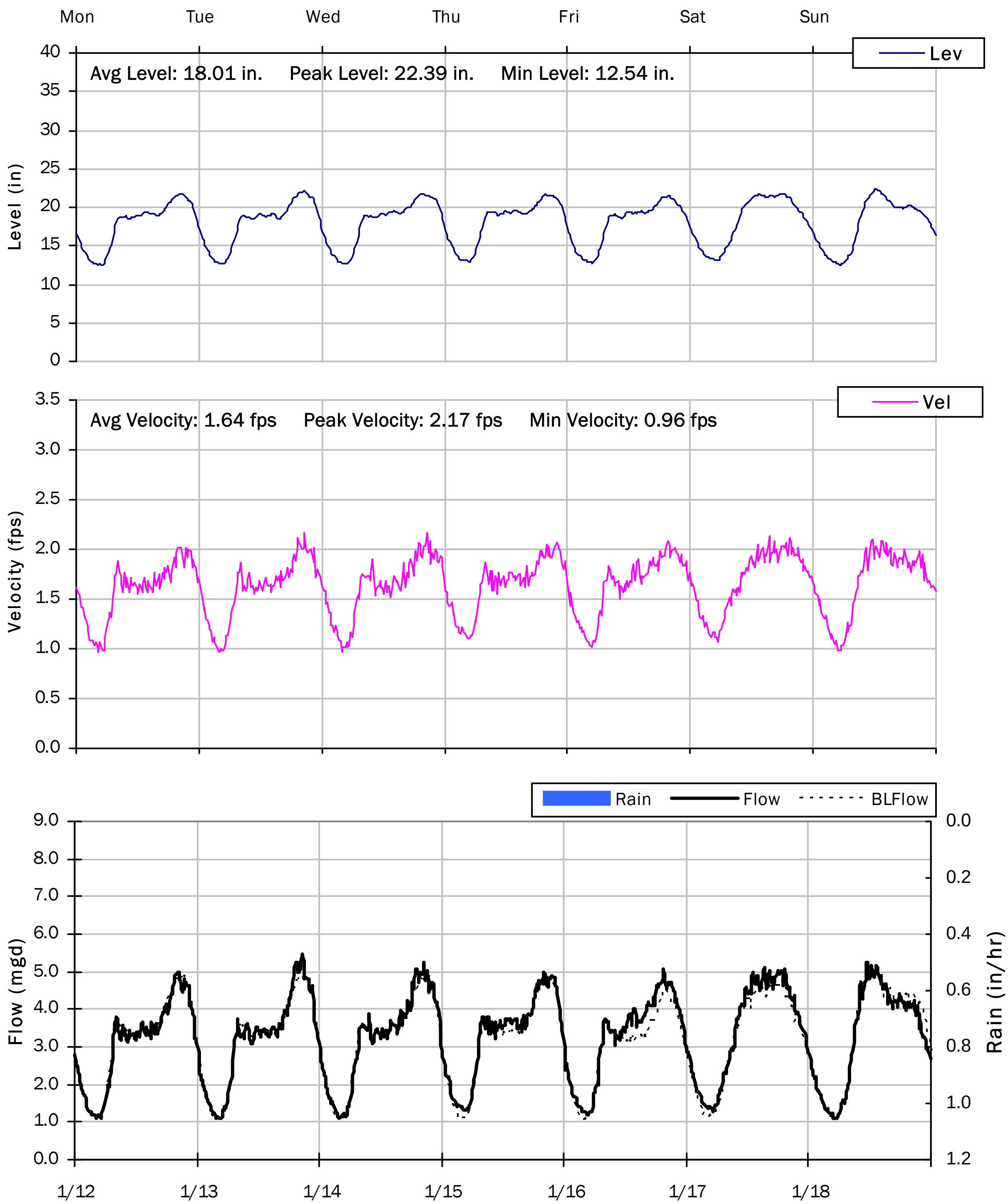




SITE 4A

Weekly Level, Velocity and Flow Hydrographs

1/12/2015 to 1/19/2015

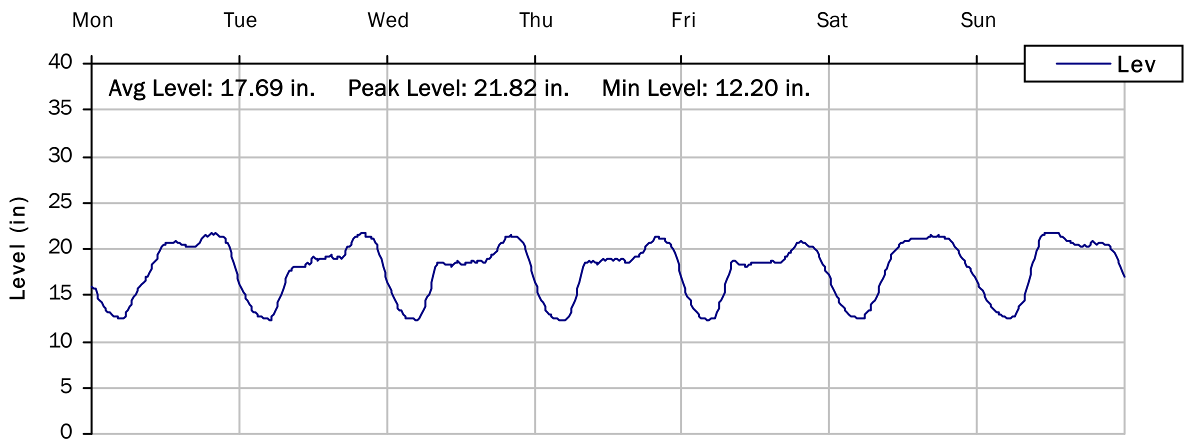


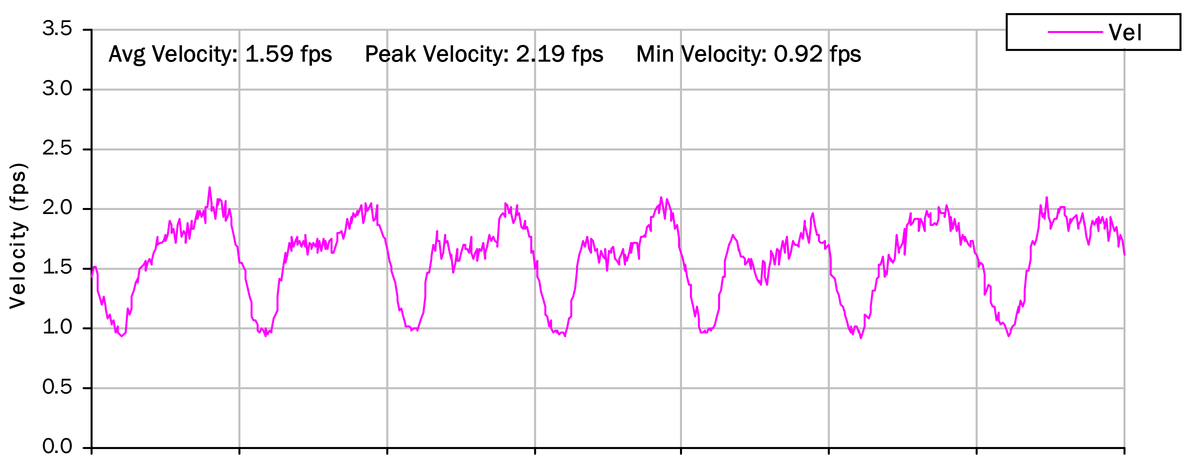
Avg Flow: 3.267 mgd Peak Flow: 5.466 mgd Min Flow: 1.093 mgd

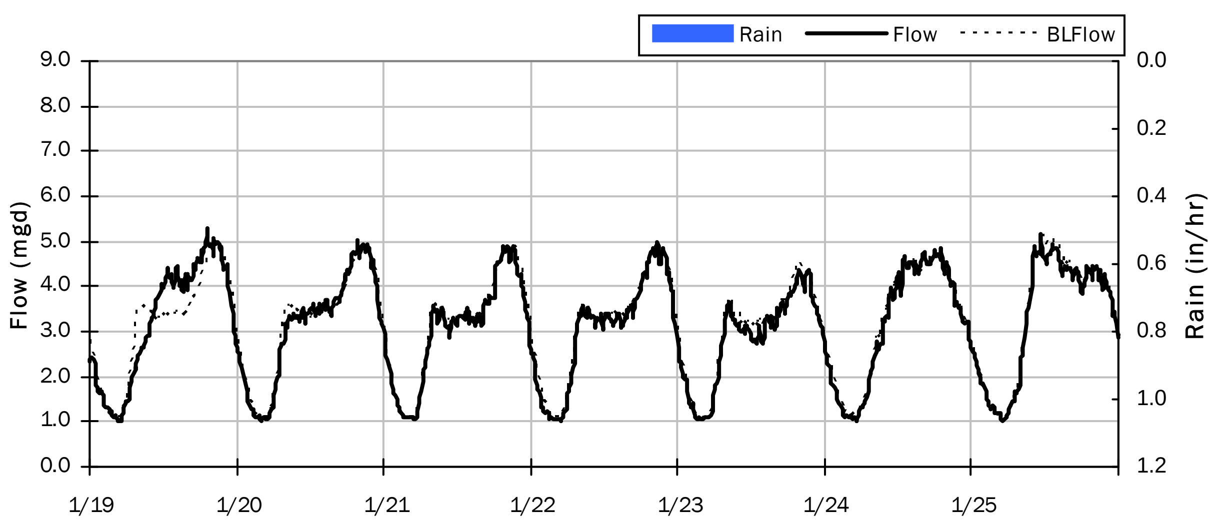
SITE 4A

Weekly Level, Velocity and Flow Hydrographs

1/19/2015 to 1/26/2015





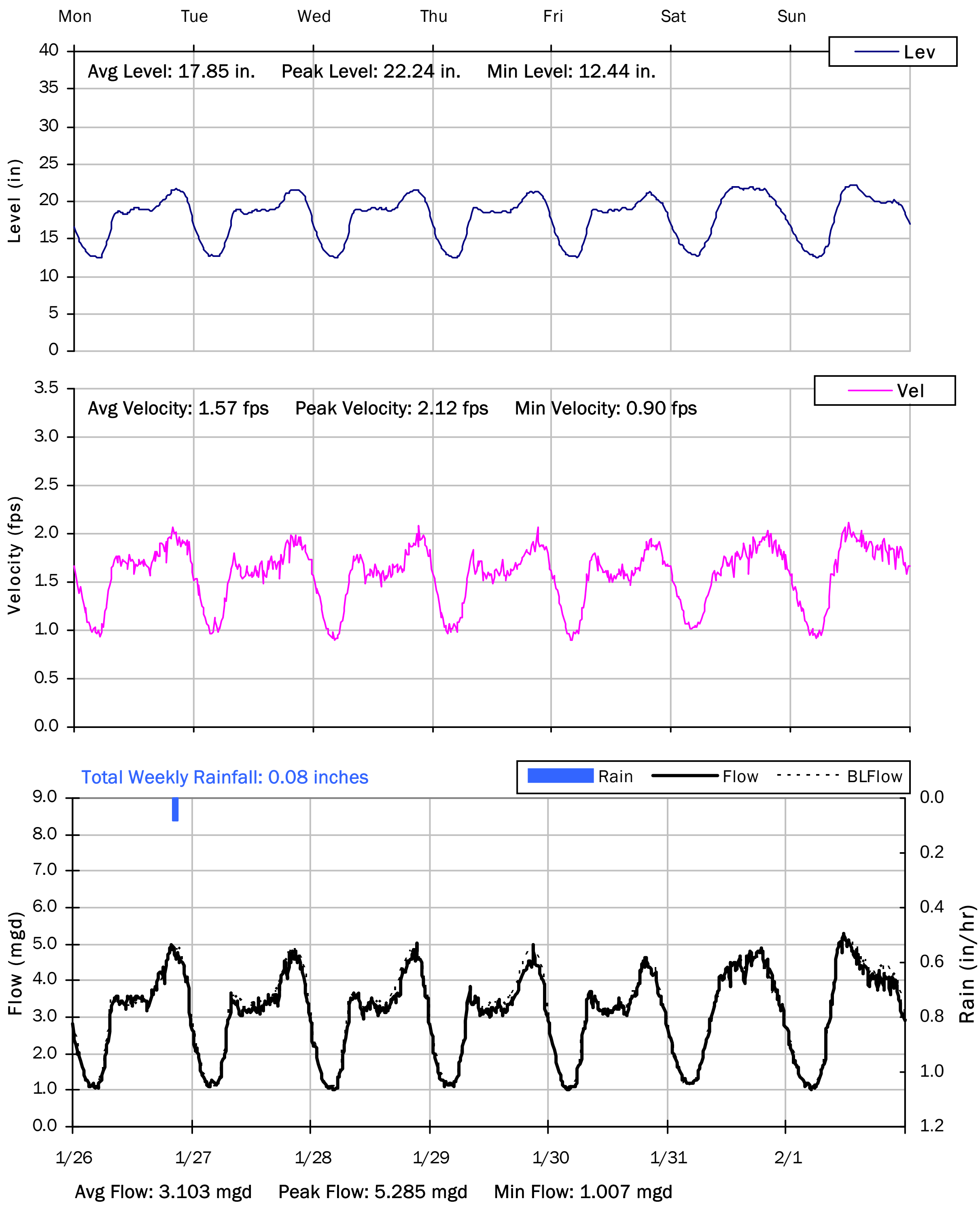


Avg Flow: 3.113 mgd Peak Flow: 5.310 mgd Min Flow: 1.011 mgd

SITE 4A

Weekly Level, Velocity and Flow Hydrographs

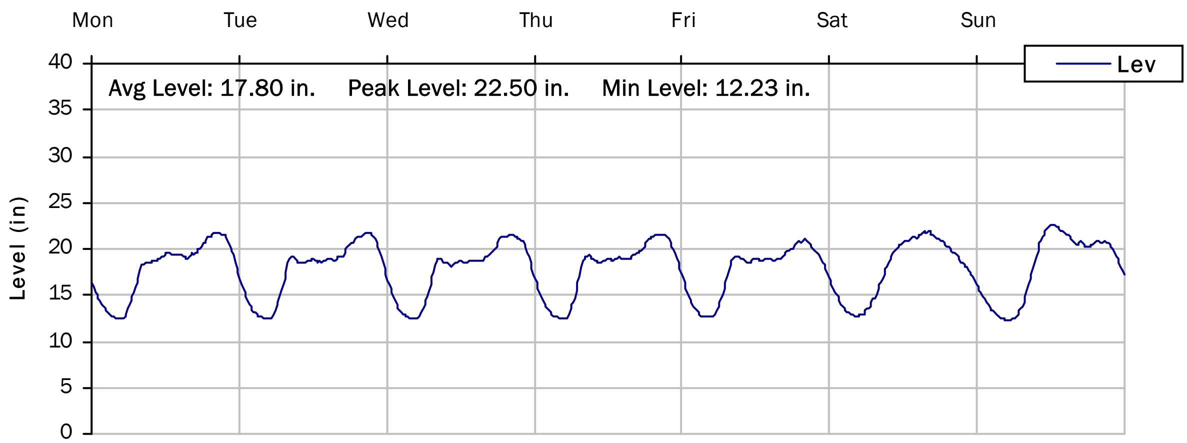
1/26/2015 to 2/2/2015

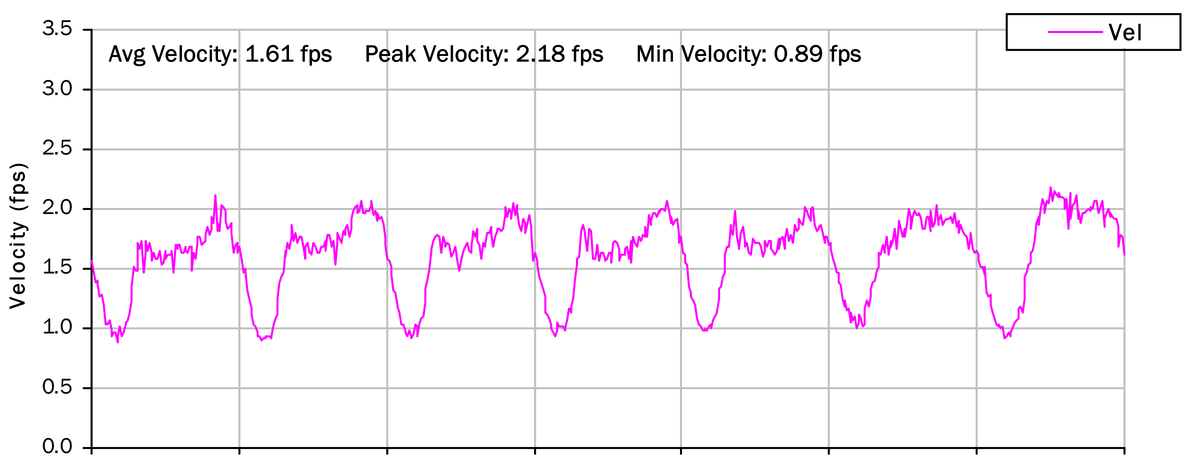


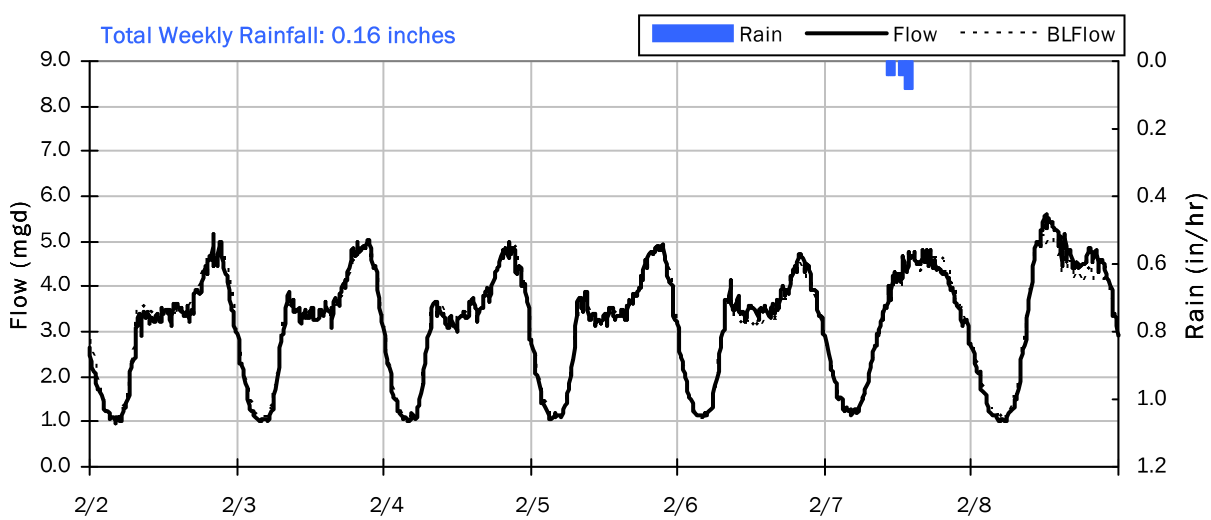
SITE 4A

Weekly Level, Velocity and Flow Hydrographs

2/2/2015 to 2/9/2015





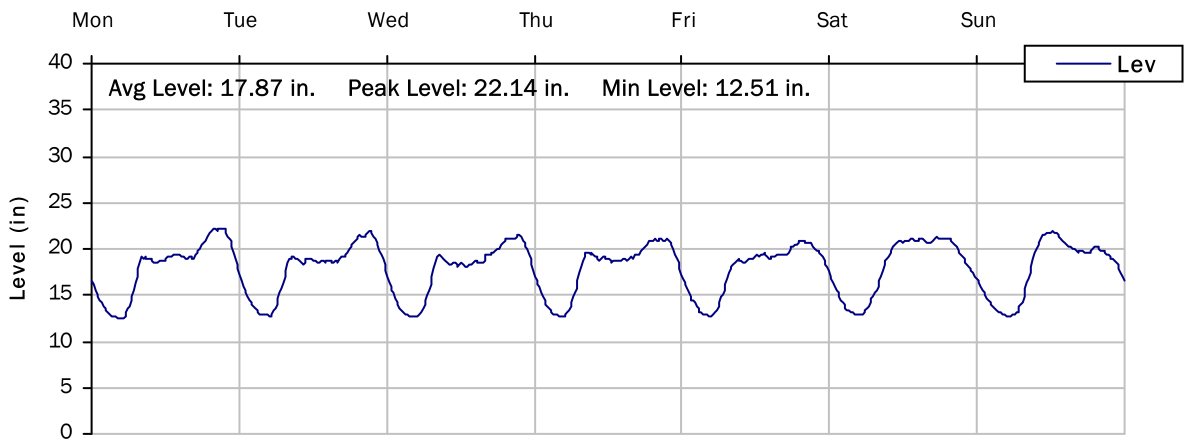


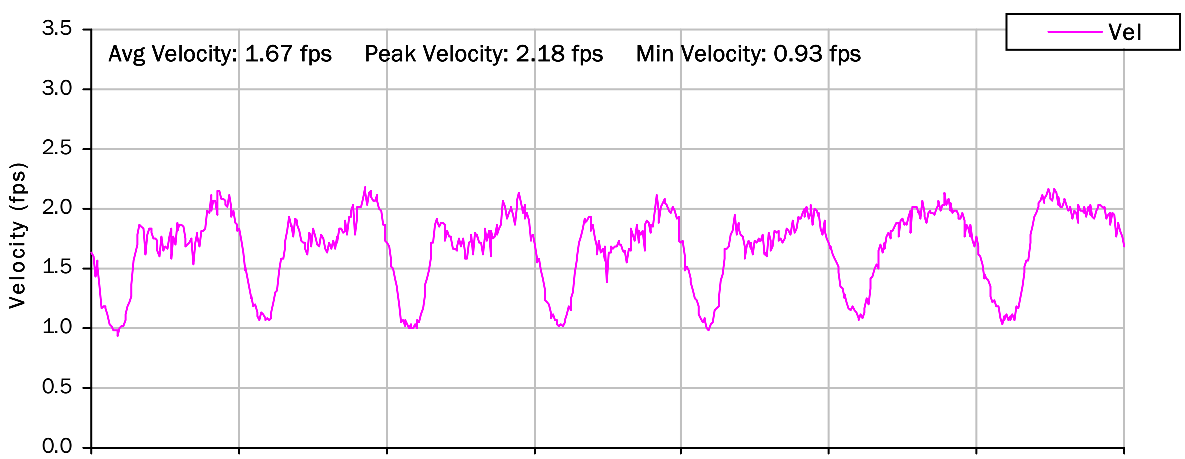
Avg Flow: 3.185 mgd Peak Flow: 5.615 mgd Min Flow: 0.989 mgd

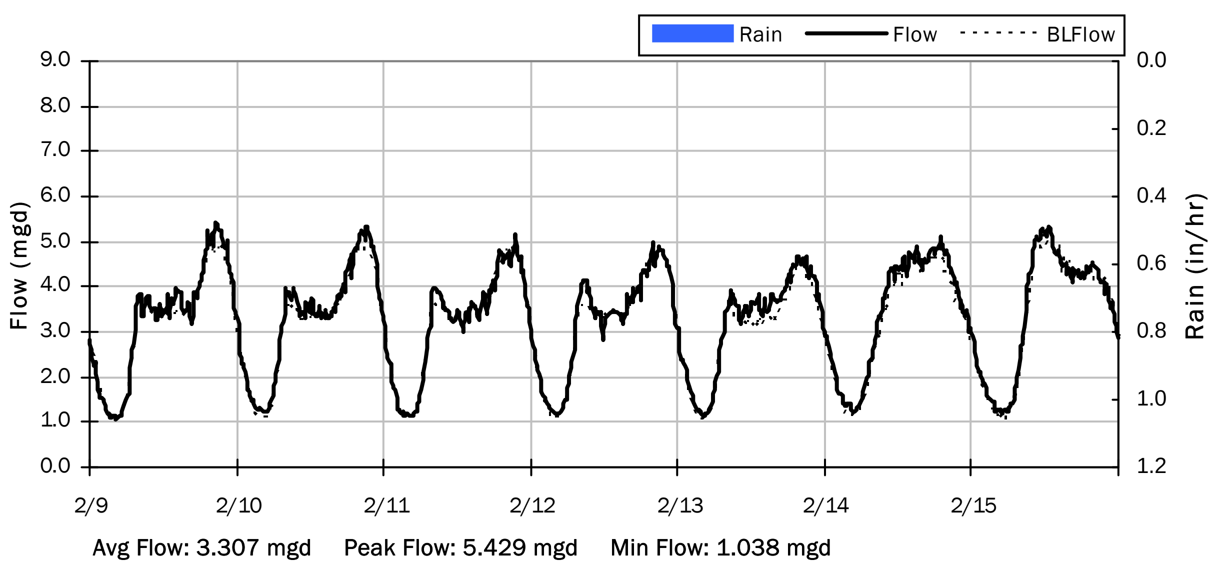
SITE 4A

Weekly Level, Velocity and Flow Hydrographs

2/9/2015 to 2/16/2015



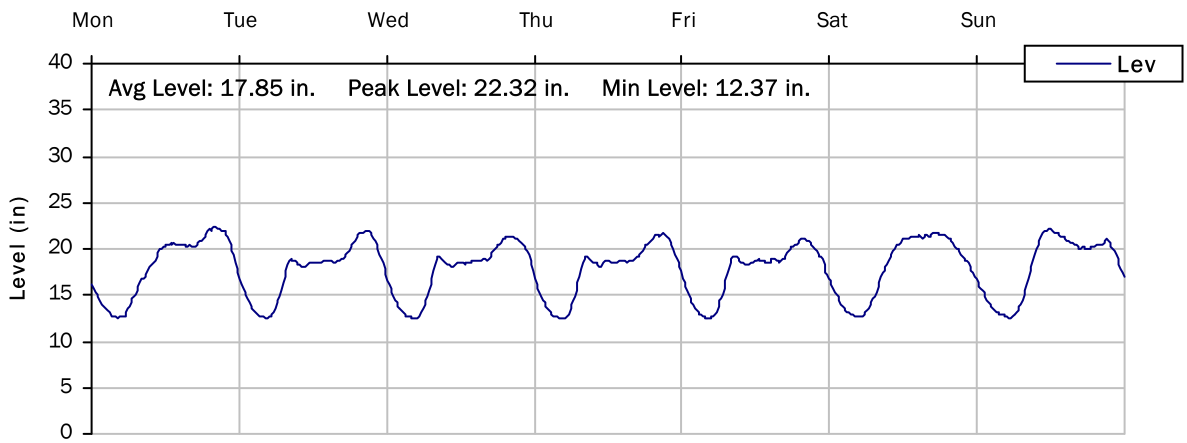


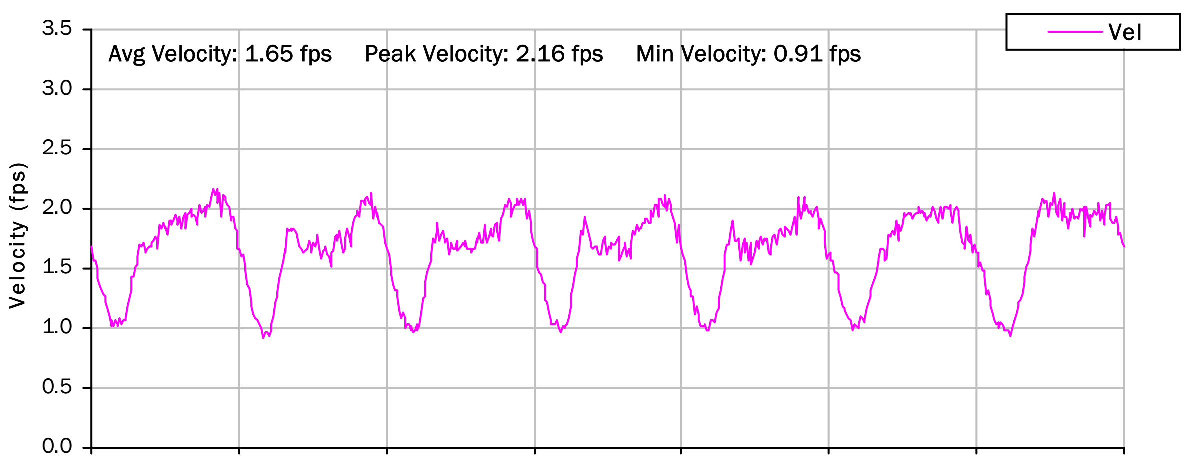


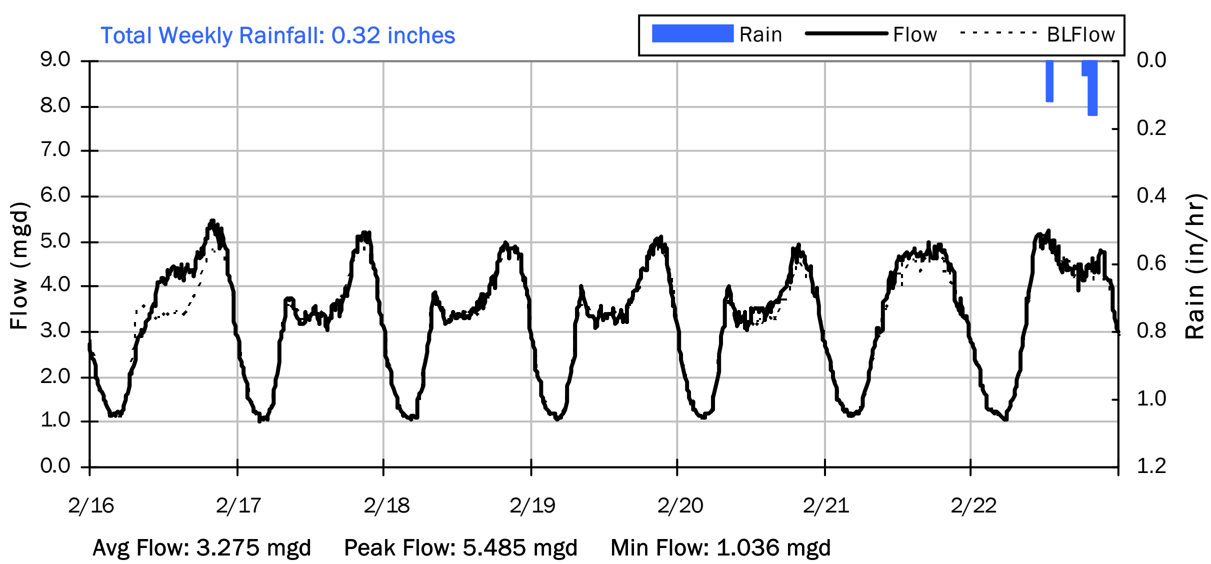
SITE 4A

Weekly Level, Velocity and Flow Hydrographs

2/16/2015 to 2/23/2015



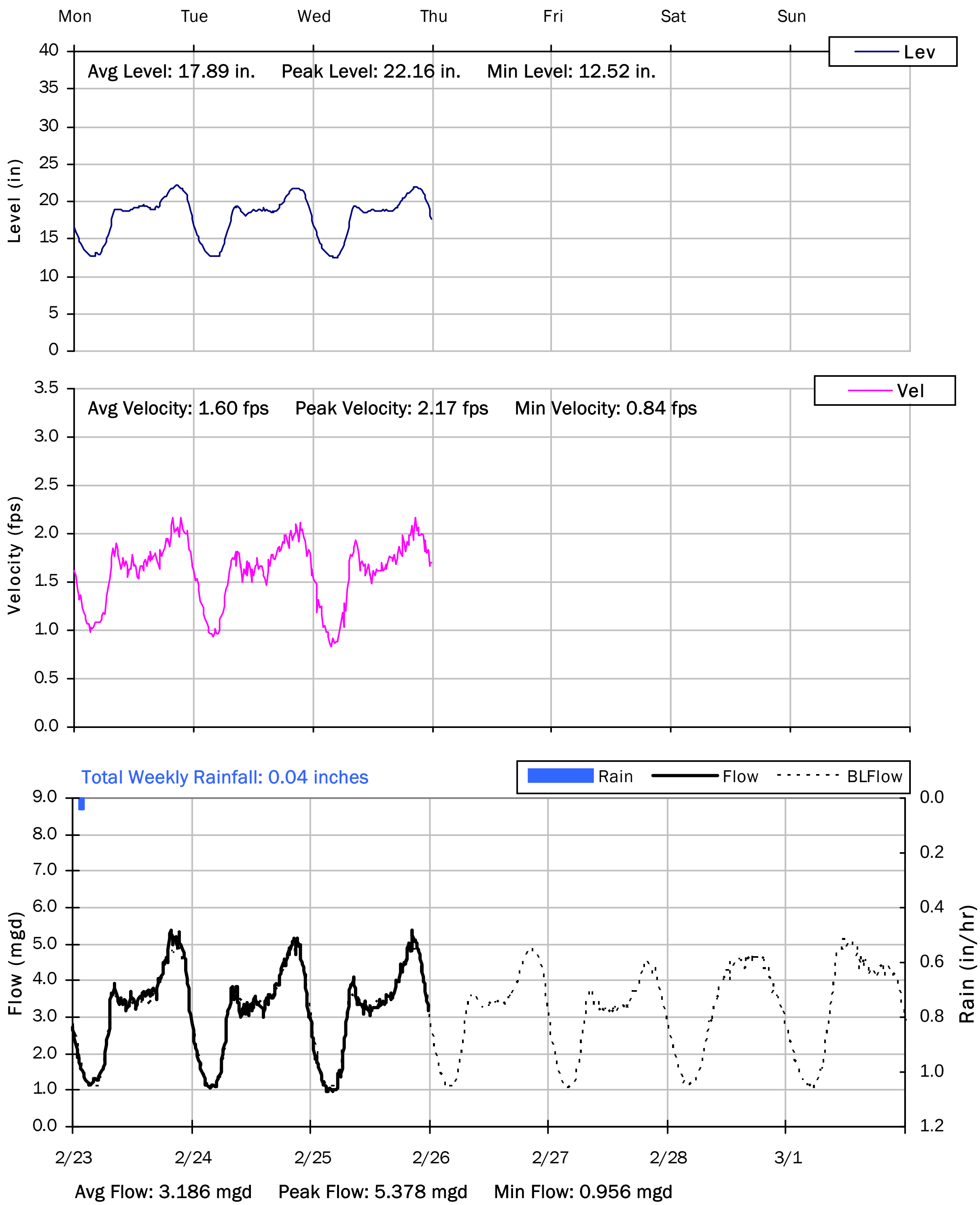




SITE 4A

Weekly Level, Velocity and Flow Hydrographs

2/23/2015 to 3/2/2015



City of Oxnard

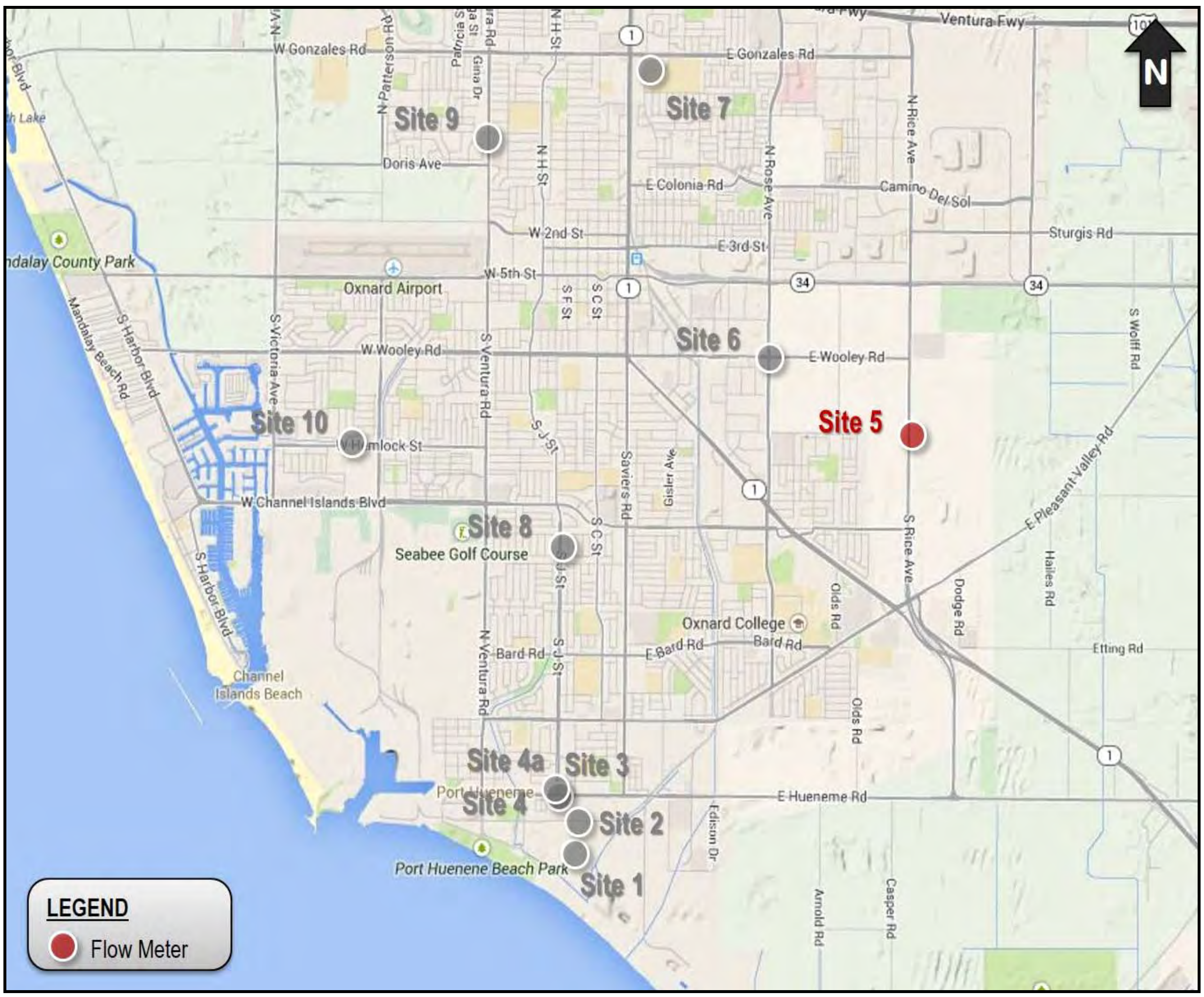
Sanitary Sewer Flow Monitoring

Temporary Monitoring: December, 2014 through February, 2015

Monitoring Site: Site 5

Location: S Rice Avenue and East of Emerson Avenue

Data Summary Report



Vicinity Map: Site 5

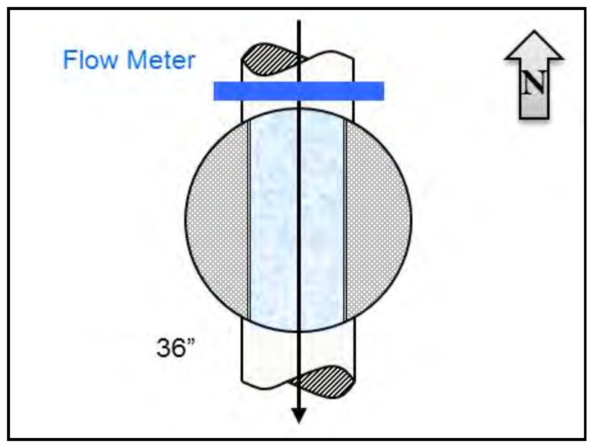
SITE 5

Site Information

Location:	S Rice Avenue and East of Emerson Avenue
Coordinates:	119.1427° W, 34.1819° N
Rim Elevation:	44 feet
Pipe Diameter:	36 inches
Baseline Flow:	1.408 mgd
Peak Measured Flow:	3.074 mgd

Satellite Map

Sanitary Map



Flow Diagram


Street View


Plan View

SITE 5

Additional Site Photos

Effluent Pipe

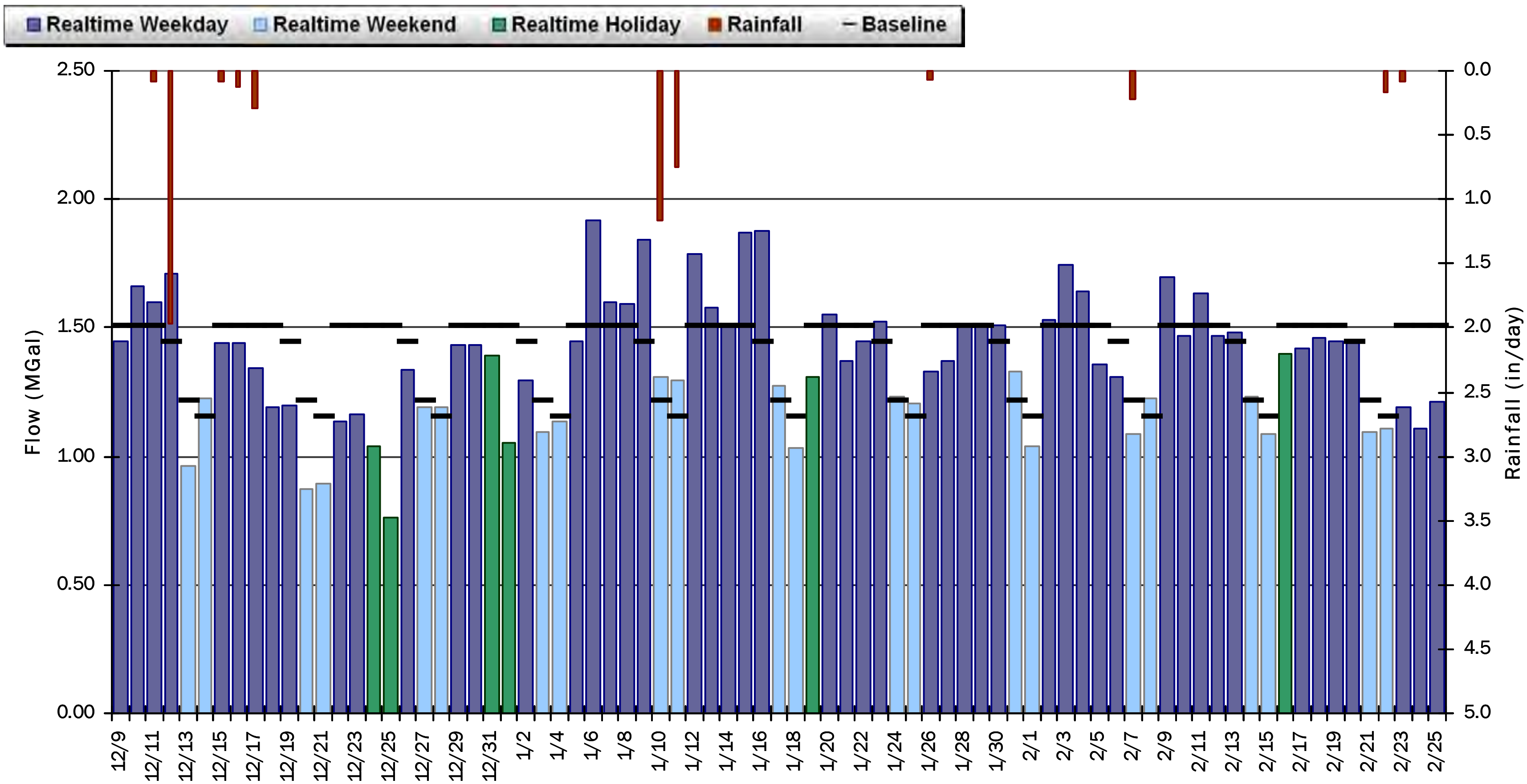
Influent Pipe

SITE 5

Period Flow Summary: Daily Flow Totals

Avg Period Flow: 1.363 MGal **Peak Daily Flow: 1.916 MGal** **Min Daily Flow: 0.762 MGal**

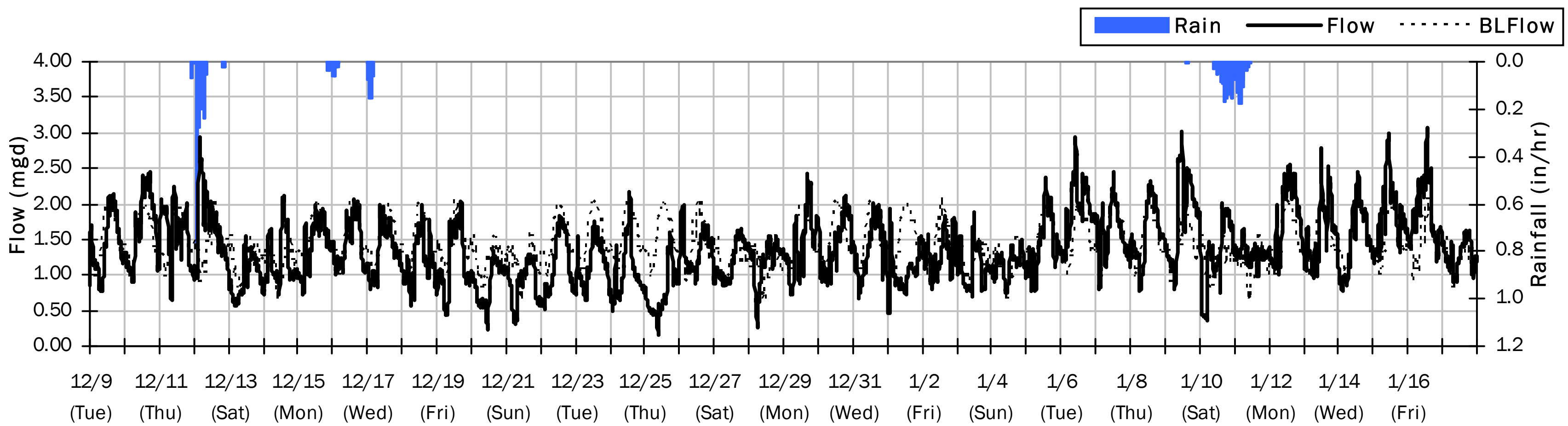
Total Period Rainfall: 5.00 inches

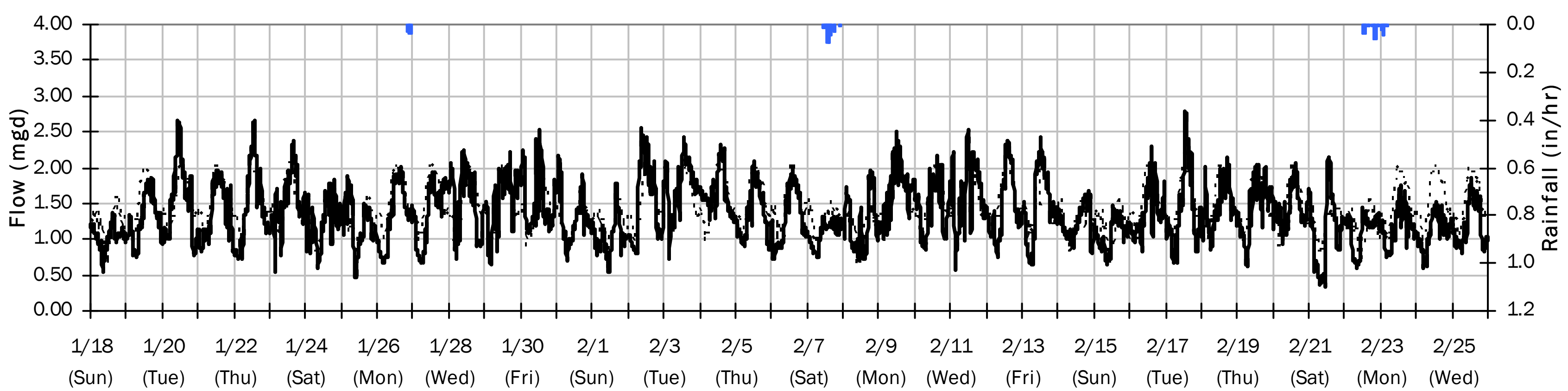


SITE 5

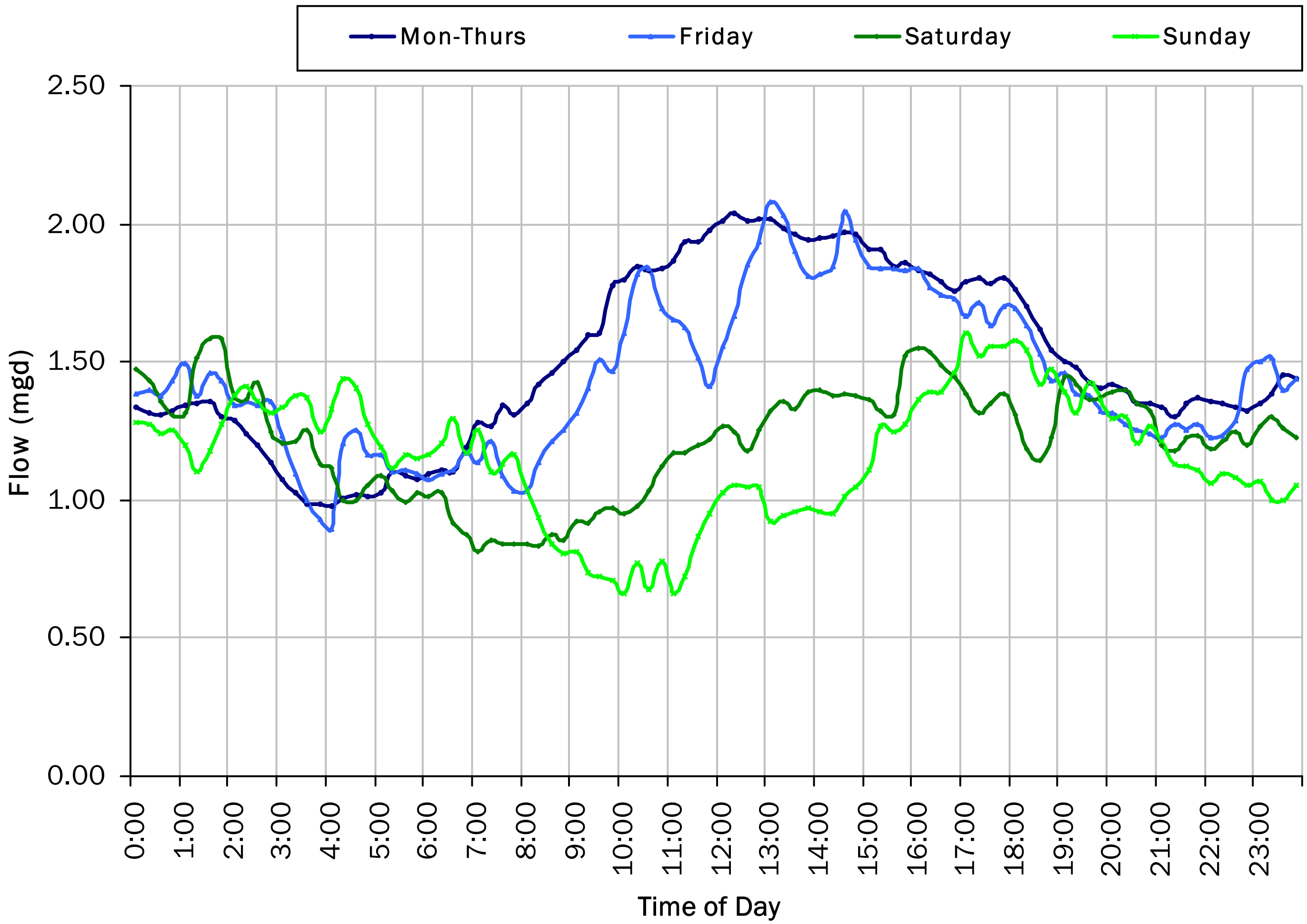
Flow Summary: 12/9/2014 to 2/25/2015

Total Period Rainfall: 5.00 inches   Avg Flow: 1.363 mgd   Peak Flow: 3.074 mgd   Min Flow: 0.153 mgd



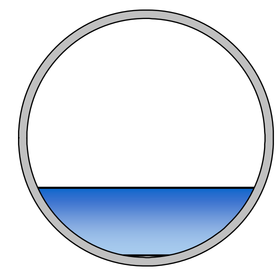


SITE 5
Baseline Flow Hydrographs



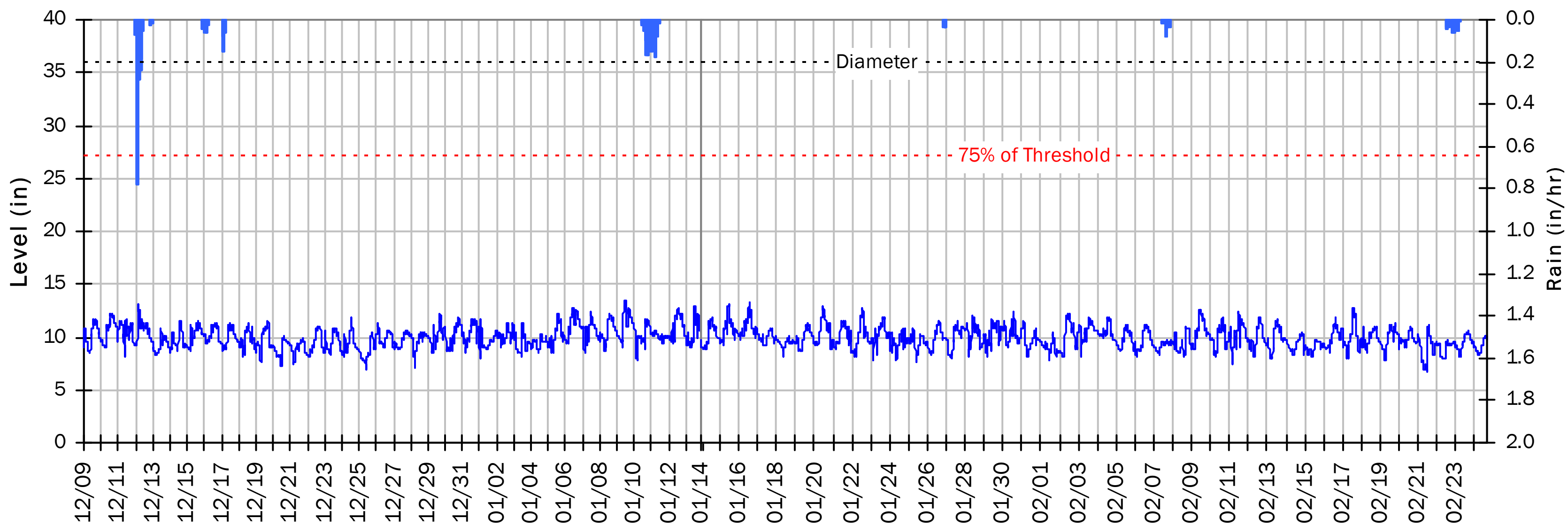
Baseline Flow:

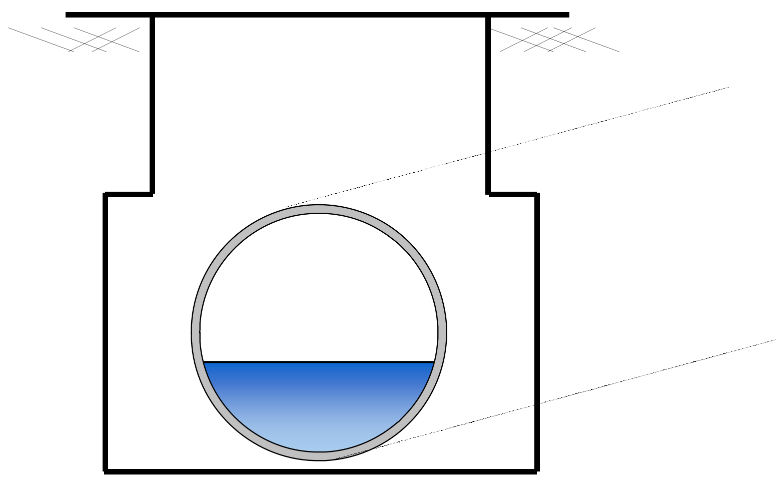
1.41 *mgd*



SITE 5
Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Monitoring Period

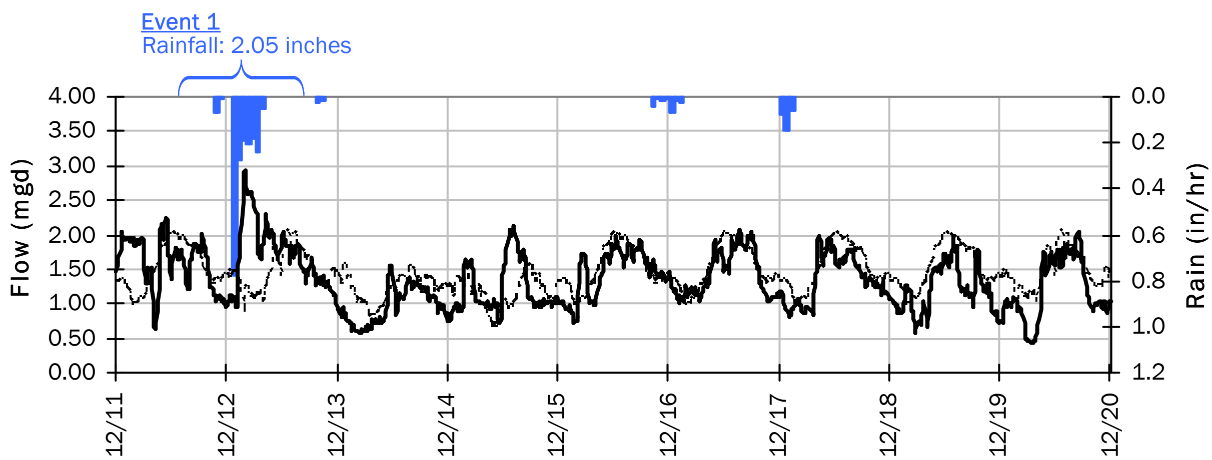




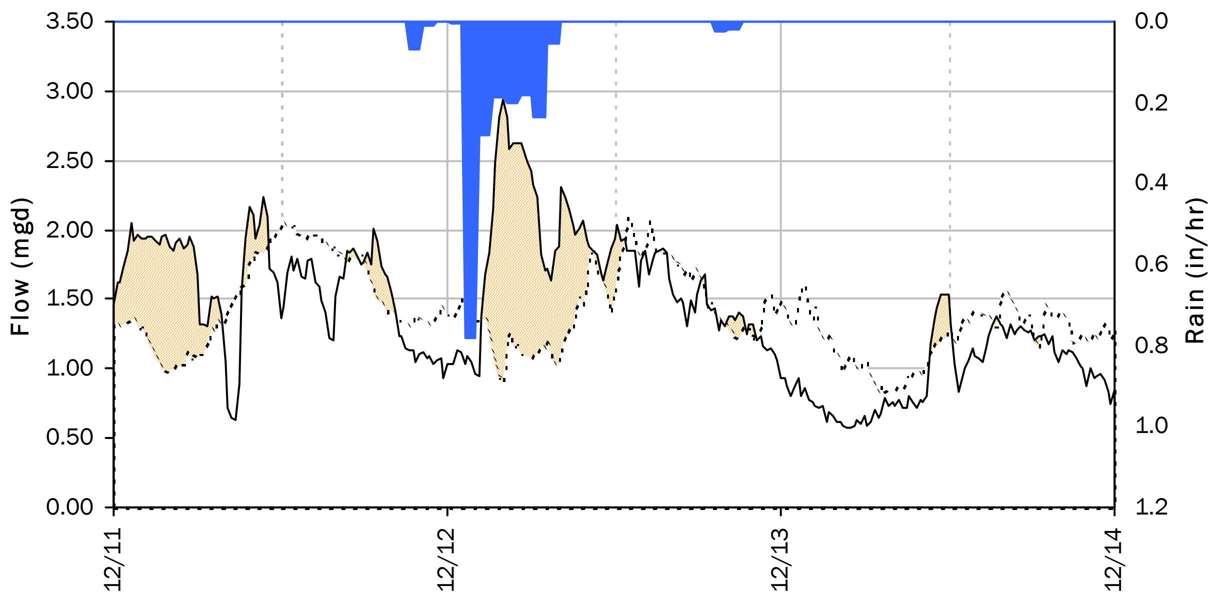
Pipe Diameter:	36	*inches*
Peak Measured Level:	13.5	*inches*
Peak d/D Ratio:	0.37	

SITE 5
I/I Summary: Event 1

Baseline and Realtime Flows with Rainfall Data over Monitoring Period



Event 1 Detail Graph

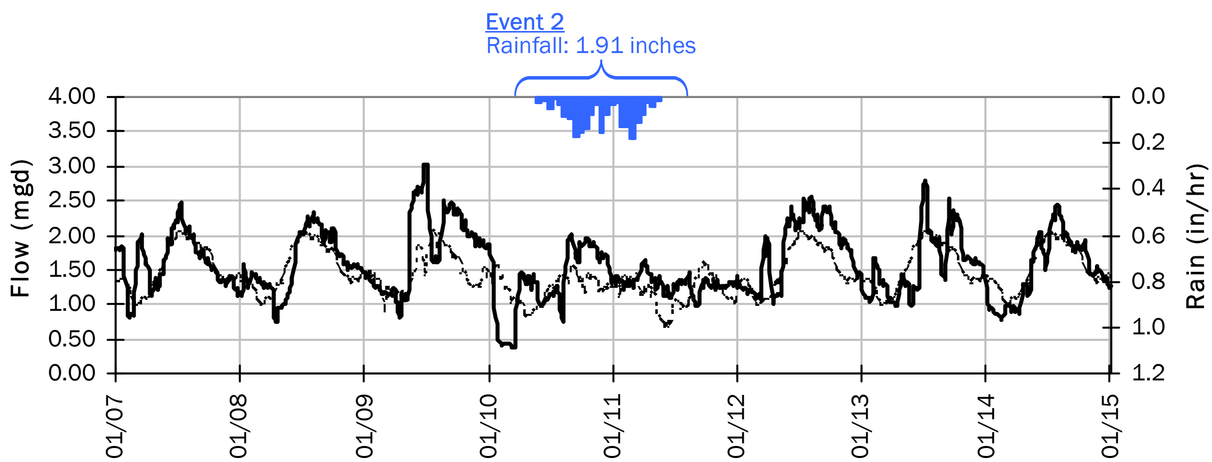


Storm Event I/I Analysis (Rain = 2.05 inches)

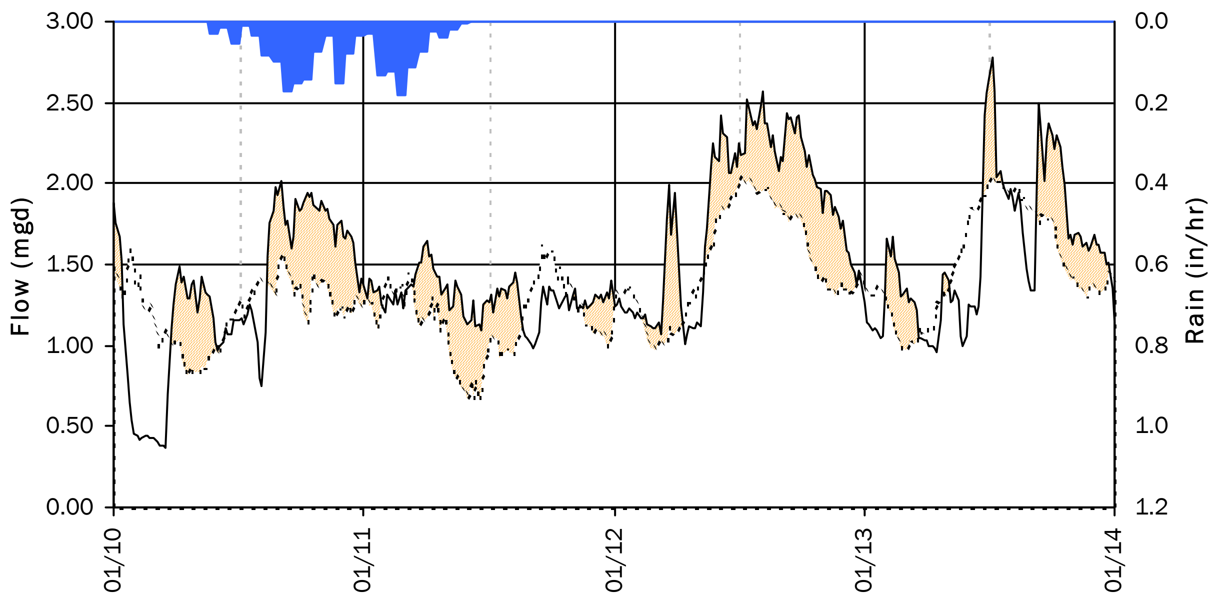
Capacity		Inflow / Infiltration	
Peak Flow:	2.94 *mgd*	Peak I/I Rate:	2.04 *mgd*
PF:	2.09	Total I/I:	-22,000 *gallons*
Peak Level:	13.10 *in*		
d/D Ratio:	0.36		

SITE 5
I/I Summary: Event 2

Baseline and Realtime Flows with Rainfall Data over Monitoring Period



Event 2 Detail Graph

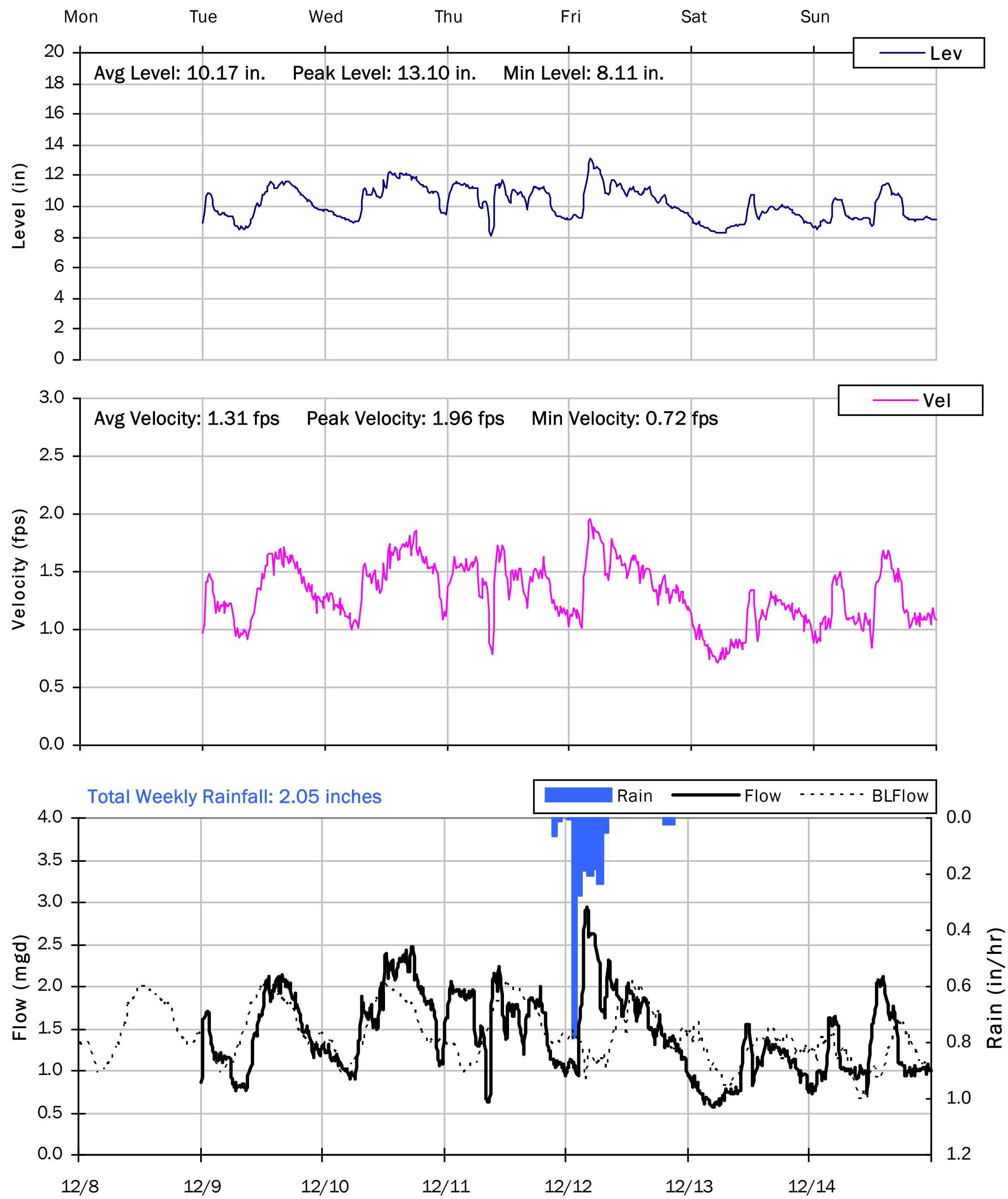


Storm Event I/I Analysis (Rain = 1.91 inches)

Capacity		Inflow / Infiltration	
Peak Flow:	2.56 *mgd*	Peak I/I Rate:	0.89 *mgd*
PF:	1.82	Total I/I:	509,000 *gallons*
Peak Level:	12.78 *in*		
d/D Ratio:	0.36		

SITE 5

Weekly Level, Velocity and Flow Hydrographs
12/8/2014 to 12/15/2014

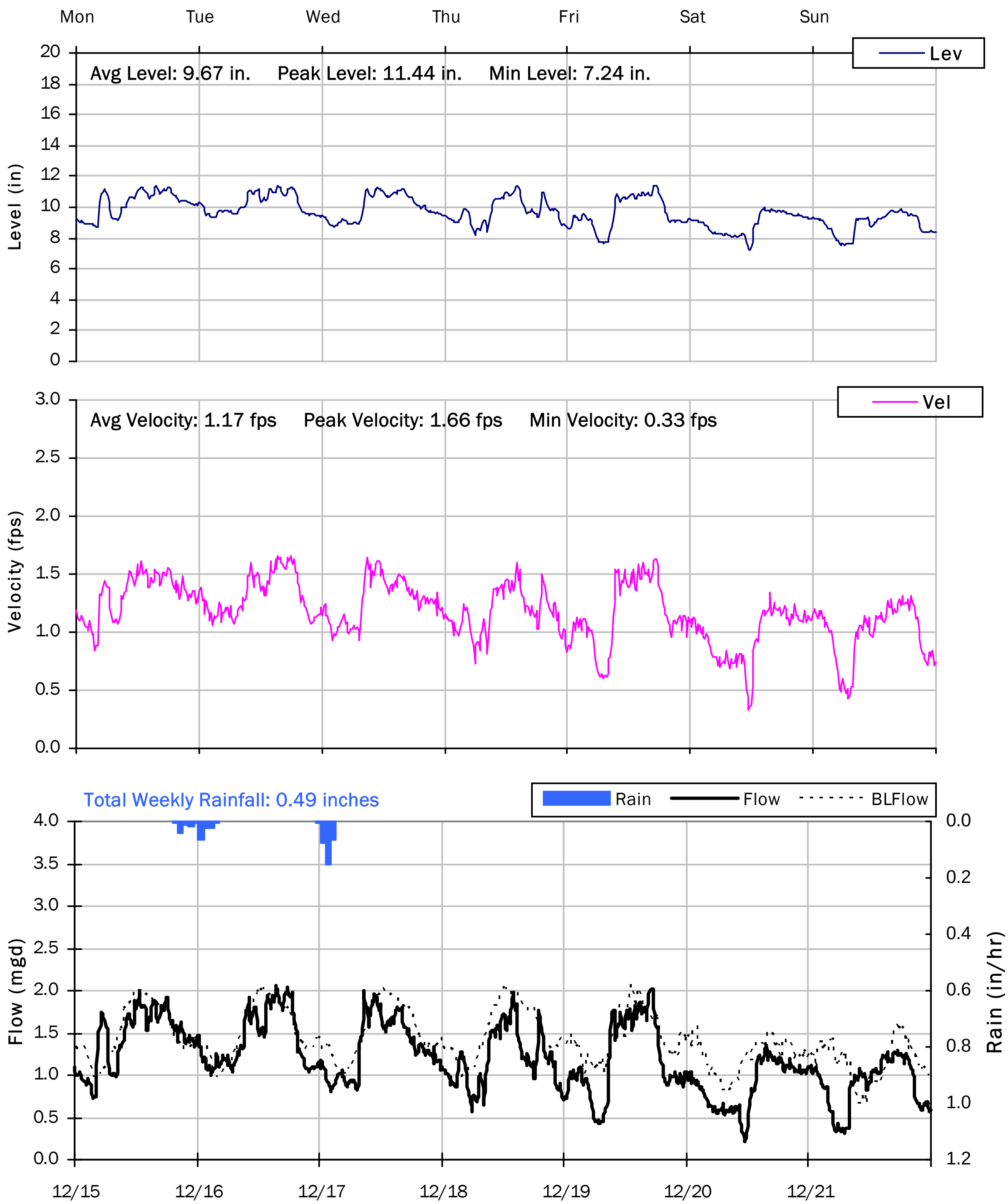


Avg Flow: 1.434 mgd   Peak Flow: 2.942 mgd   Min Flow: 0.568 mgd

SITE 5

Weekly Level, Velocity and Flow Hydrographs

12/15/2014 to 12/22/2014

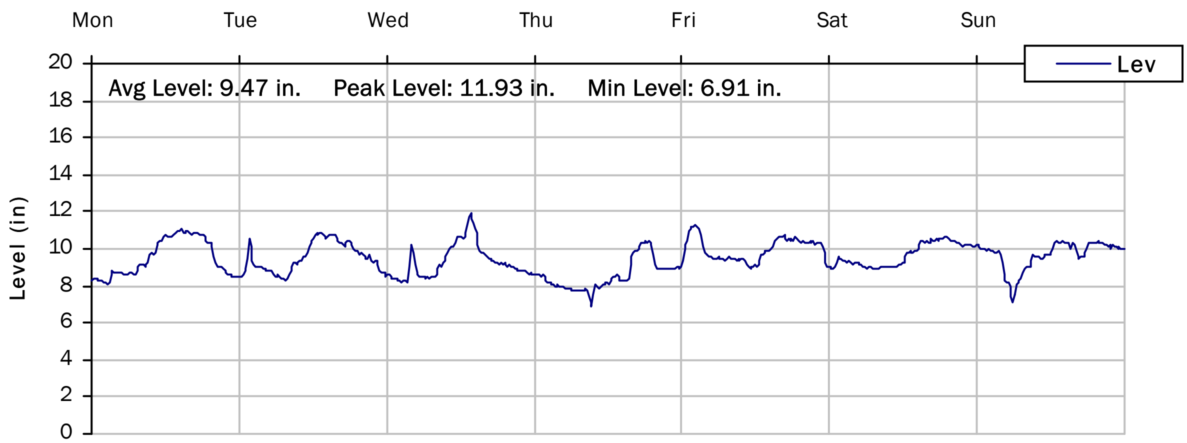


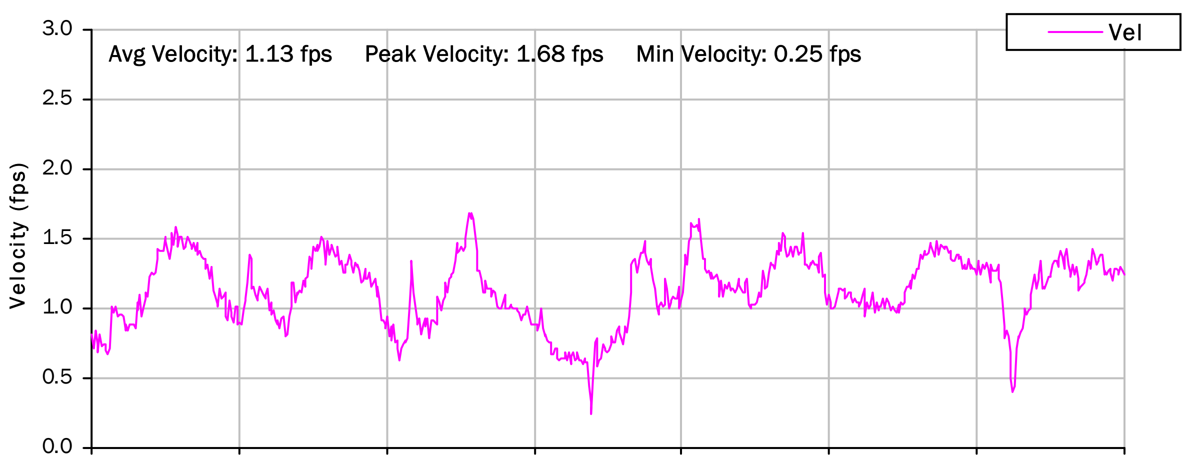
Avg Flow: 1.197 mgd Peak Flow: 2.067 mgd Min Flow: 0.220 mgd

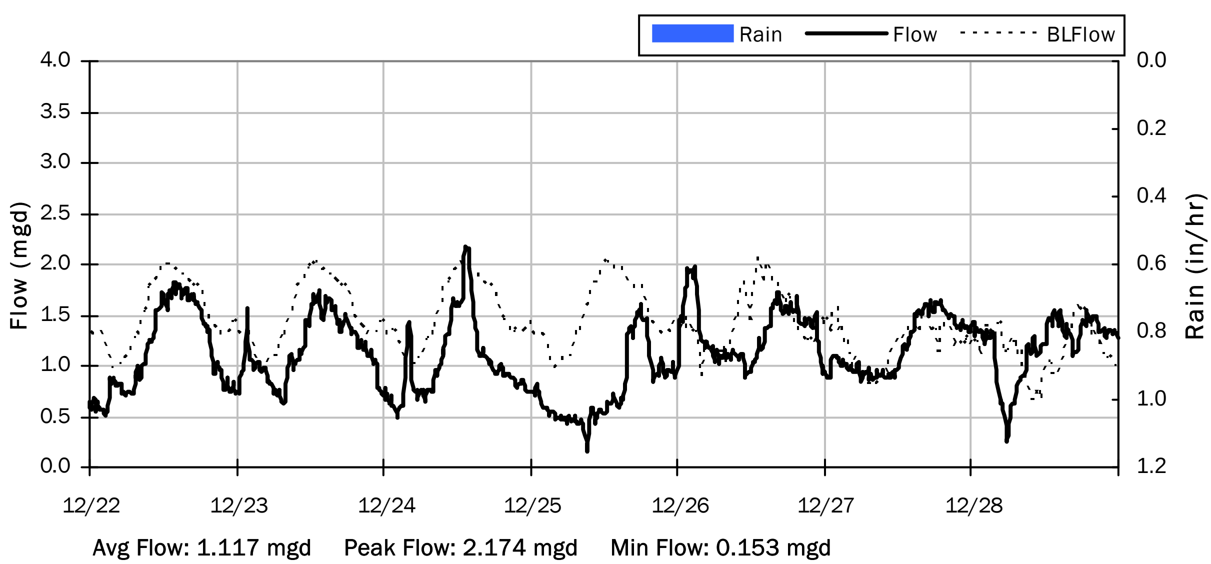
SITE 5

Weekly Level, Velocity and Flow Hydrographs

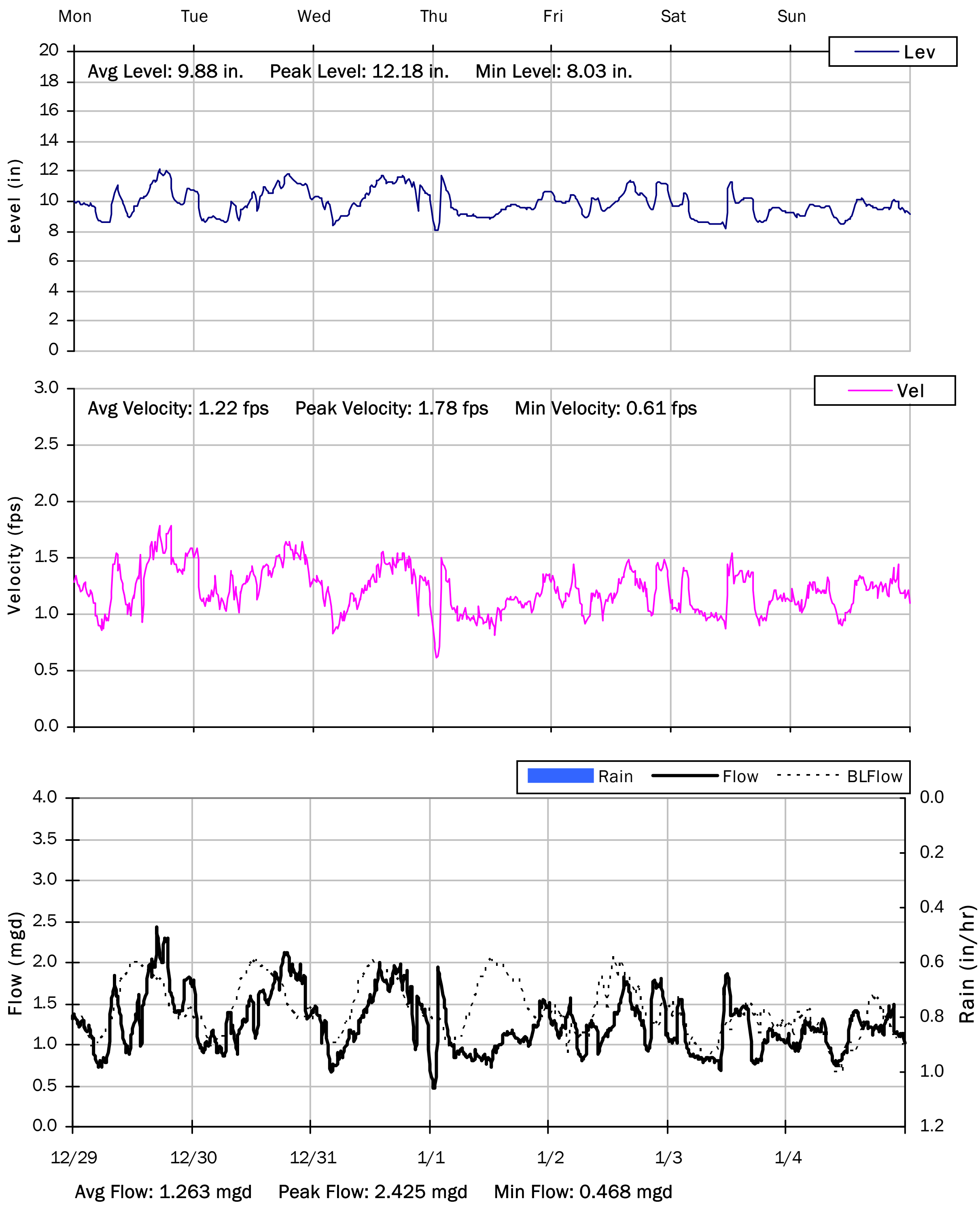
12/22/2014 to 12/29/2014







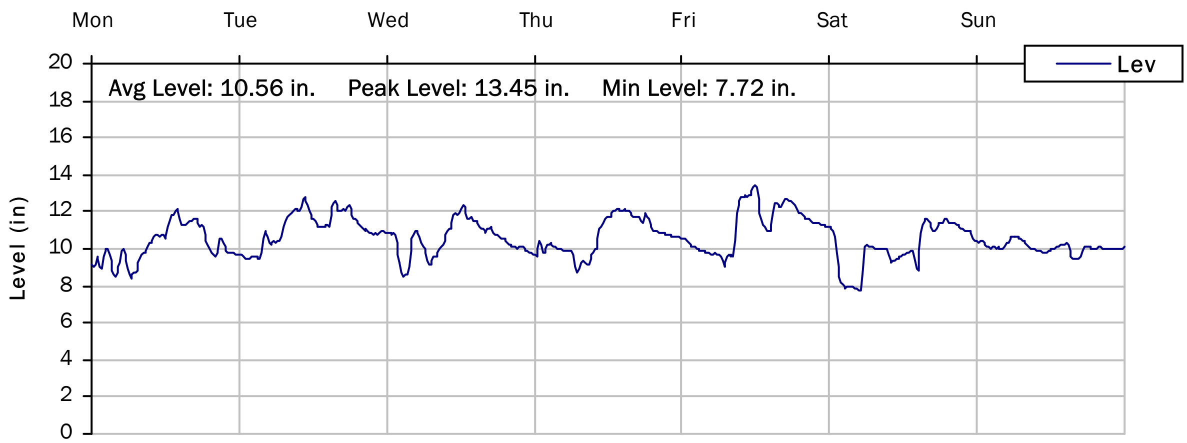
SITE 5
Weekly Level, Velocity and Flow Hydrographs
12/29/2014 to 1/5/2015

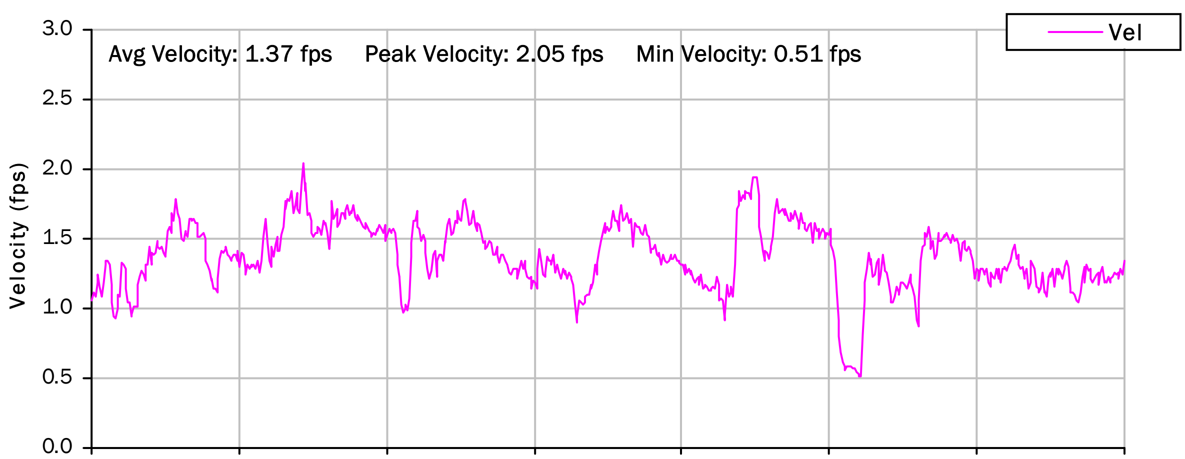


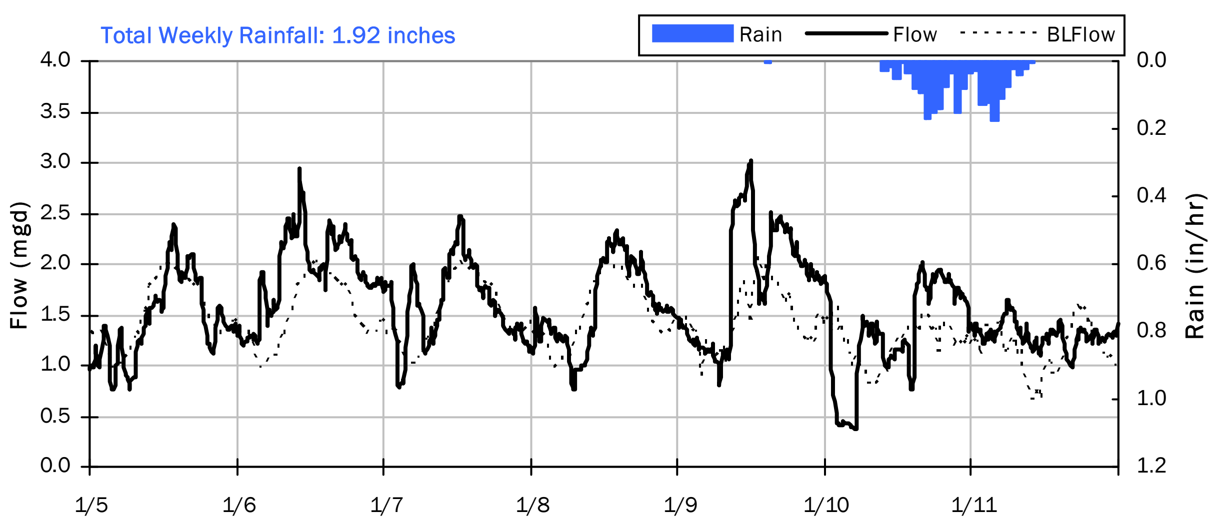
SITE 5

Weekly Level, Velocity and Flow Hydrographs

1/5/2015 to 1/12/2015





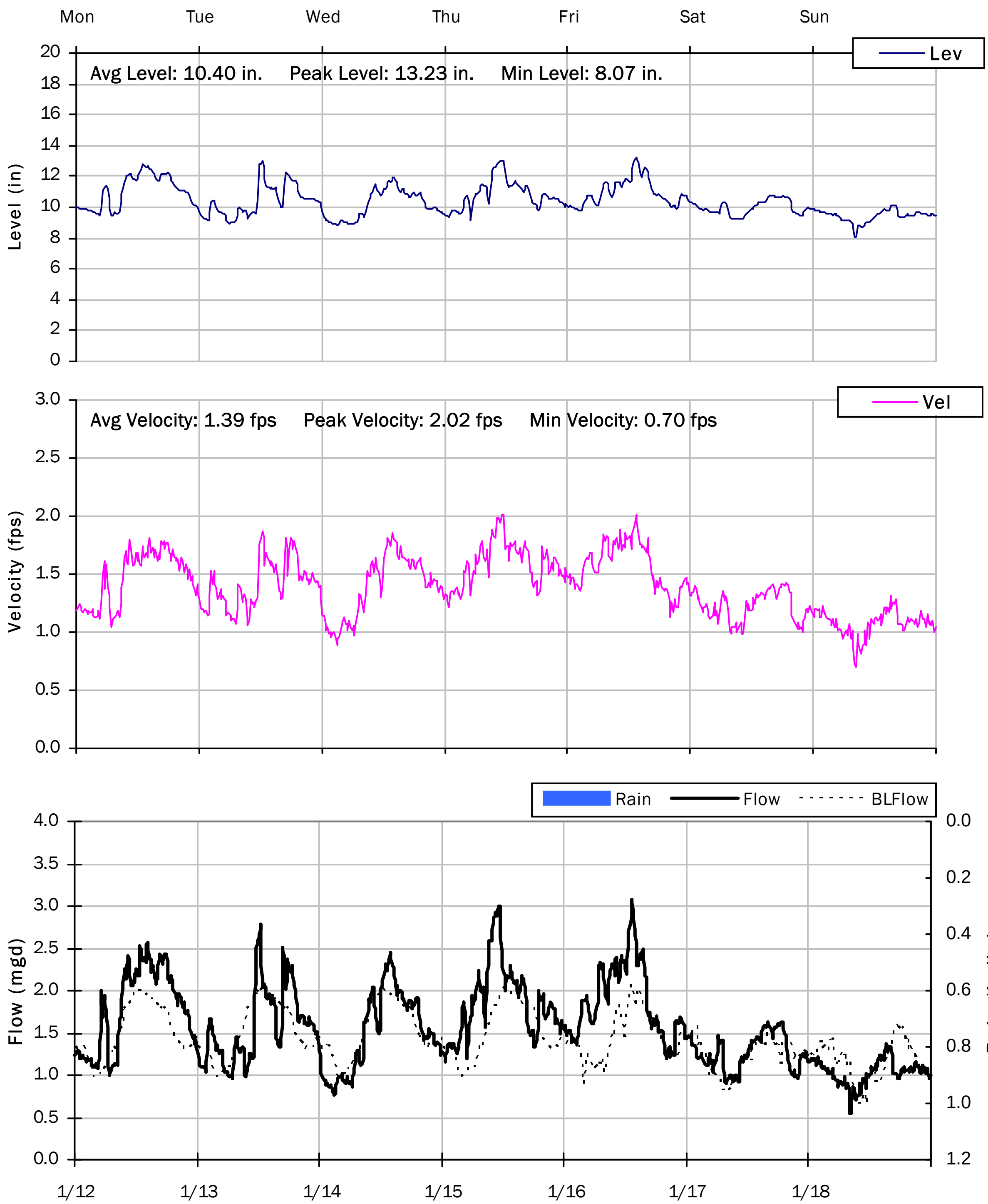


Avg Flow: 1.572 mgd Peak Flow: 3.026 mgd Min Flow: 0.366 mgd

SITE 5

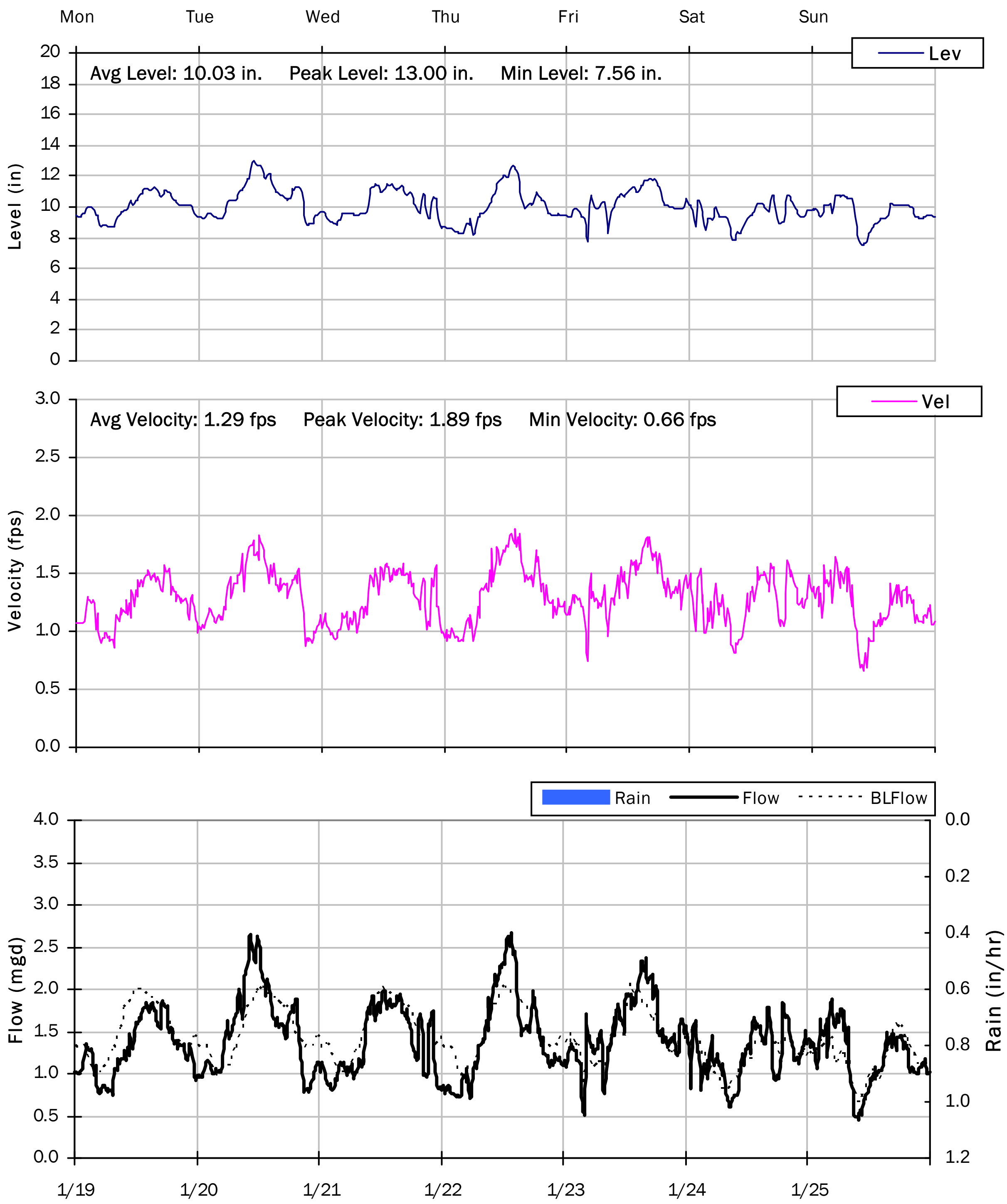
Weekly Level, Velocity and Flow Hydrographs

1/12/2015 to 1/19/2015



Avg Flow: 1.561 mgd Peak Flow: 3.074 mgd Min Flow: 0.541 mgd

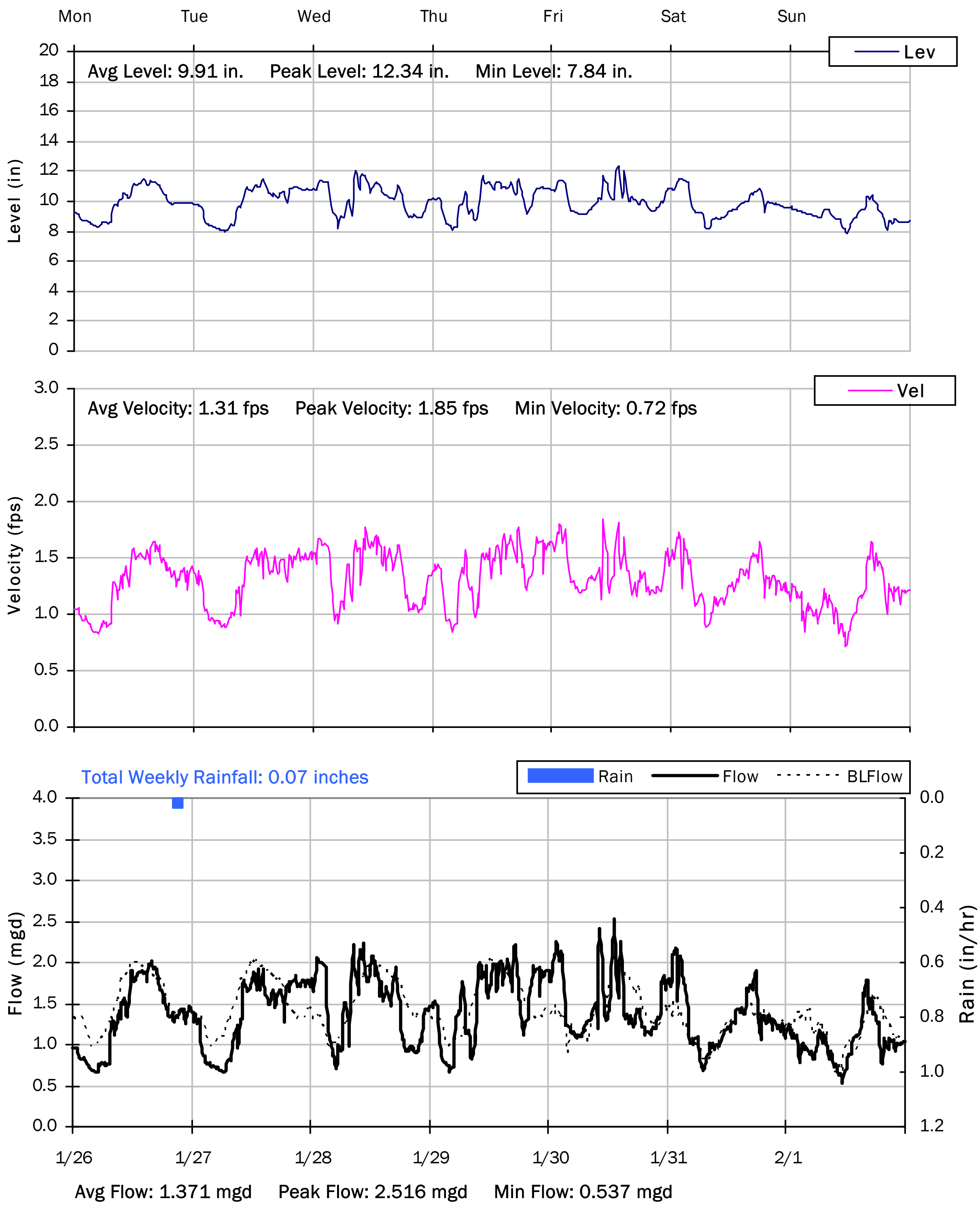
SITE 5
Weekly Level, Velocity and Flow Hydrographs
1/19/2015 to 1/26/2015



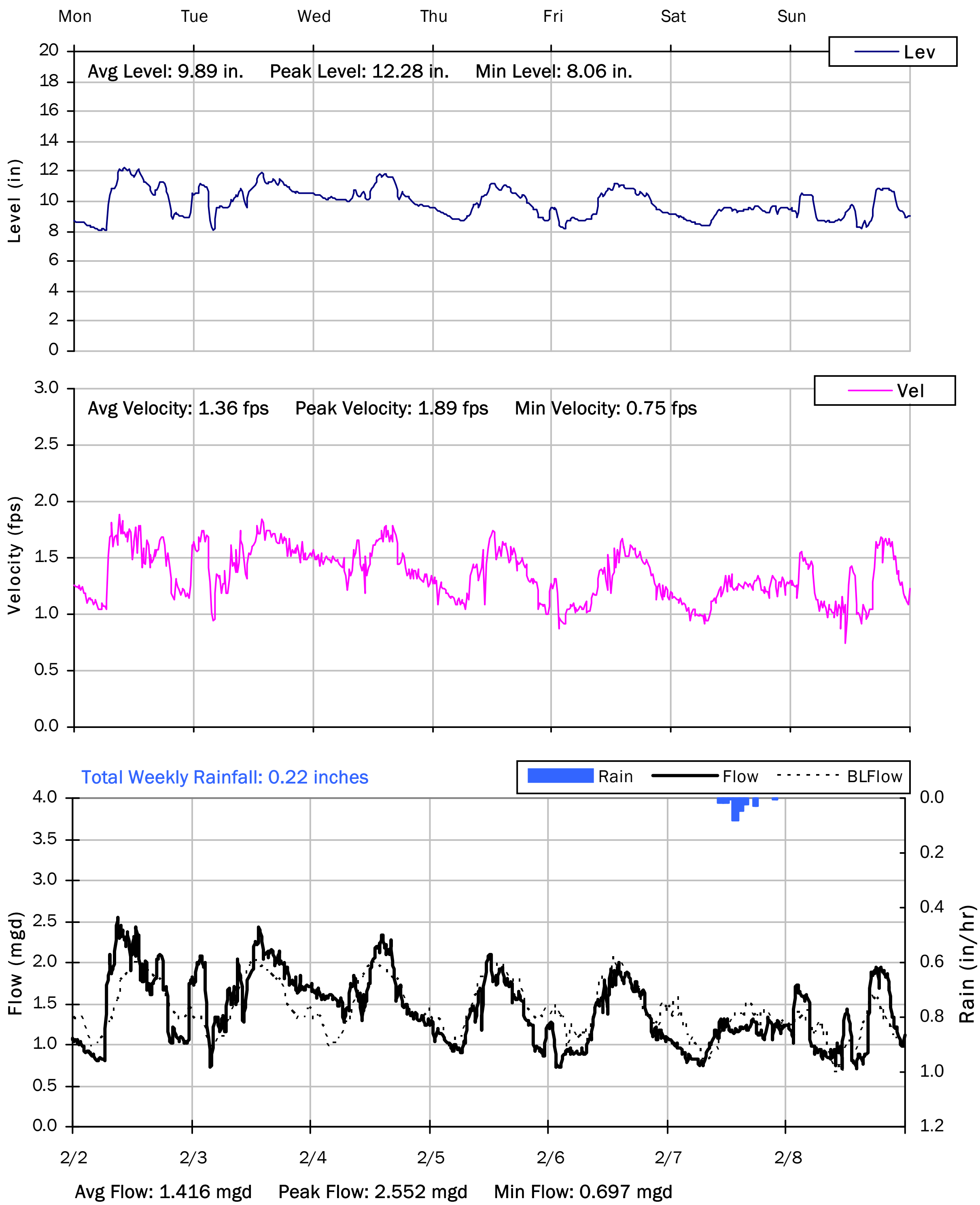
Avg Flow: 1.376 mgd Peak Flow: 2.663 mgd Min Flow: 0.460 mgd

SITE 5

Weekly Level, Velocity and Flow Hydrographs
1/26/2015 to 2/2/2015



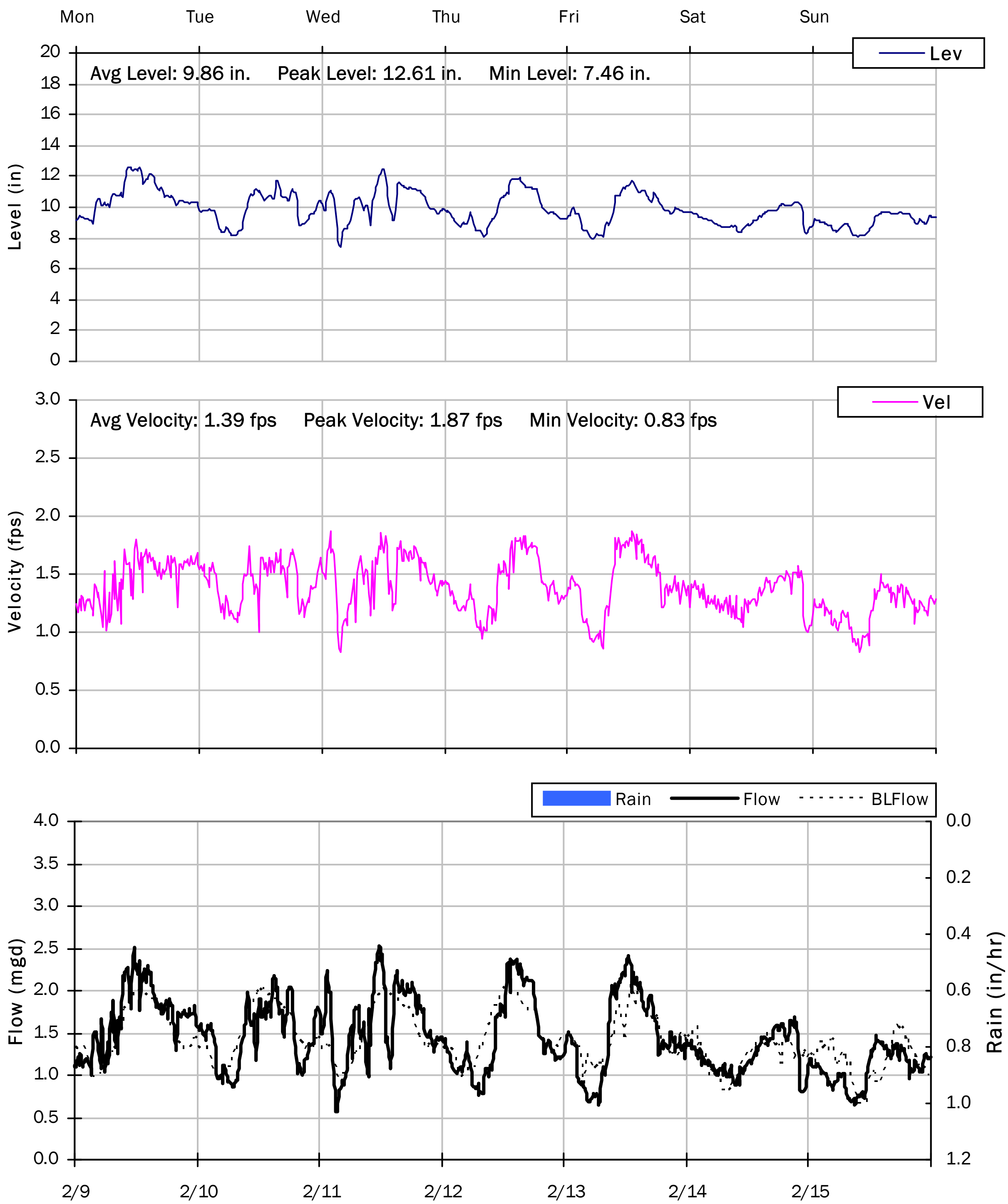
SITE 5
Weekly Level, Velocity and Flow Hydrographs
2/2/2015 to 2/9/2015



SITE 5

Weekly Level, Velocity and Flow Hydrographs

2/9/2015 to 2/16/2015

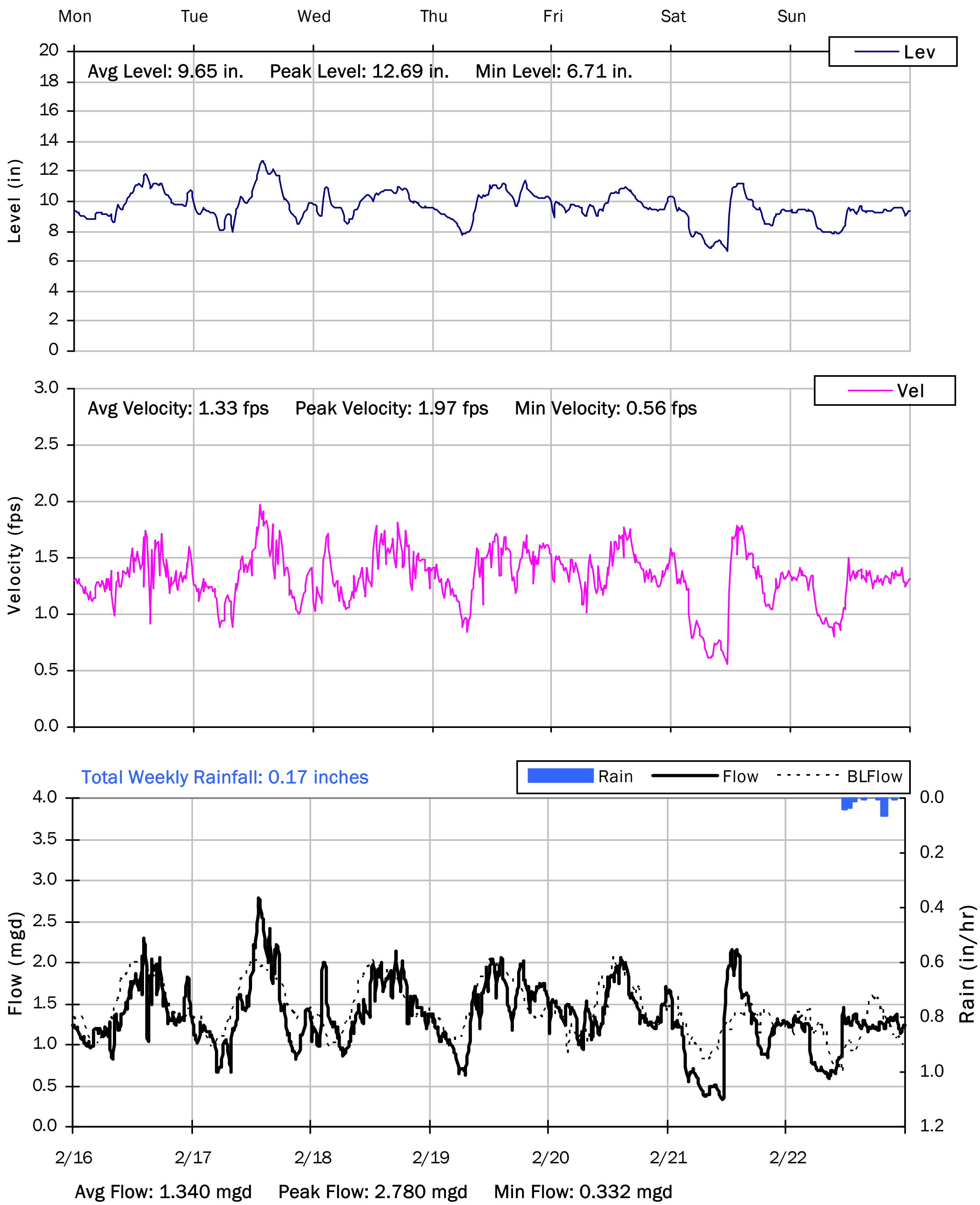


Avg Flow: 1.439 mgd Peak Flow: 2.535 mgd Min Flow: 0.570 mgd

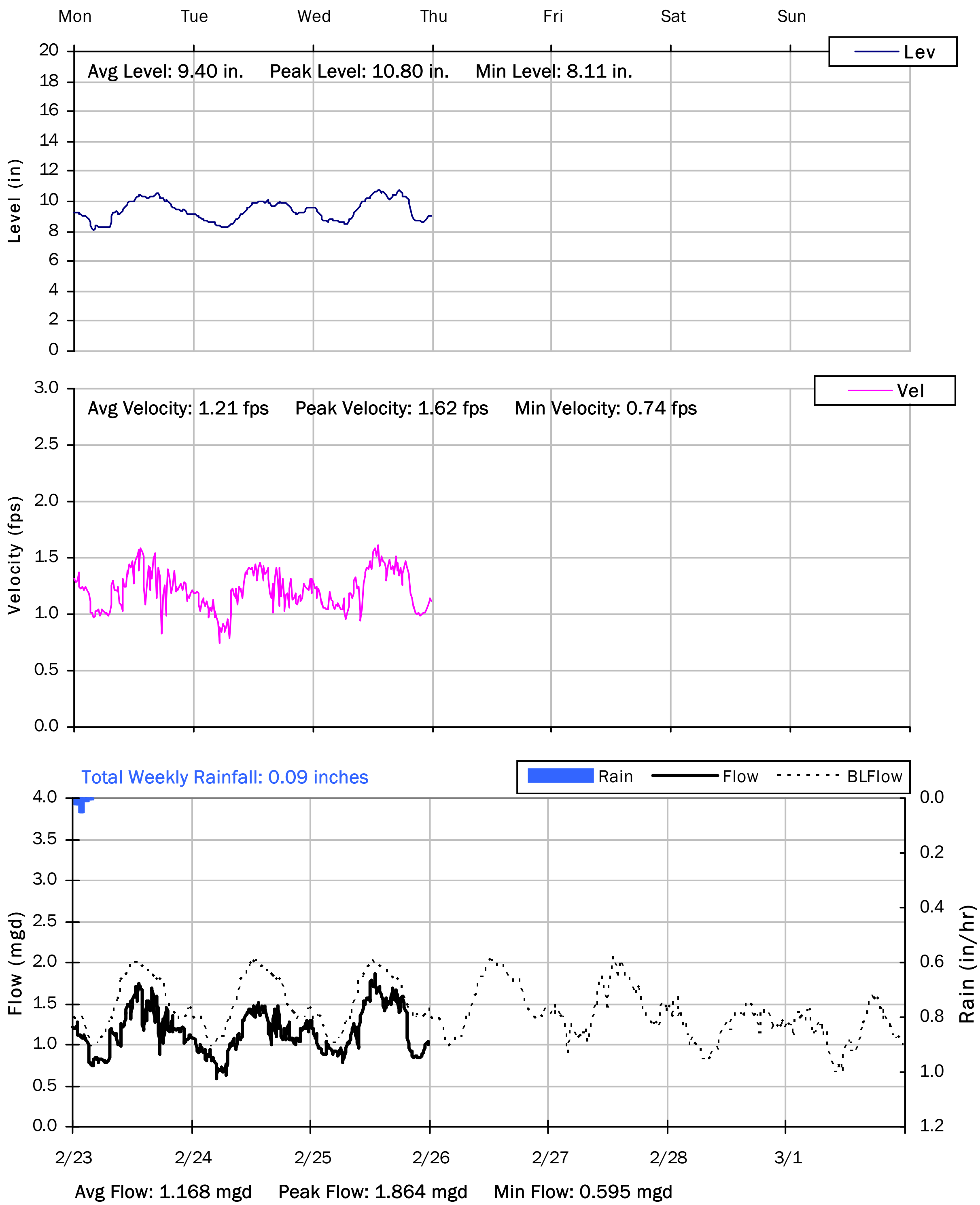
SITE 5

Weekly Level, Velocity and Flow Hydrographs

2/16/2015 to 2/23/2015



SITE 5
Weekly Level, Velocity and Flow Hydrographs
2/23/2015 to 3/2/2015



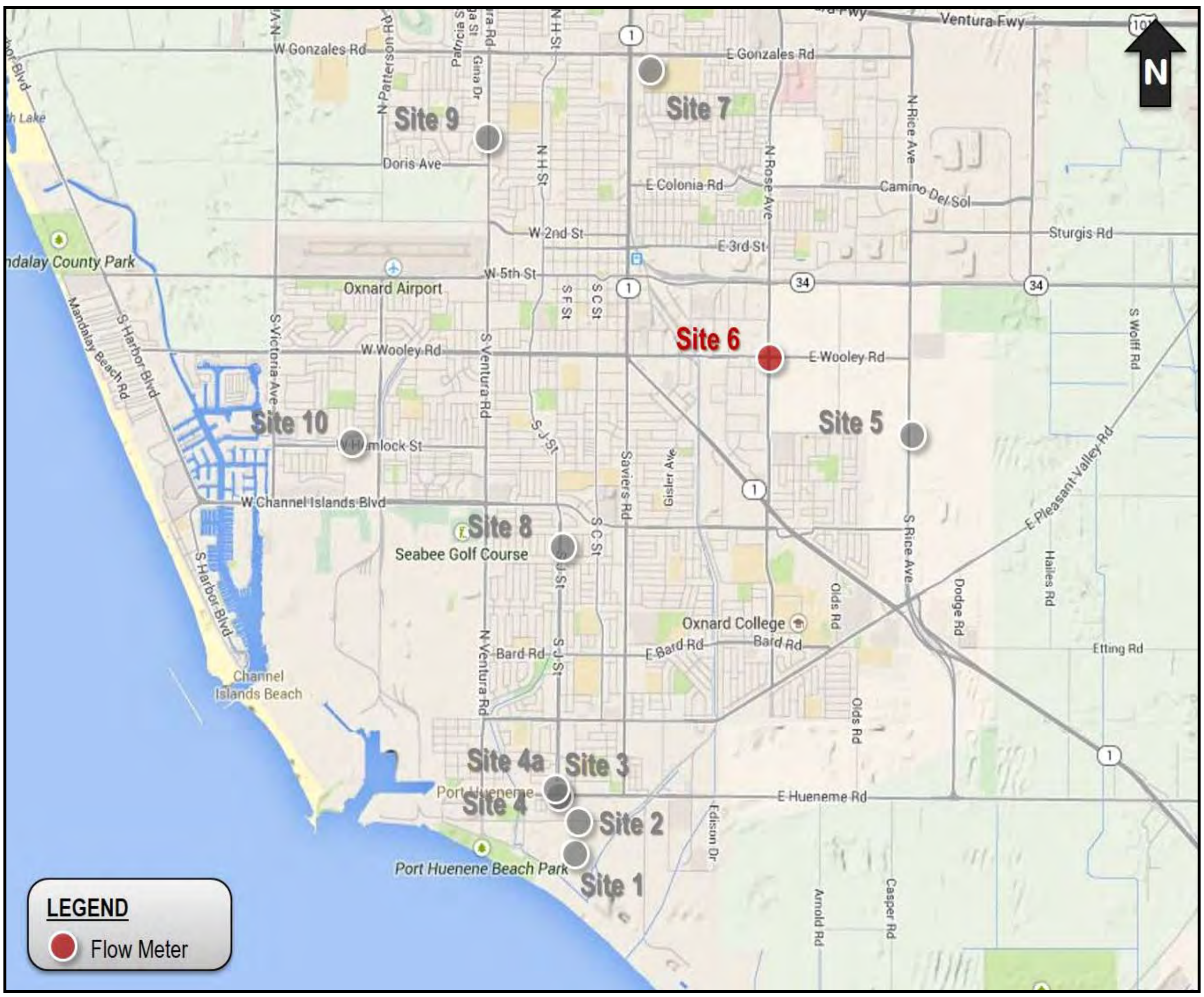
City of Oxnard

Sanitary Sewer Flow Monitoring
Temporary Monitoring: December, 2014 through February, 2015

Monitoring Site: Site 6

Location: S Rose Avenue and E Wooley Road

Data Summary Report



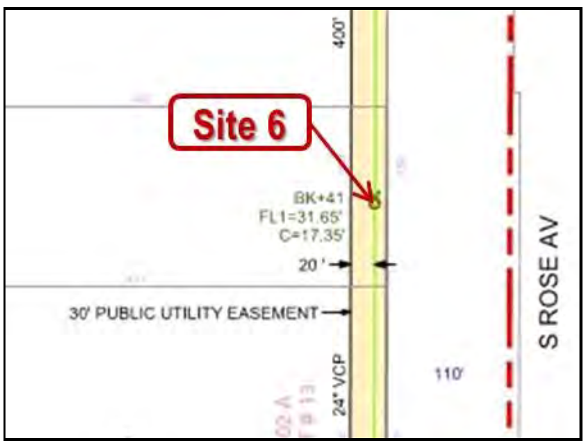
Vicinity Map: Site 6

SITE 6

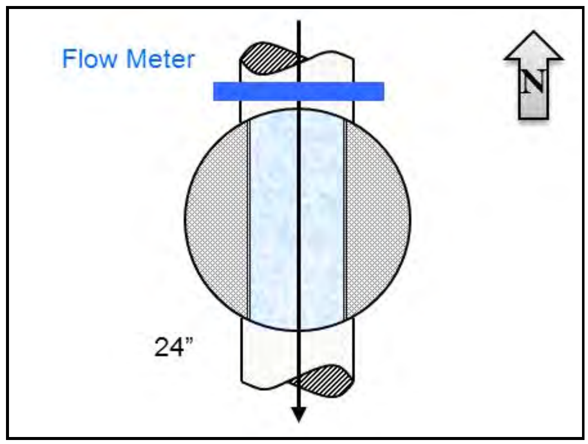
Site Information

Location:	S Rose Avenue and E Wooley Road
Coordinates:	119.1601° W, 34.1893° N
Rim Elevation:	49 feet
Pipe Diameter:	24 inches
Baseline Flow:	1.197 mgd
Peak Measured Flow:	2.292 mgd

Satellite Map



Sanitary Map



Flow Diagram


Street View


Plan View

SITE 6

Additional Site Photos

Effluent Pipe

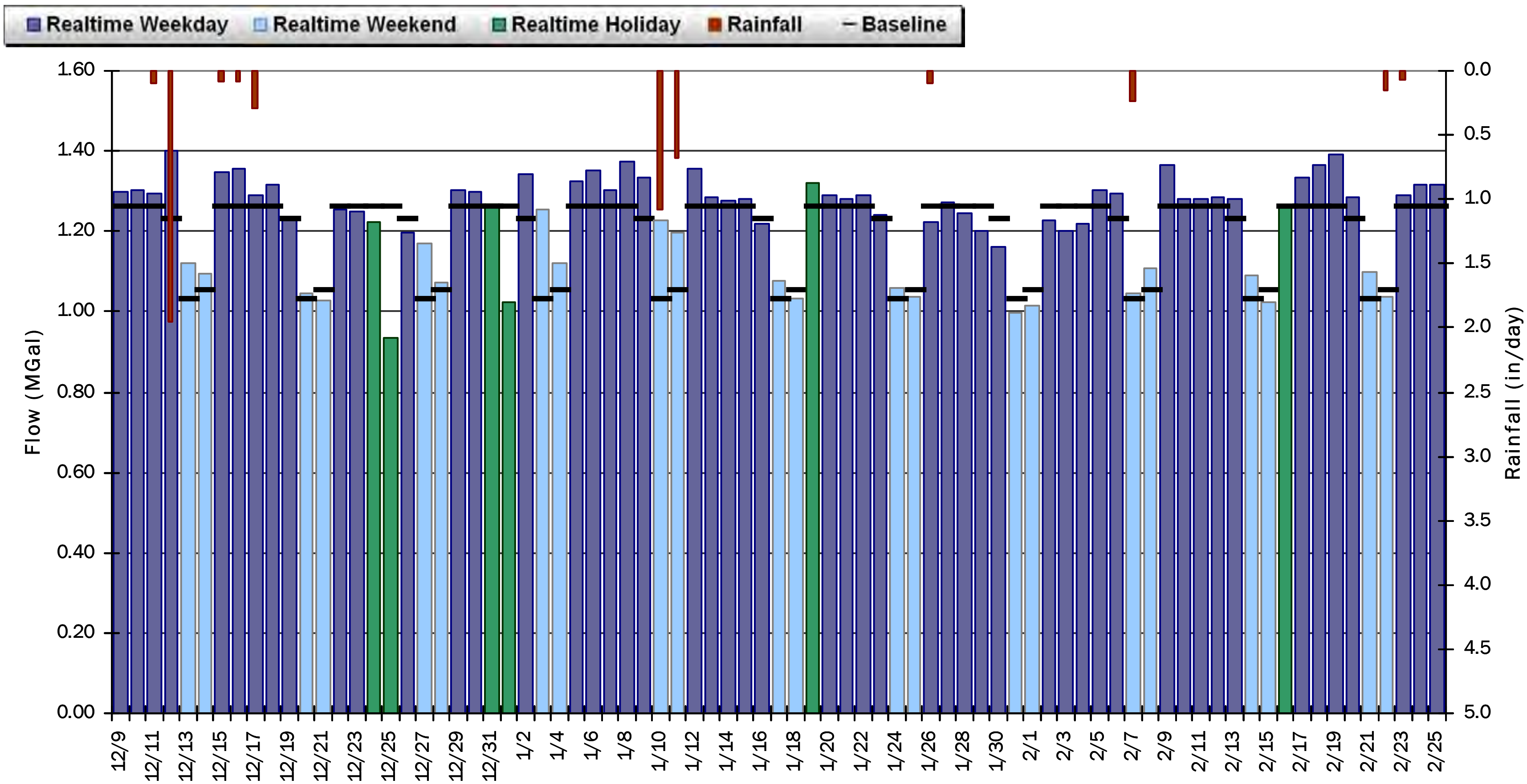
Influent Pipe

SITE 6

Period Flow Summary: Daily Flow Totals

Avg Period Flow: 1.226 MGal **Peak Daily Flow: 1.403 MGal** **Min Daily Flow: 0.933 MGal**

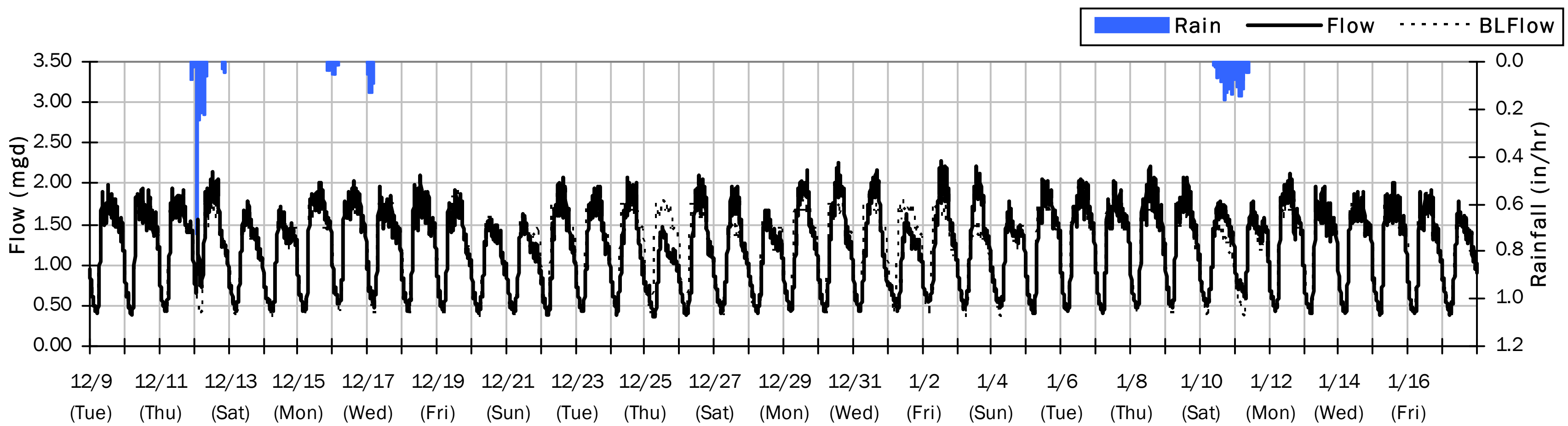
Total Period Rainfall: 4.81 inches

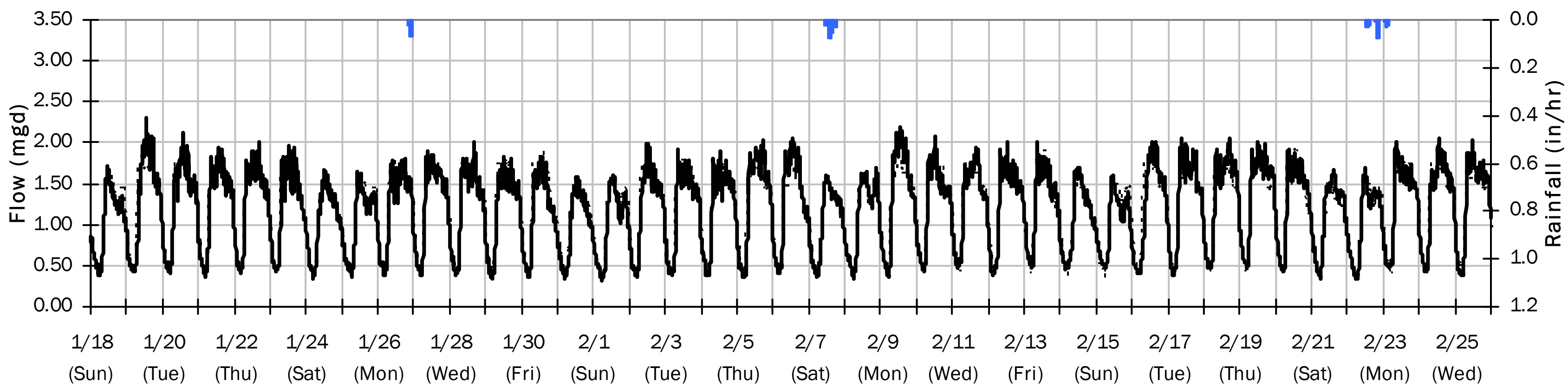


SITE 6

Flow Summary: 12/9/2014 to 2/25/2015

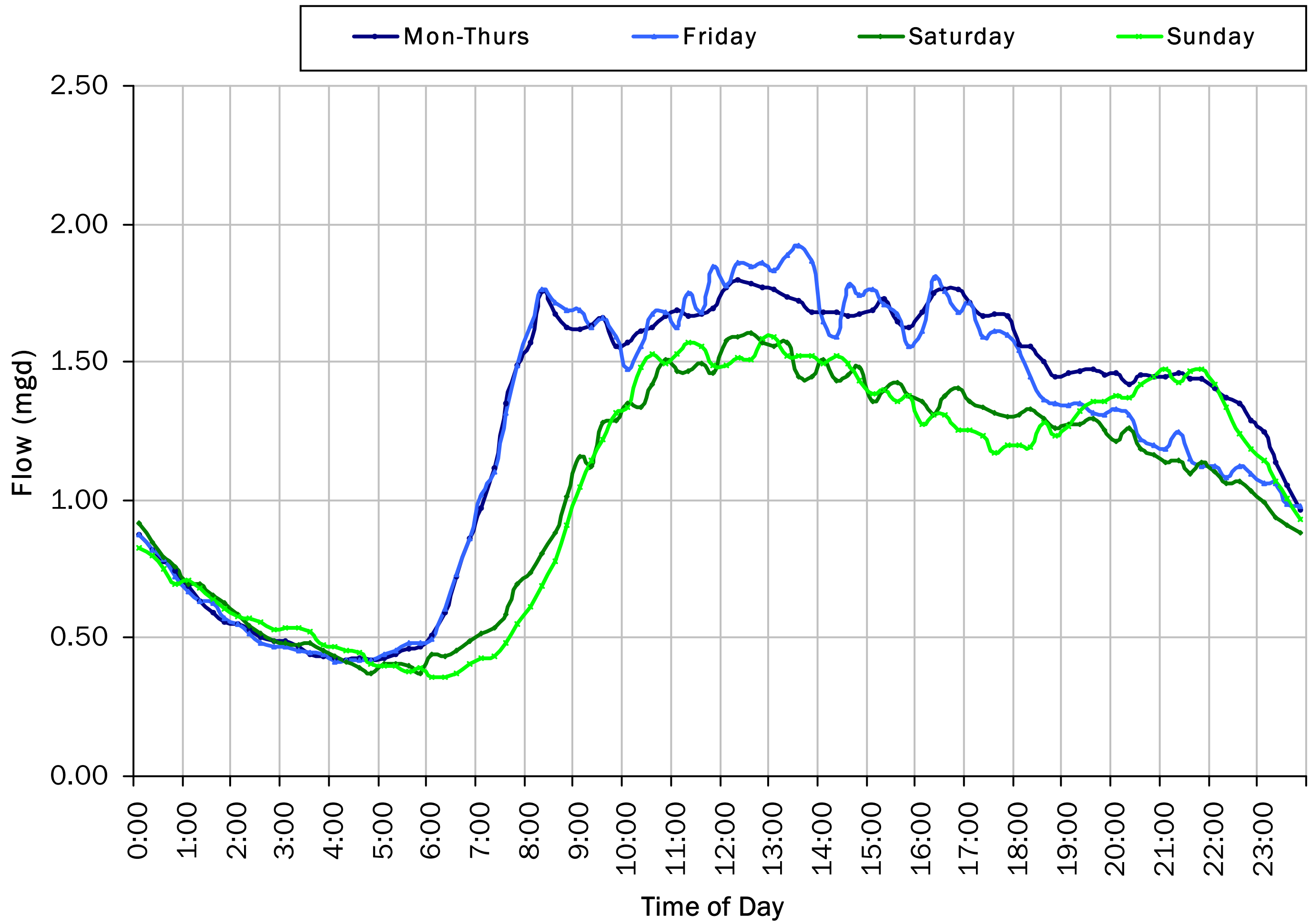
Total Period Rainfall: 4.81 inches   Avg Flow: 1.226 mgd   Peak Flow: 2.292 mgd   Min Flow: 0.309 mgd





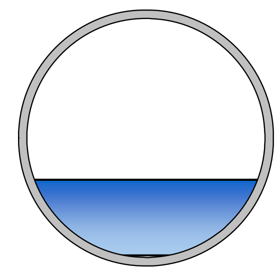
SITE 6

Baseline Flow Hydrographs



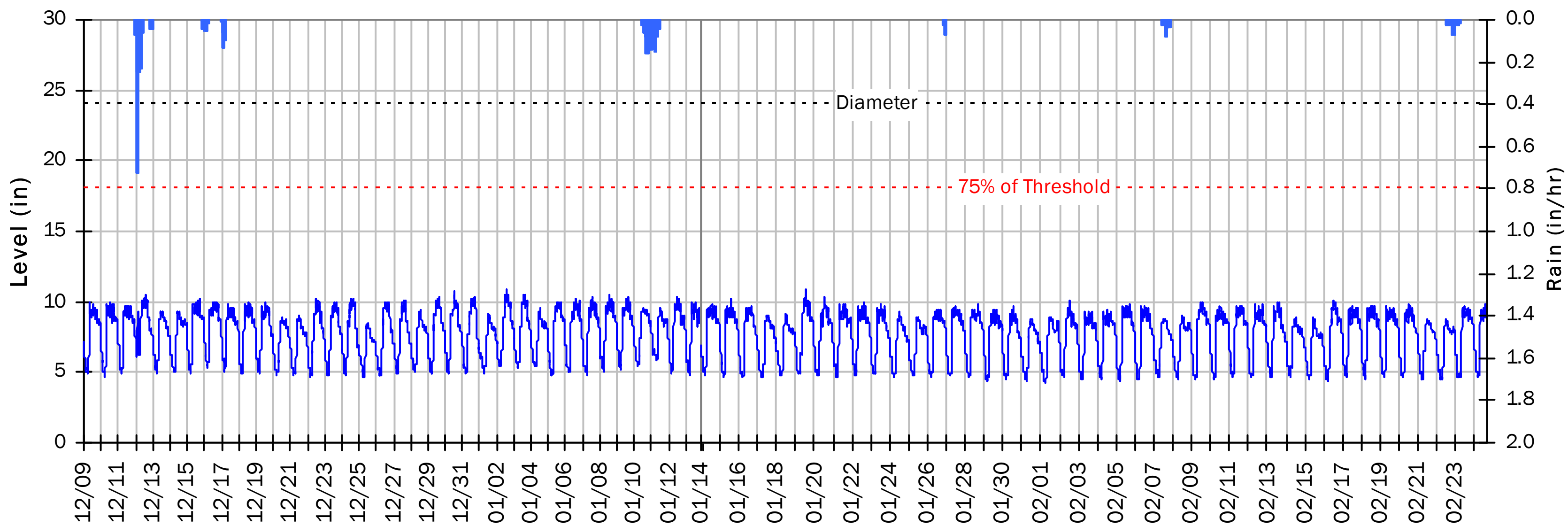
Baseline Flow:

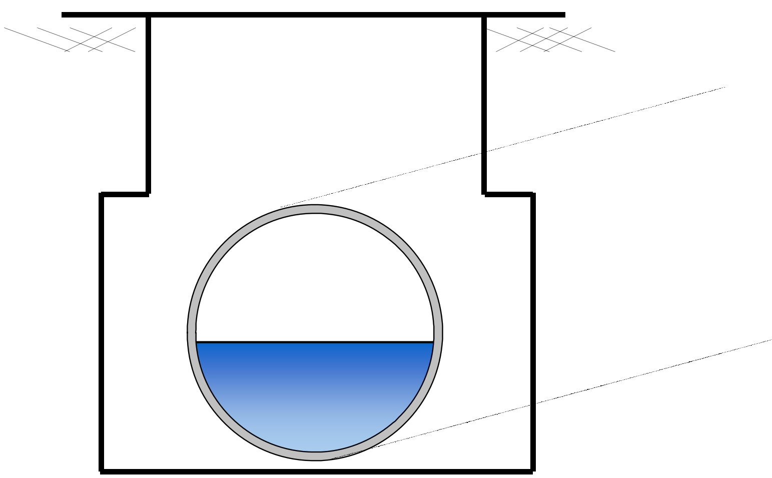
1.20 *mgd*



SITE 6
Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Monitoring Period

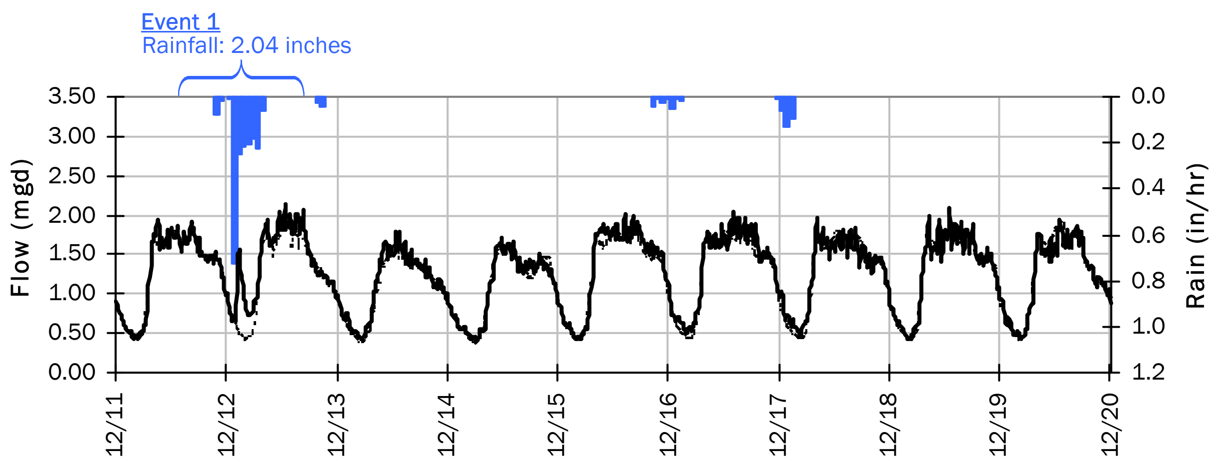




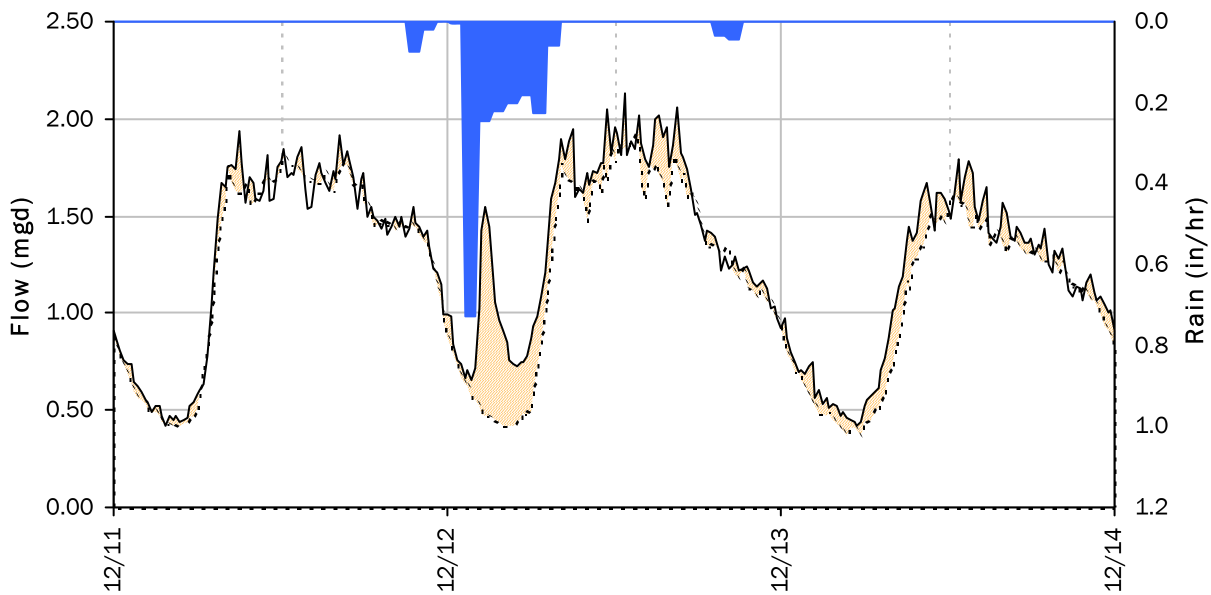
Pipe Diameter:	24	*inches*
Peak Measured Level:	11	*inches*
Peak d/D Ratio:	0.46	

SITE 6
I/I Summary: Event 1

Baseline and Realtime Flows with Rainfall Data over Monitoring Period



Event 1 Detail Graph

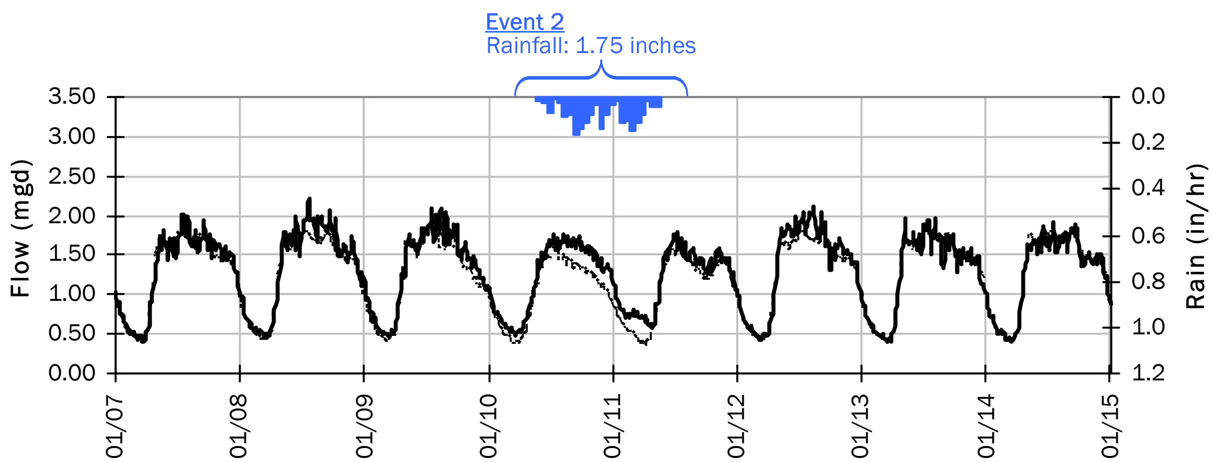


Storm Event I/I Analysis (Rain = 2.04 inches)

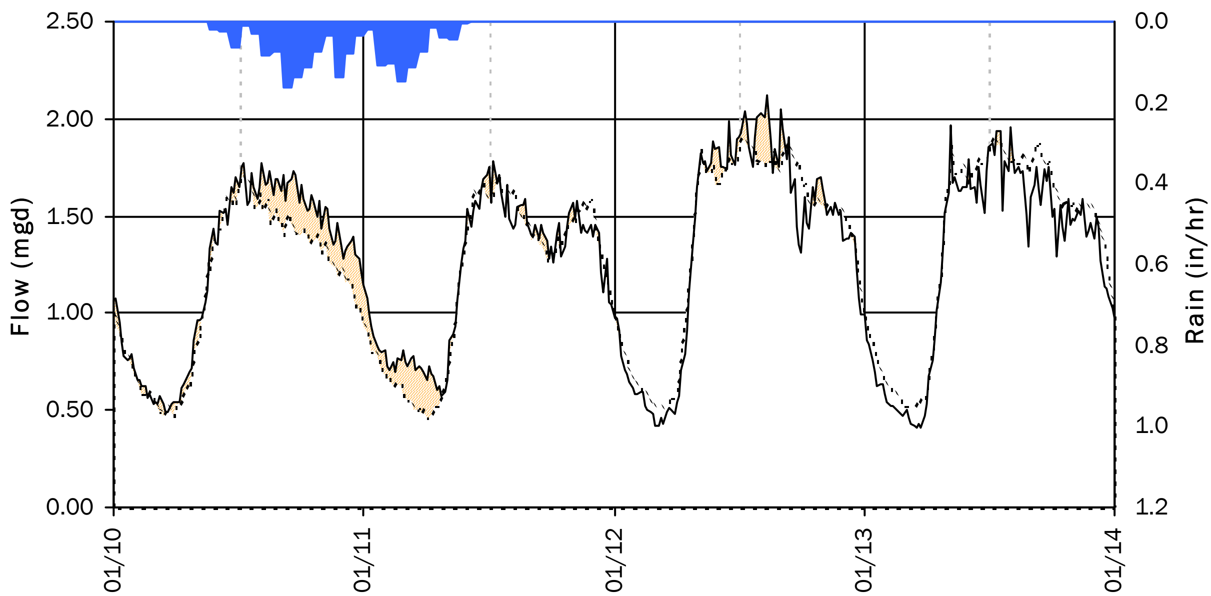
Capacity		Inflow / Infiltration	
Peak Flow:	2.13 *mgd*	Peak I/I Rate:	1.08 *mgd*
PF:	1.78	Total I/I:	264,000 *gallons*
Peak Level:	10.44 *in*		
d/D Ratio:	0.44		

SITE 6
I/I Summary: Event 2

Baseline and Realtime Flows with Rainfall Data over Monitoring Period



Event 2 Detail Graph



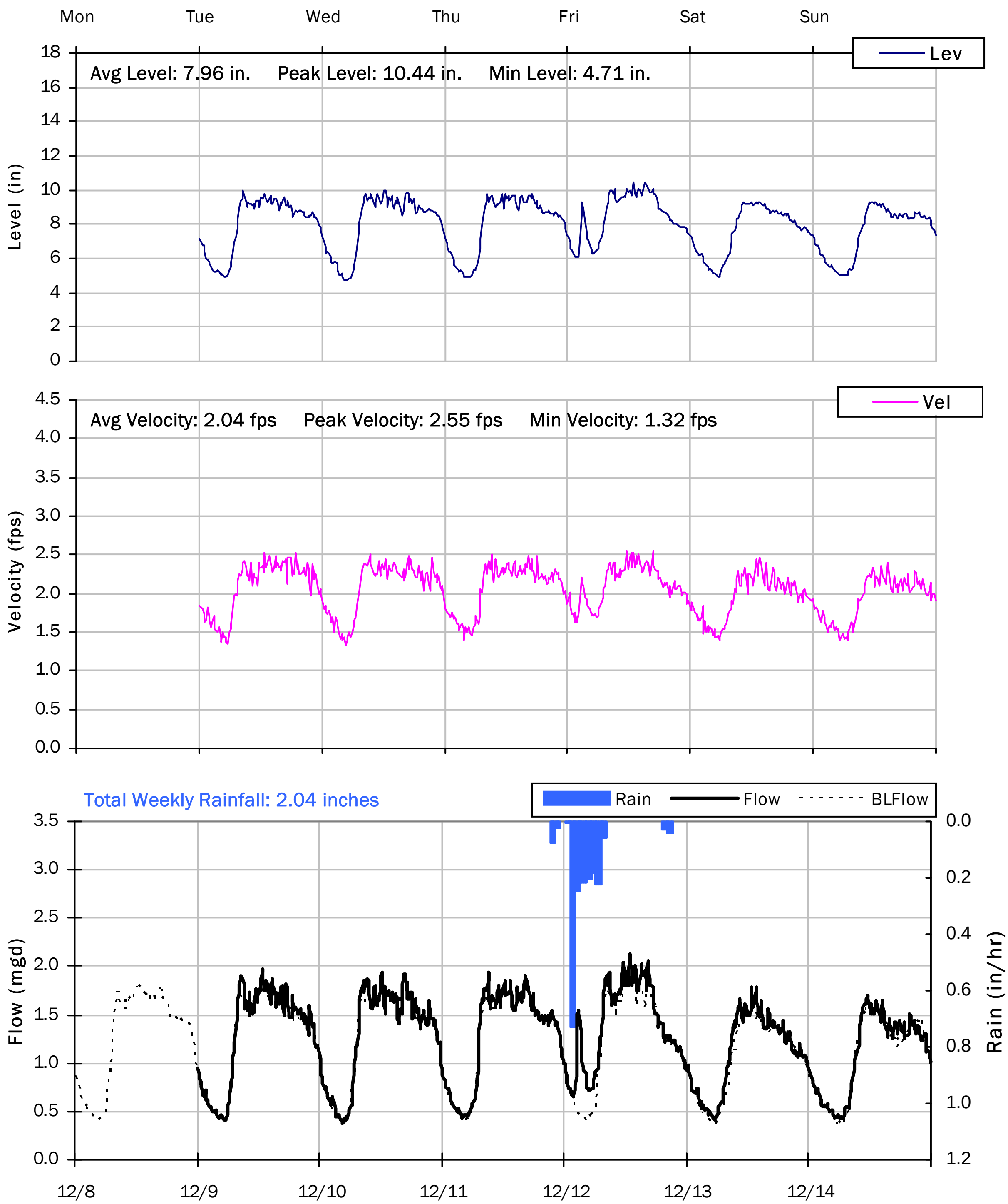
Storm Event I/I Analysis (Rain = 1.75 inches)

Capacity		Inflow / Infiltration	
Peak Flow:	2.13 *mgd*	Peak I/I Rate:	0.36 *mgd*
PF:	1.78	Total I/I:	128,000 *gallons*
Peak Level:	10.40 *in*		
d/D Ratio:	0.43		

SITE 6

Weekly Level, Velocity and Flow Hydrographs

12/8/2014 to 12/15/2014

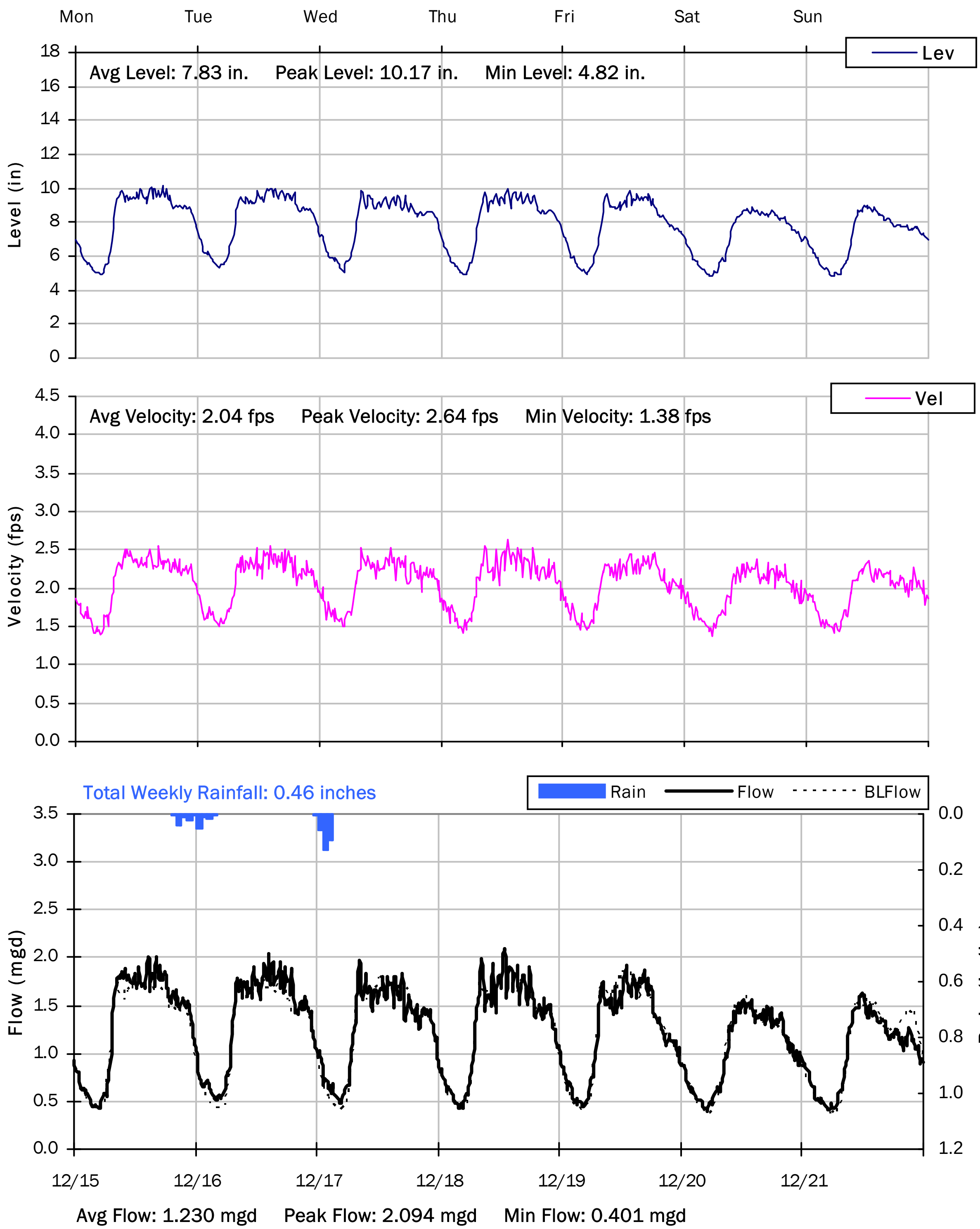


Avg Flow: 1.253 mgd Peak Flow: 2.134 mgd Min Flow: 0.374 mgd

SITE 6

Weekly Level, Velocity and Flow Hydrographs

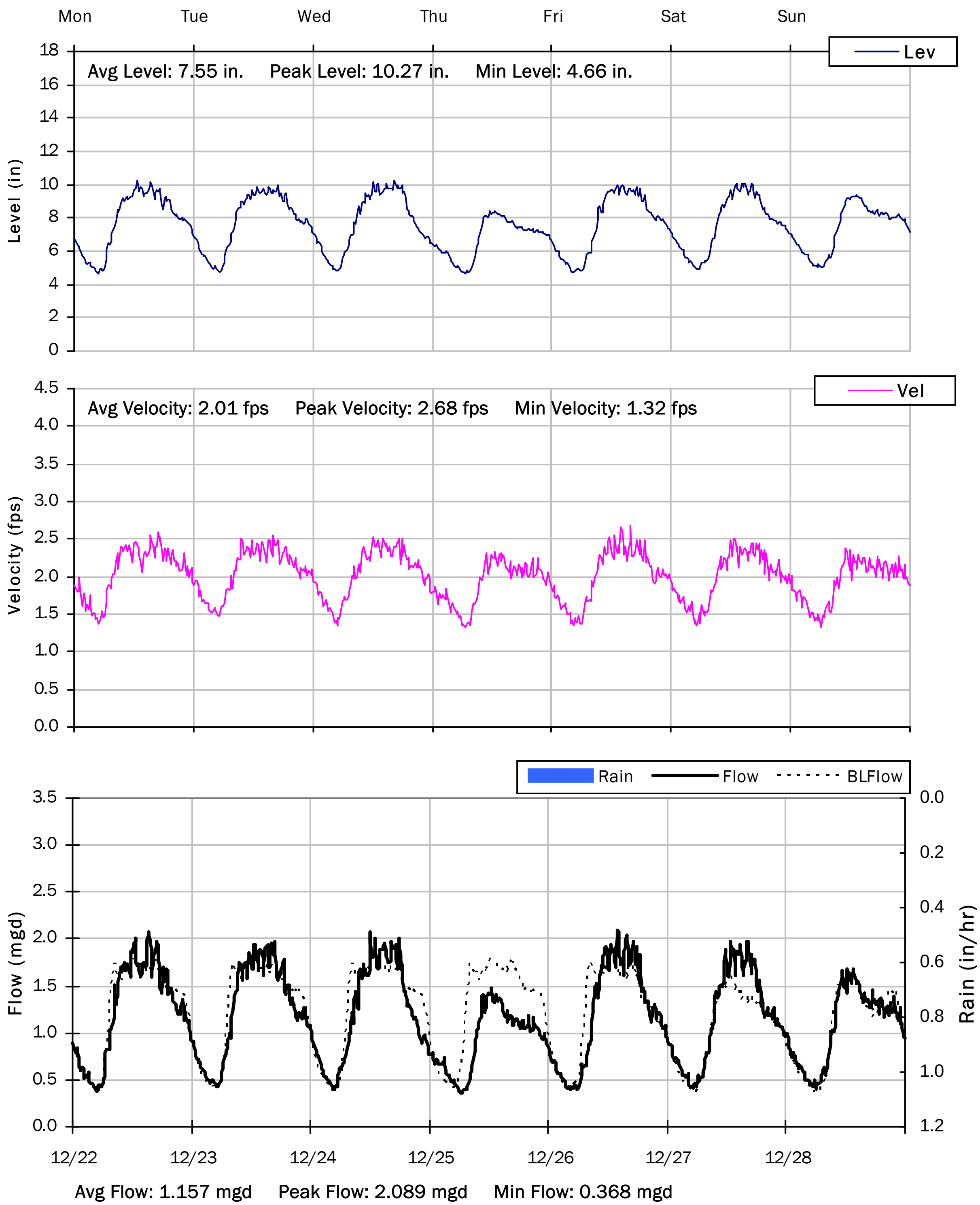
12/15/2014 to 12/22/2014



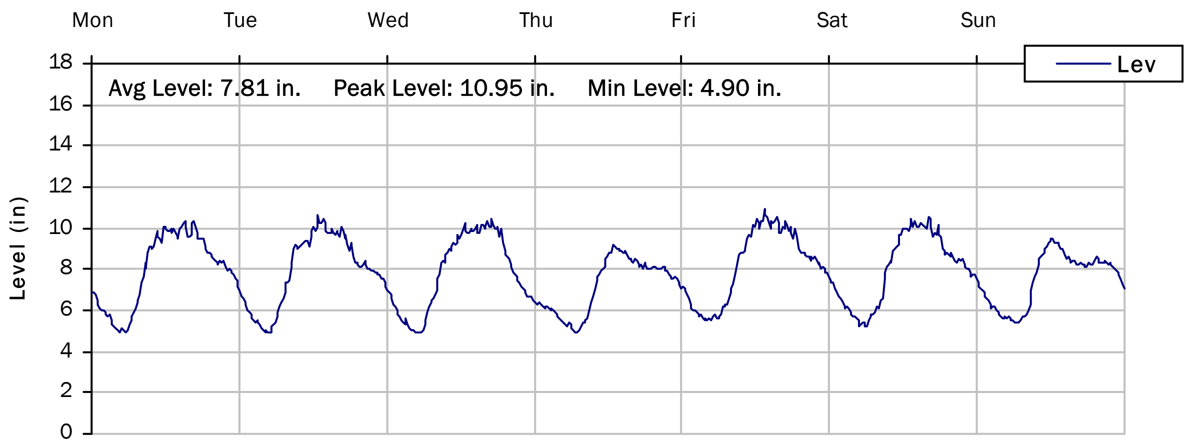
SITE 6

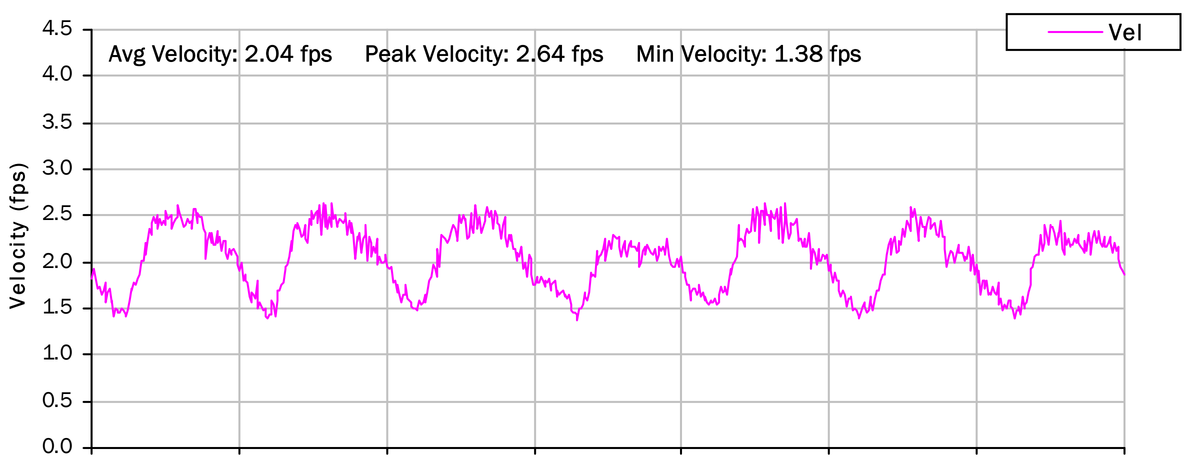
Weekly Level, Velocity and Flow Hydrographs

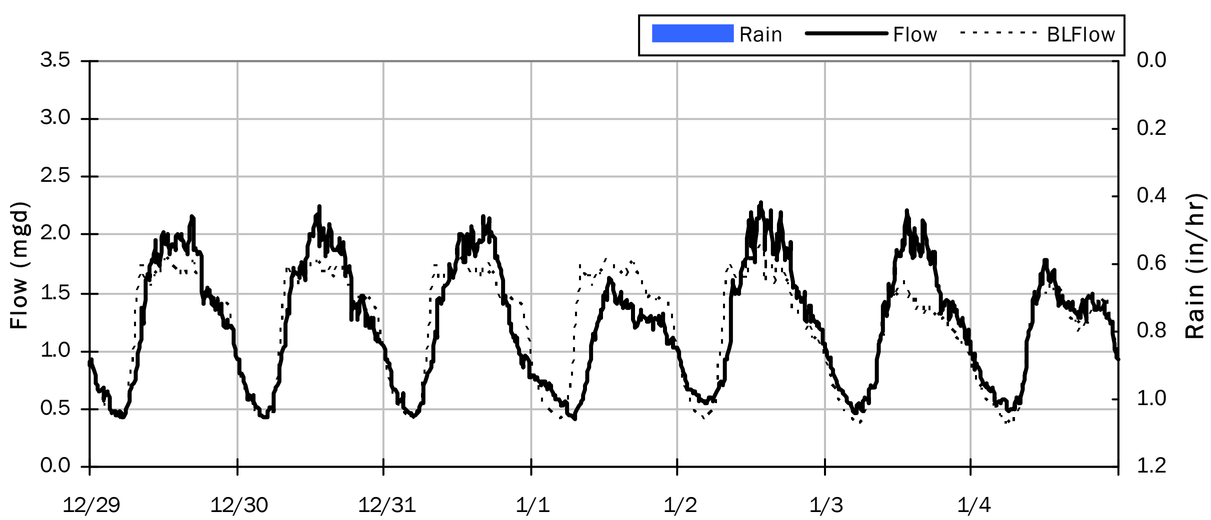
12/22/2014 to 12/29/2014



SITE 6
Weekly Level, Velocity and Flow Hydrographs
12/29/2014 to 1/5/2015





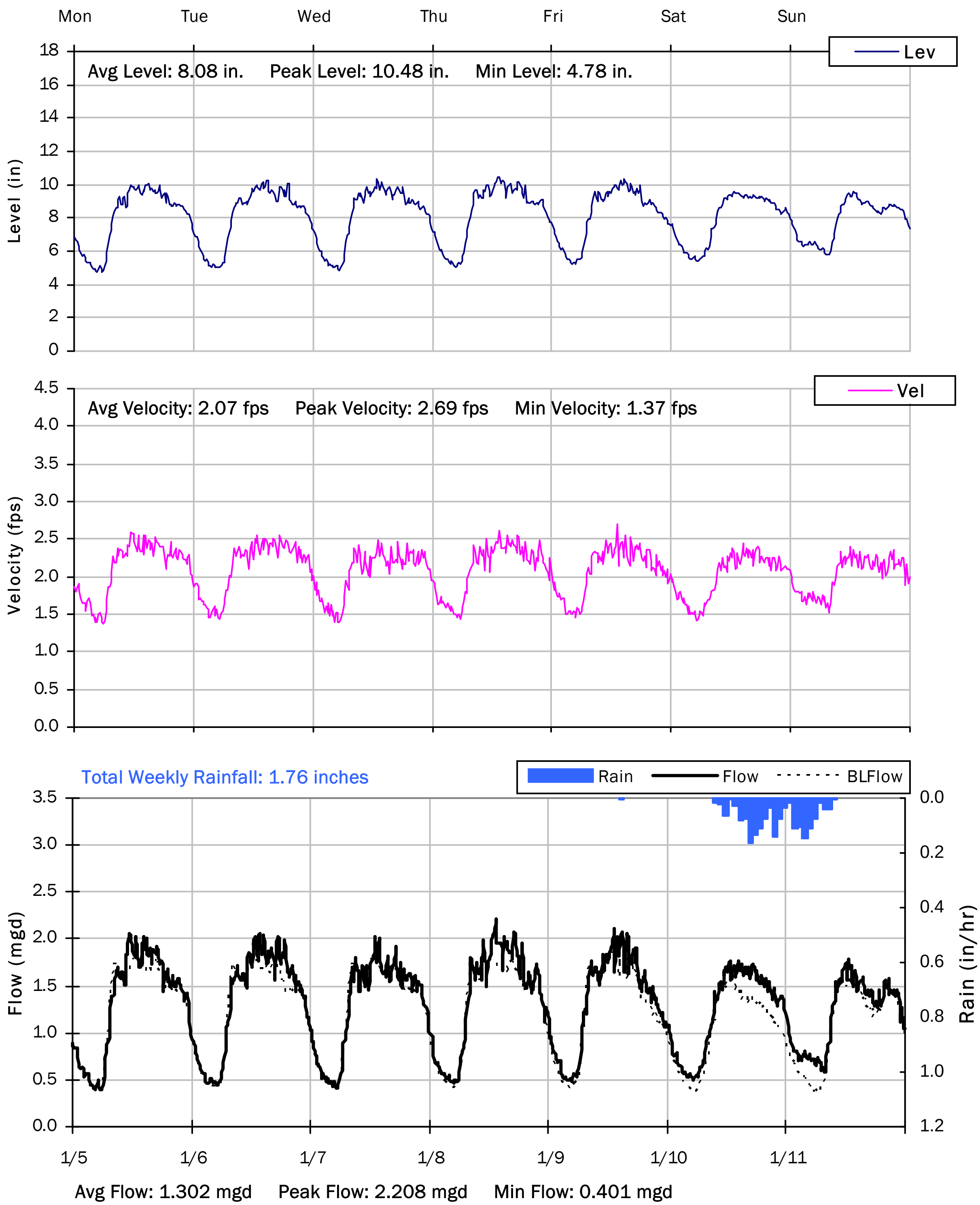


Avg Flow: 1.231 mgd   Peak Flow: 2.278 mgd   Min Flow: 0.419 mgd

SITE 6

Weekly Level, Velocity and Flow Hydrographs

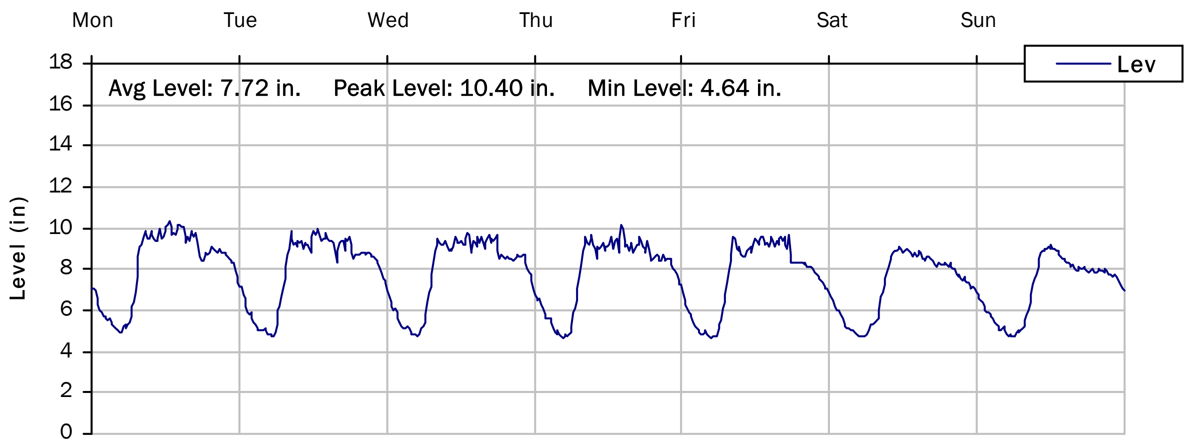
1/5/2015 to 1/12/2015

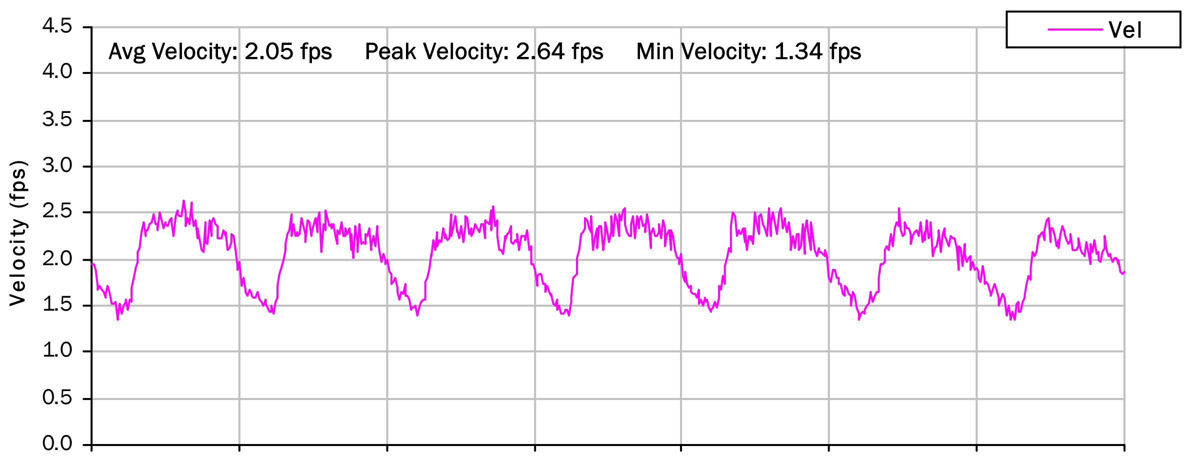


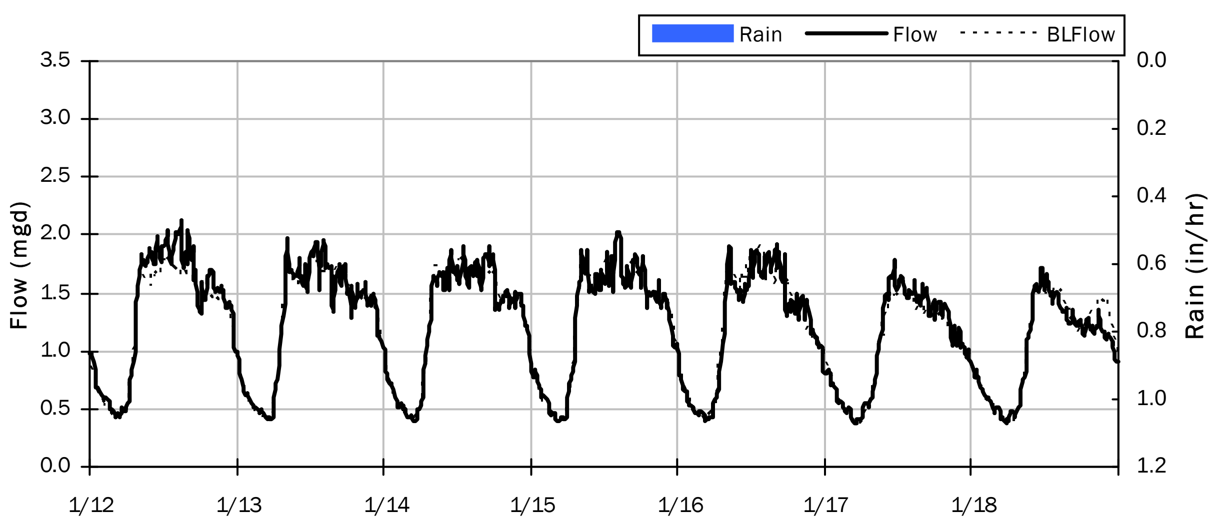
SITE 6

Weekly Level, Velocity and Flow Hydrographs

1/12/2015 to 1/19/2015

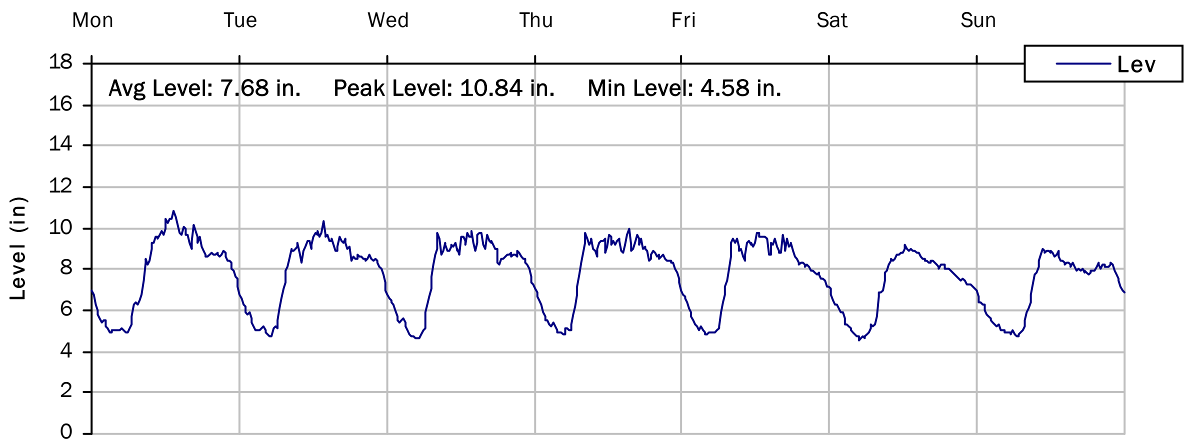


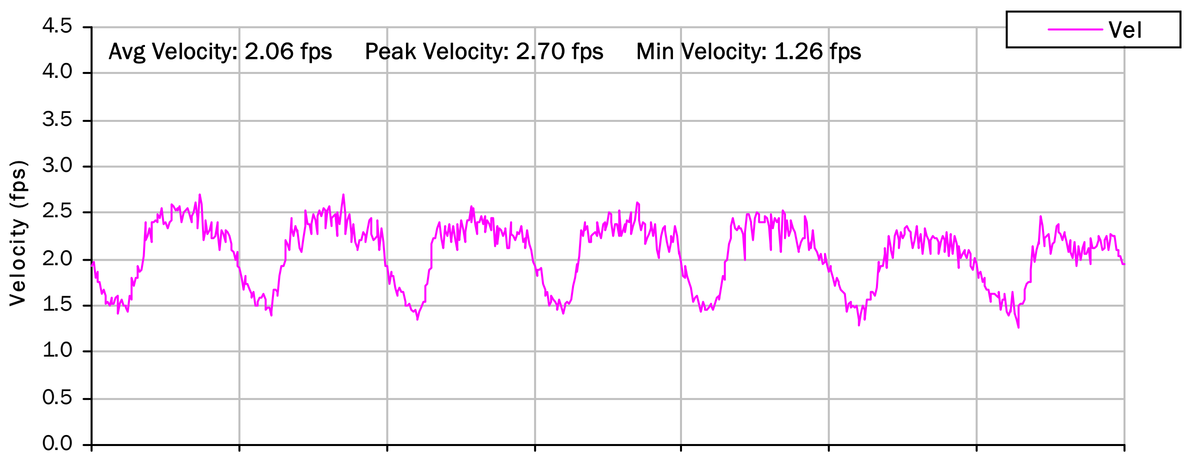


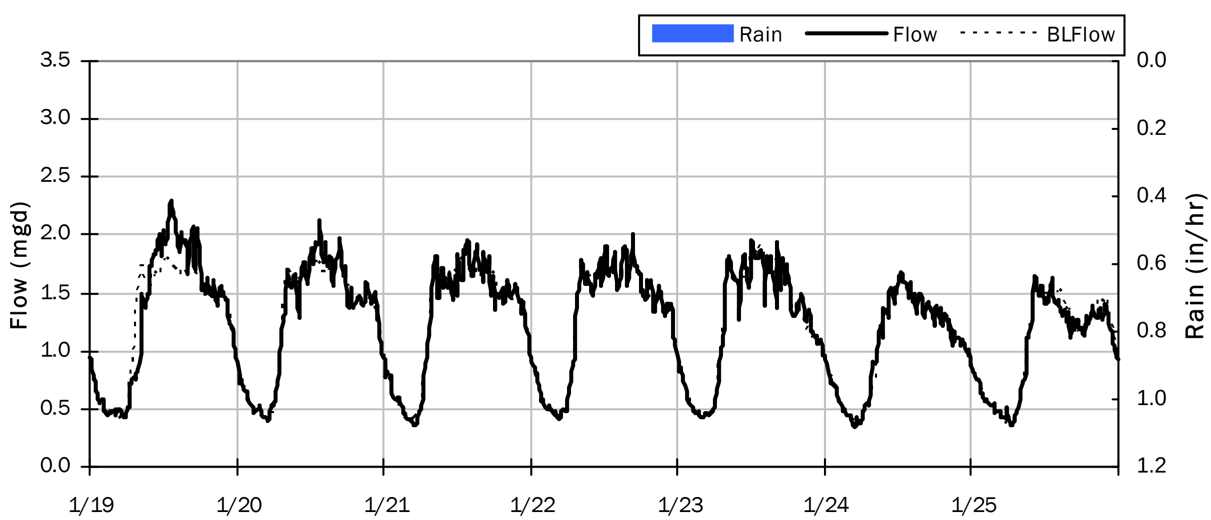


Avg Flow: 1.219 mgd Peak Flow: 2.126 mgd Min Flow: 0.381 mgd

SITE 6
Weekly Level, Velocity and Flow Hydrographs
1/19/2015 to 1/26/2015





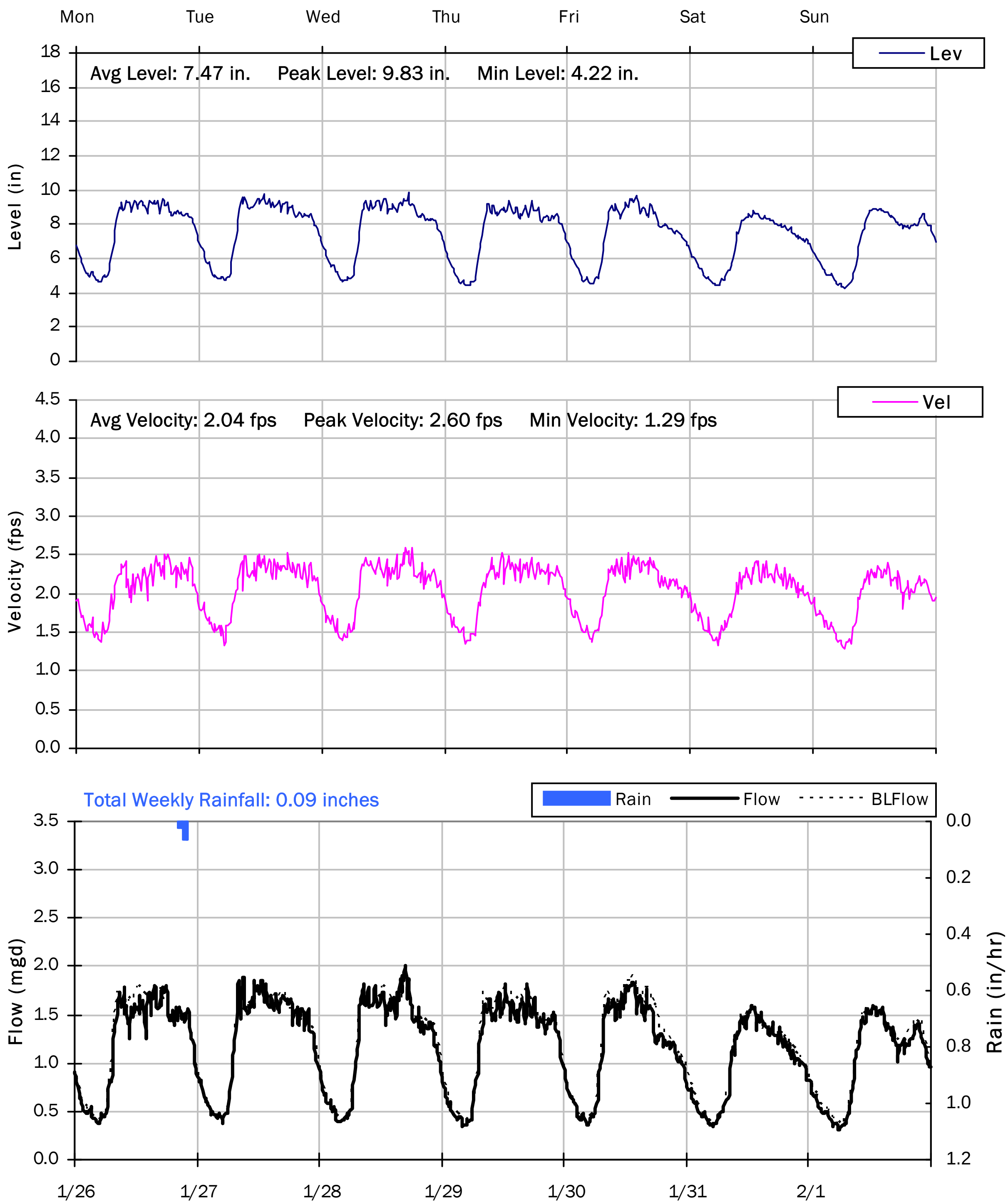


Avg Flow: 1.217 mgd Peak Flow: 2.292 mgd Min Flow: 0.350 mgd

SITE 6

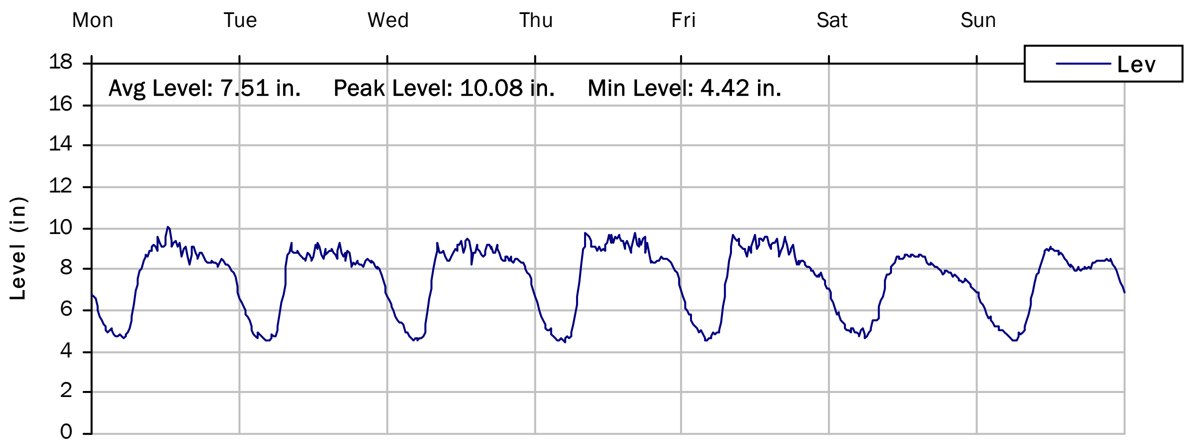
Weekly Level, Velocity and Flow Hydrographs

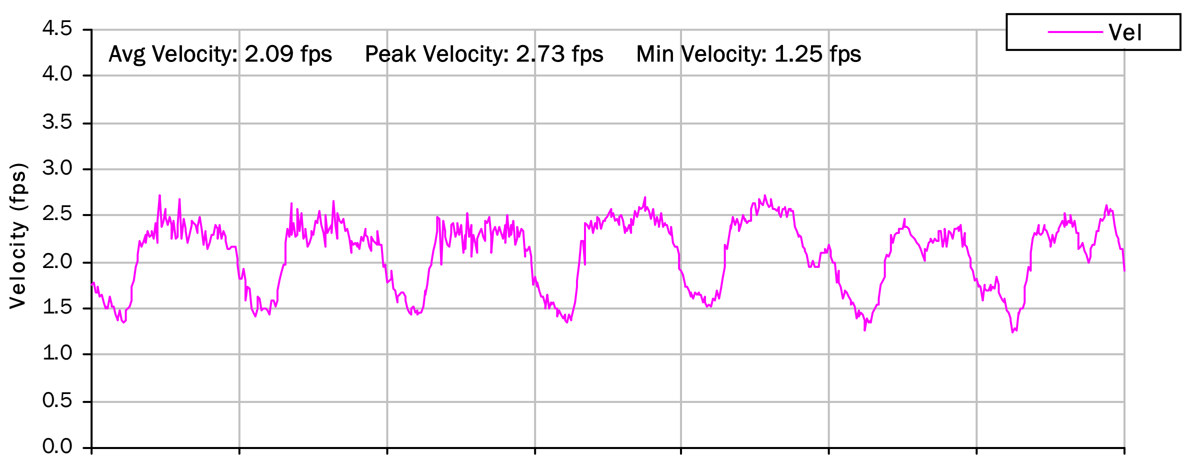
1/26/2015 to 2/2/2015

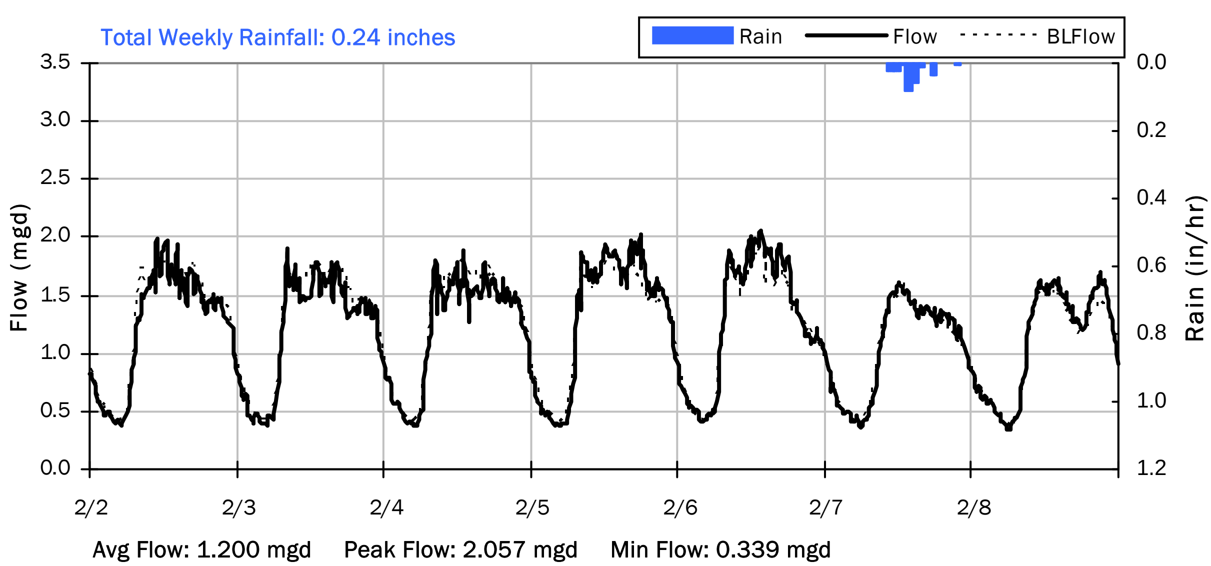


Avg Flow: 1.159 mgd Peak Flow: 2.005 mgd Min Flow: 0.309 mgd

SITE 6
Weekly Level, Velocity and Flow Hydrographs
2/2/2015 to 2/9/2015



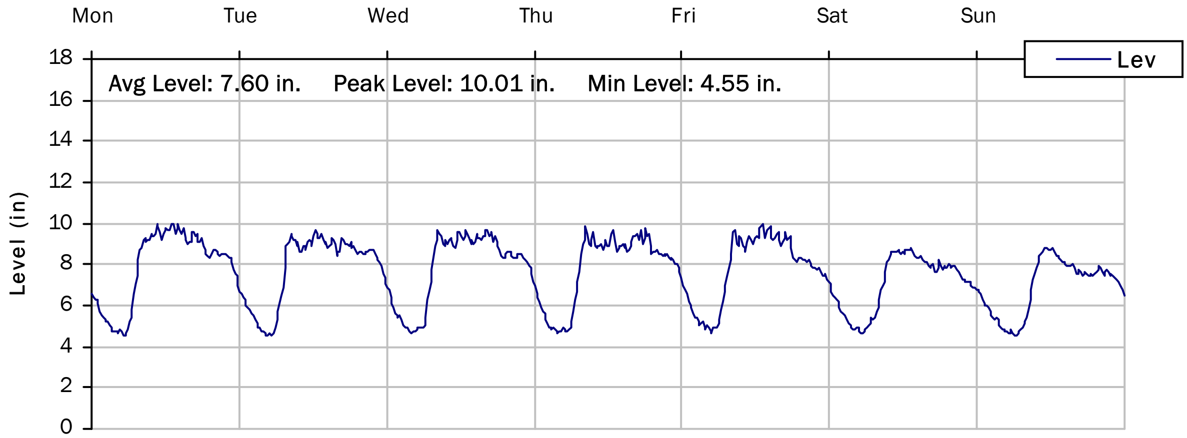


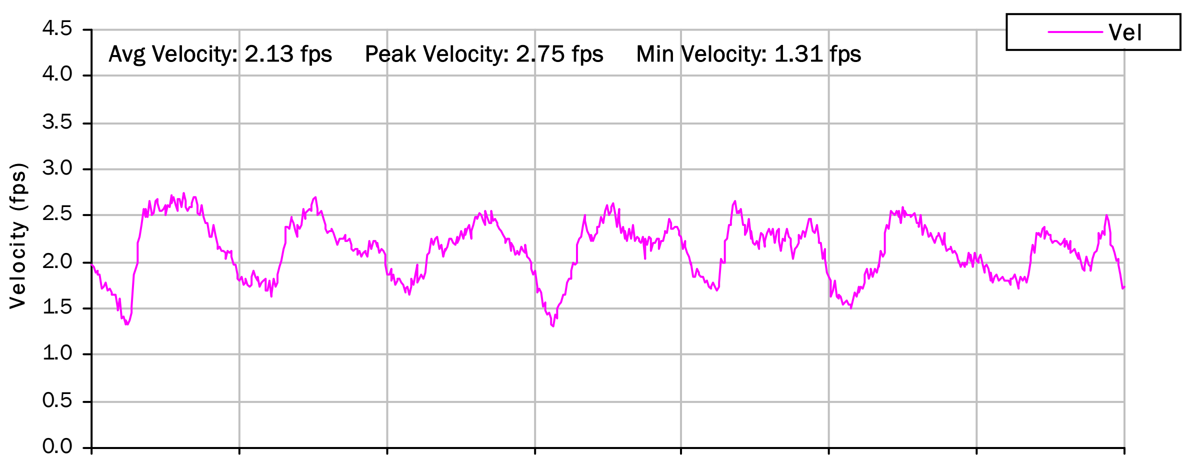


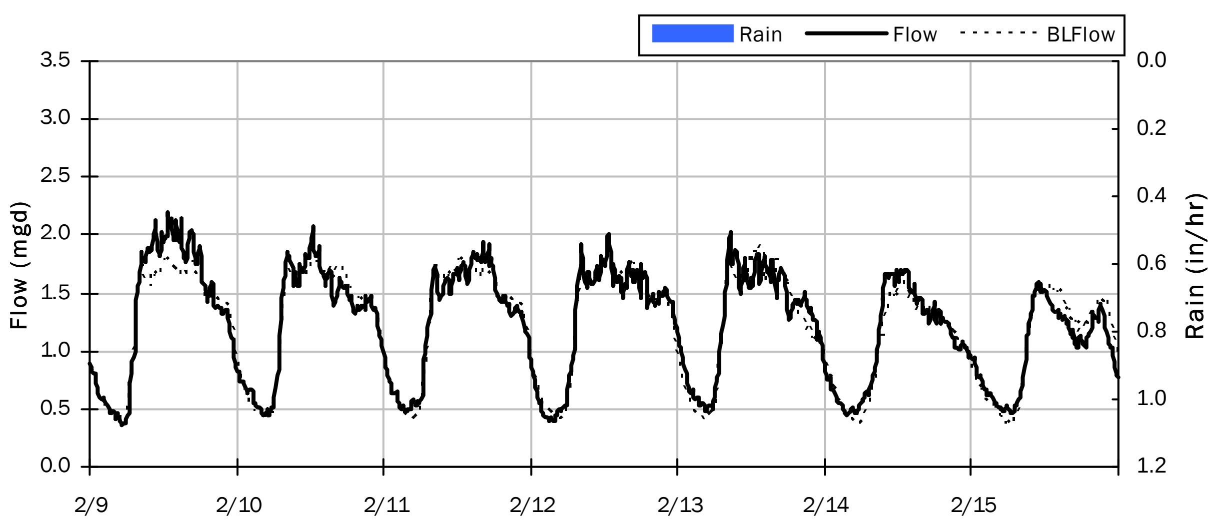
SITE 6

Weekly Level, Velocity and Flow Hydrographs

2/9/2015 to 2/16/2015

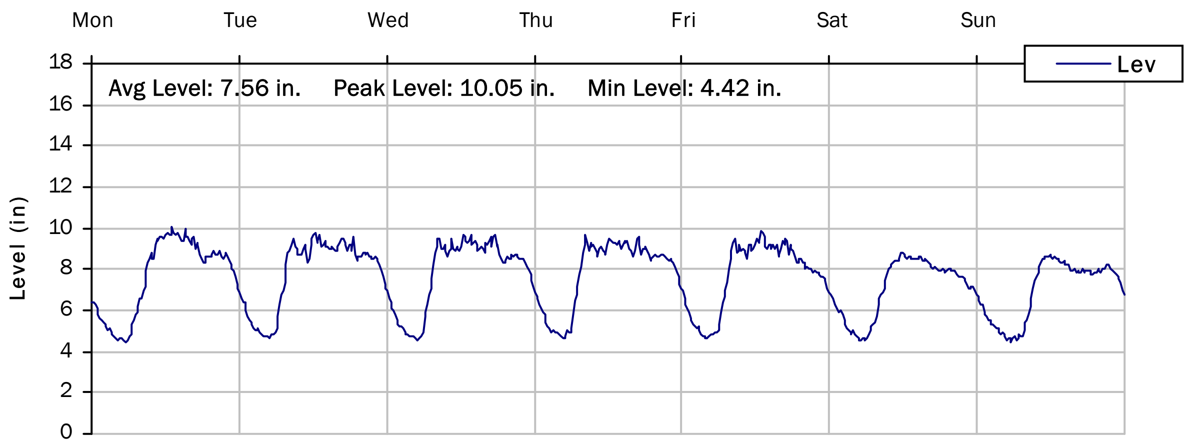


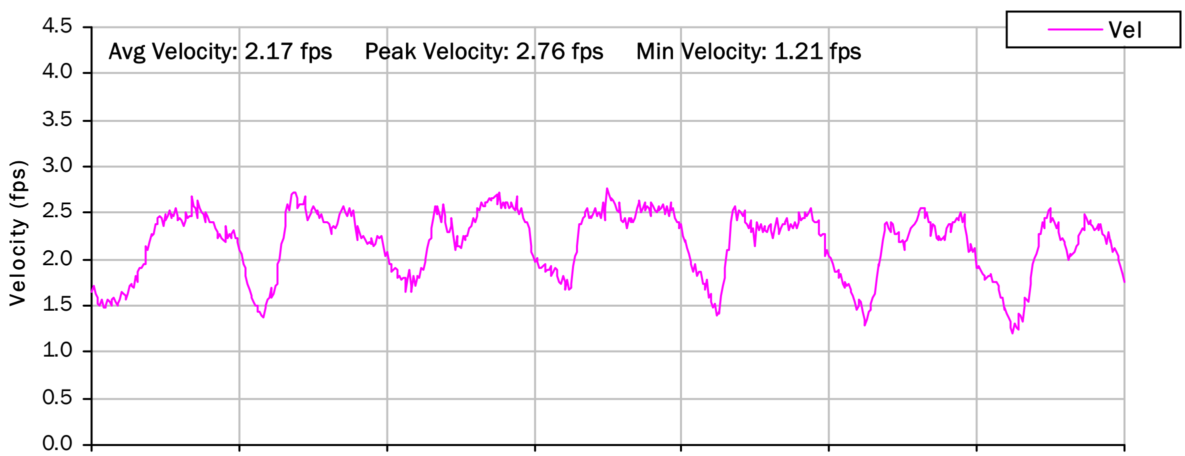


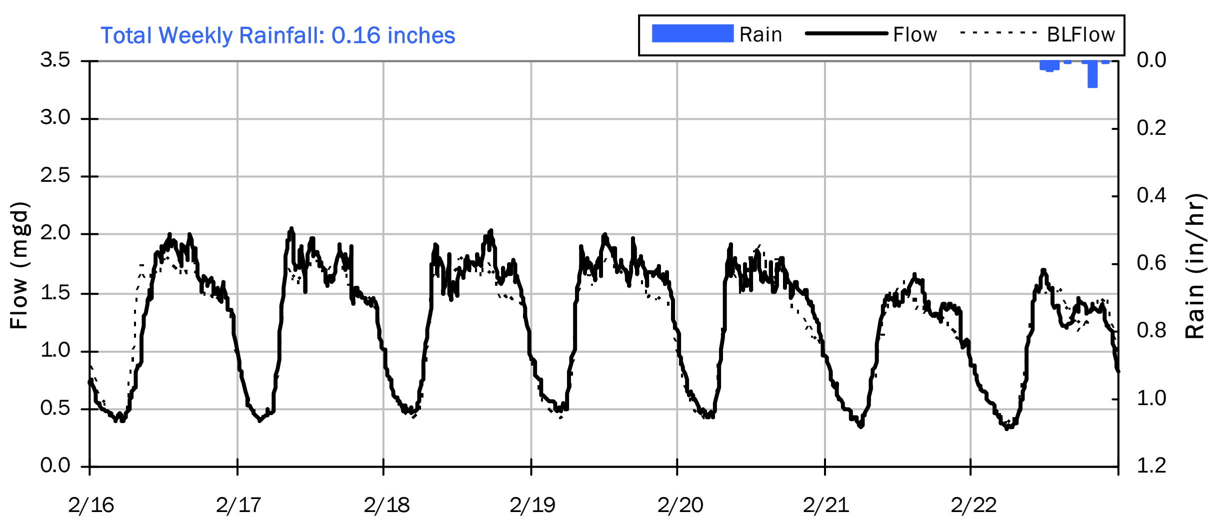


Avg Flow: 1.230 mgd   Peak Flow: 2.191 mgd   Min Flow: 0.361 mgd

SITE 6
Weekly Level, Velocity and Flow Hydrographs
2/16/2015 to 2/23/2015

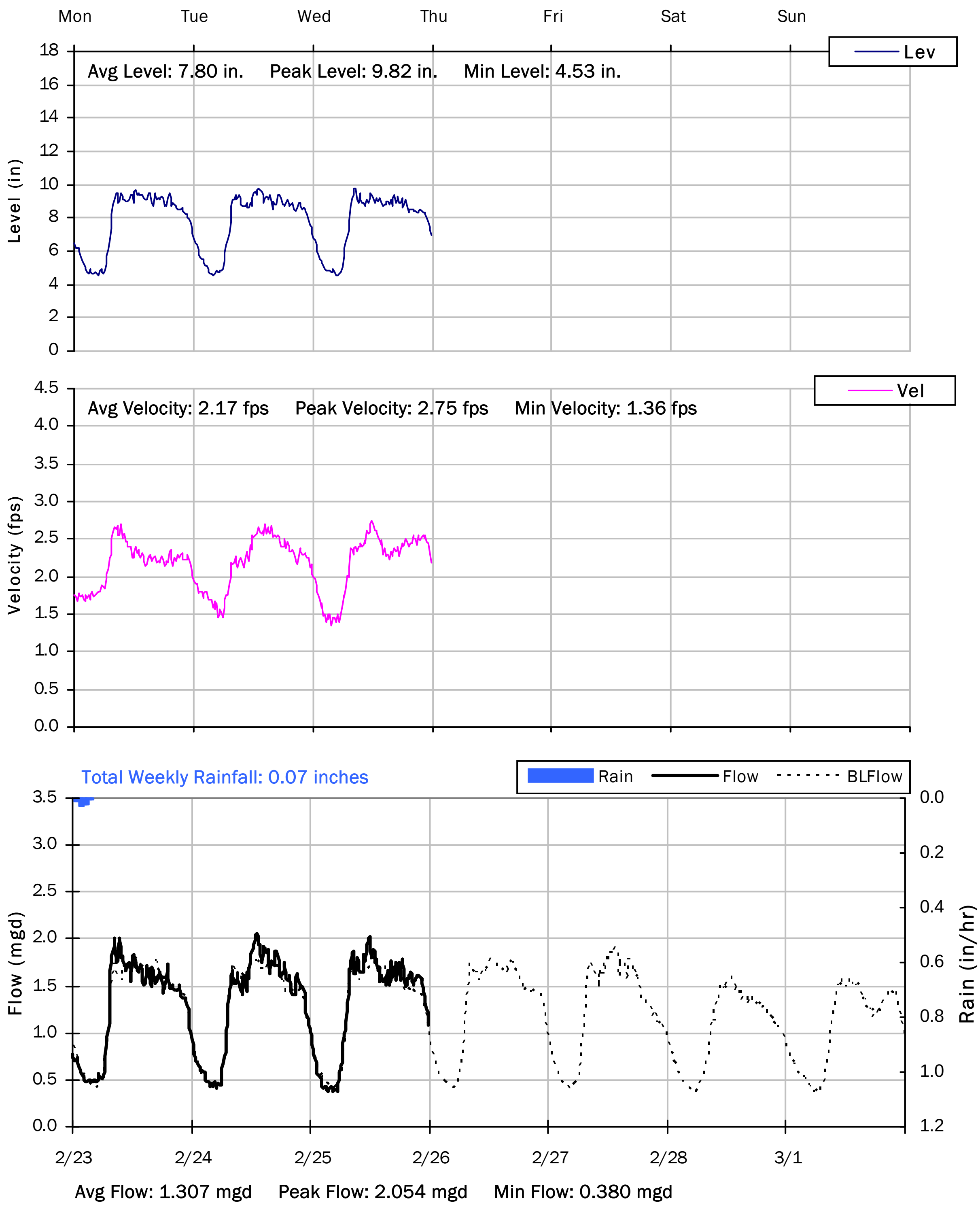






Avg Flow: 1.253 mgd Peak Flow: 2.051 mgd Min Flow: 0.330 mgd

SITE 6
Weekly Level, Velocity and Flow Hydrographs
2/23/2015 to 3/2/2015



City of Oxnard

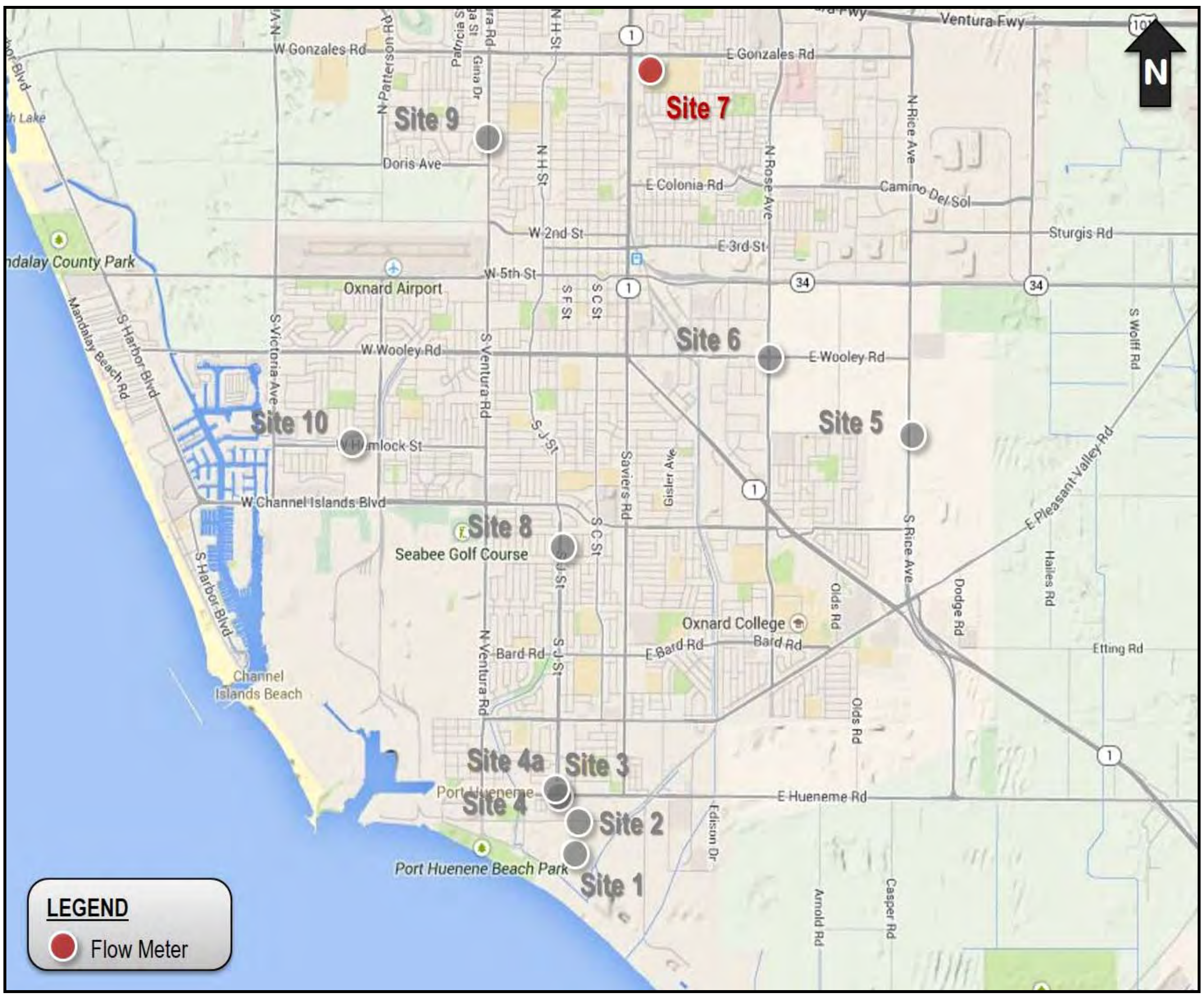
Sanitary Sewer Flow Monitoring

Temporary Monitoring: December, 2014 through February, 2015

Monitoring Site: Site 7

Location: E Gonzales Road and Bahia Drive

Data Summary Report



Vicinity Map: Site 7

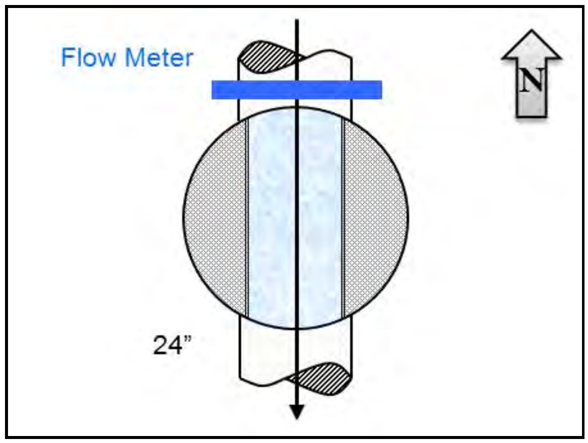
SITE 7

Site Information

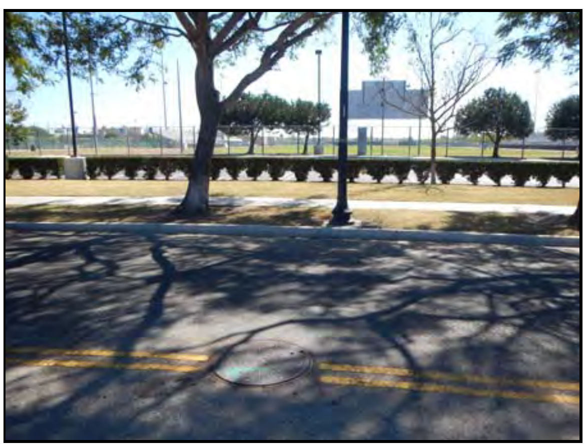
Location:	E Gonzales Road and Bahia Drive
Coordinates:	119.1750° W, 34.2192° N
Rim Elevation:	74 feet
Pipe Diameter:	24 inches
Baseline Flow:	0.333 mgd
Peak Measured Flow:	0.620 mgd

Satellite Map

Sanitary Map



Flow Diagram


Street View


Plan View

SITE 7

Additional Site Photos

Effluent Pipe

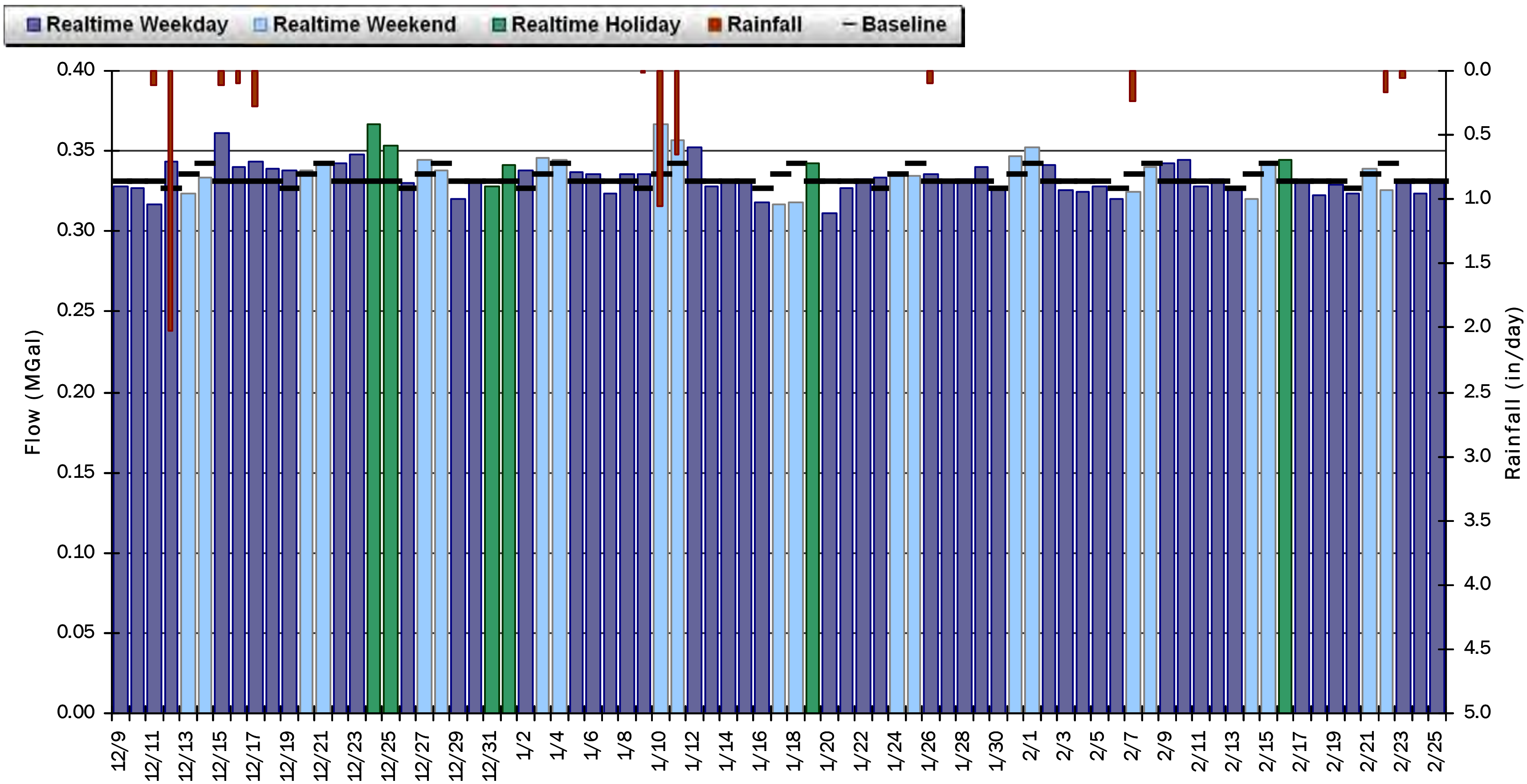
Influent Pipe

SITE 7

Period Flow Summary: Daily Flow Totals

Avg Period Flow: 0.335 MGal **Peak Daily Flow: 0.367 MGal** **Min Daily Flow: 0.311 MGal**

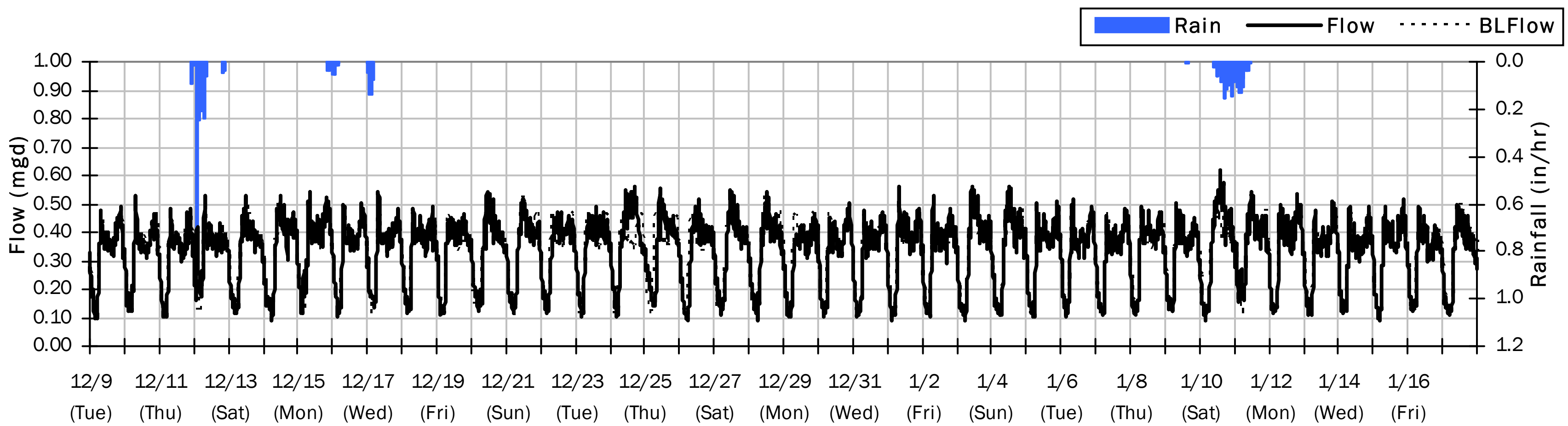
Total Period Rainfall: 4.88 inches

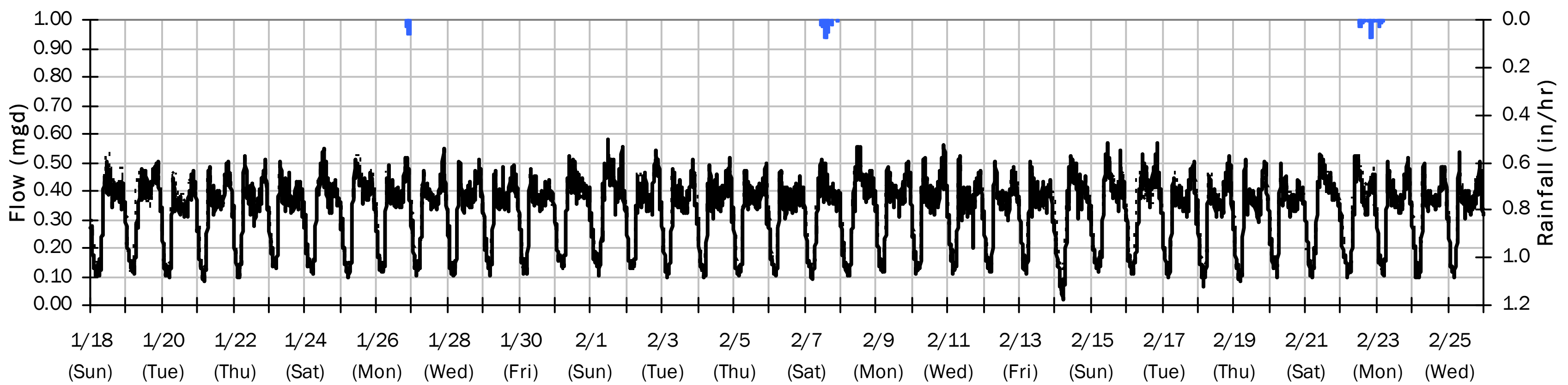


SITE 7

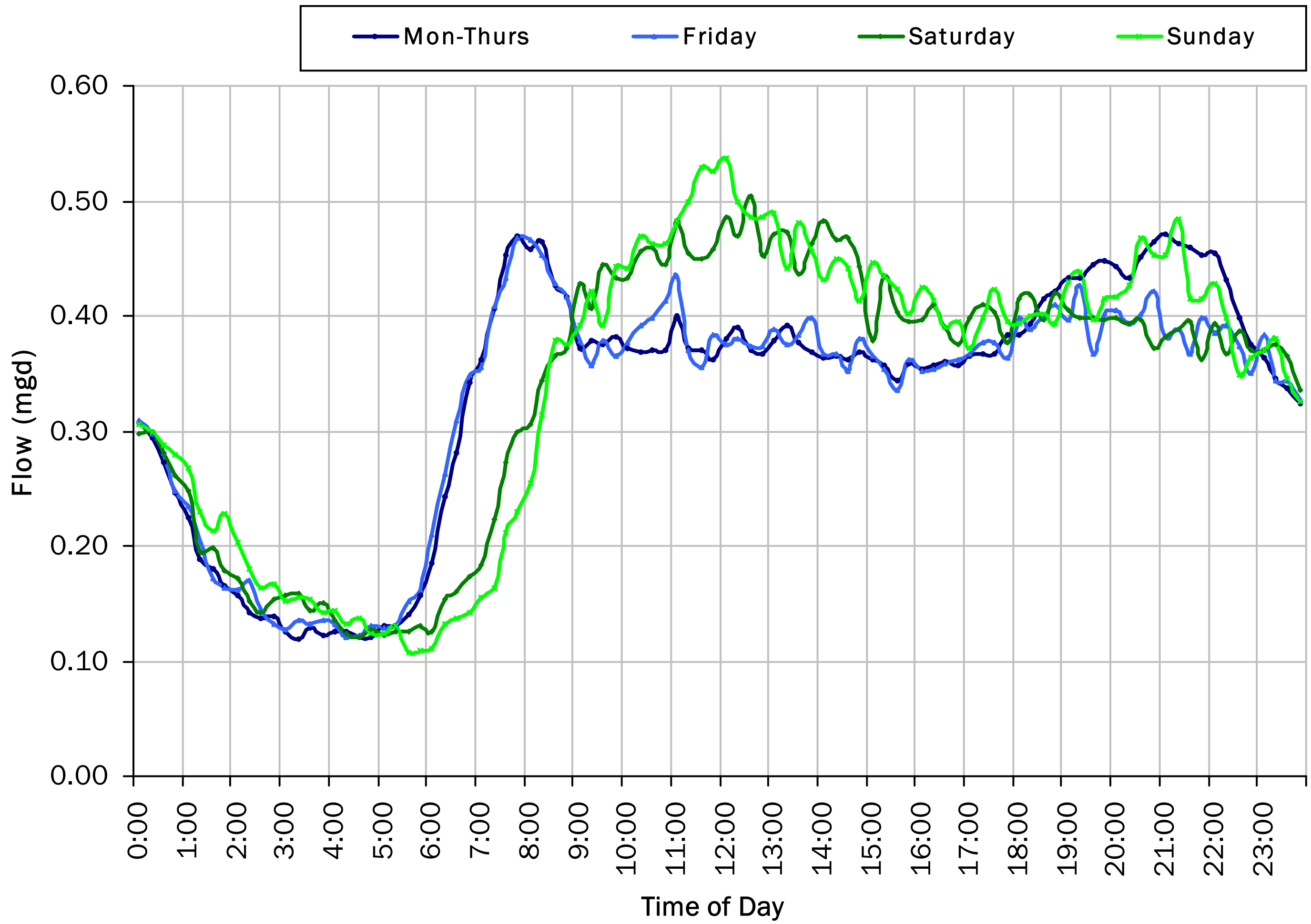
Flow Summary: 12/9/2014 to 2/25/2015

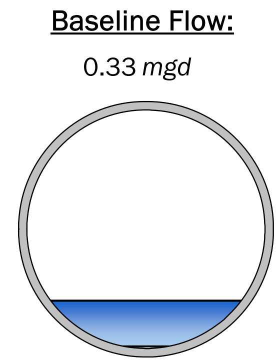
Total Period Rainfall: 4.88 inches   Avg Flow: 0.335 mgd   Peak Flow: 0.620 mgd   Min Flow: 0.017 mgd





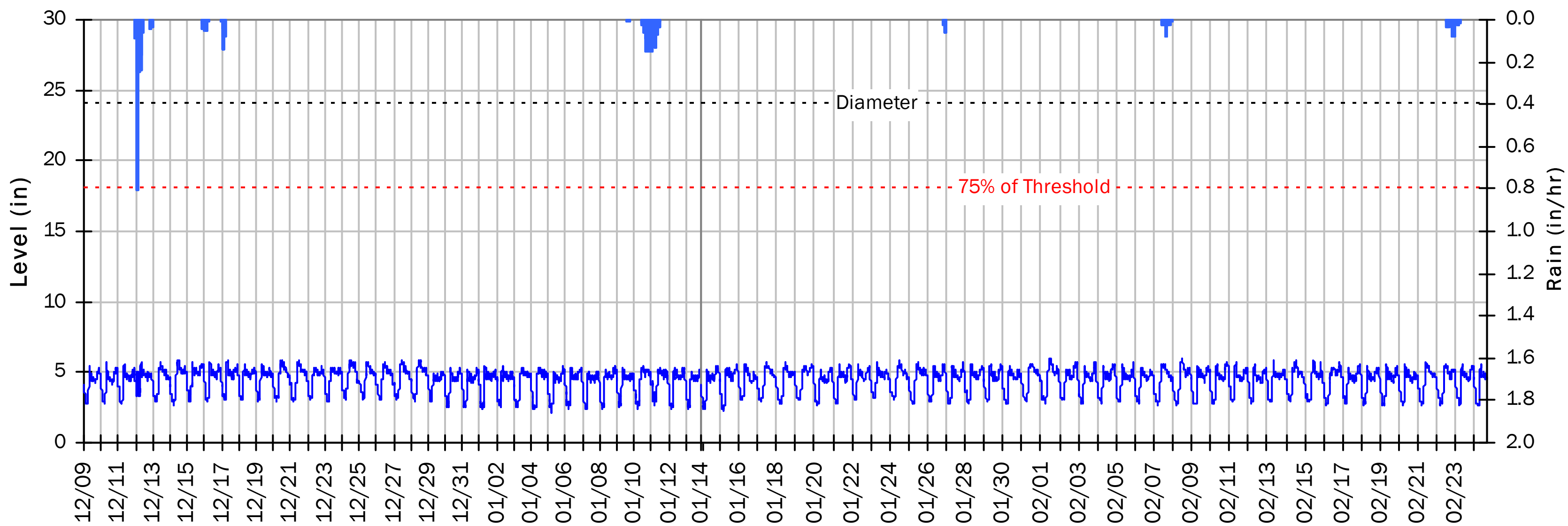
SITE 7
Baseline Flow Hydrographs

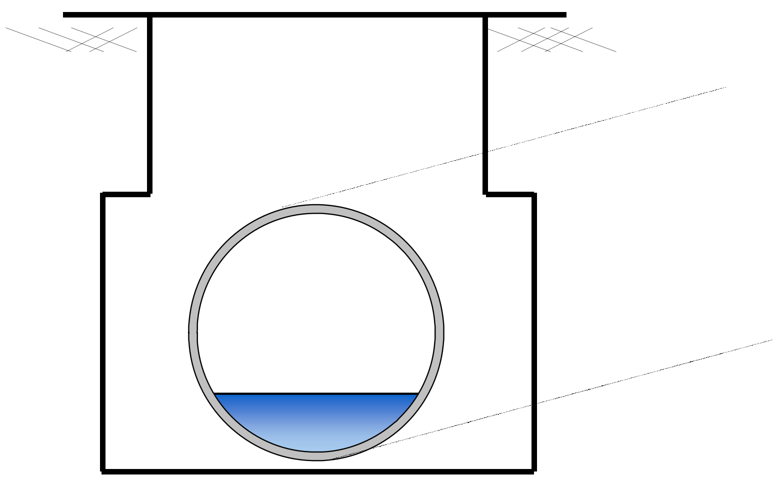




SITE 7
Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Monitoring Period



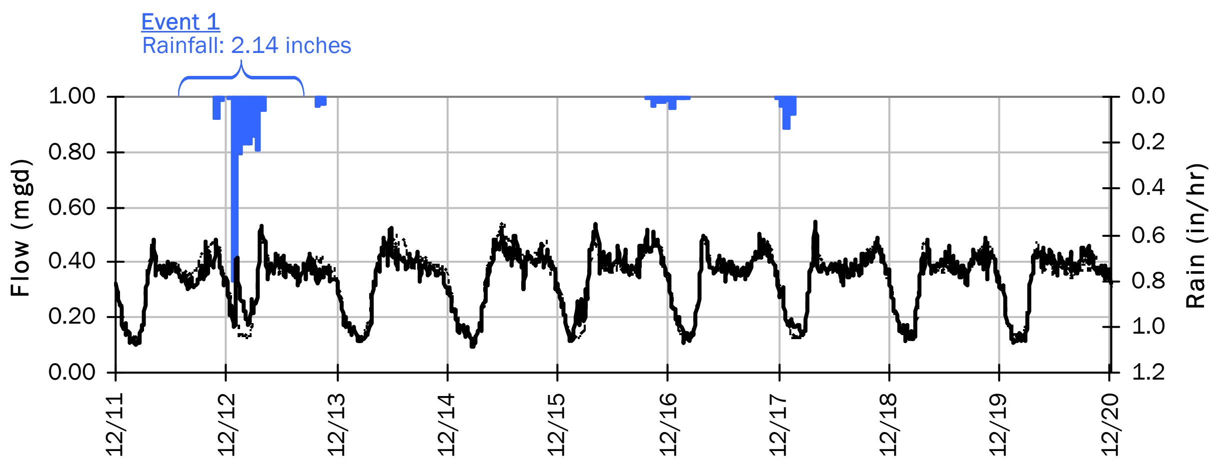


Pipe Diameter:	24	*inches*
Peak Measured Level:	5.92	*inches*
Peak d/D Ratio:	0.25	

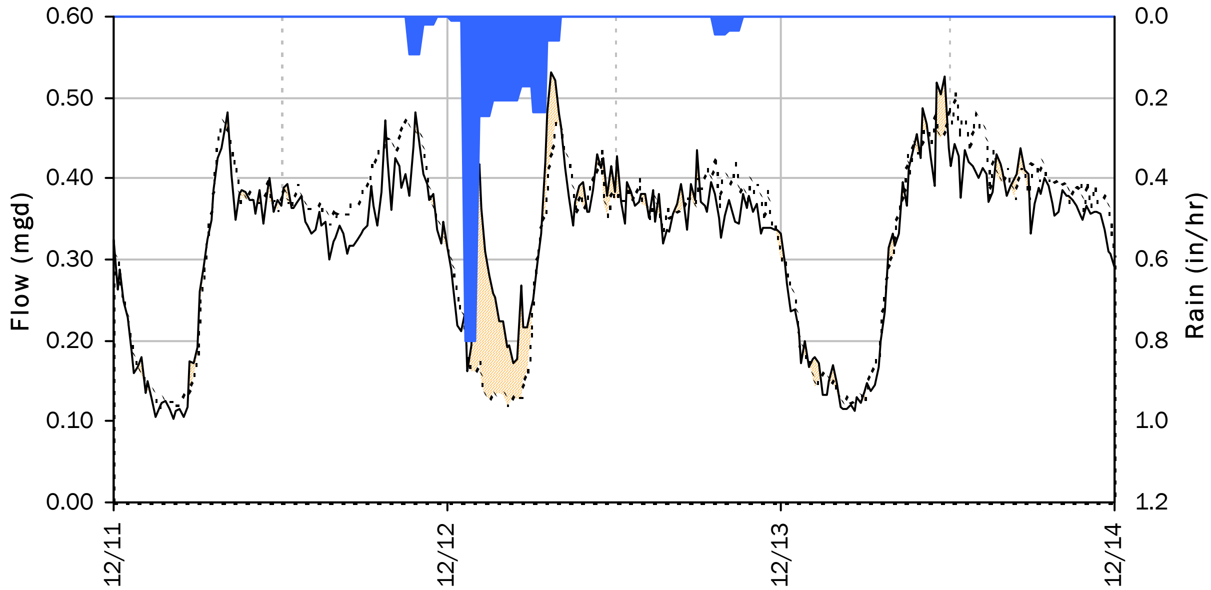
SITE 7

I/I Summary: Event 1

Baseline and Realtime Flows with Rainfall Data over Monitoring Period



Event 1 Detail Graph

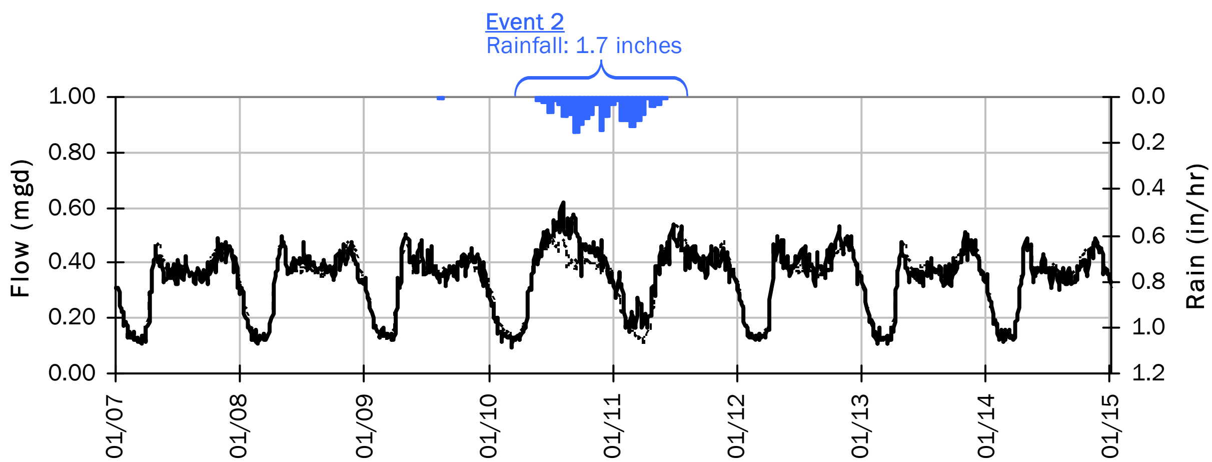


Storm Event I/I Analysis (Rain = 2.14 inches)

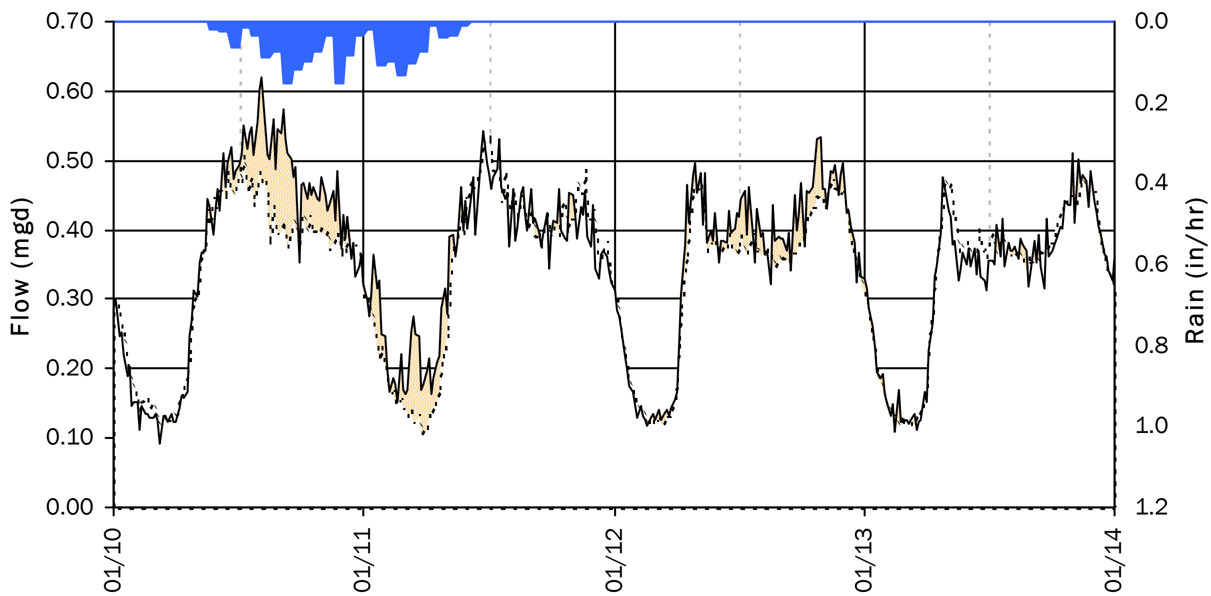
Capacity		Inflow / Infiltration	
Peak Flow:	0.53 *mgd*	Peak I/I Rate:	0.25 *mgd*
PF:	1.59	Total I/I:	4,000 *gallons*
Peak Level:	5.76 *in*		
d/D Ratio:	0.24		

SITE 7
I/I Summary: Event 2

Baseline and Realtime Flows with Rainfall Data over Monitoring Period



Event 2 Detail Graph



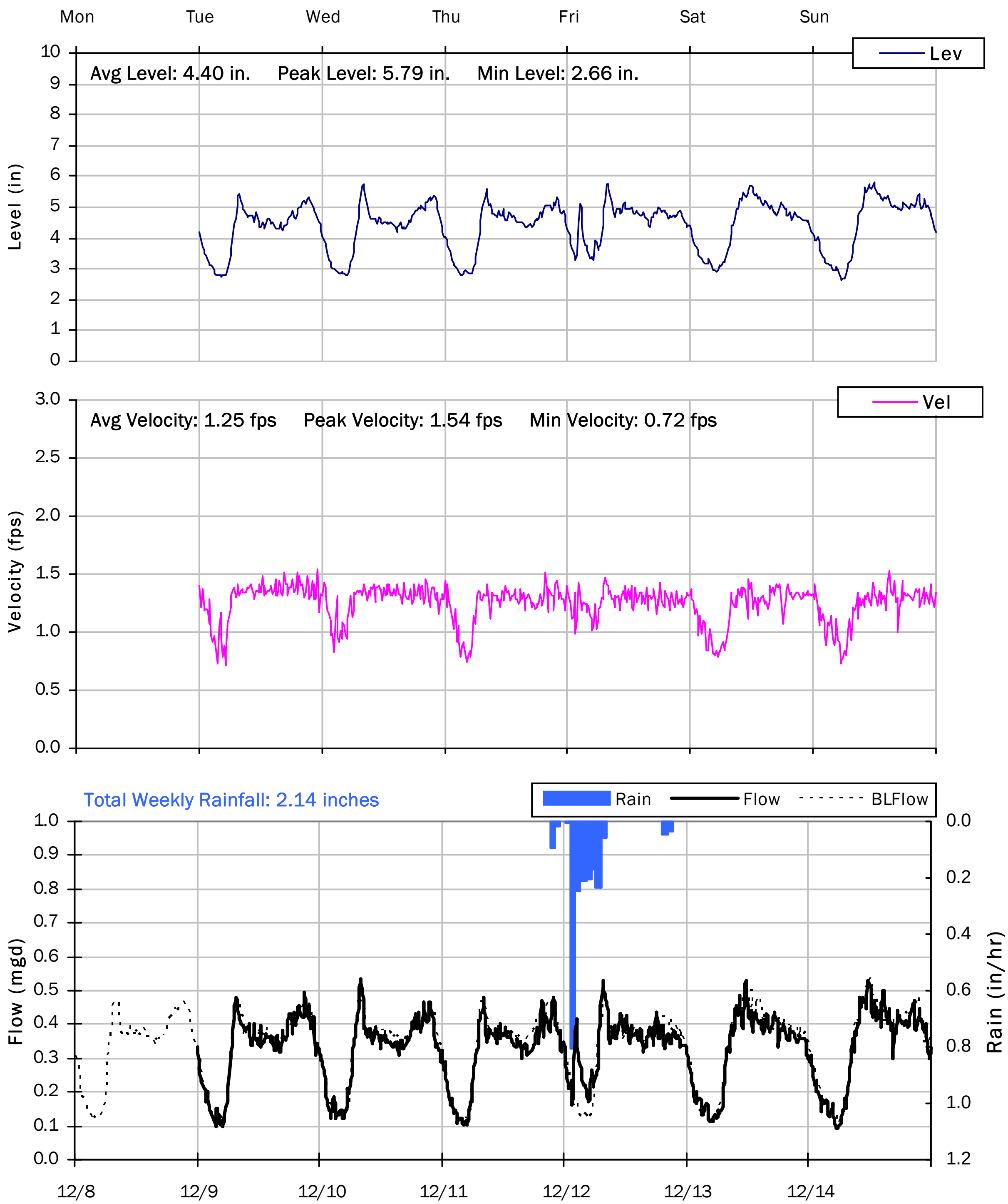
Storm Event I/I Analysis (Rain = 1.70 inches)

Capacity		Inflow / Infiltration	
Peak Flow:	0.62 *mgd*	Peak I/I Rate:	0.16 *mgd*
PF:	1.86	Total I/I:	65,000 *gallons*
Peak Level:	5.40 *in*		
d/D Ratio:	0.23		

SITE 7

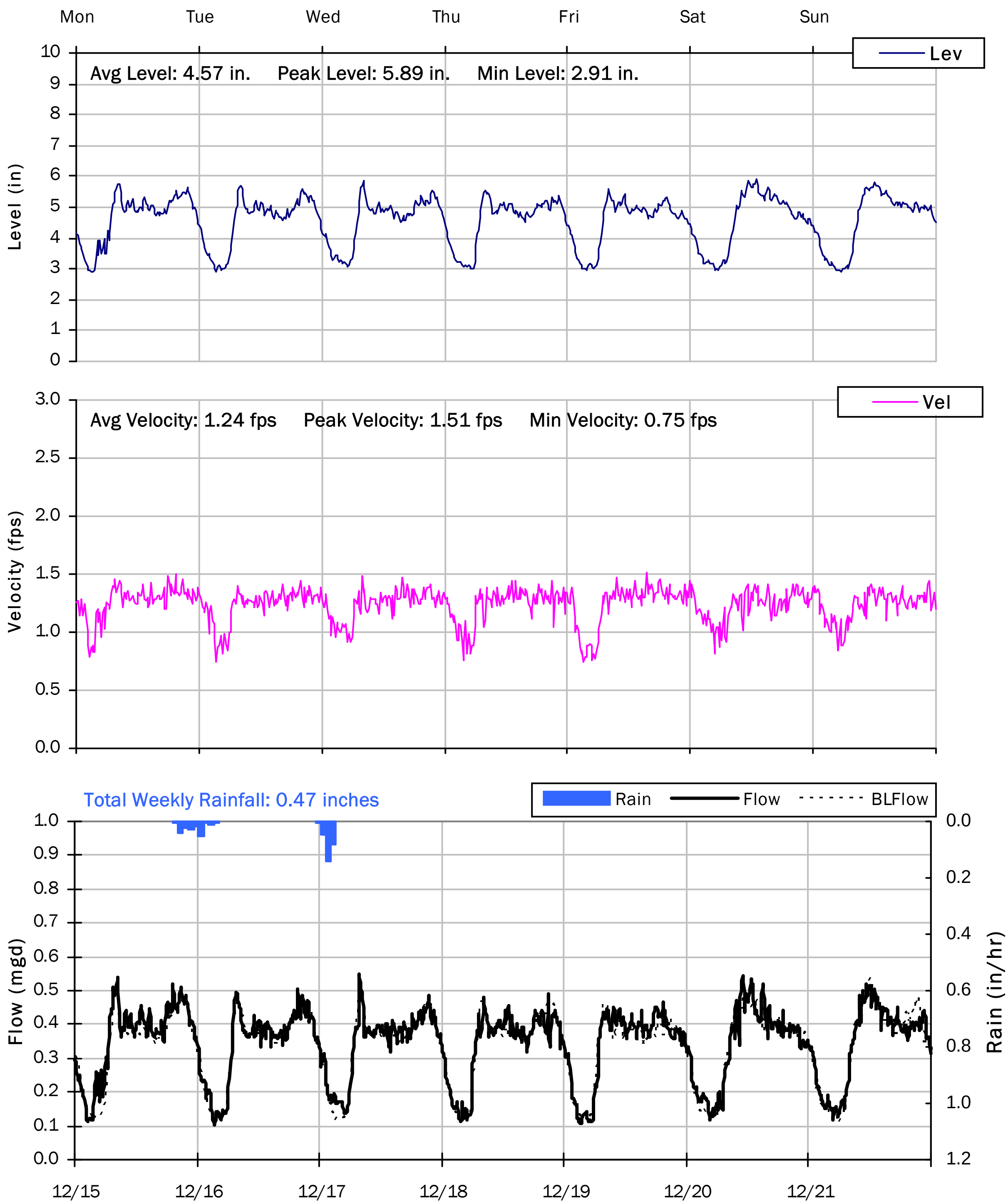
Weekly Level, Velocity and Flow Hydrographs

12/8/2014 to 12/15/2014



Avg Flow: 0.329 mgd Peak Flow: 0.532 mgd Min Flow: 0.091 mgd

SITE 7
Weekly Level, Velocity and Flow Hydrographs
12/15/2014 to 12/22/2014

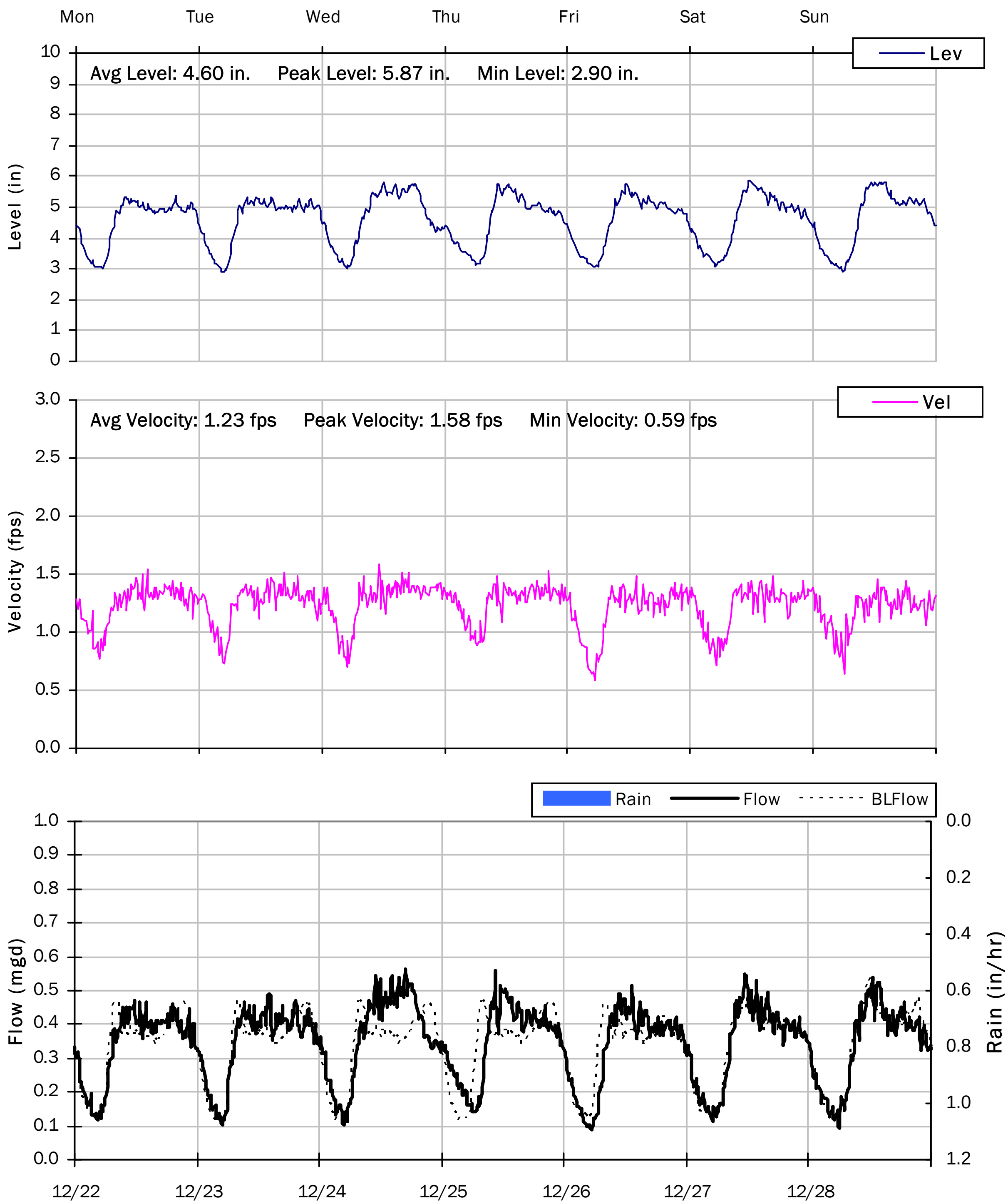


Avg Flow: 0.343 mgd Peak Flow: 0.545 mgd Min Flow: 0.105 mgd

SITE 7

Weekly Level, Velocity and Flow Hydrographs

12/22/2014 to 12/29/2014

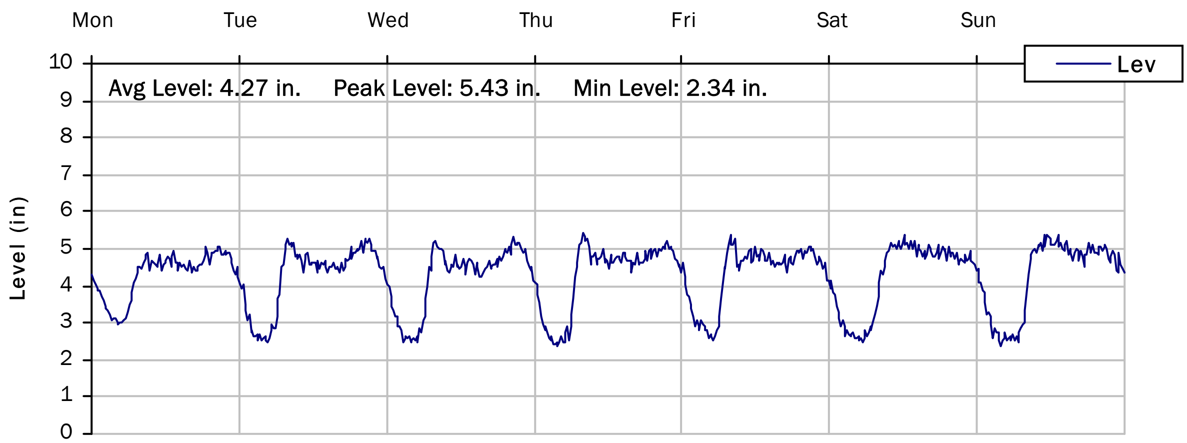


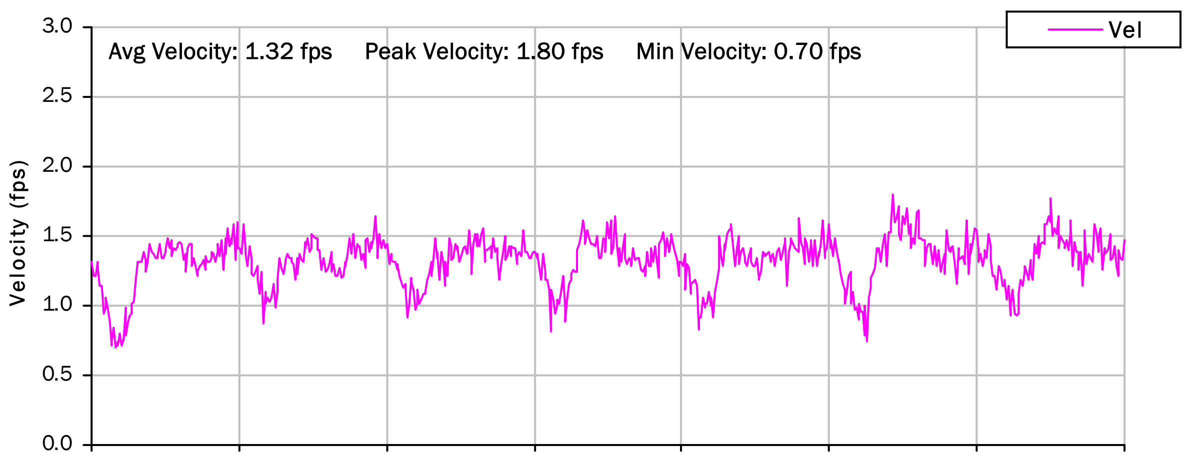
Avg Flow: 0.346 mgd Peak Flow: 0.563 mgd Min Flow: 0.089 mgd

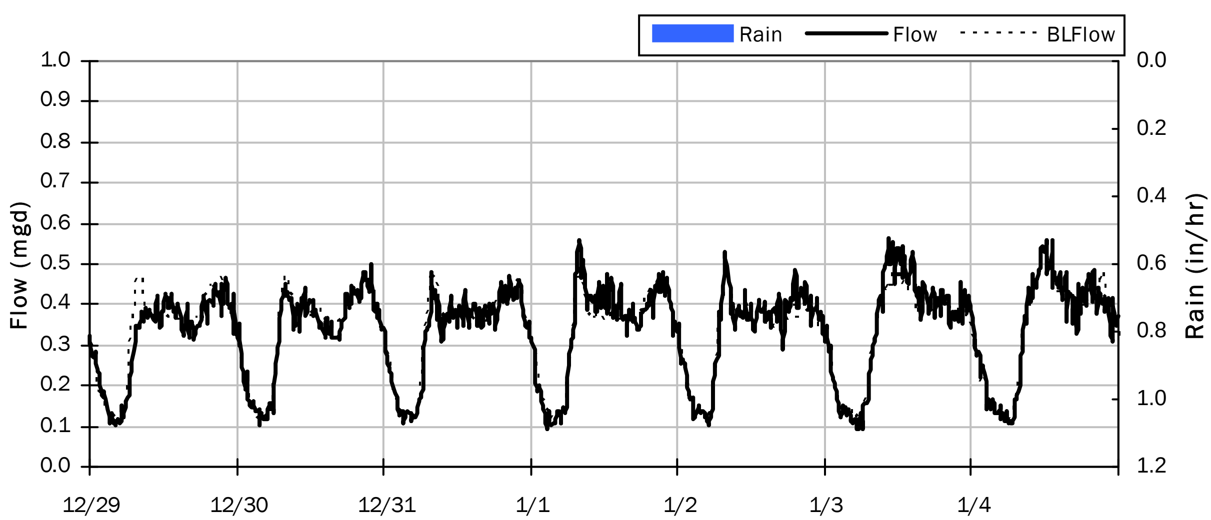
SITE 7

Weekly Level, Velocity and Flow Hydrographs

12/29/2014 to 1/5/2015





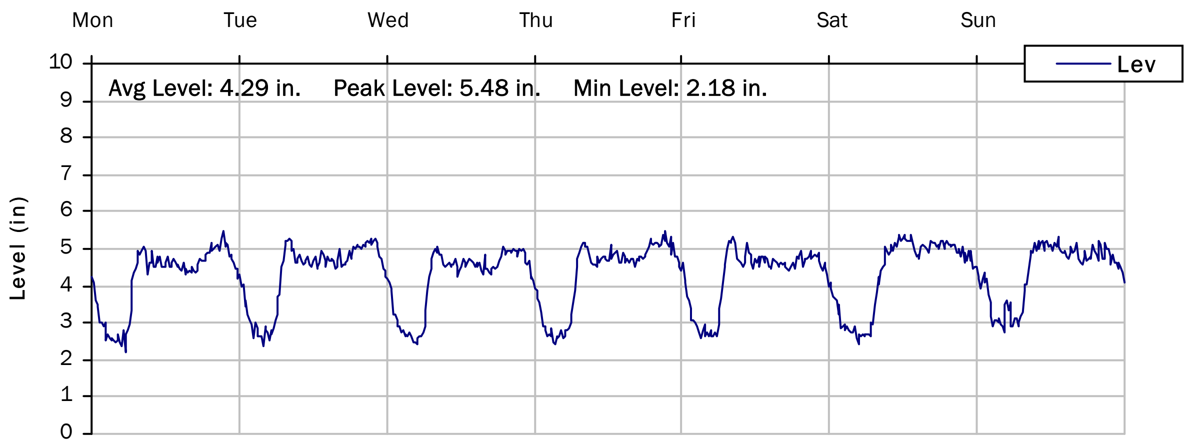


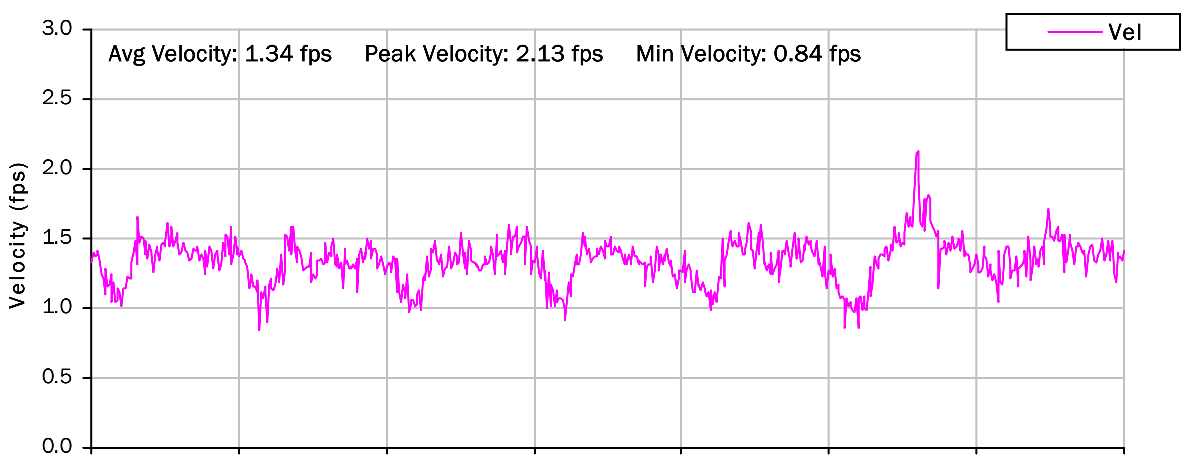
Avg Flow: 0.335 mgd Peak Flow: 0.562 mgd Min Flow: 0.092 mgd

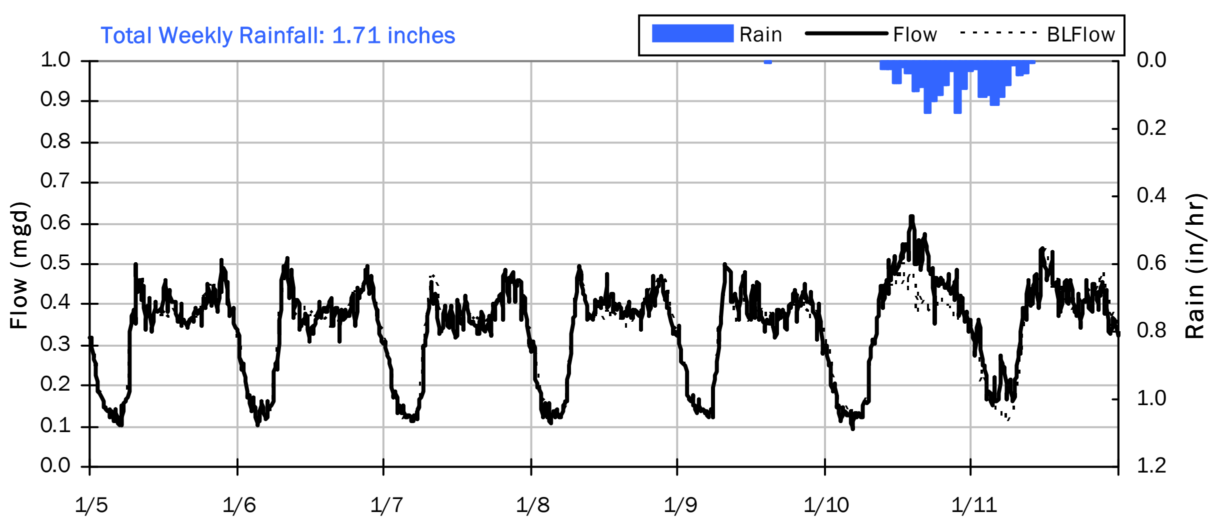
SITE 7

Weekly Level, Velocity and Flow Hydrographs

1/5/2015 to 1/12/2015

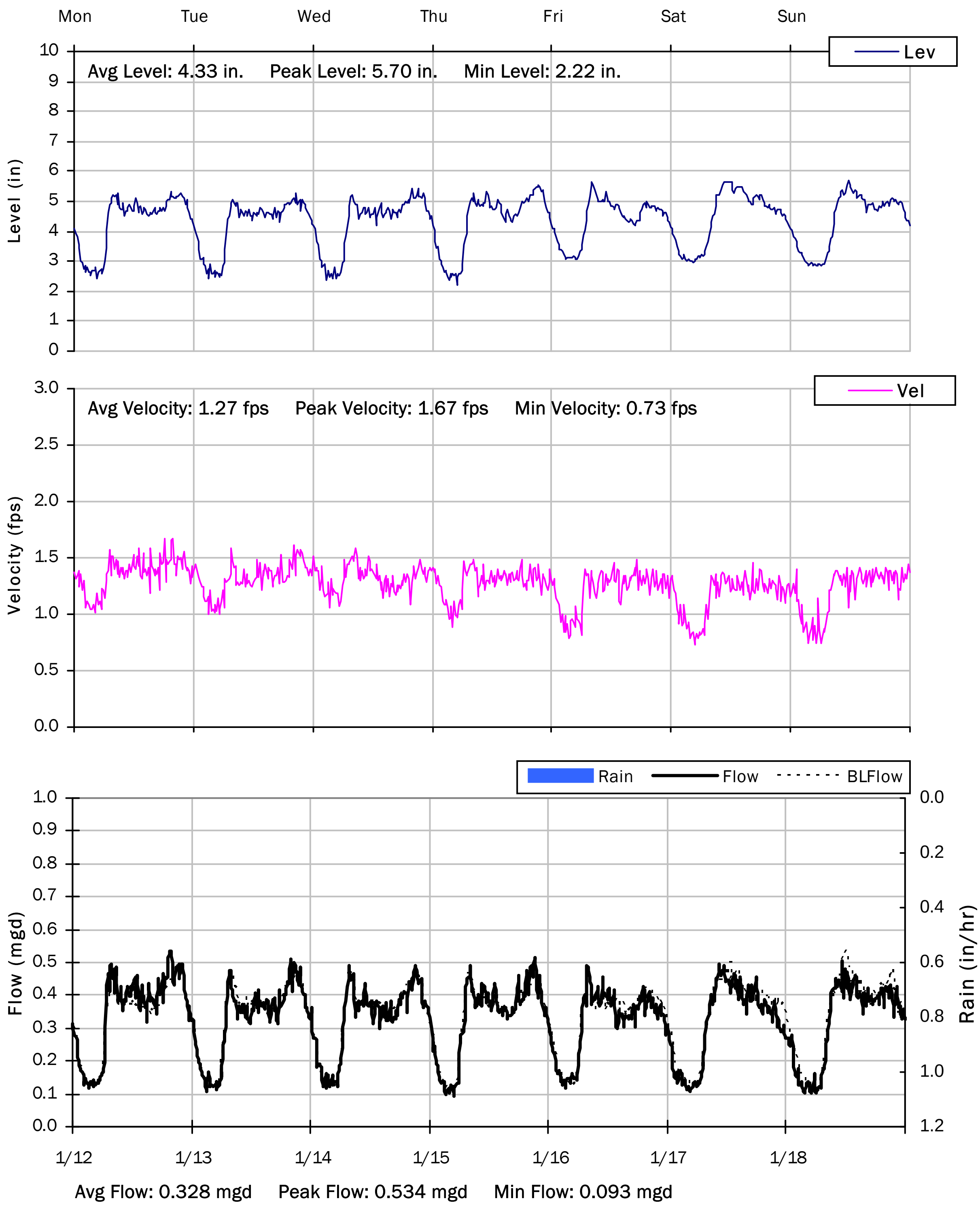




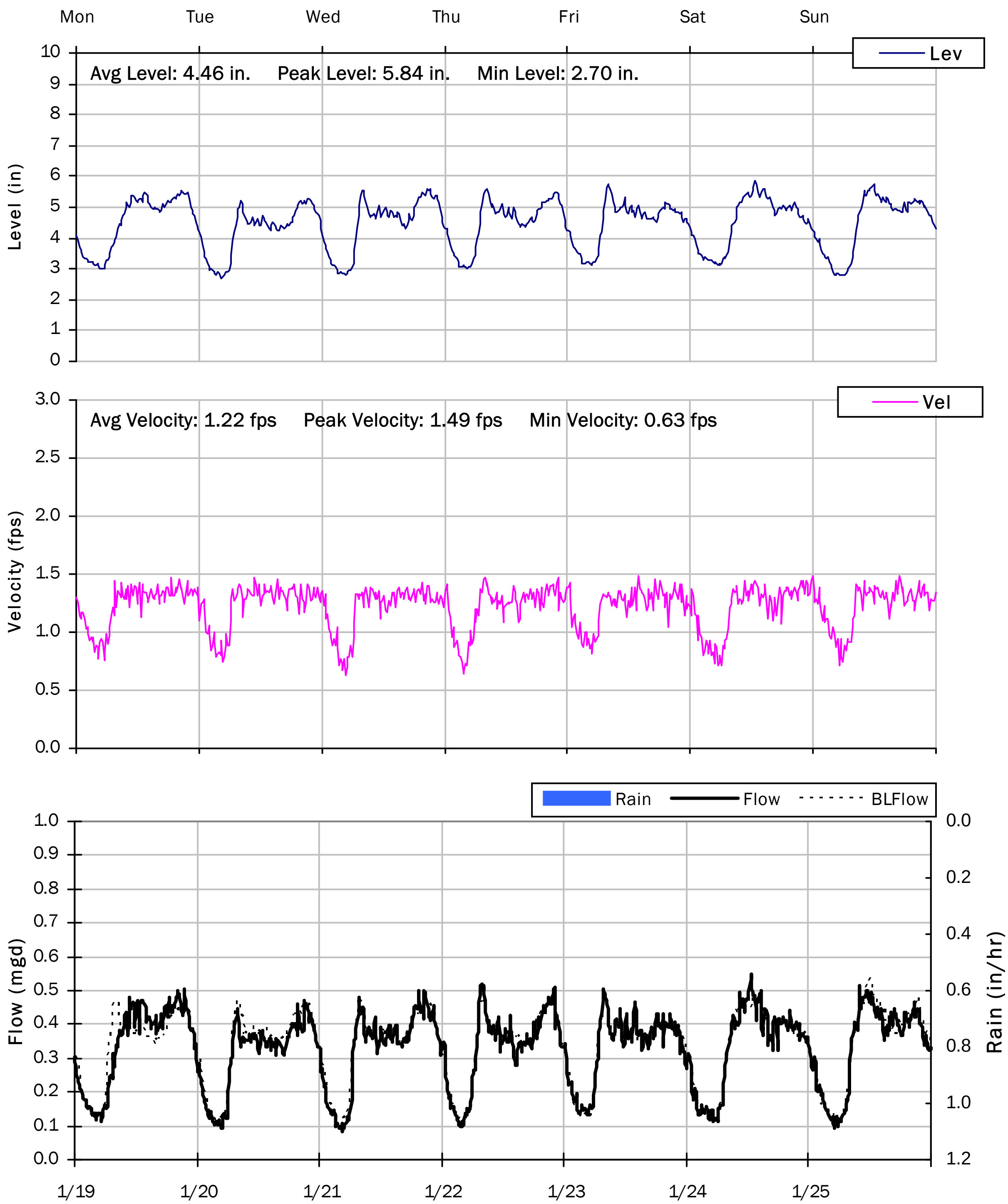


Avg Flow: 0.342 mgd Peak Flow: 0.620 mgd Min Flow: 0.092 mgd

SITE 7
Weekly Level, Velocity and Flow Hydrographs
1/12/2015 to 1/19/2015



SITE 7
Weekly Level, Velocity and Flow Hydrographs
1/19/2015 to 1/26/2015

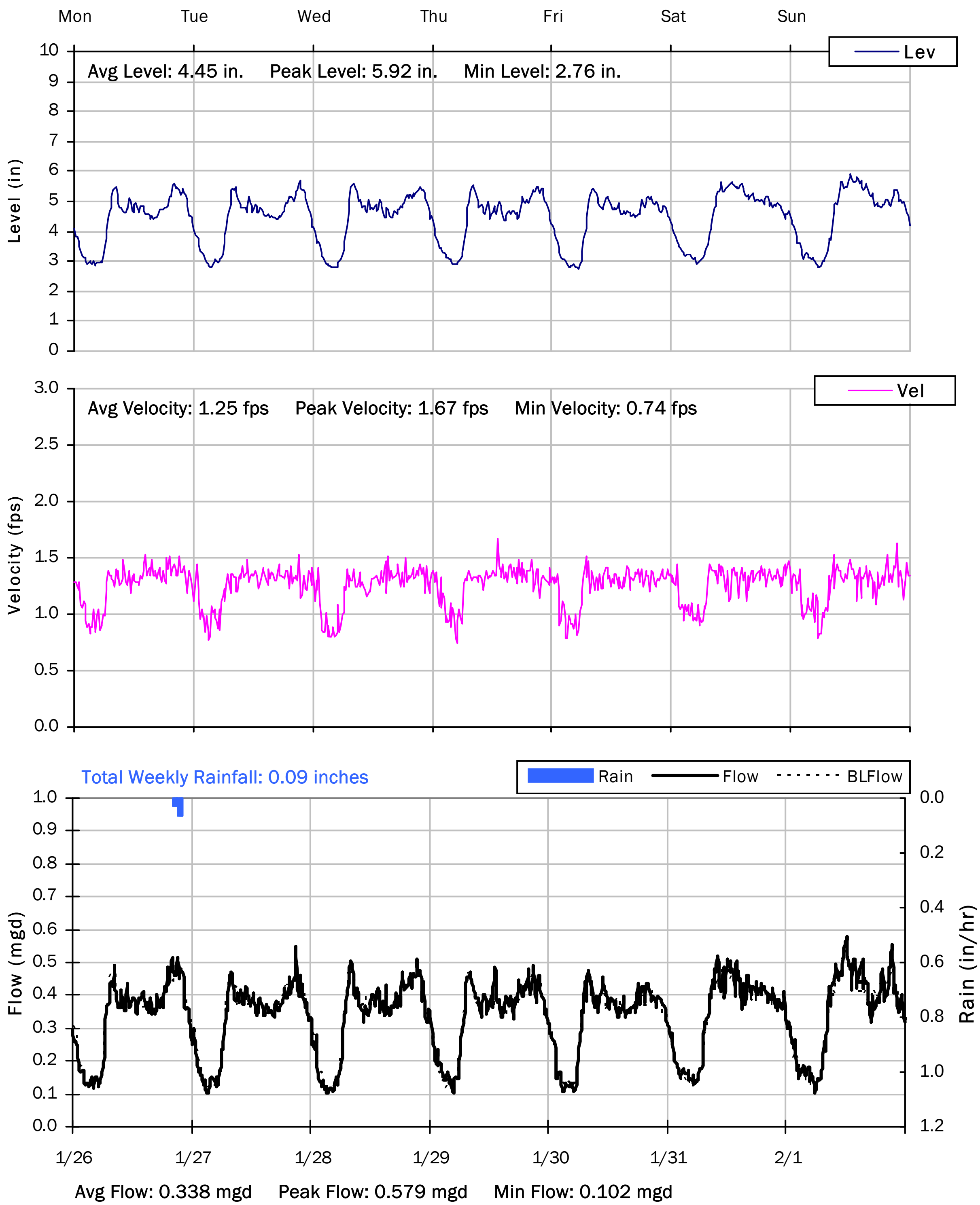


Avg Flow: 0.331 mgd   Peak Flow: 0.549 mgd   Min Flow: 0.084 mgd

SITE 7

Weekly Level, Velocity and Flow Hydrographs

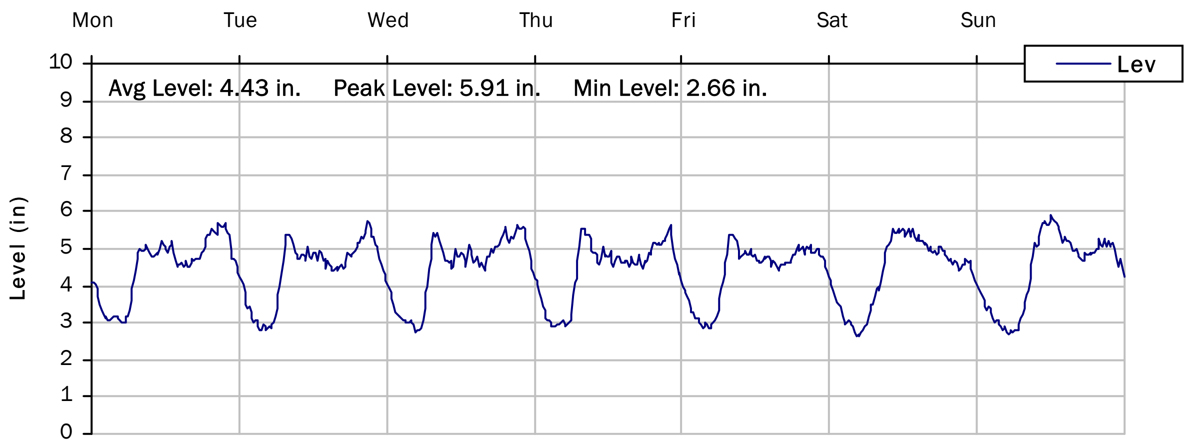
1/26/2015 to 2/2/2015

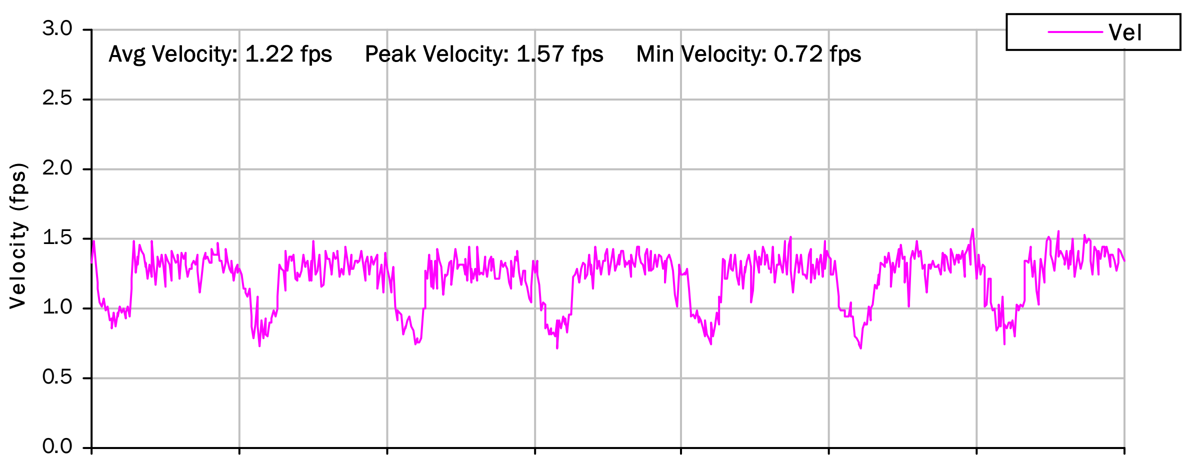


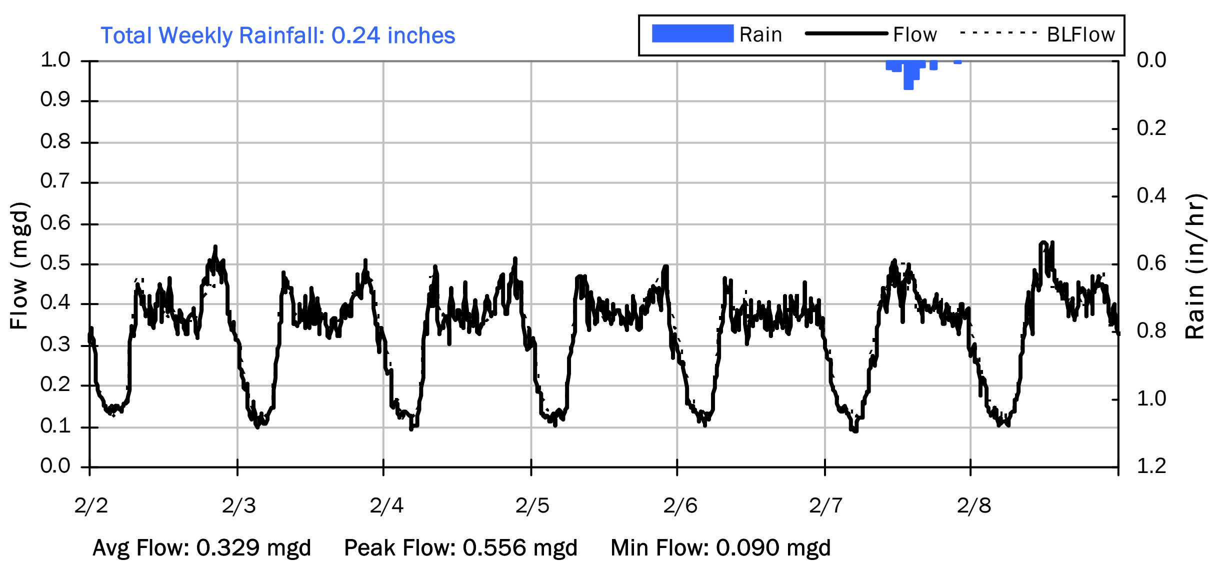
SITE 7

Weekly Level, Velocity and Flow Hydrographs

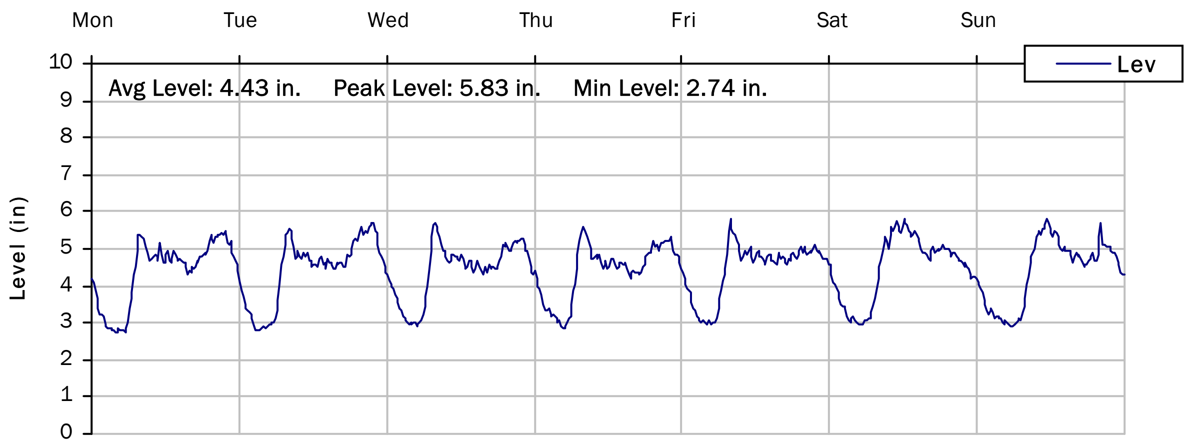
2/2/2015 to 2/9/2015

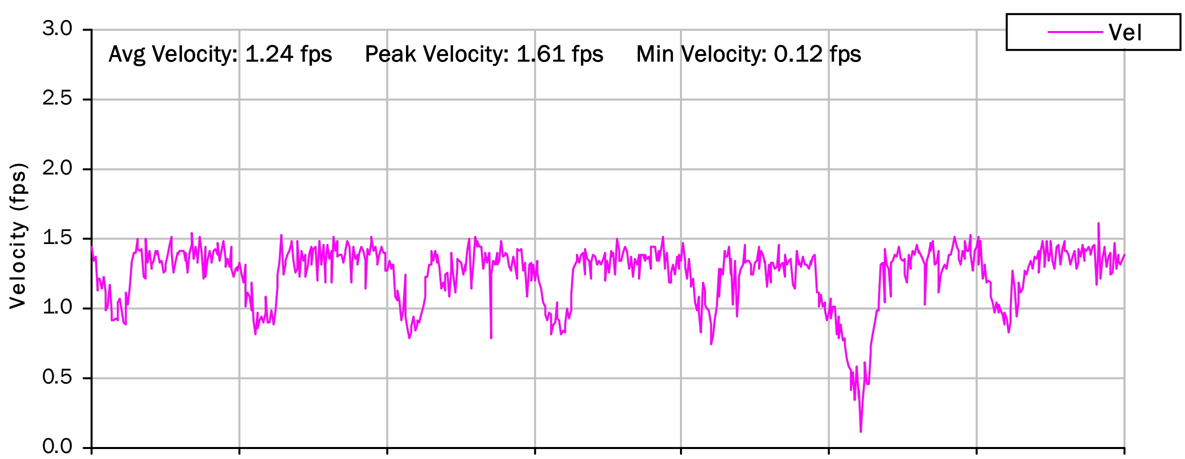


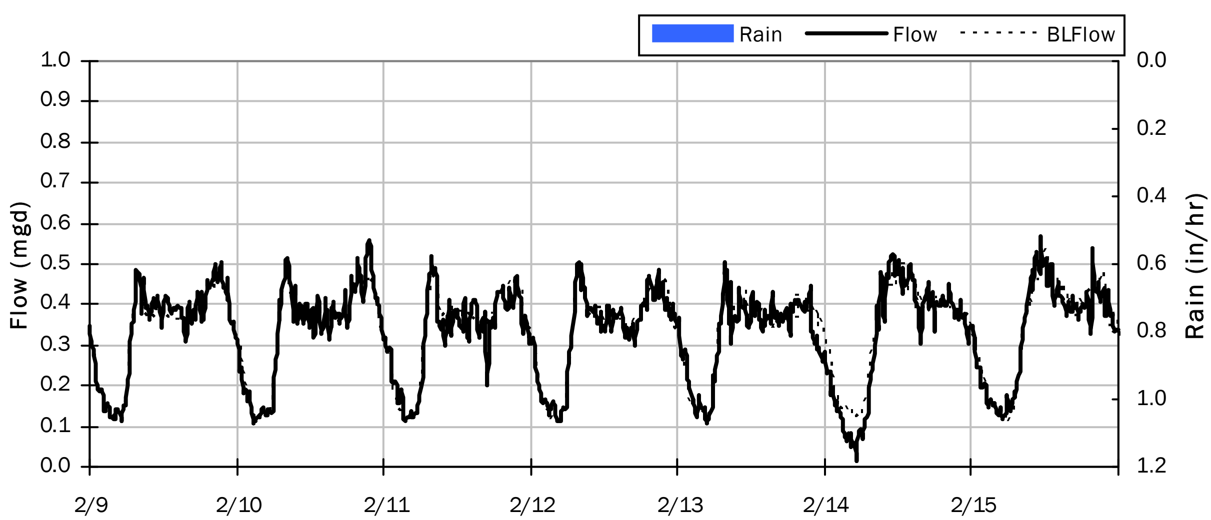




SITE 7
Weekly Level, Velocity and Flow Hydrographs
2/9/2015 to 2/16/2015





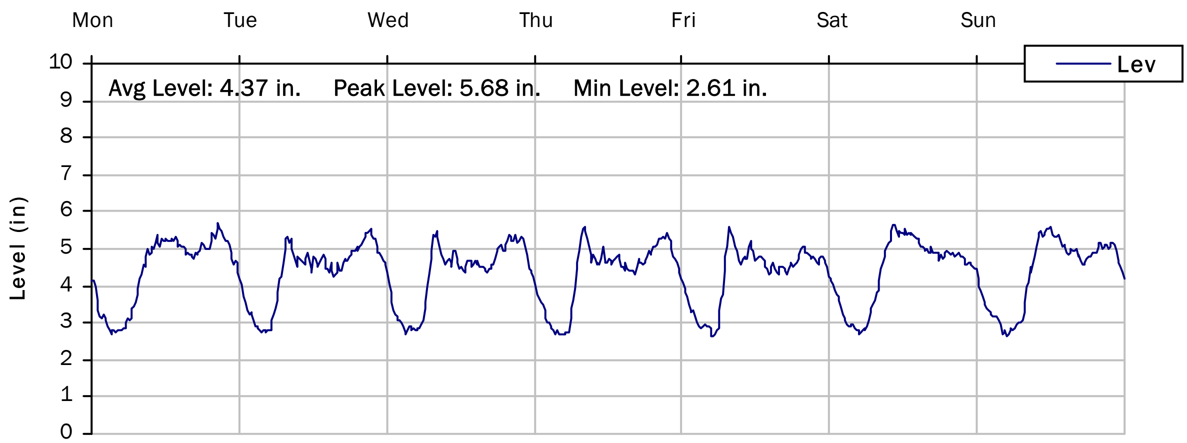


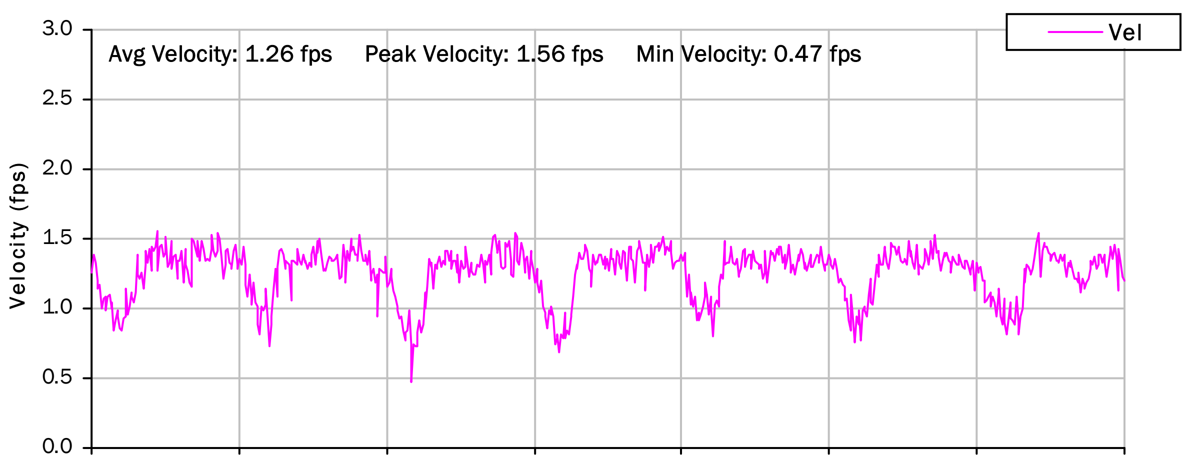
Avg Flow: 0.334 mgd Peak Flow: 0.568 mgd Min Flow: 0.017 mgd

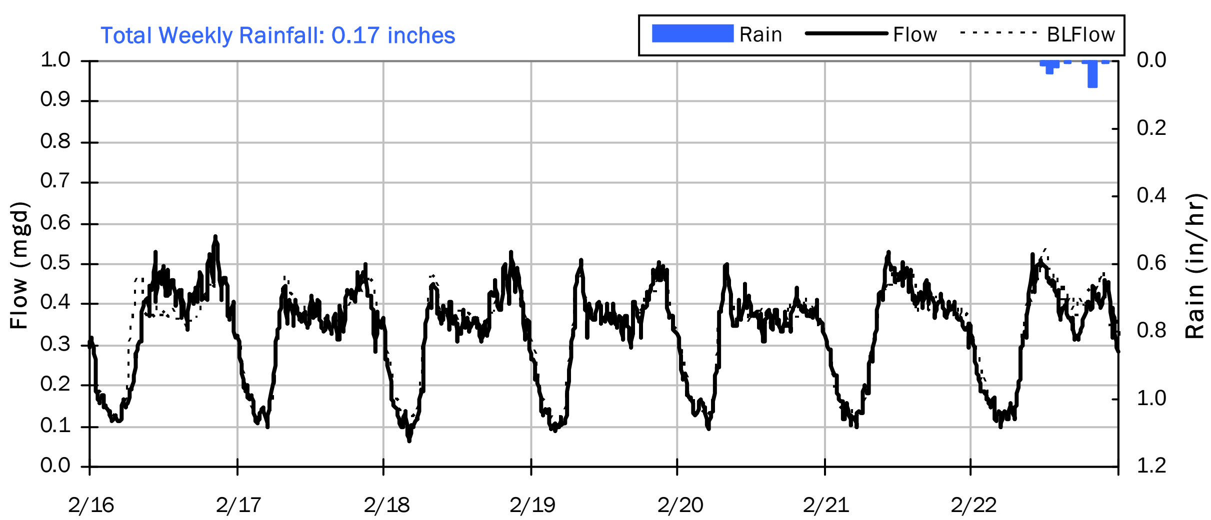
SITE 7

Weekly Level, Velocity and Flow Hydrographs

2/16/2015 to 2/23/2015

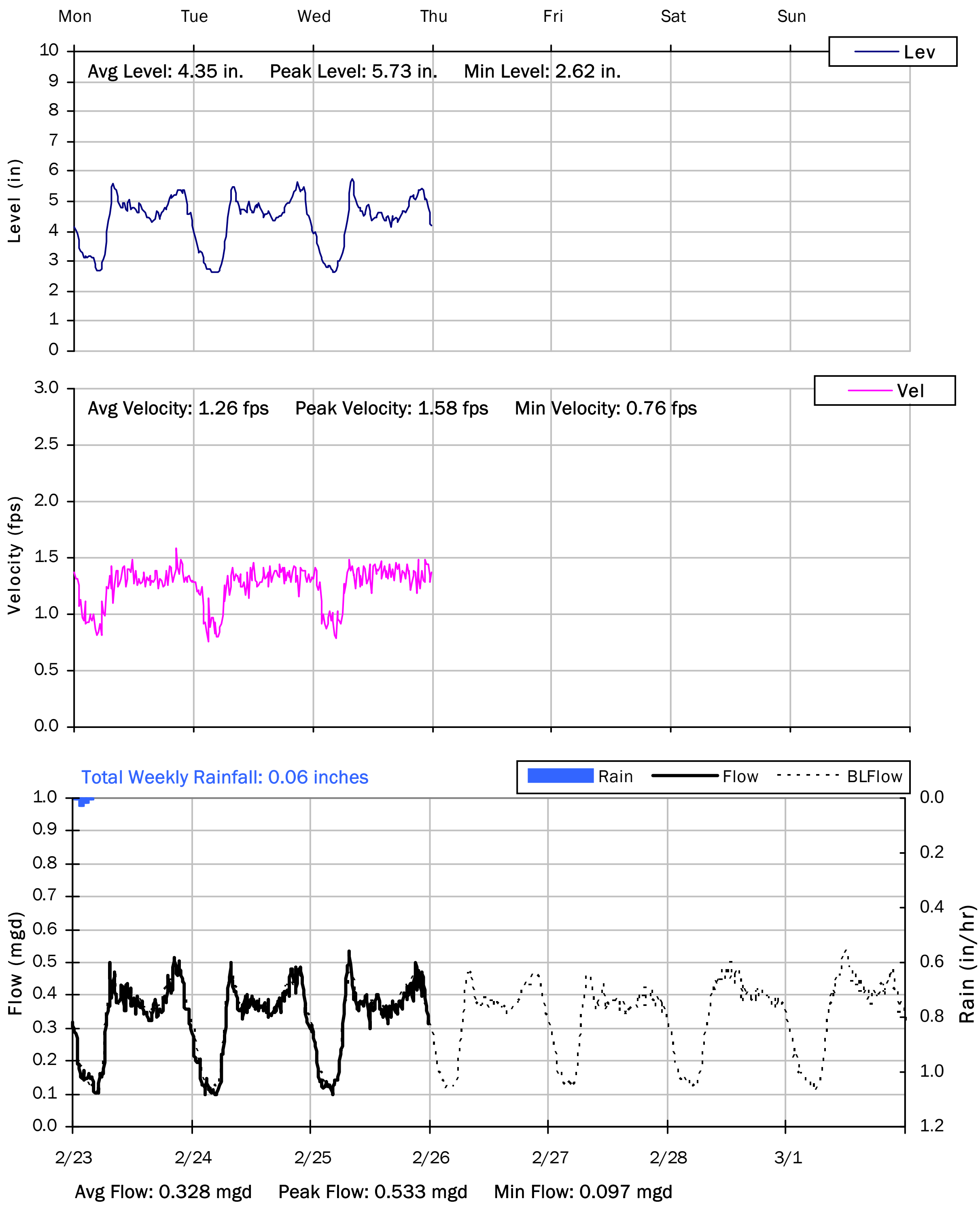






Avg Flow: 0.331 mgd   Peak Flow: 0.567 mgd   Min Flow: 0.063 mgd

SITE 7
Weekly Level, Velocity and Flow Hydrographs
2/23/2015 to 3/2/2015



City of Oxnard

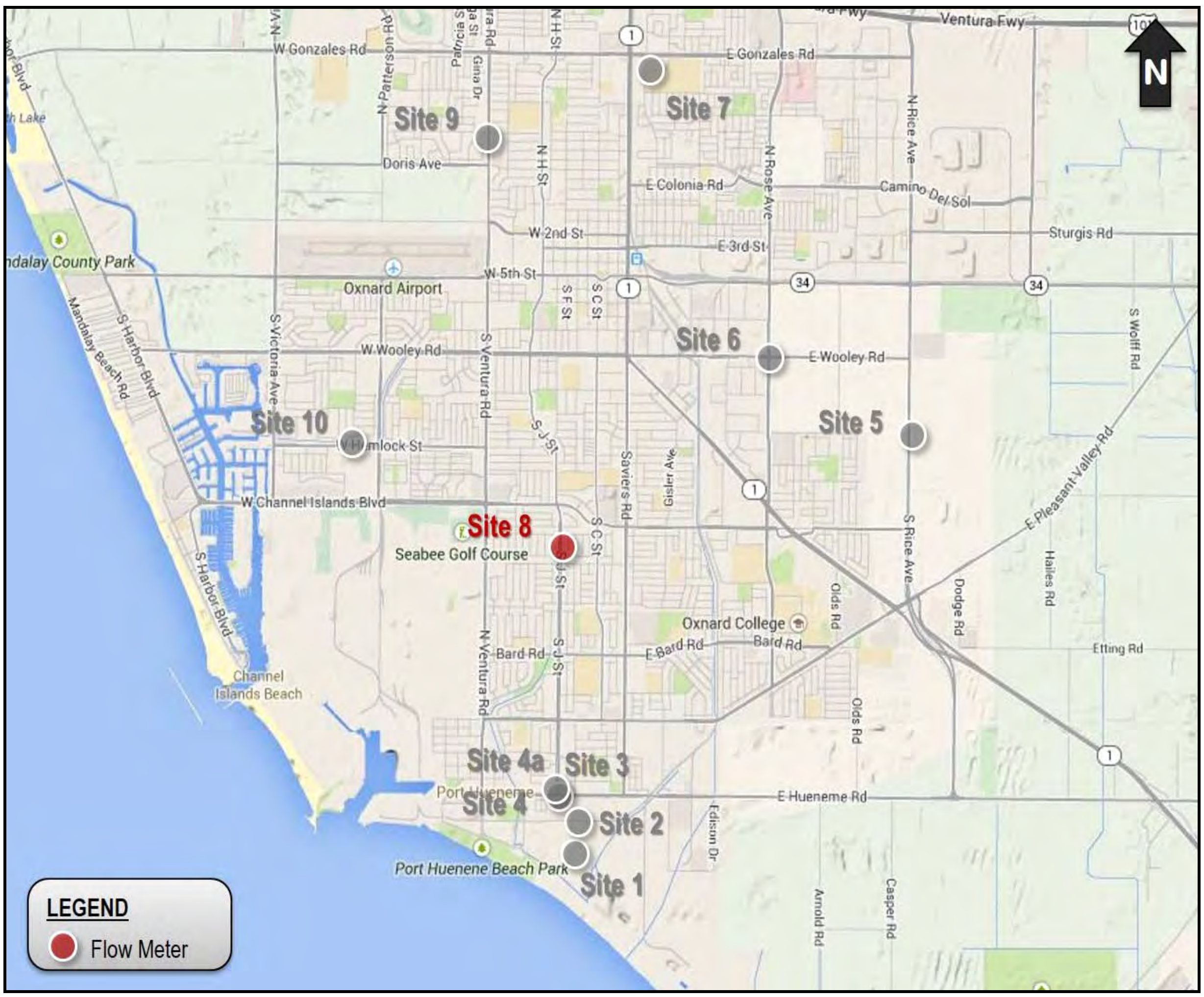
Sanitary Sewer Flow Monitoring

Temporary Monitoring: December, 2014 through February, 2015

Monitoring Site: Site 8

Location: J Street, between Spruce Street and Teakwood Street

Data Summary Report



Vicinity Map: Site 8

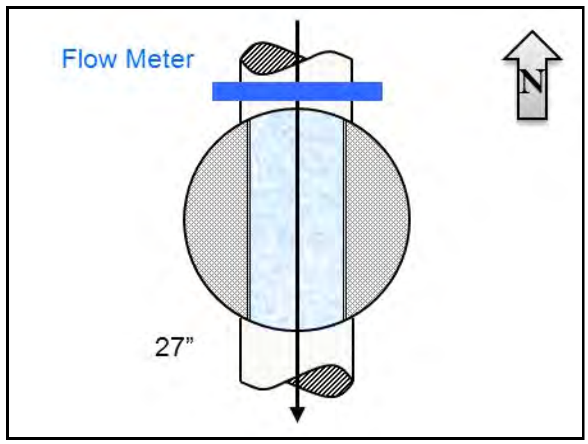
SITE 8

Site Information

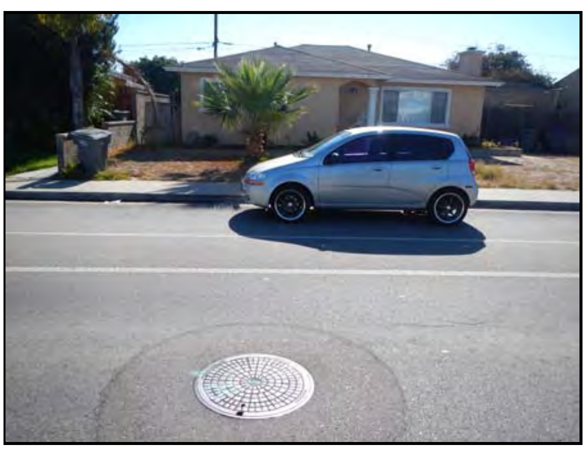
Location:	J Street, between Spruce Street and Teakwood Street
Coordinates:	119.1857° W, 34.1716° N
Rim Elevation:	25 feet
Pipe Diameter:	27 inches
Baseline Flow:	1.638 mgd
Peak Measured Flow:	4.540 mgd

Satellite Map

Sanitary Map



Flow Diagram


Street View


Plan View

SITE 8

Additional Site Photos

Effluent Pipe

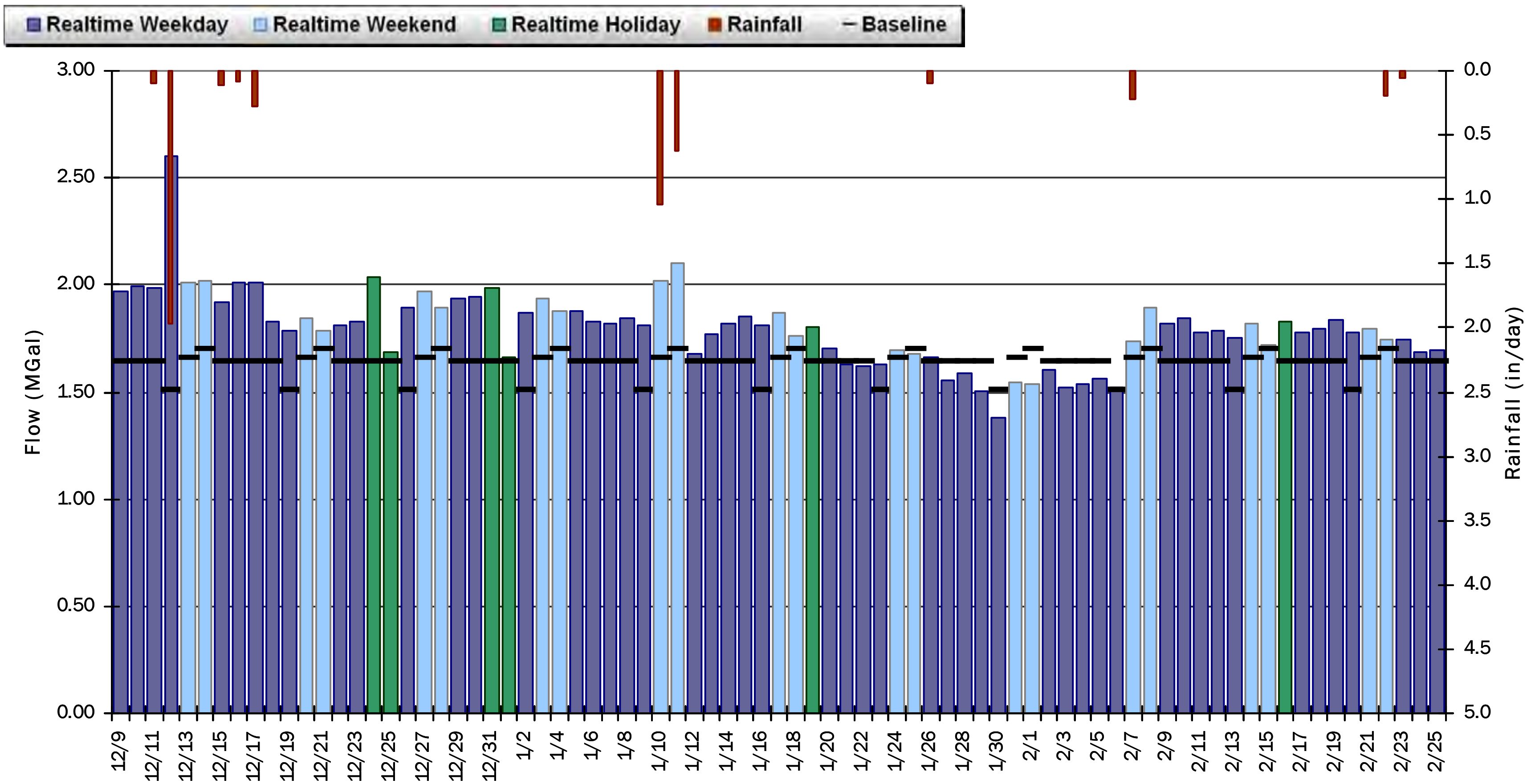
Influent Pipe

SITE 8

Period Flow Summary: Daily Flow Totals

Avg Period Flow: 1.799 MGal **Peak Daily Flow: 2.602 MGal** **Min Daily Flow: 1.381 MGal**

Total Period Rainfall: 4.78 inches

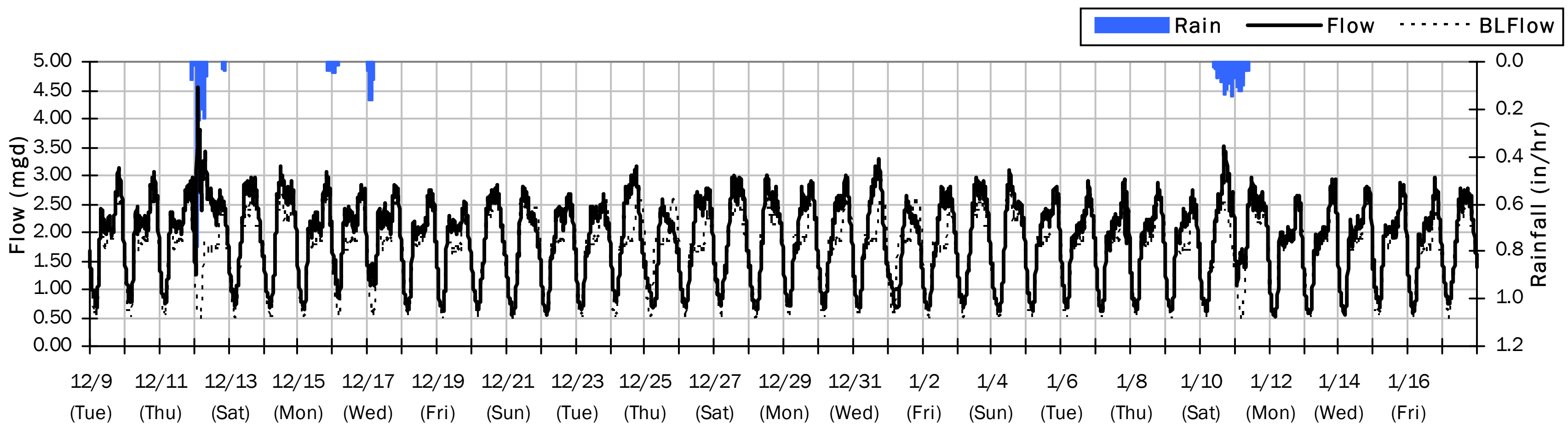


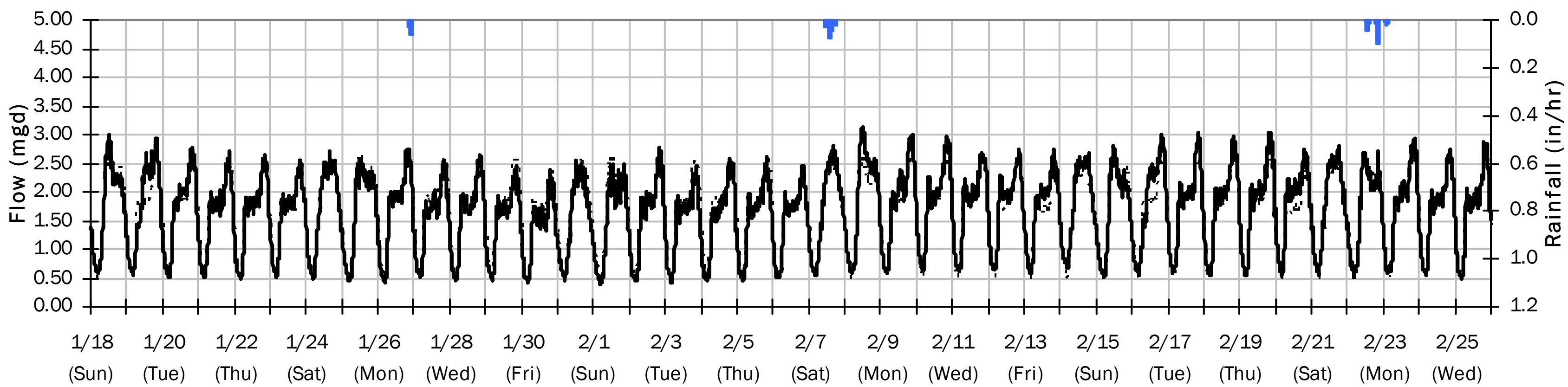
SITE 8

Flow Summary: 12/9/2014 to 2/25/2015

Total Period Rainfall: 4.78 inches

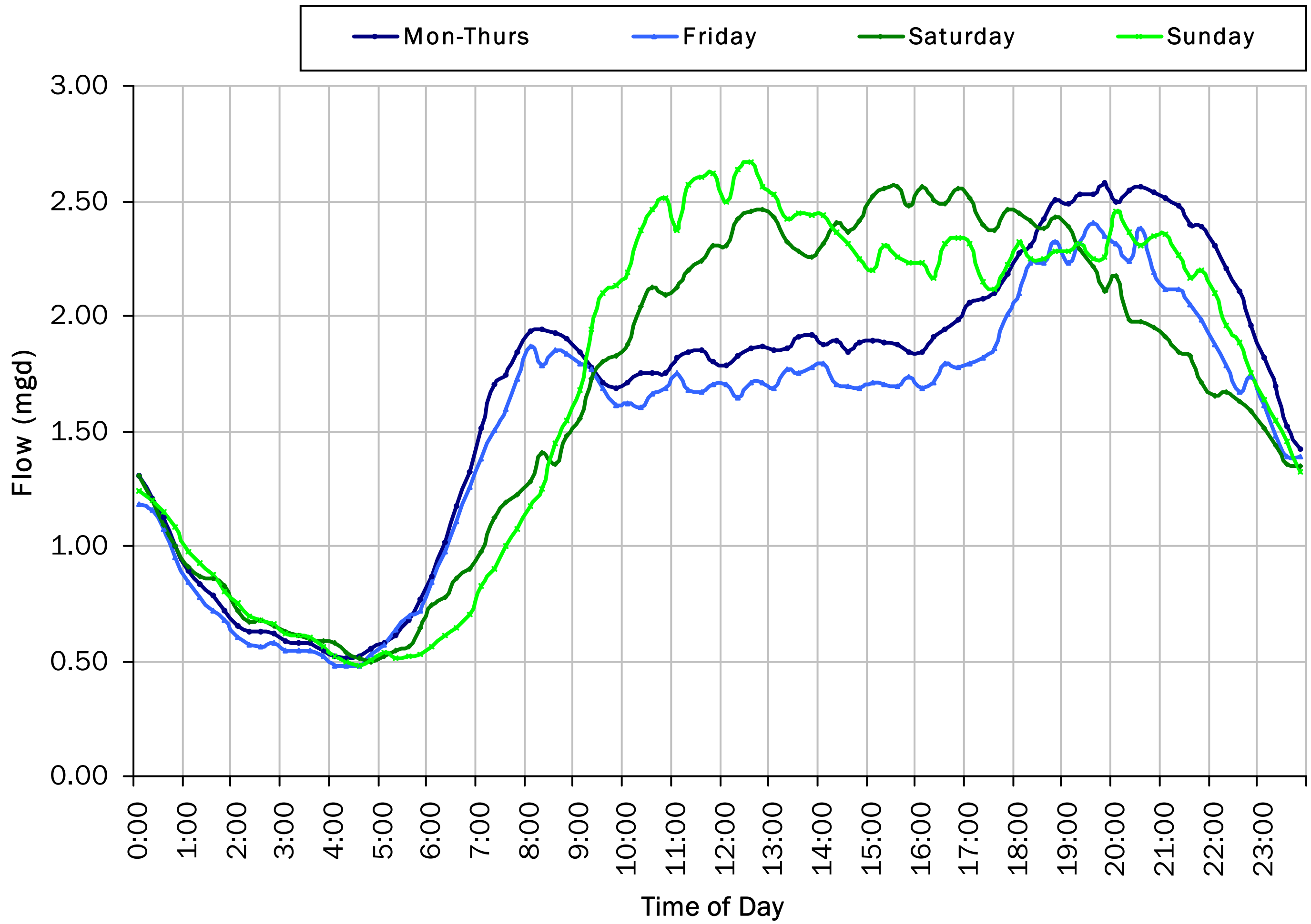
Avg Flow: 1.799 mgd   Peak Flow: 4.540 mgd   Min Flow: 0.401 mgd





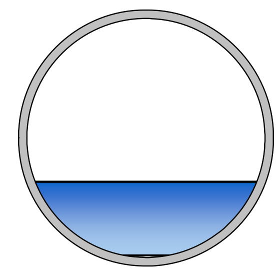
SITE 8

Baseline Flow Hydrographs



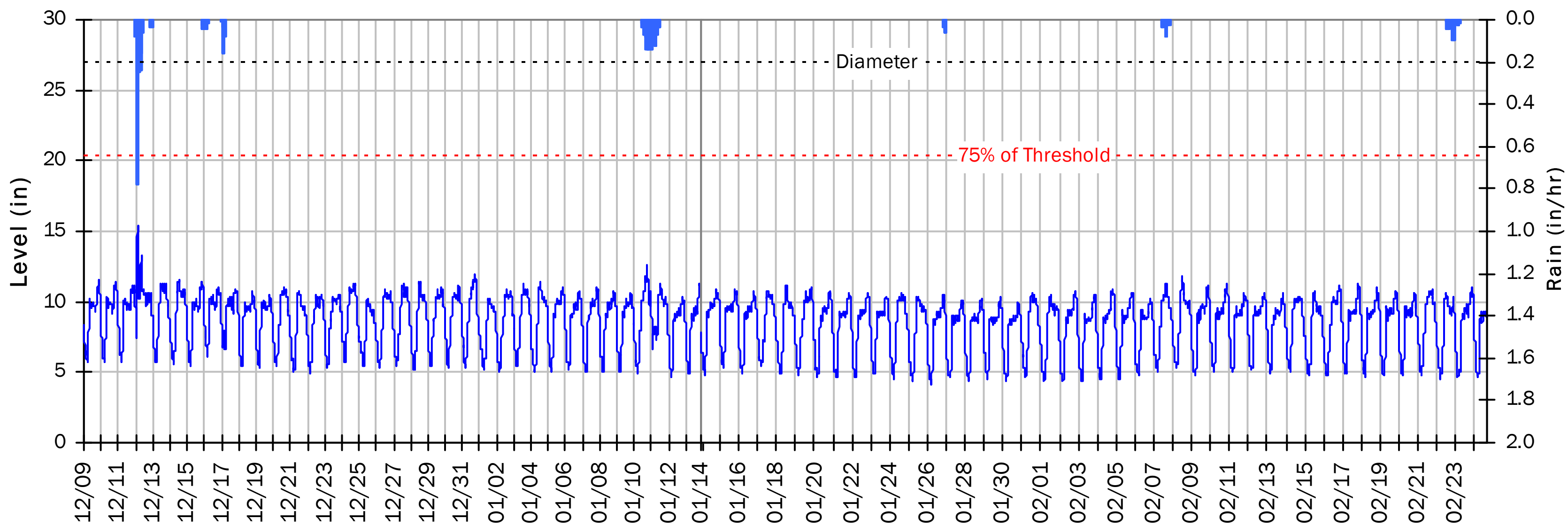
Baseline Flow:

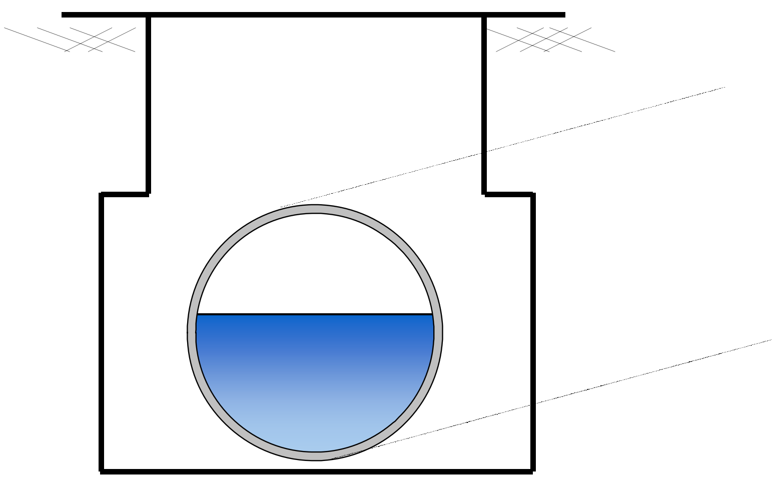
1.64 *mgd*



SITE 8
Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Monitoring Period

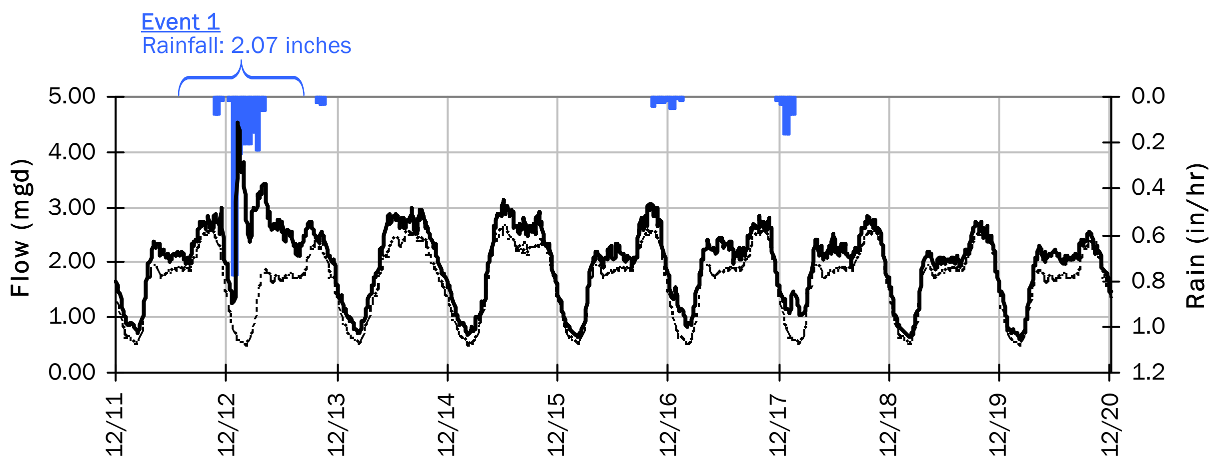




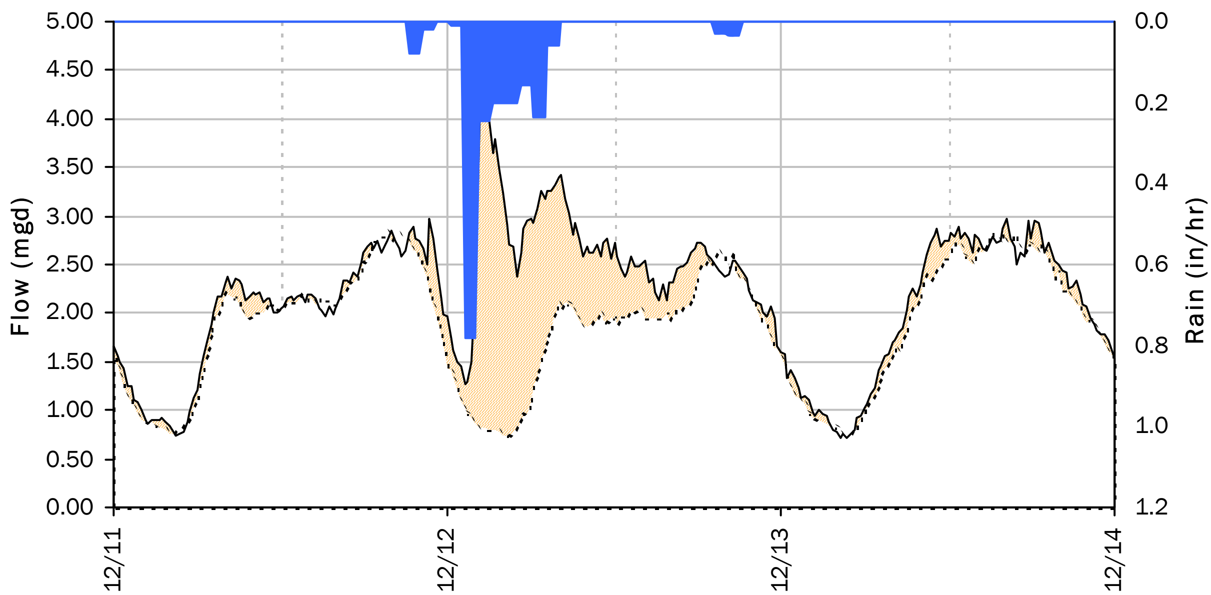
Pipe Diameter:	27	*inches*
Peak Measured Level:	15.5	*inches*
Peak d/D Ratio:	0.57	

SITE 8
I/I Summary: Event 1

Baseline and Realtime Flows with Rainfall Data over Monitoring Period



Event 1 Detail Graph

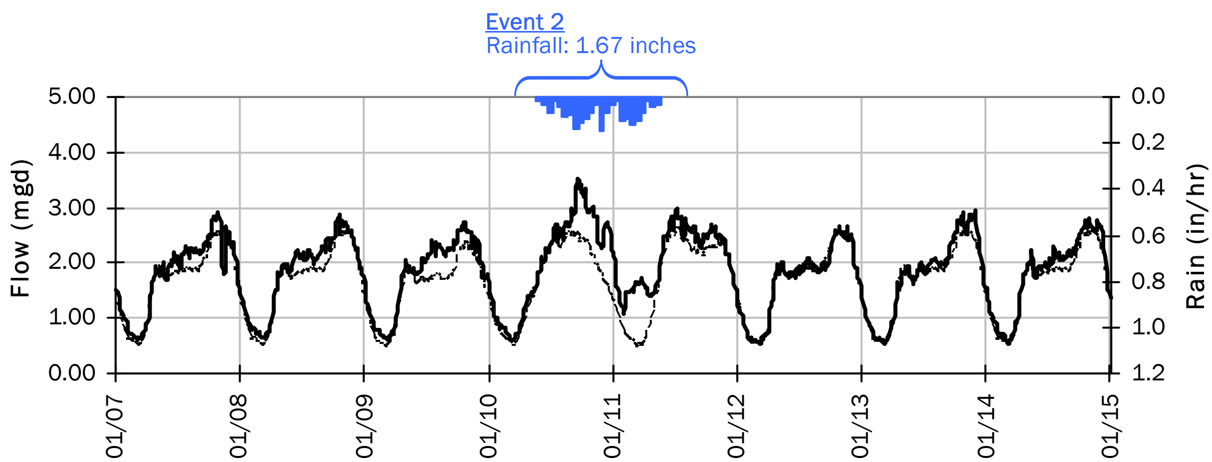


Storm Event I/I Analysis (Rain = 2.07 inches)

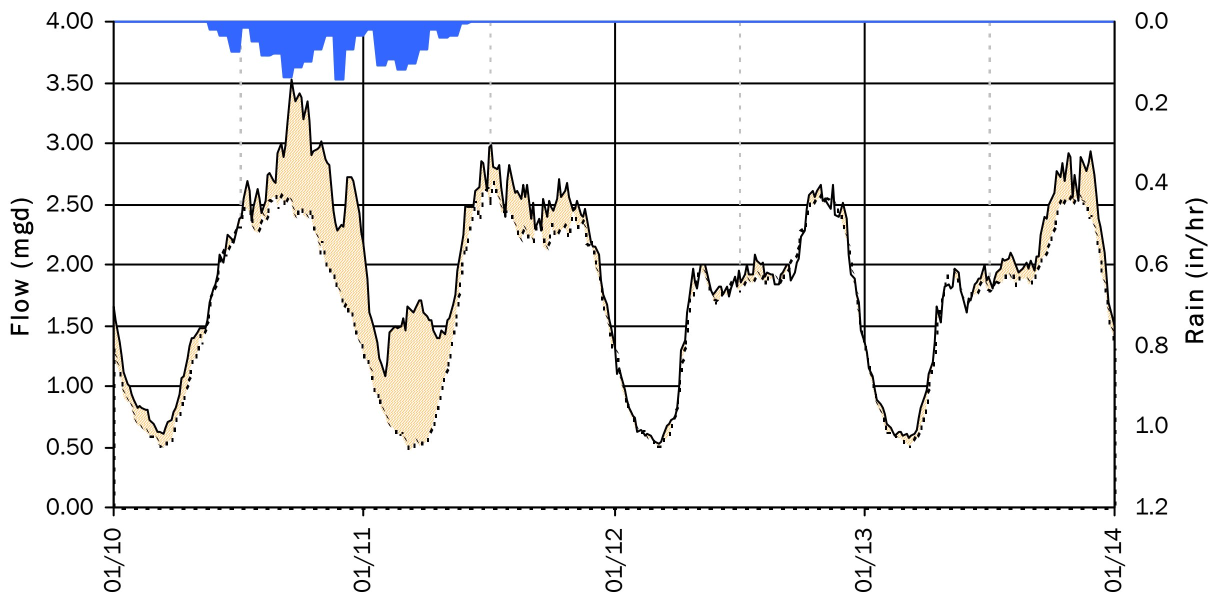
Capacity		Inflow / Infiltration	
Peak Flow:	4.54 *mgd*	Peak I/I Rate:	3.73 *mgd*
PF:	2.77	Total I/I:	981,000 *gallons*
Peak Level:	15.45 *in*		
d/D Ratio:	0.57		

SITE 8
I/I Summary: Event 2

Baseline and Realtime Flows with Rainfall Data over Monitoring Period



Event 2 Detail Graph



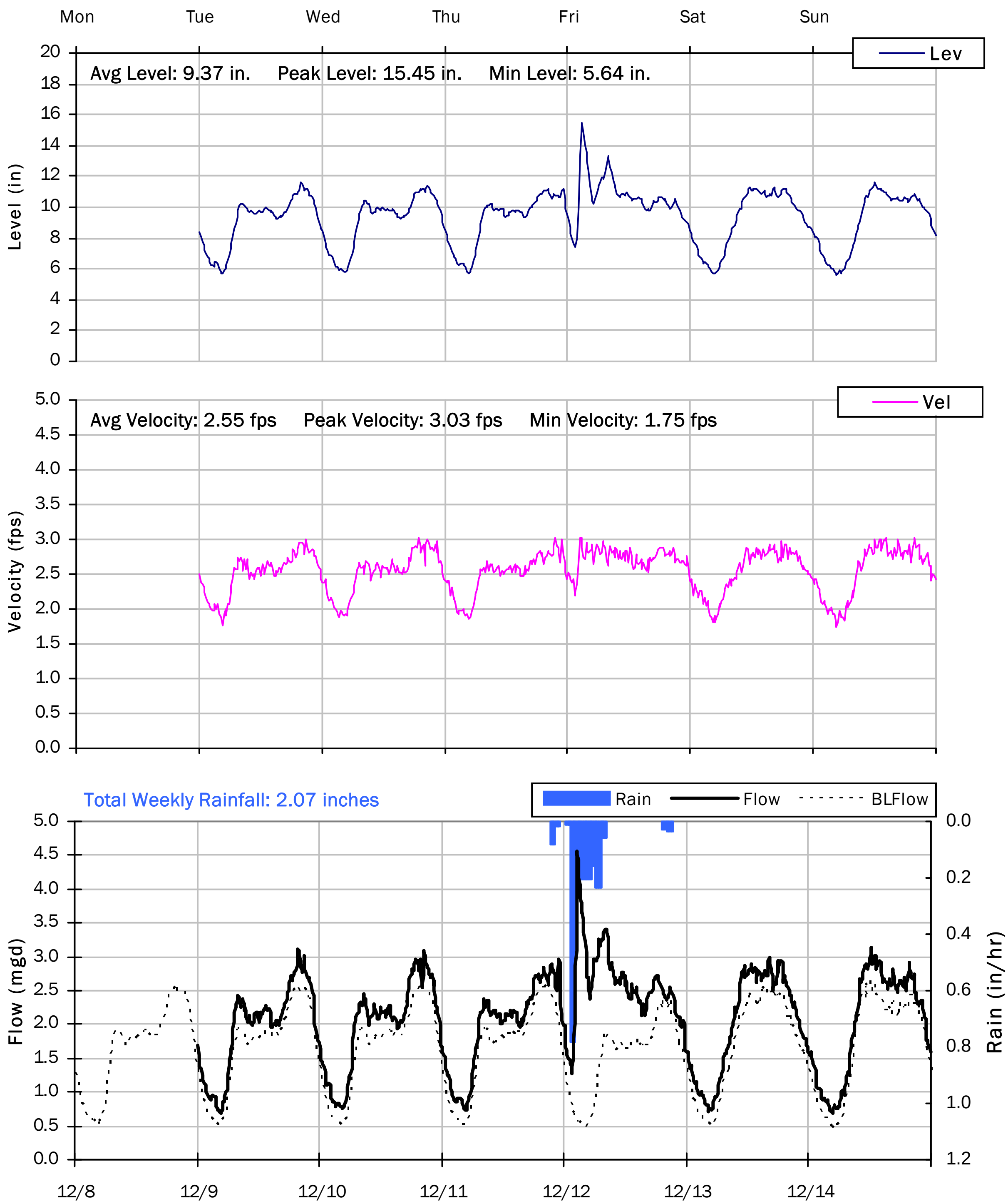
Storm Event I/I Analysis (Rain = 1.67 inches)

Capacity		Inflow / Infiltration	
Peak Flow:	3.52 *mgd*	Peak I/I Rate:	1.20 *mgd*
PF:	2.15	Total I/I:	791,000 *gallons*
Peak Level:	12.65 *in*		
d/D Ratio:	0.47		

SITE 8

Weekly Level, Velocity and Flow Hydrographs

12/8/2014 to 12/15/2014

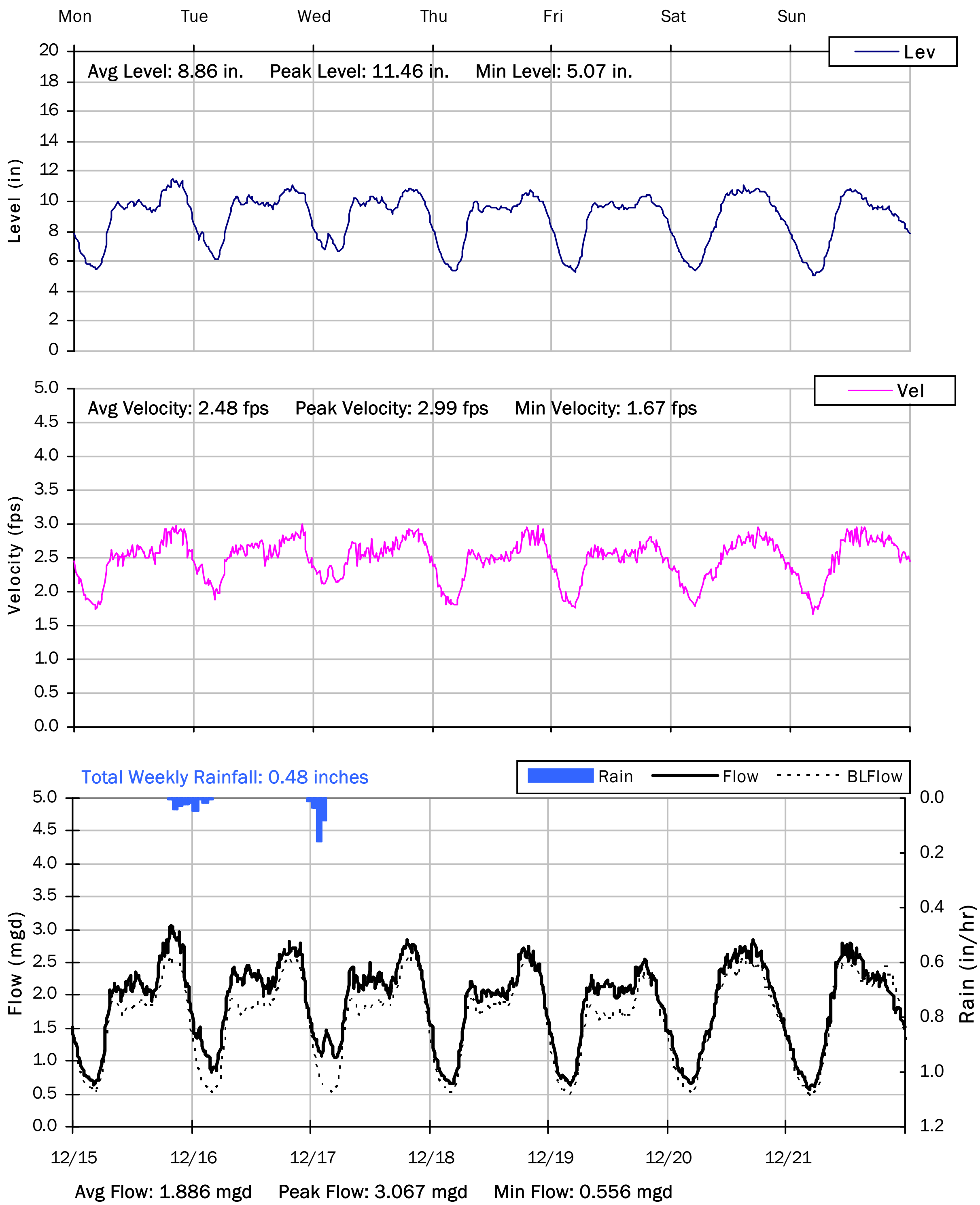


Avg Flow: 2.096 mgd Peak Flow: 4.540 mgd Min Flow: 0.683 mgd

SITE 8

Weekly Level, Velocity and Flow Hydrographs

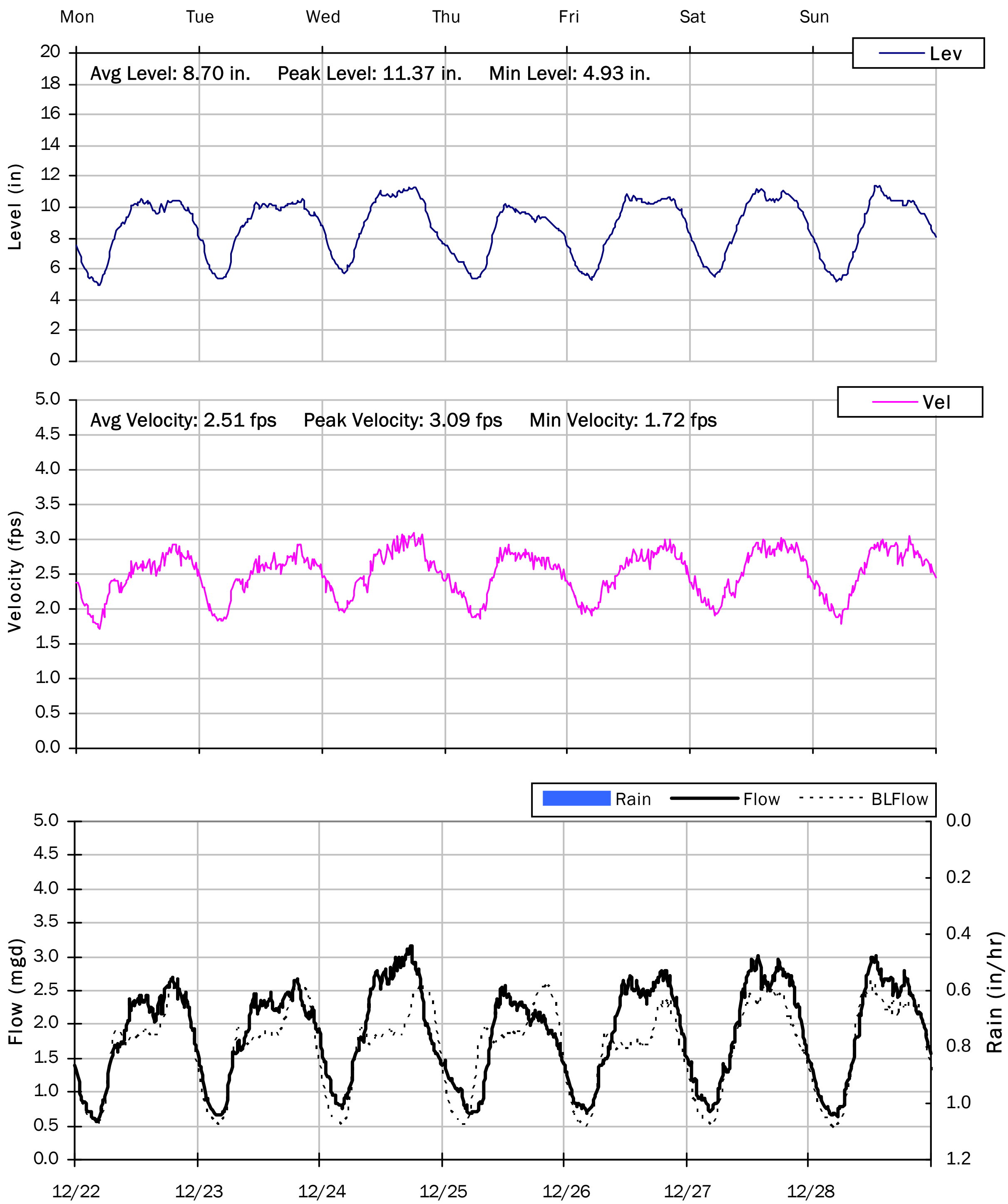
12/15/2014 to 12/22/2014



SITE 8

Weekly Level, Velocity and Flow Hydrographs

12/22/2014 to 12/29/2014

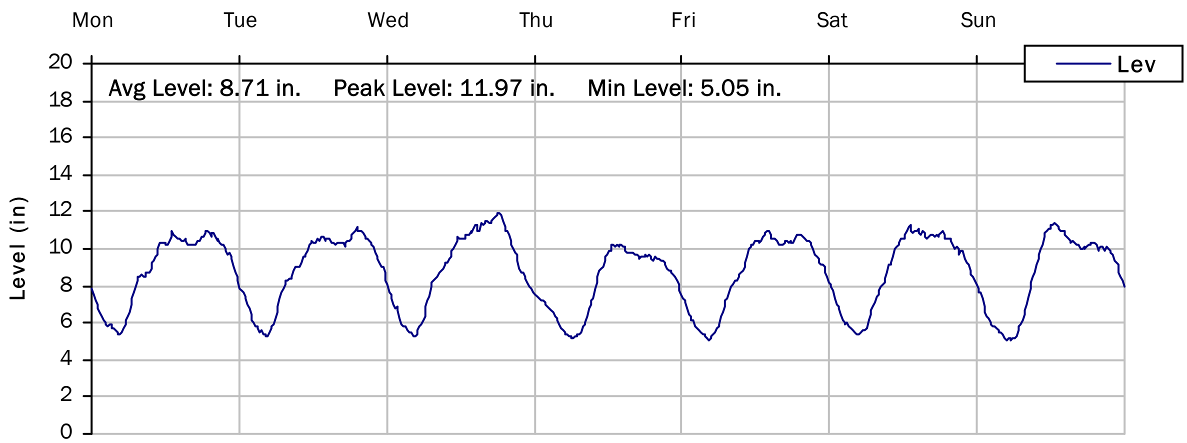


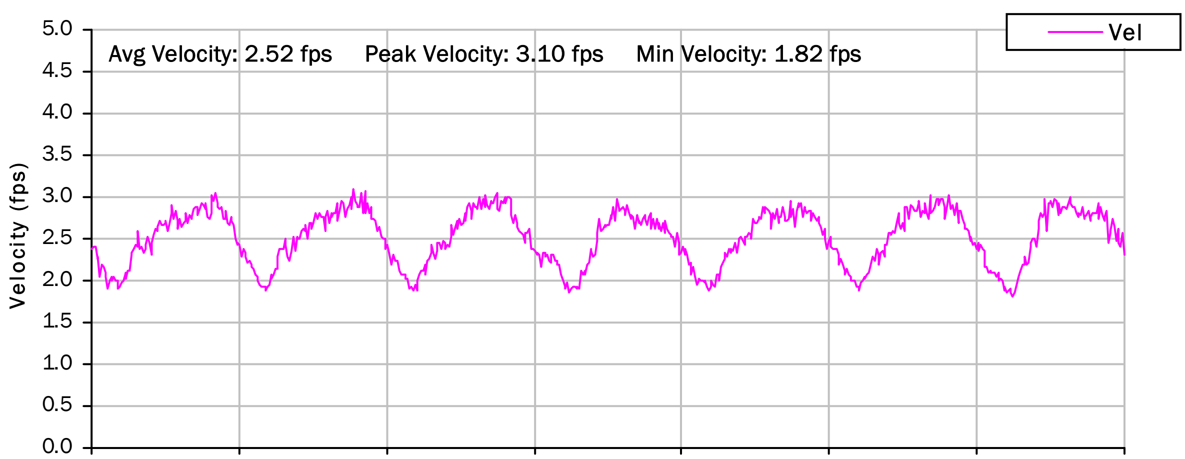
Avg Flow: 1.874 mgd Peak Flow: 3.150 mgd Min Flow: 0.552 mgd

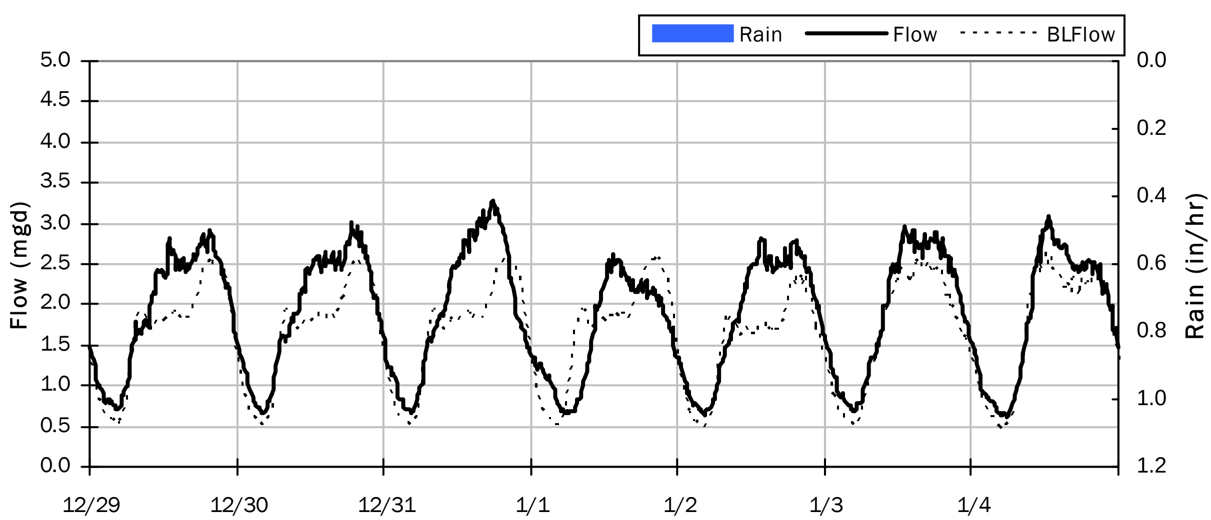
SITE 8

Weekly Level, Velocity and Flow Hydrographs

12/29/2014 to 1/5/2015



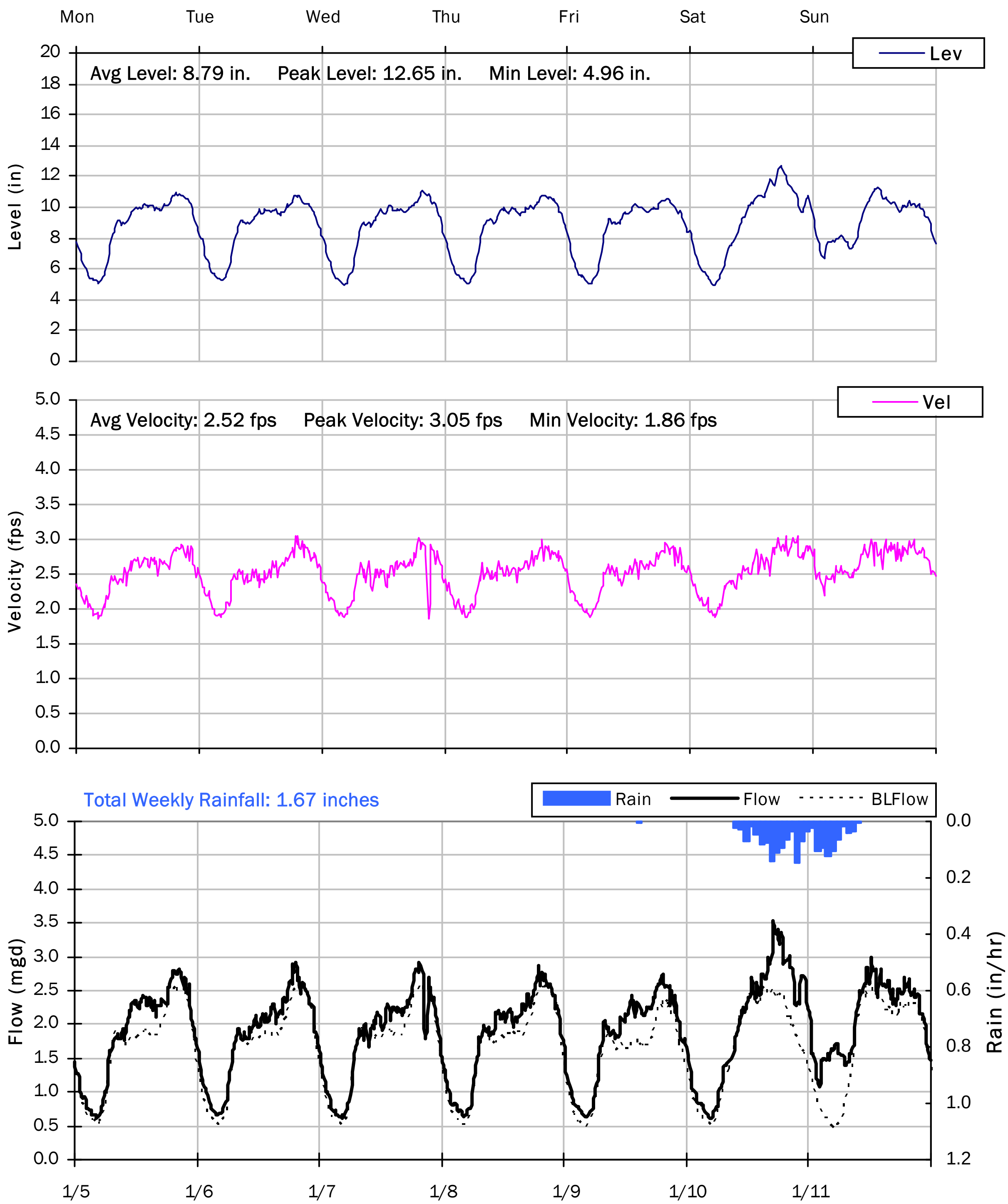




Avg Flow: 1.888 mgd Peak Flow: 3.289 mgd Min Flow: 0.616 mgd

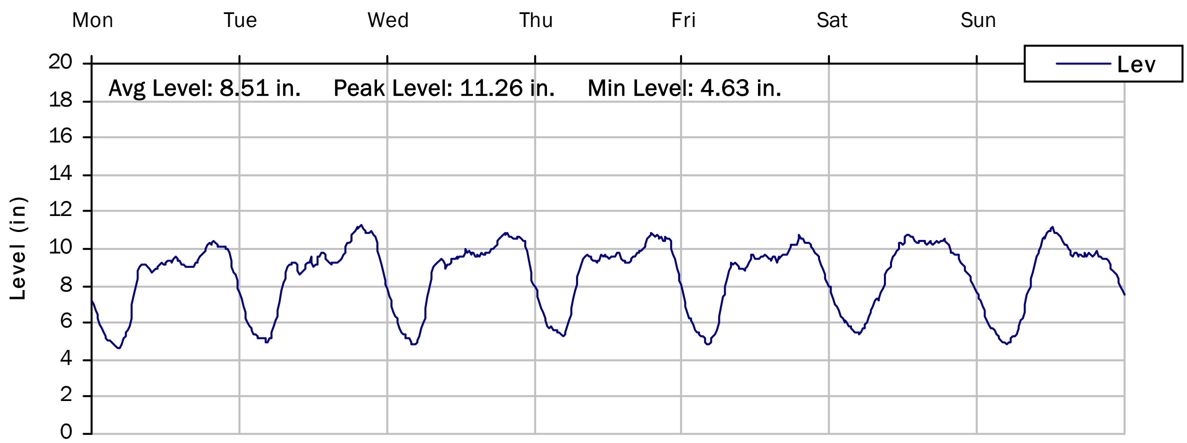
SITE 8

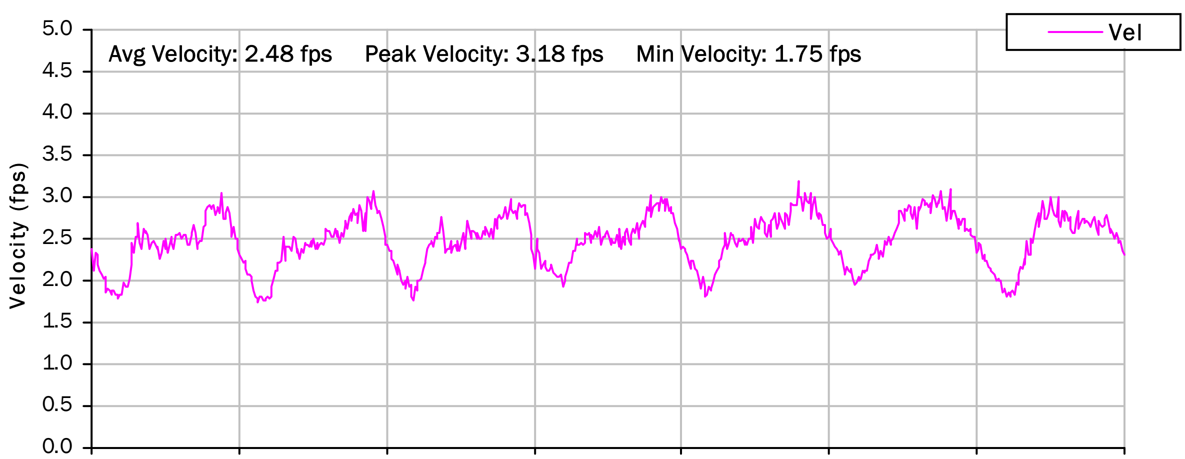
Weekly Level, Velocity and Flow Hydrographs
1/5/2015 to 1/12/2015

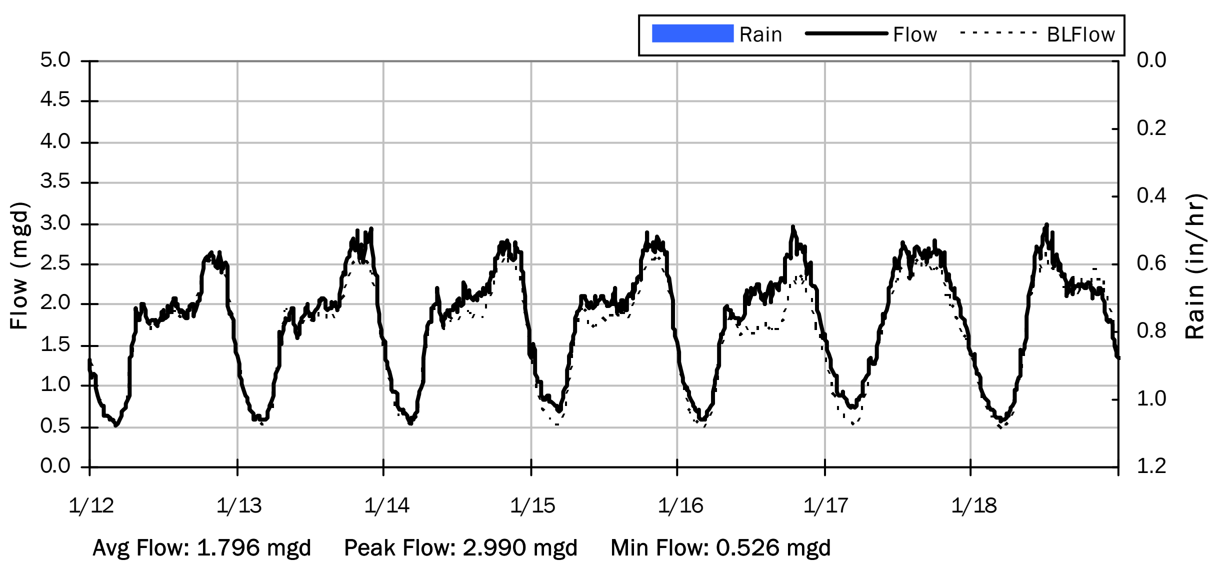


Avg Flow: 1.899 mgd Peak Flow: 3.519 mgd Min Flow: 0.605 mgd

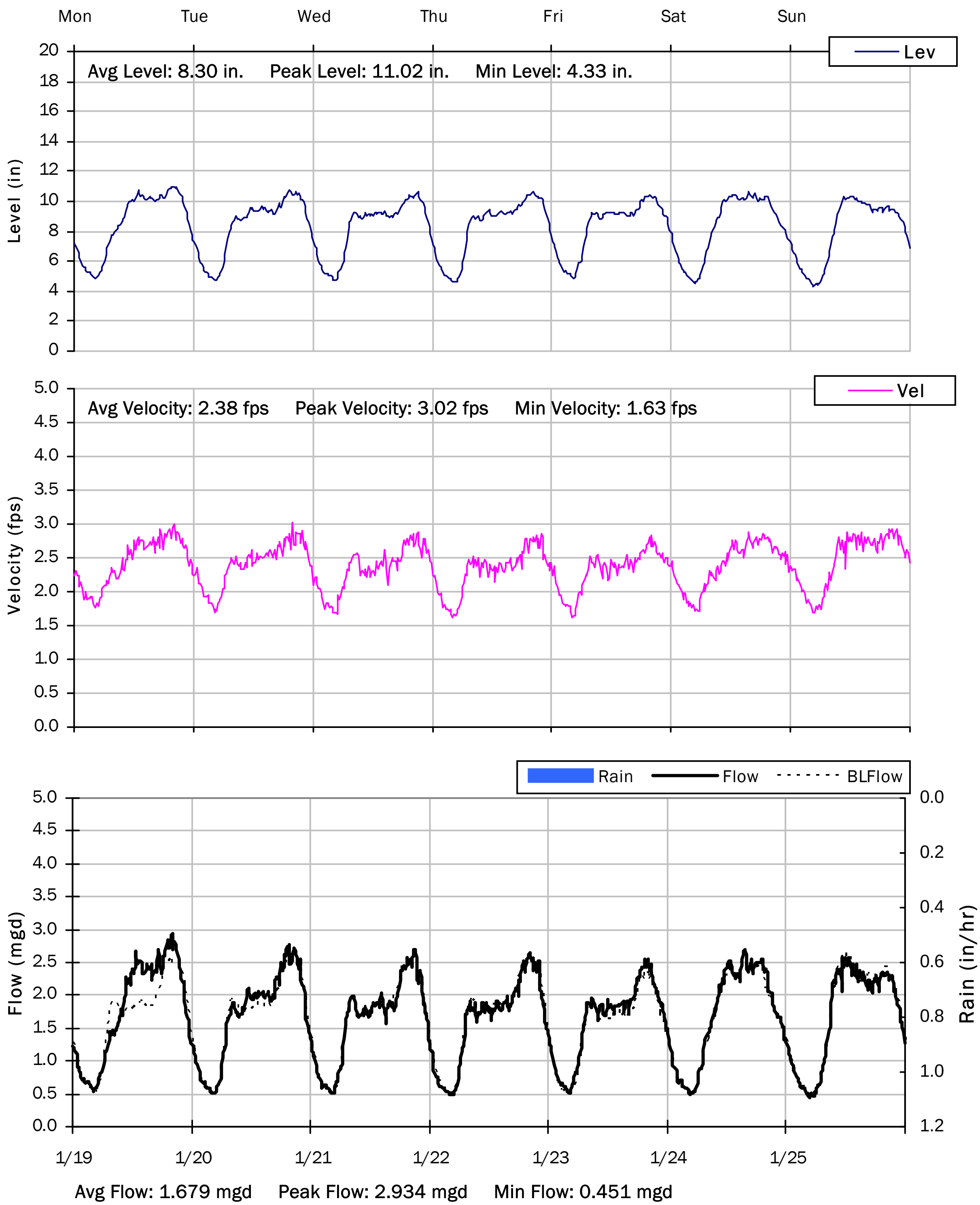
SITE 8
Weekly Level, Velocity and Flow Hydrographs
1/12/2015 to 1/19/2015







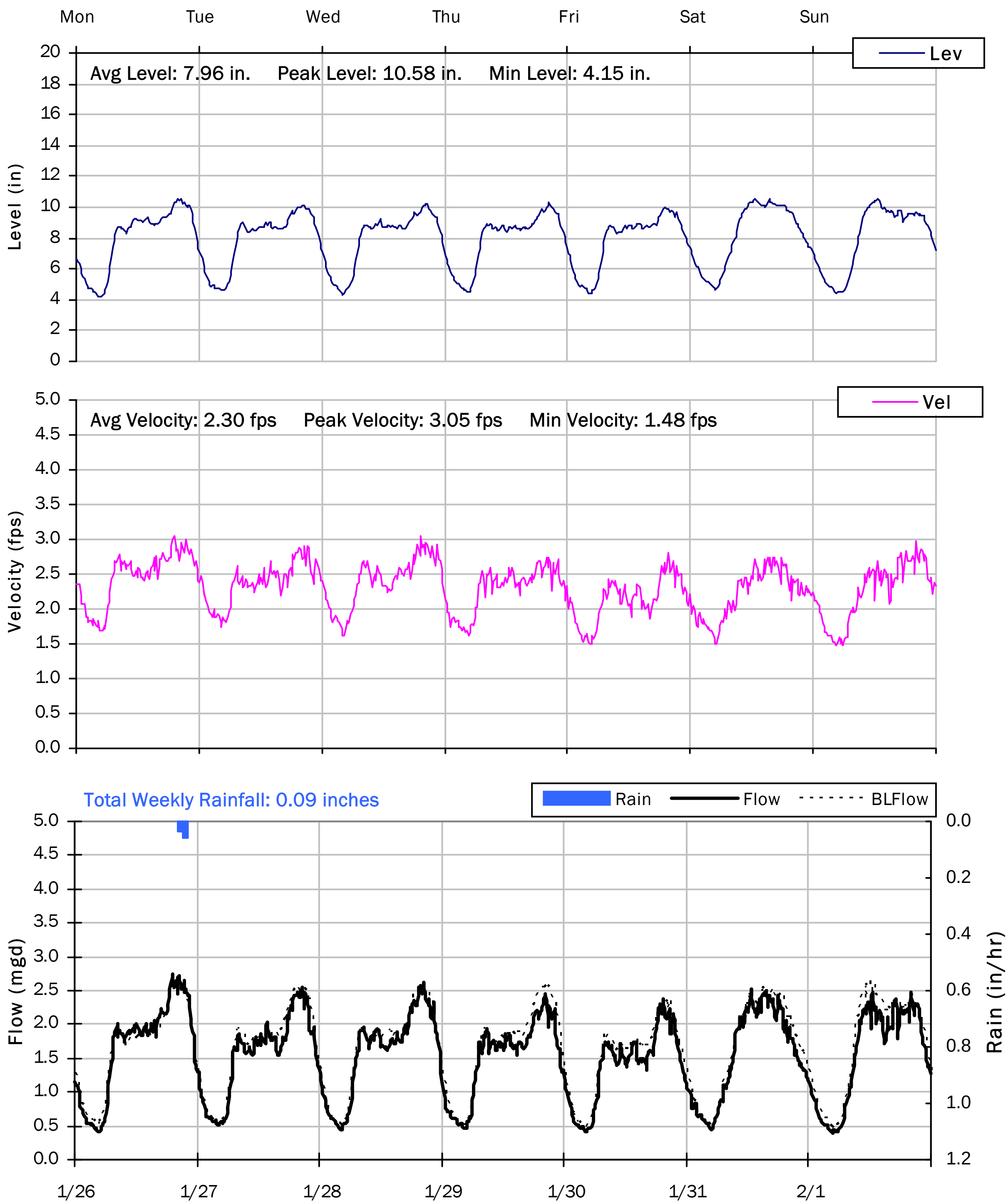
SITE 8
Weekly Level, Velocity and Flow Hydrographs
1/19/2015 to 1/26/2015



SITE 8

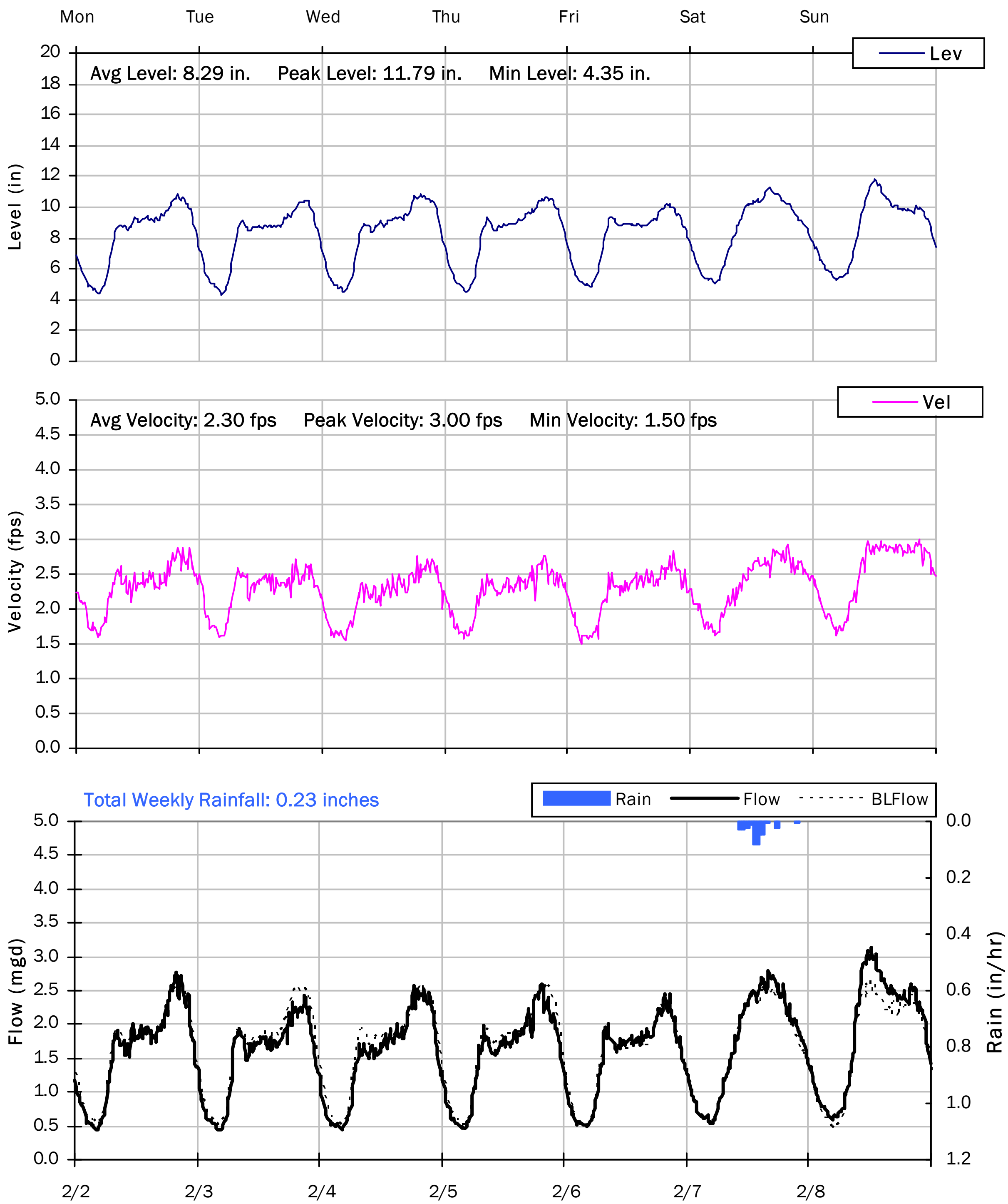
Weekly Level, Velocity and Flow Hydrographs

1/26/2015 to 2/2/2015



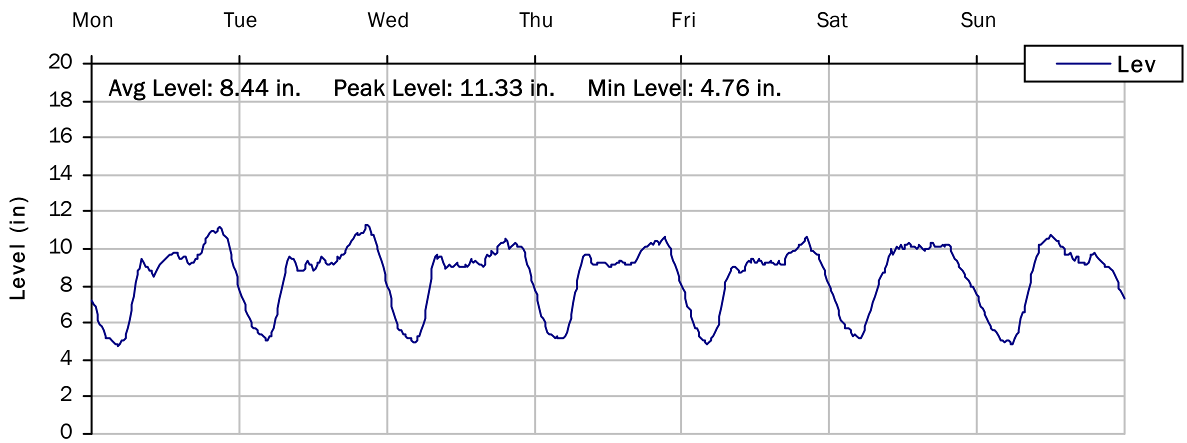
Avg Flow: 1.539 mgd Peak Flow: 2.741 mgd Min Flow: 0.401 mgd

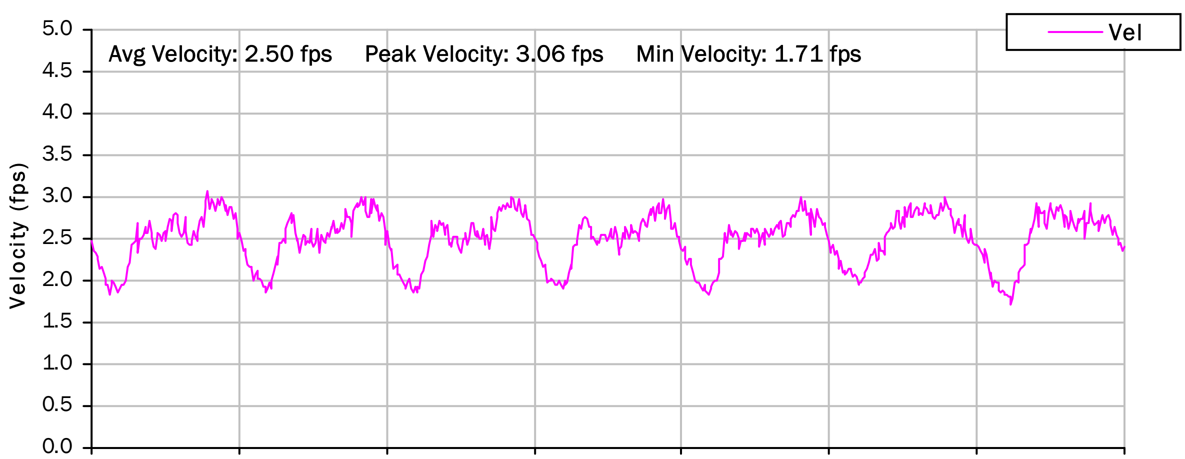
SITE 8
Weekly Level, Velocity and Flow Hydrographs
2/2/2015 to 2/9/2015

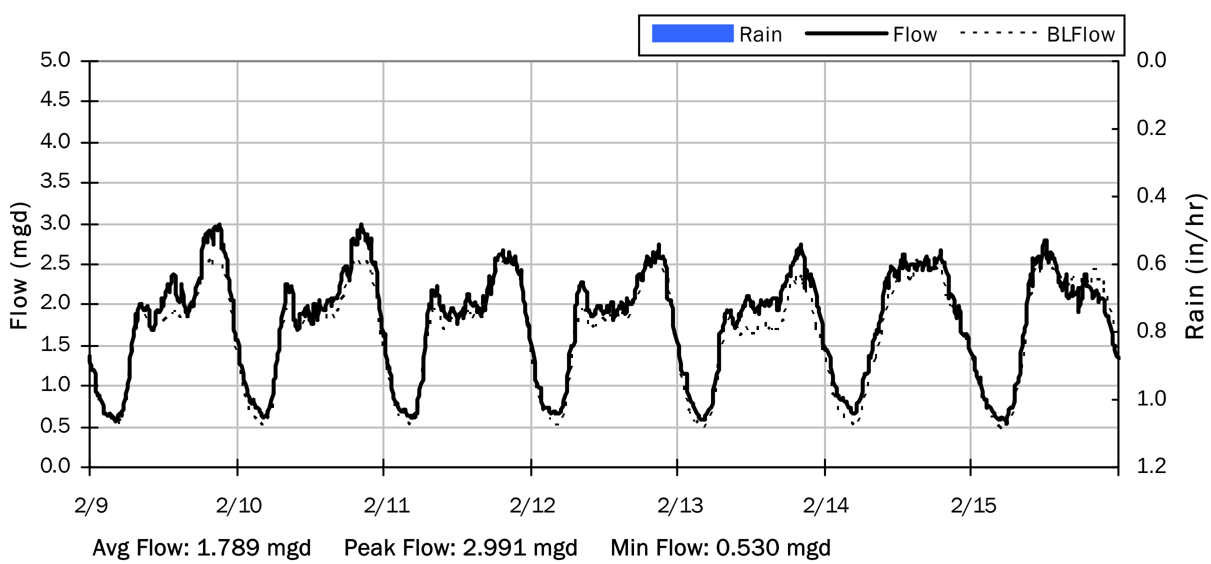


Avg Flow: 1.625 mgd Peak Flow: 3.139 mgd Min Flow: 0.432 mgd

SITE 8
Weekly Level, Velocity and Flow Hydrographs
2/9/2015 to 2/16/2015

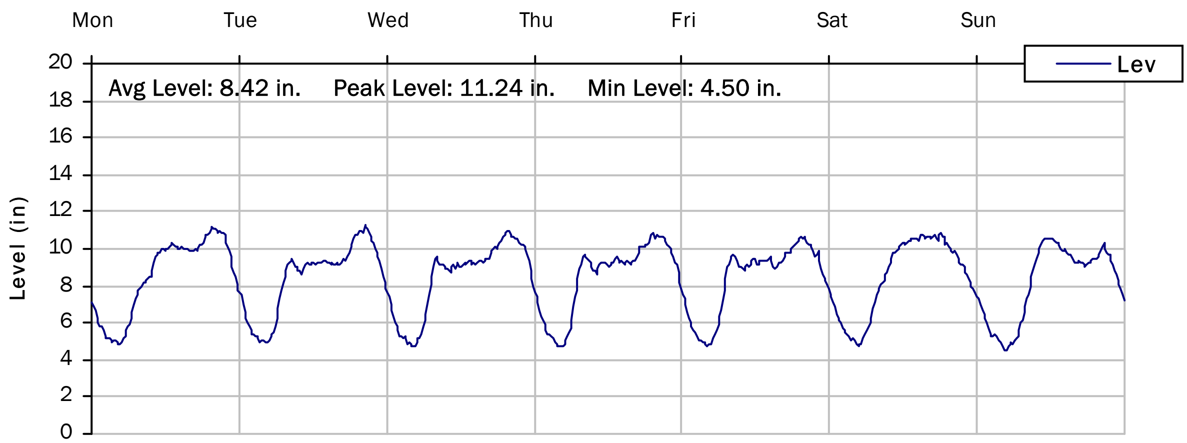


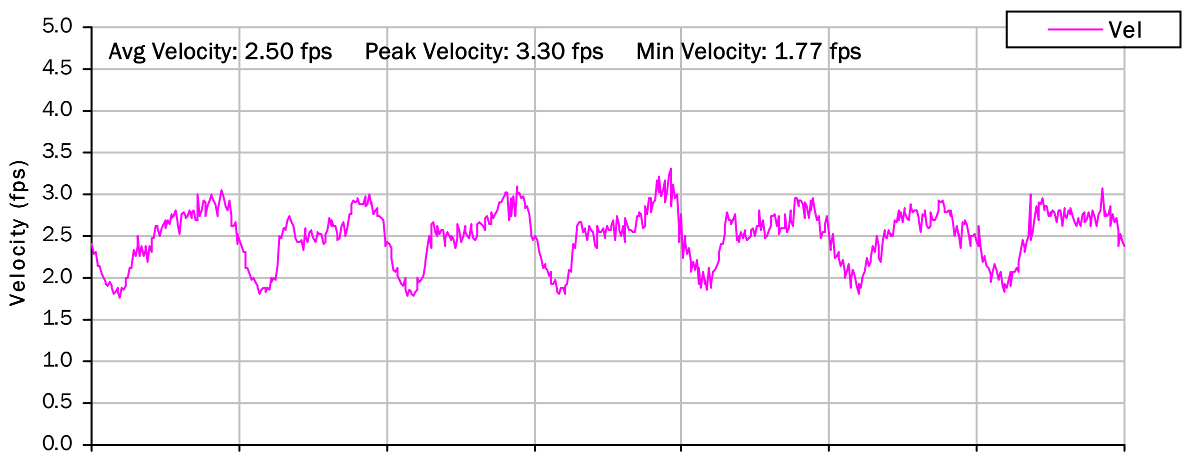


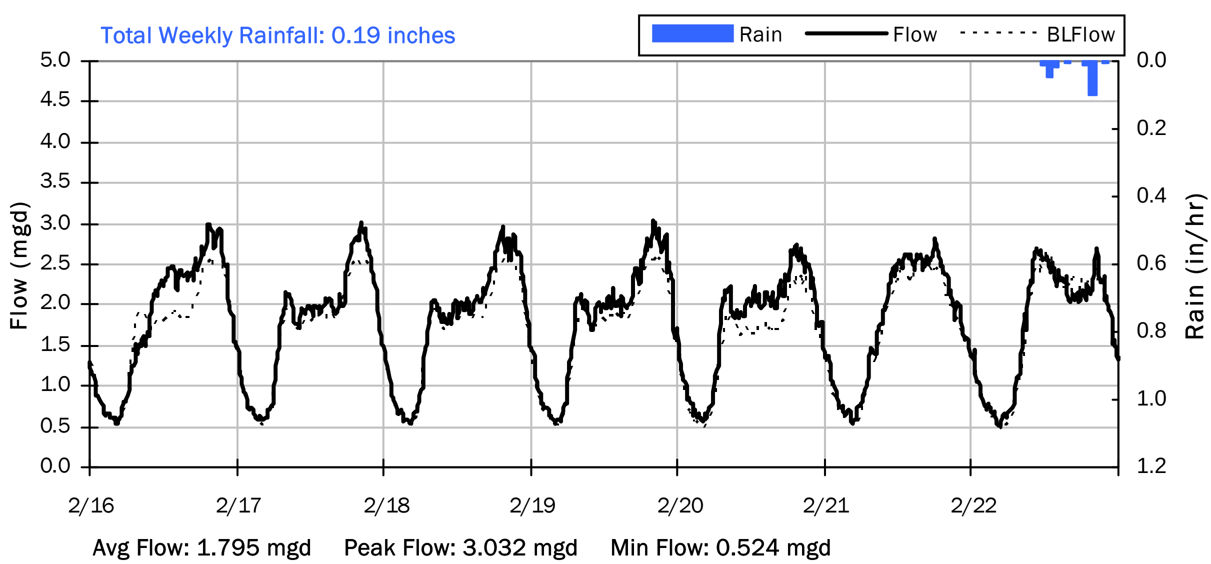


SITE 8

Weekly Level, Velocity and Flow Hydrographs
2/16/2015 to 2/23/2015



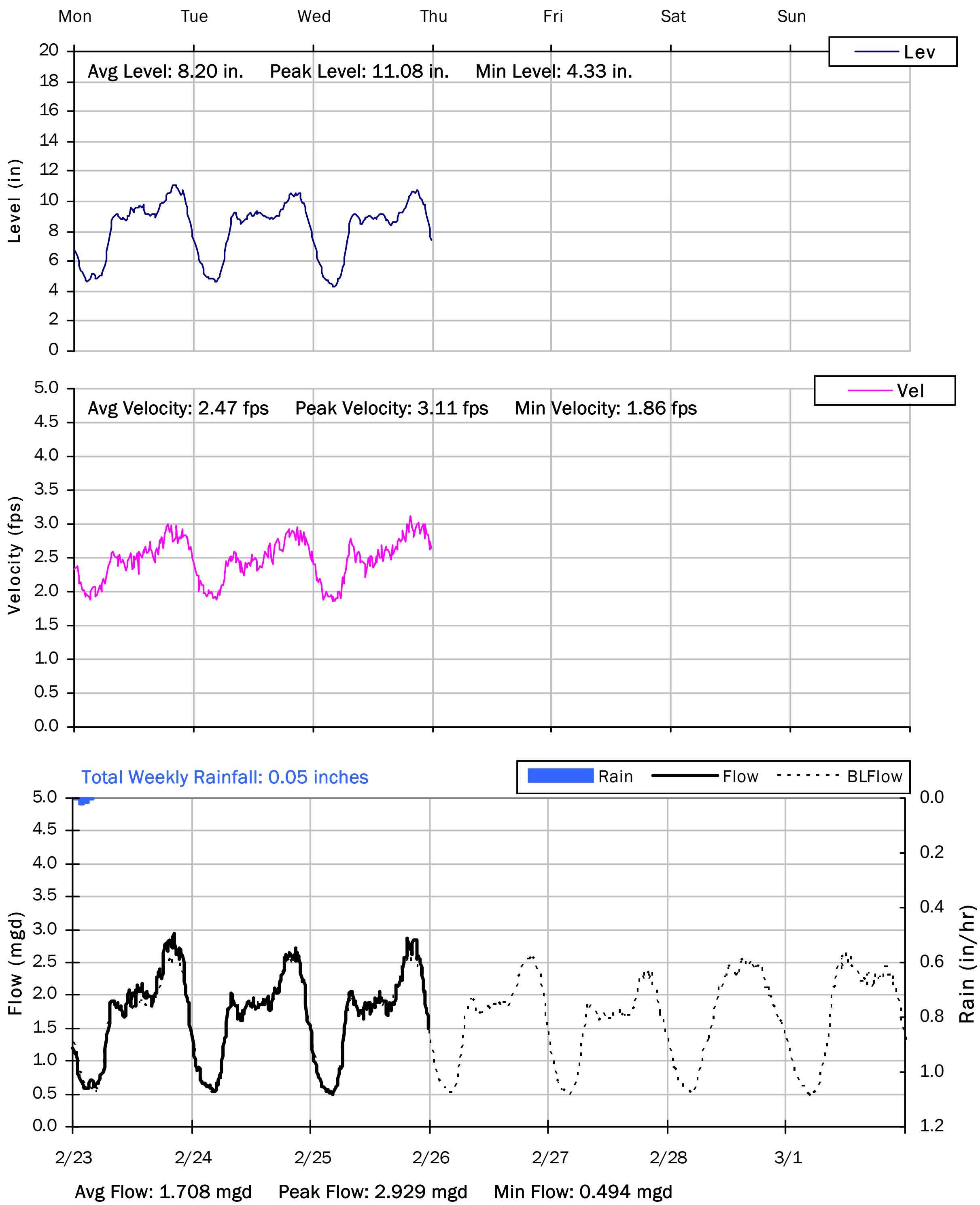




SITE 8

Weekly Level, Velocity and Flow Hydrographs

2/23/2015 to 3/2/2015



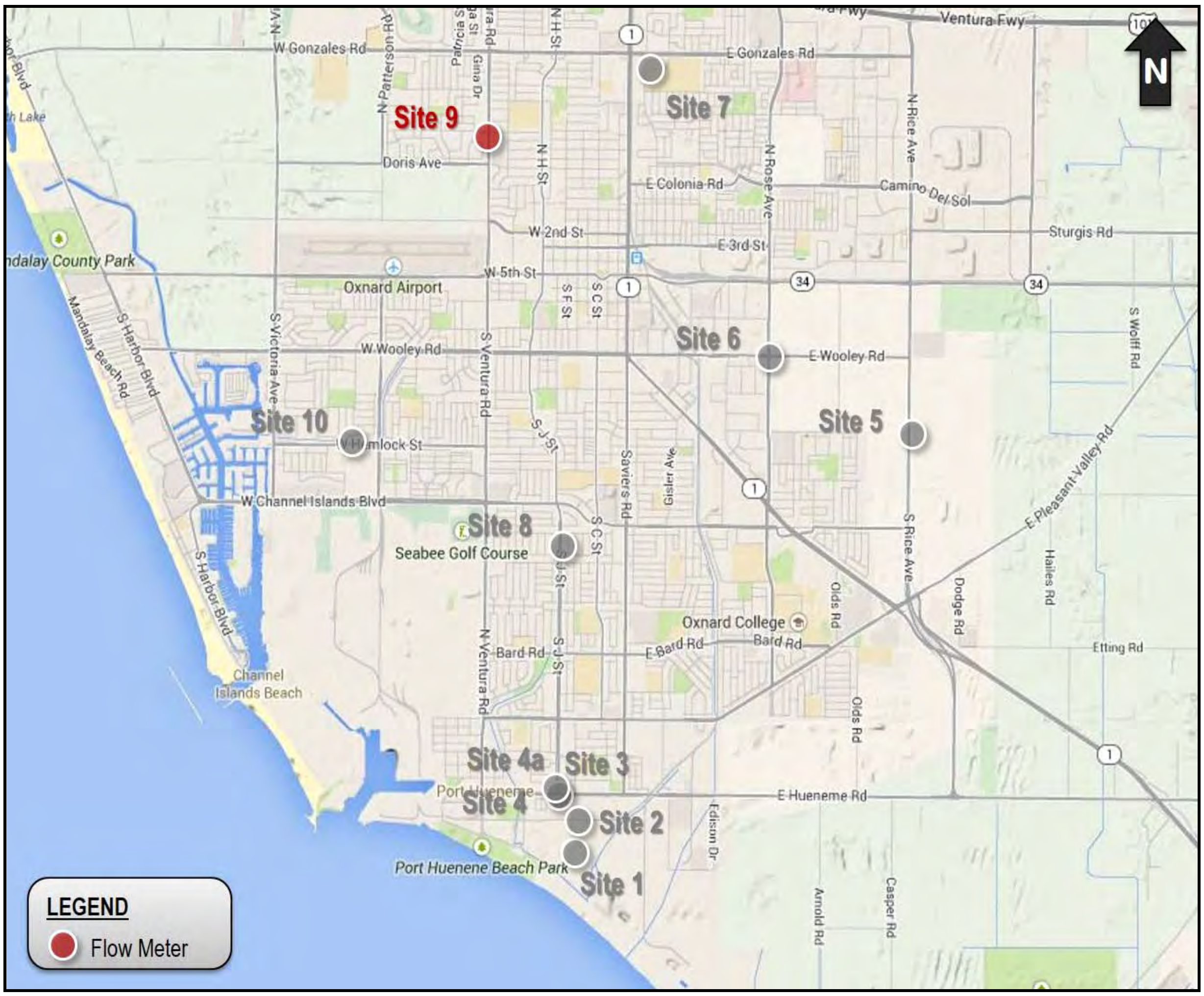
City of Oxnard

Sanitary Sewer Flow Monitoring
Temporary Monitoring: December, 2014 through February, 2015

Monitoring Site: Site 9

Location: N Ventura Road, between Devonshire Drive and Doris Avenue

Data Summary Report



Vicinity Map: Site 9

SITE 9

Site Information

Location: N Ventura Road, between Devonshire Drive and Doris Avenue

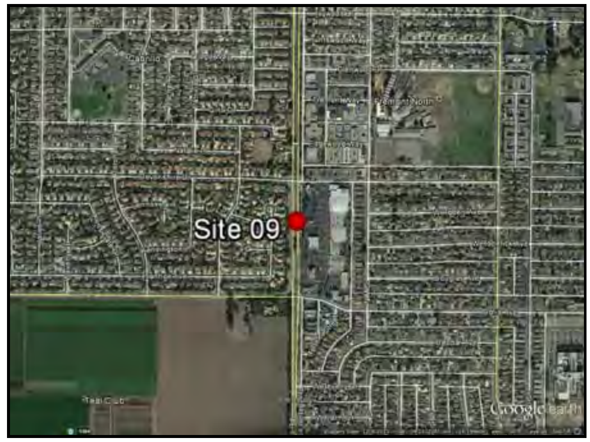
Coordinates: 119.1946° W, 34.2103° N

Rim Elevation: 54 feet

Pipe Diameter: 42 inches

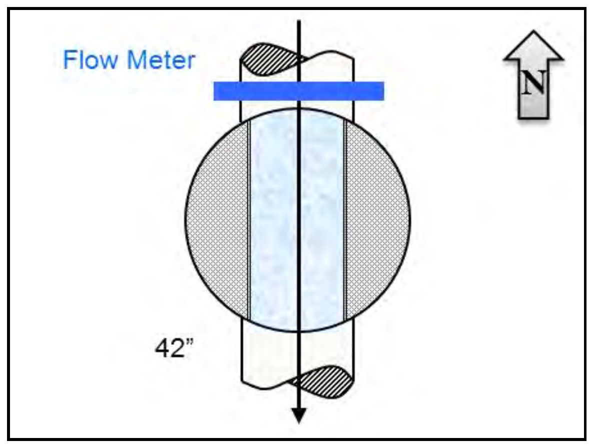
Baseline Flow: 2.306 mgd

Peak Measured Flow: 4.053 mgd



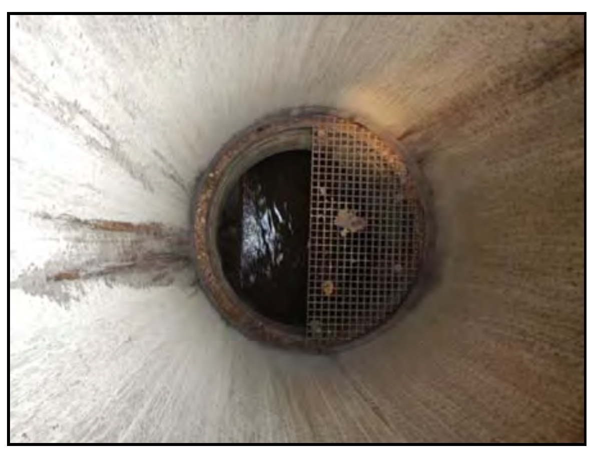
Satellite Map

Sanitary Map



Flow Diagram


Street View


Plan View

SITE 9

Additional Site Photos

Effluent Pipe

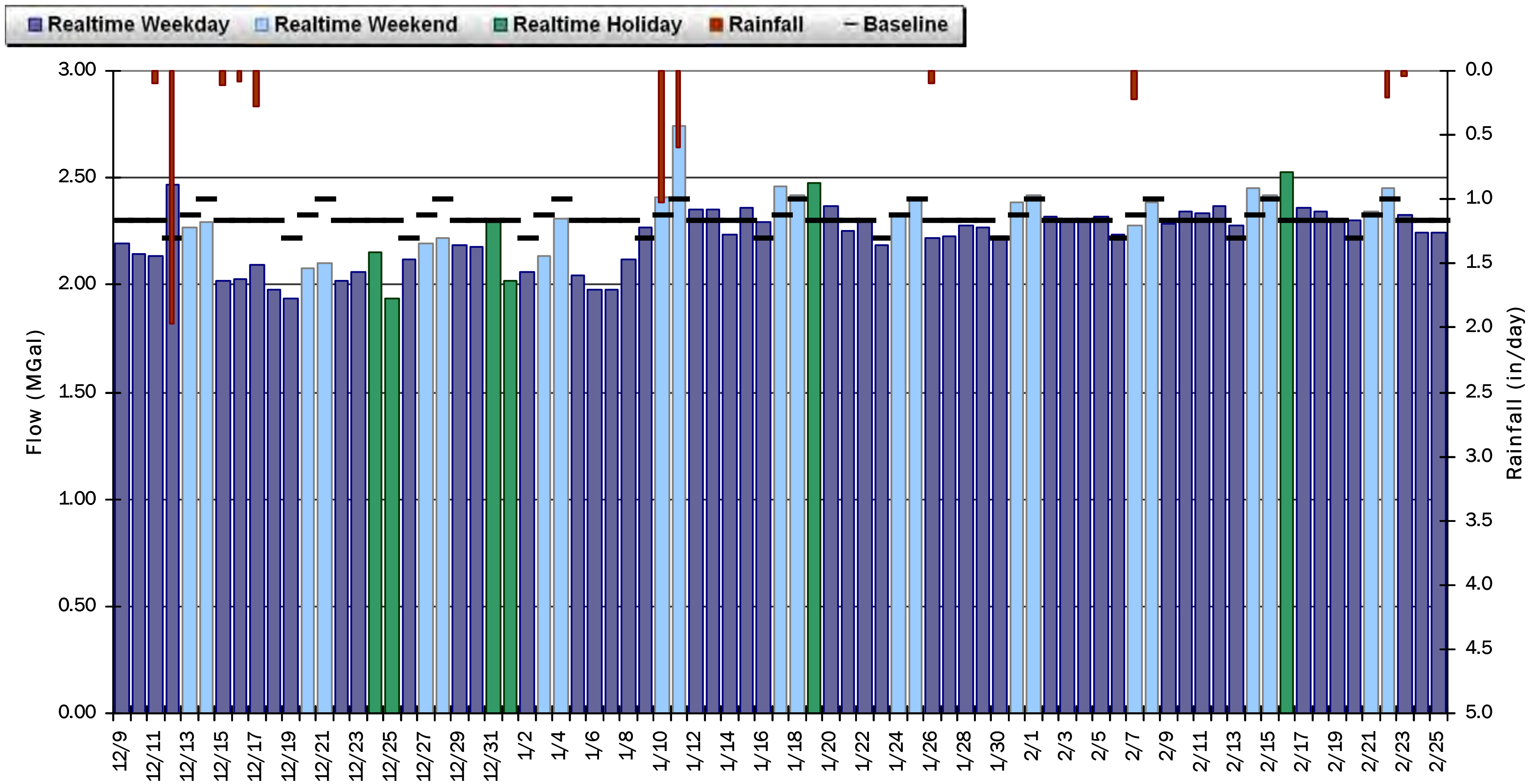
Influent Pipe

SITE 9

Period Flow Summary: Daily Flow Totals

Avg Period Flow: 2.254 MGal **Peak Daily Flow: 2.741 MGal** **Min Daily Flow: 1.934 MGal**

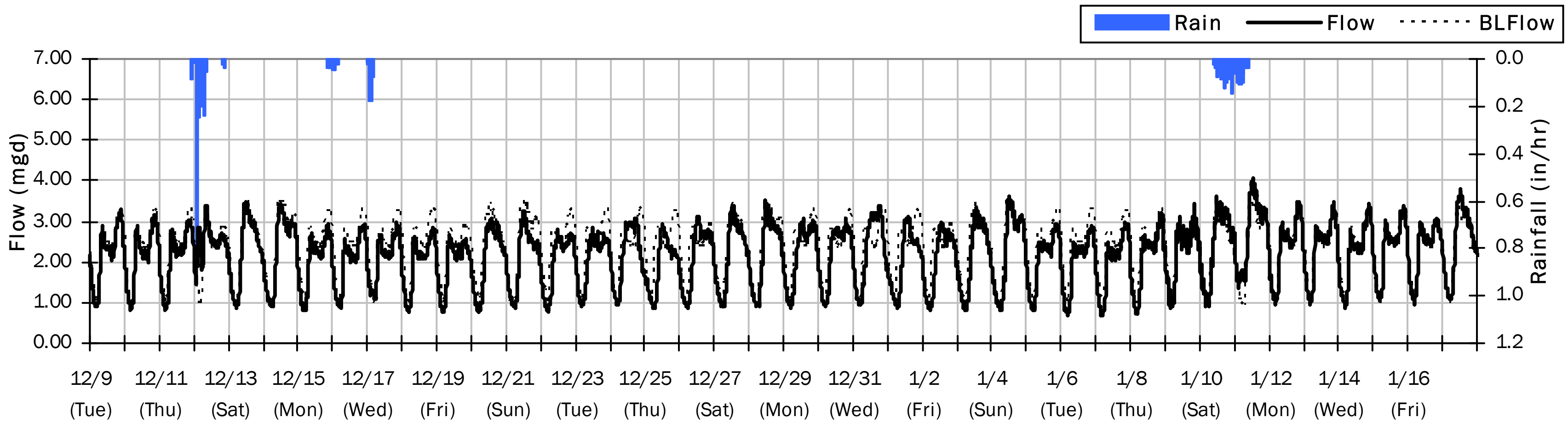
Total Period Rainfall: 4.74 inches

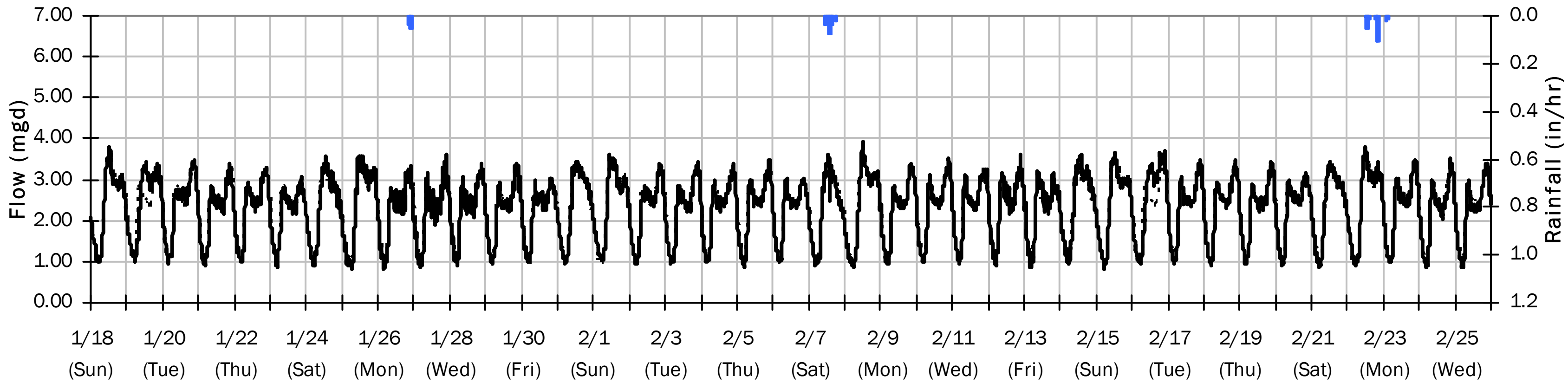


SITE 9

Flow Summary: 12/9/2014 to 2/25/2015

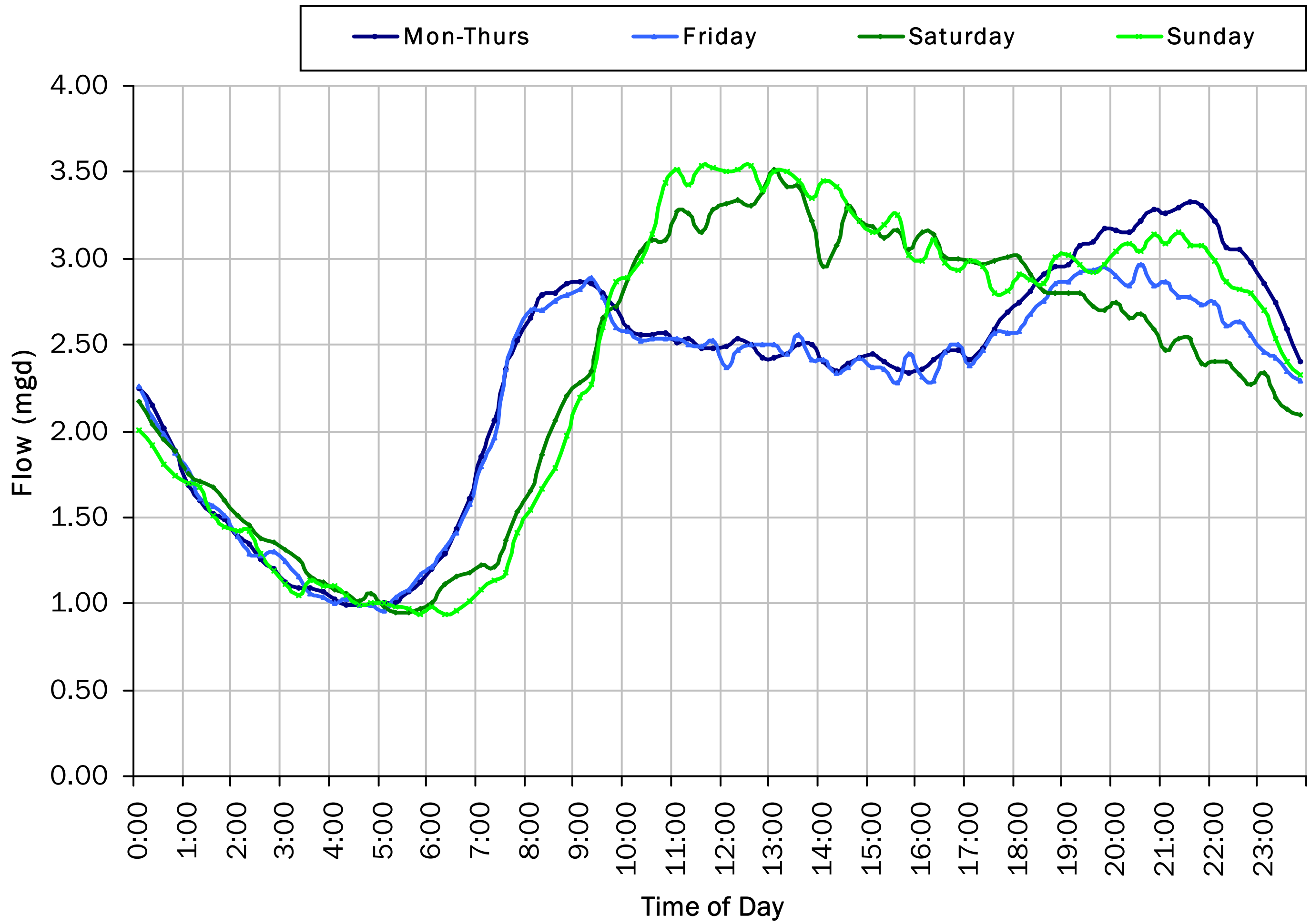
Total Period Rainfall: 4.74 inches   Avg Flow: 2.254 mgd   Peak Flow: 4.053 mgd   Min Flow: 0.677 mgd





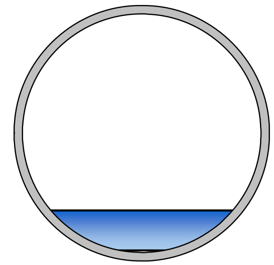
SITE 9

Baseline Flow Hydrographs



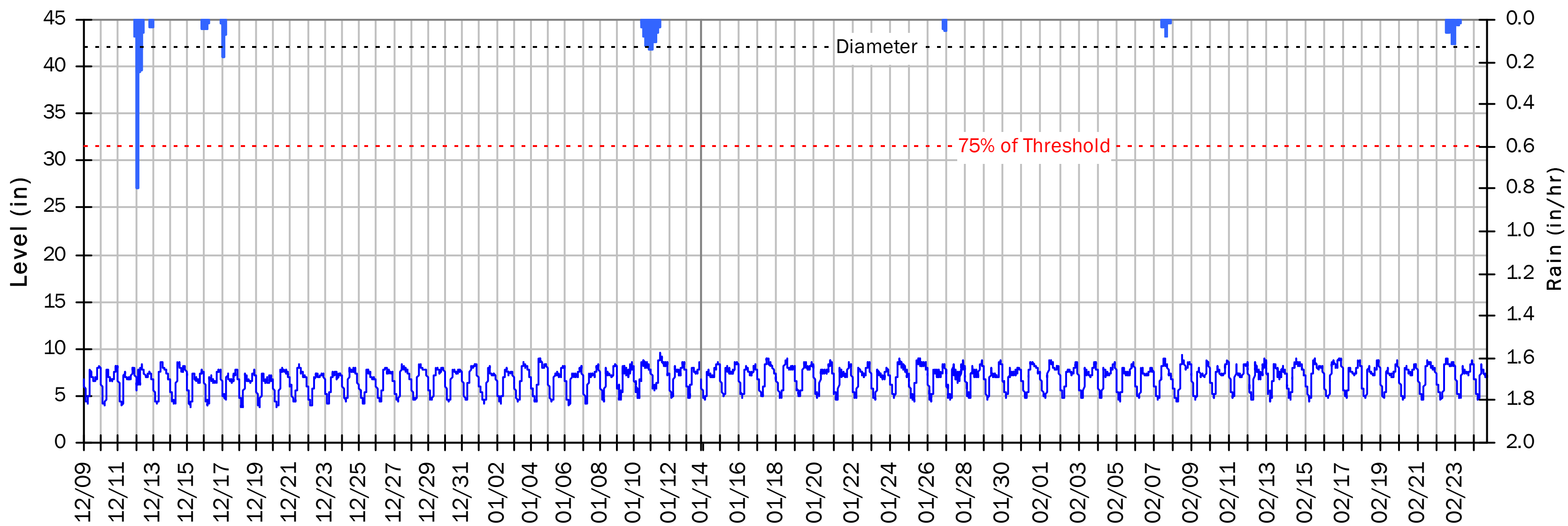
Baseline Flow:

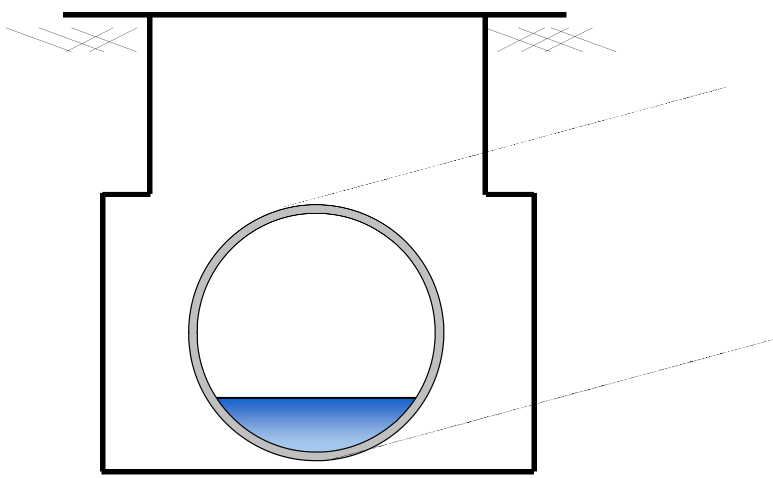
2.31 *mgd*



SITE 9
Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Monitoring Period





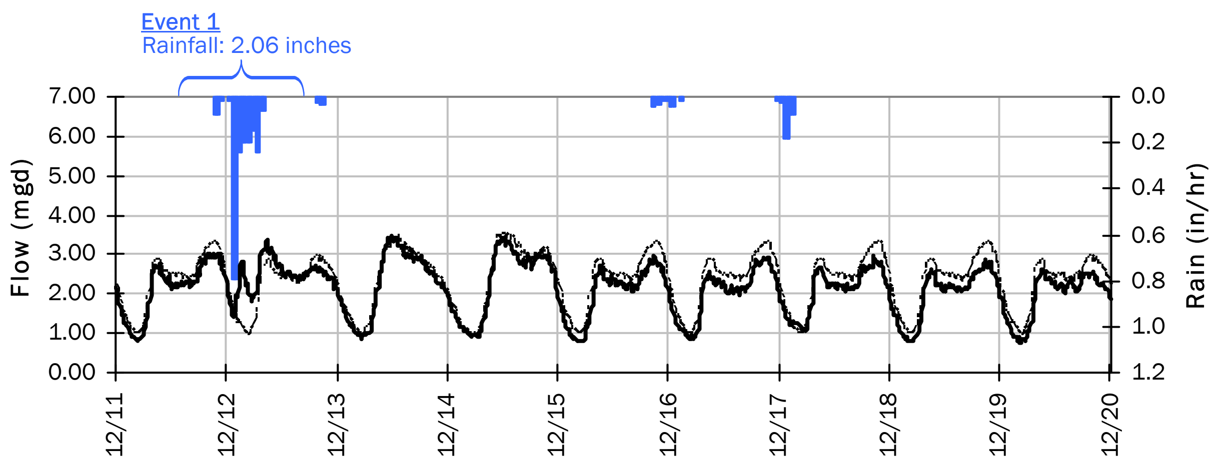
Pipe Diameter: 42 *inches*

Peak Measured Level: 9.48 *inches*

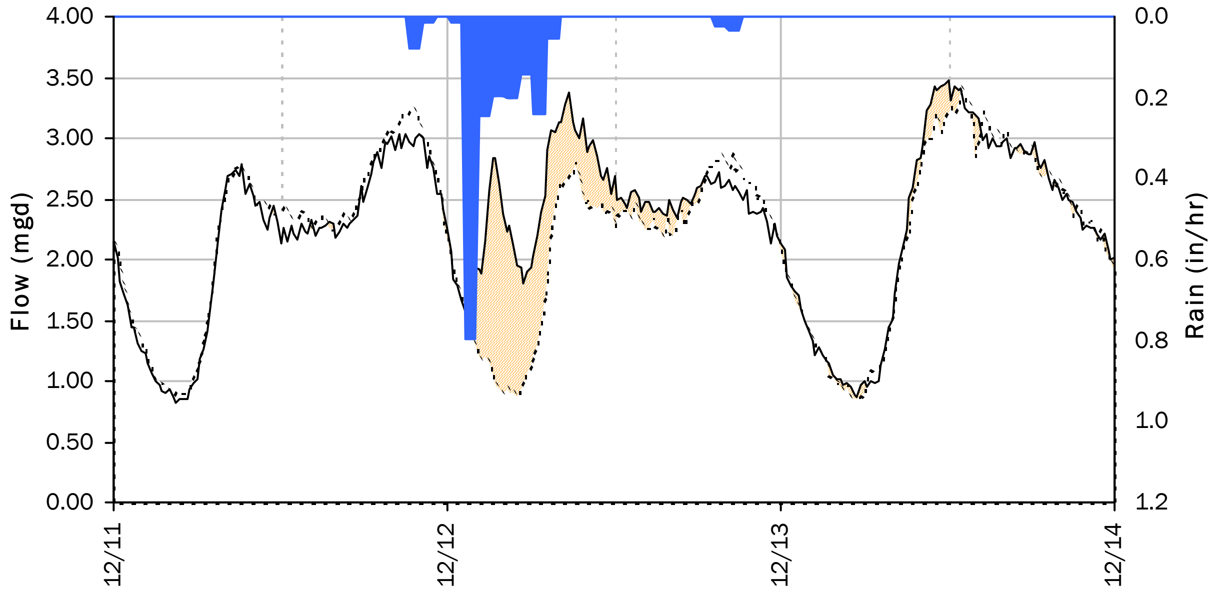
Peak d/D Ratio: 0.23

SITE 9
I/I Summary: Event 1

Baseline and Realtime Flows with Rainfall Data over Monitoring Period



Event 1 Detail Graph

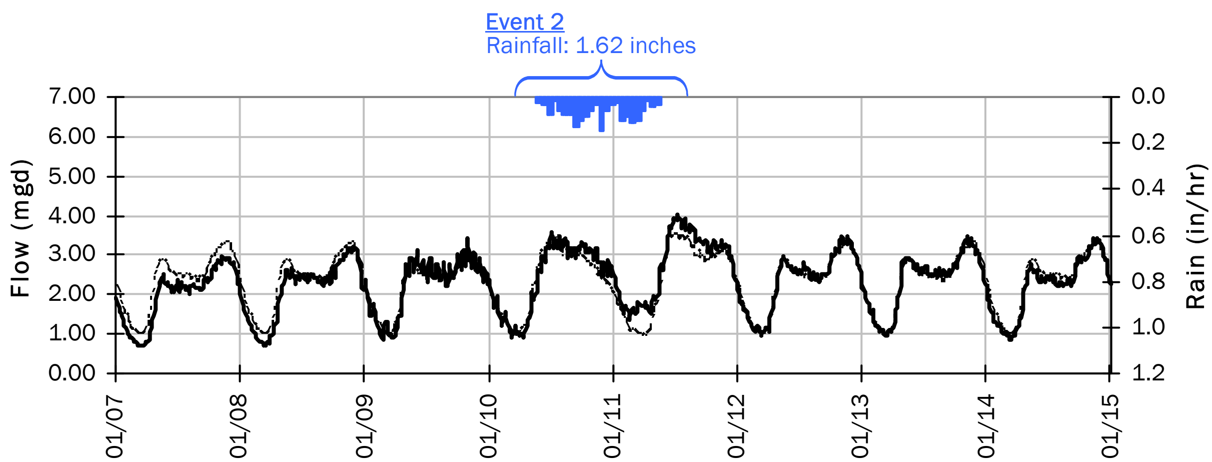


Storm Event I/I Analysis (Rain = 2.06 inches)

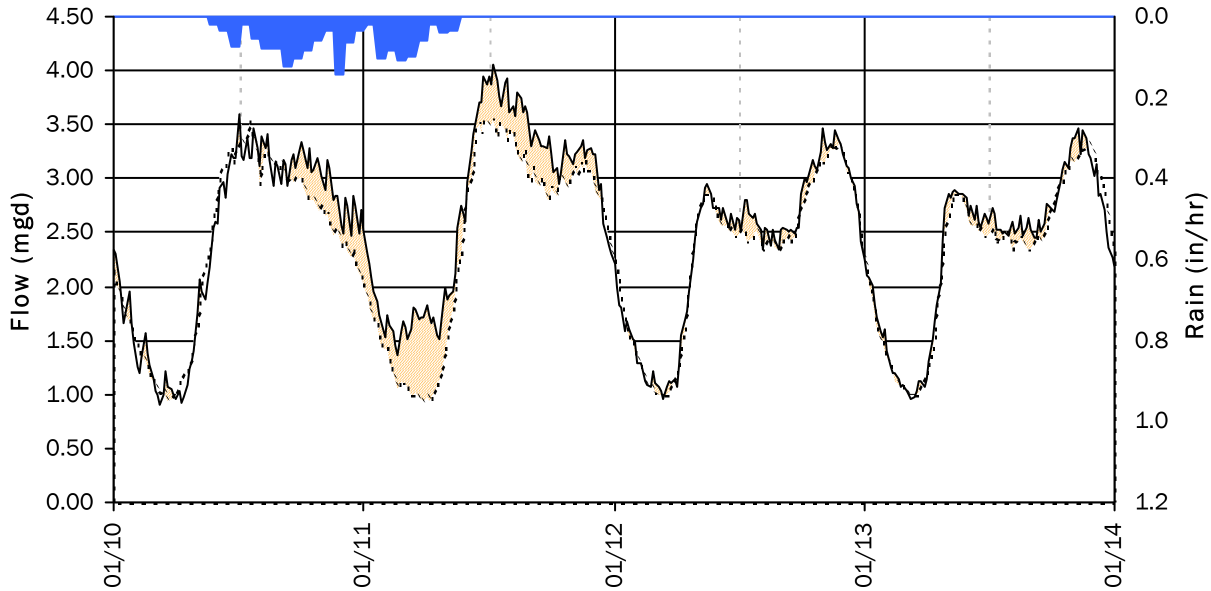
Capacity		Inflow / Infiltration	
Peak Flow:	3.47 *mgd*	Peak I/I Rate:	1.88 *mgd*
PF:	1.50	Total I/I:	386,000 *gallons*
Peak Level:	8.59 *in*		
d/D Ratio:	0.20		

SITE 9
I/I Summary: Event 2

Baseline and Realtime Flows with Rainfall Data over Monitoring Period



Event 2 Detail Graph



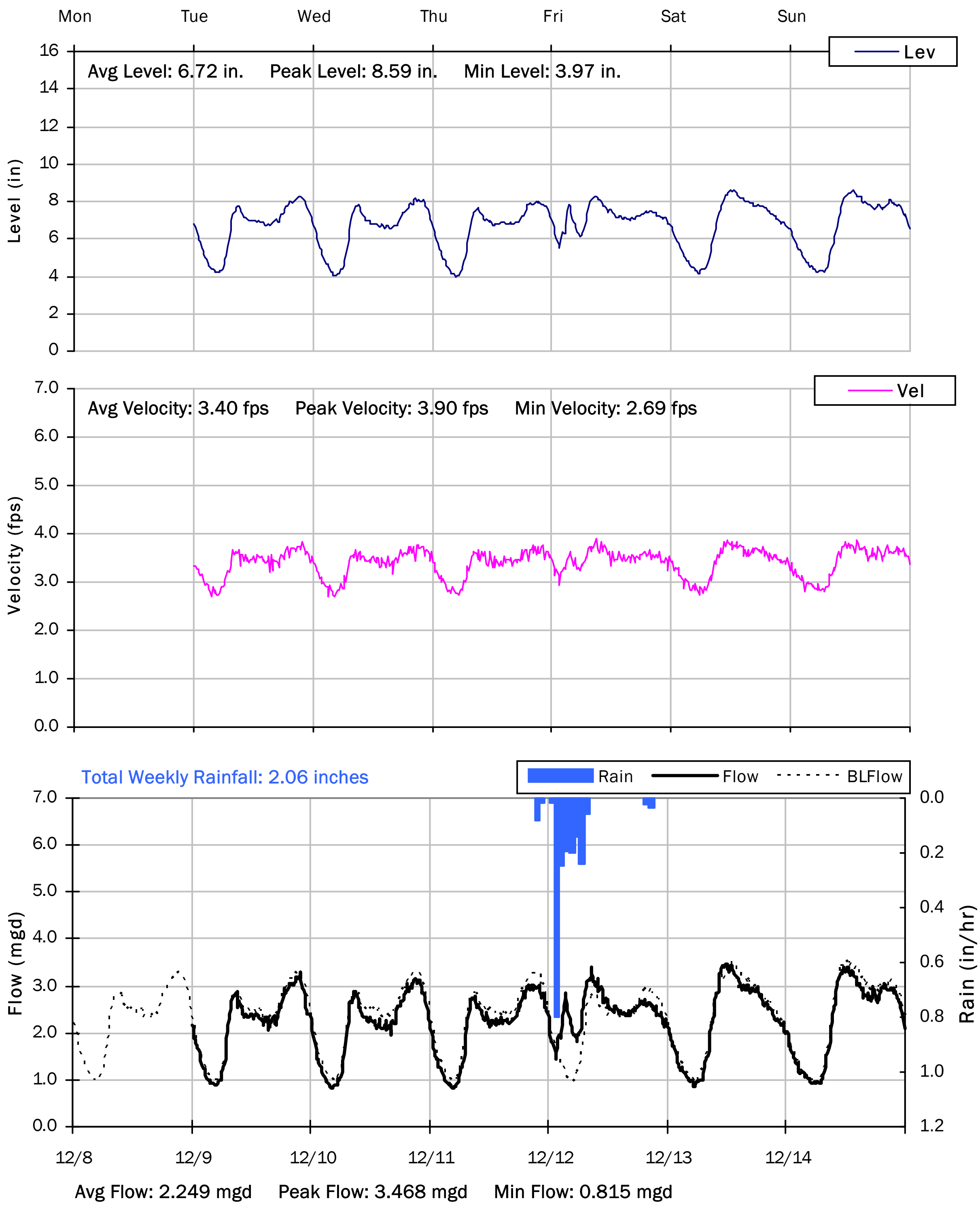
Storm Event I/I Analysis (Rain = 1.62 inches)

Capacity		Inflow / Infiltration	
Peak Flow:	4.05 *mgd*	Peak I/I Rate:	0.84 *mgd*
PF:	1.76	Total I/I:	475,000 *gallons*
Peak Level:	9.48 *in*		
d/D Ratio:	0.23		

SITE 9

Weekly Level, Velocity and Flow Hydrographs

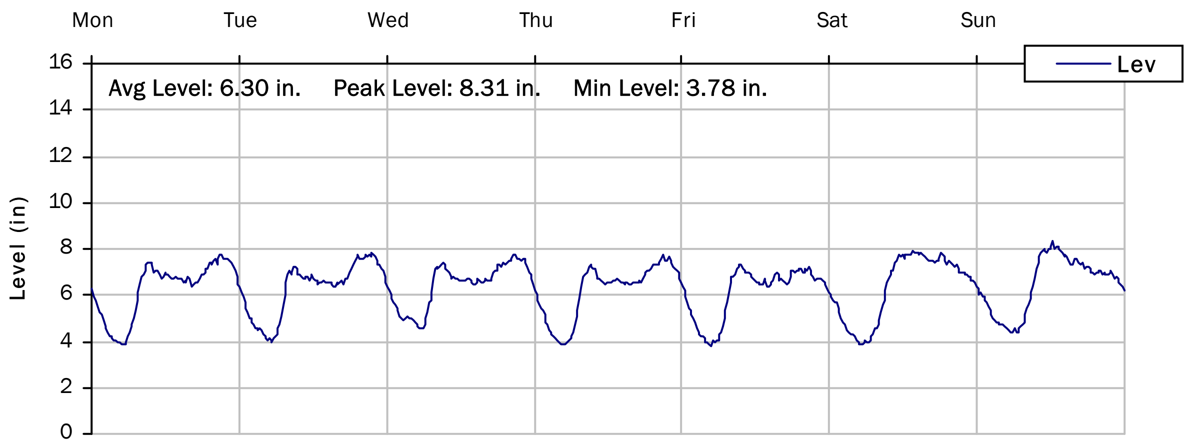
12/8/2014 to 12/15/2014

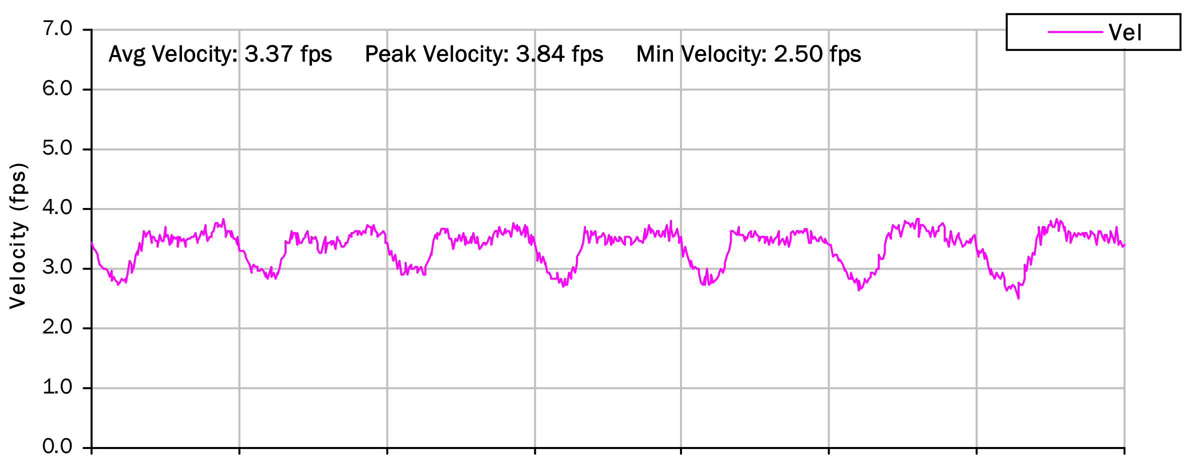


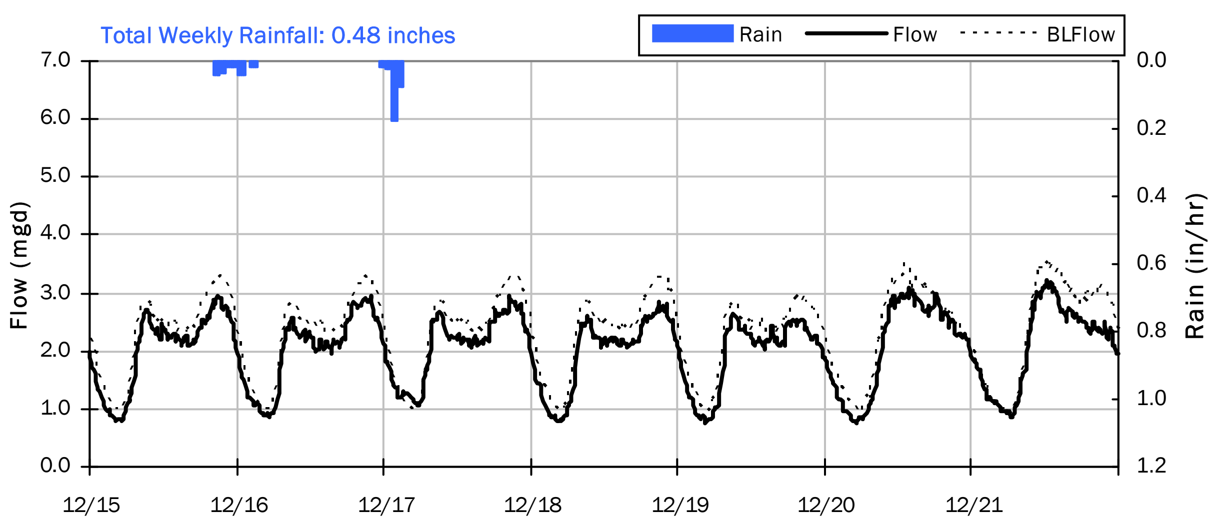
SITE 9

Weekly Level, Velocity and Flow Hydrographs

12/15/2014 to 12/22/2014





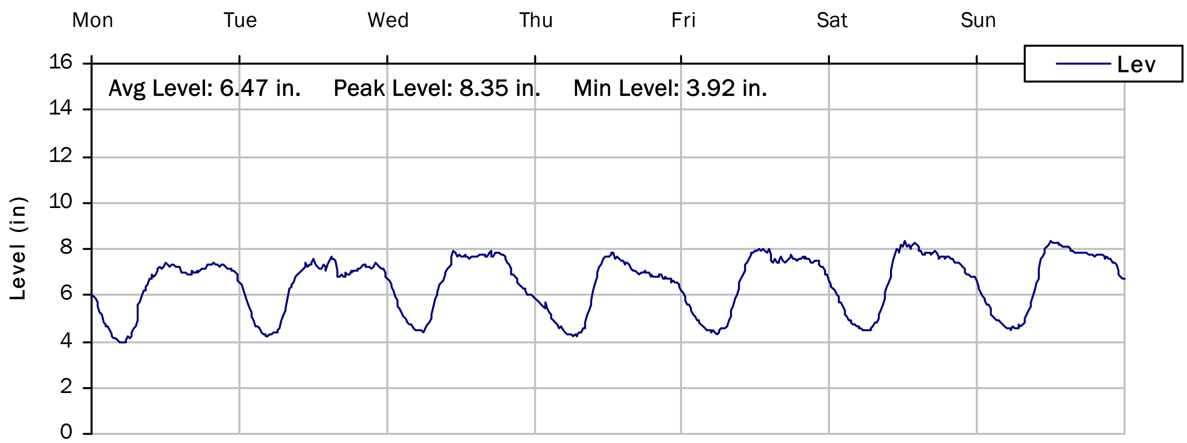


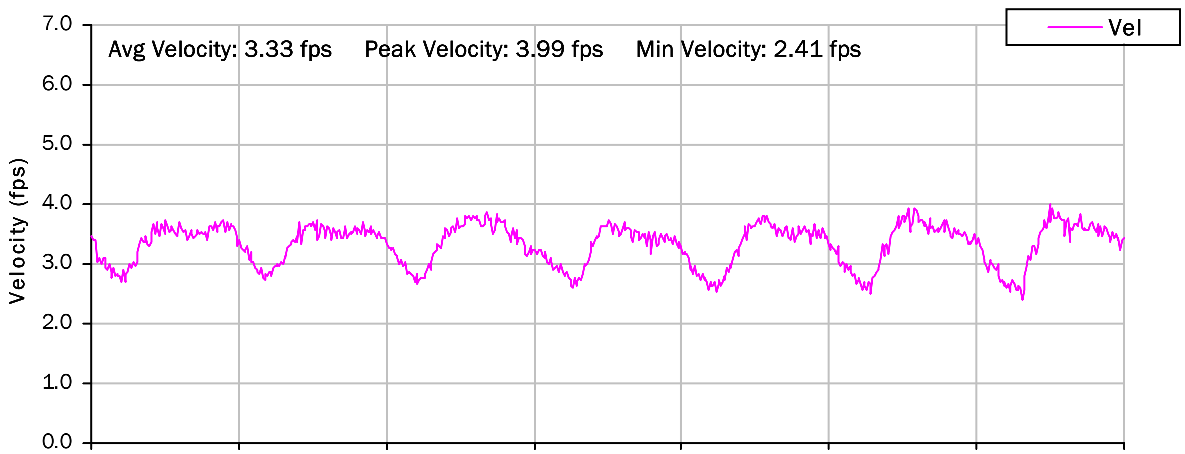
Avg Flow: 2.035 mgd   Peak Flow: 3.230 mgd   Min Flow: 0.758 mgd

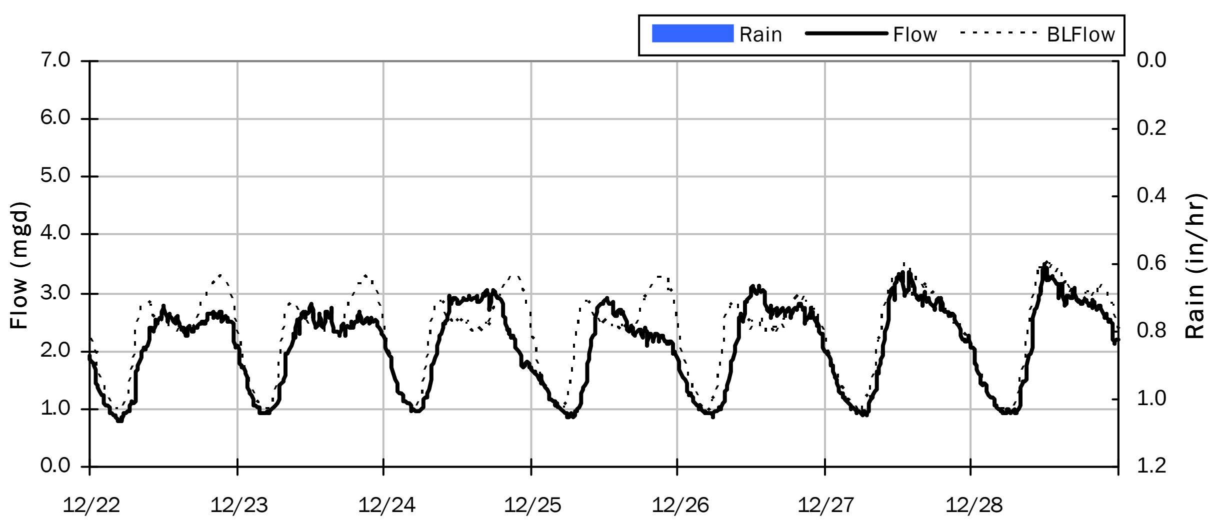
SITE 9

Weekly Level, Velocity and Flow Hydrographs

12/22/2014 to 12/29/2014

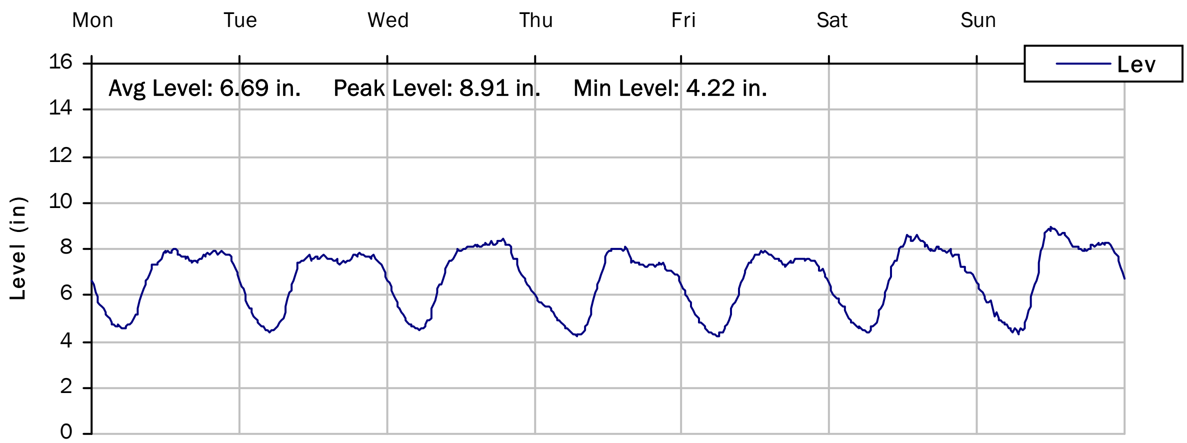


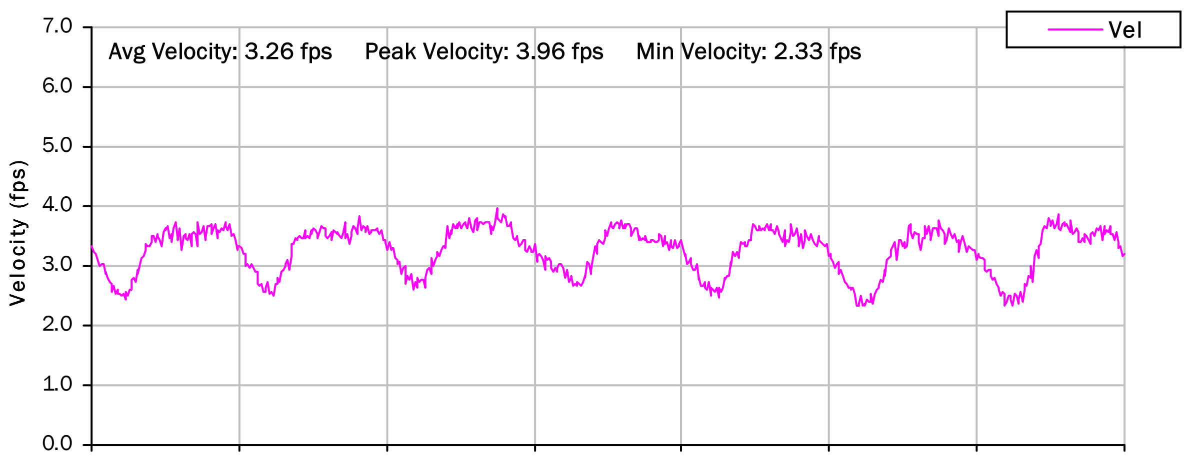


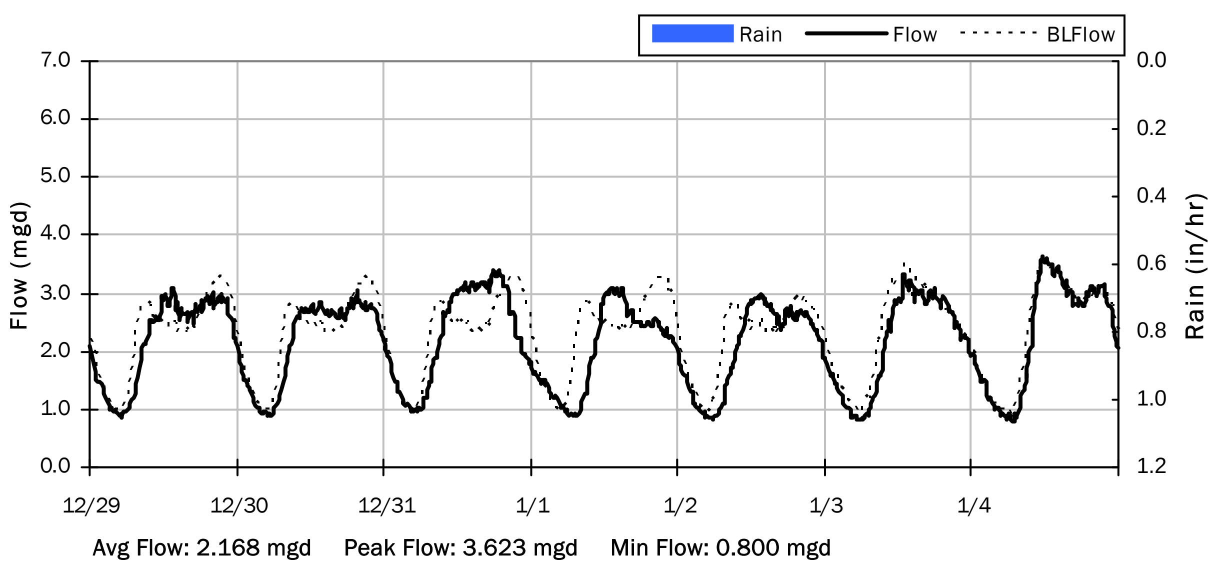


Avg Flow: 2.100 mgd Peak Flow: 3.504 mgd Min Flow: 0.790 mgd

SITE 9
Weekly Level, Velocity and Flow Hydrographs
12/29/2014 to 1/5/2015



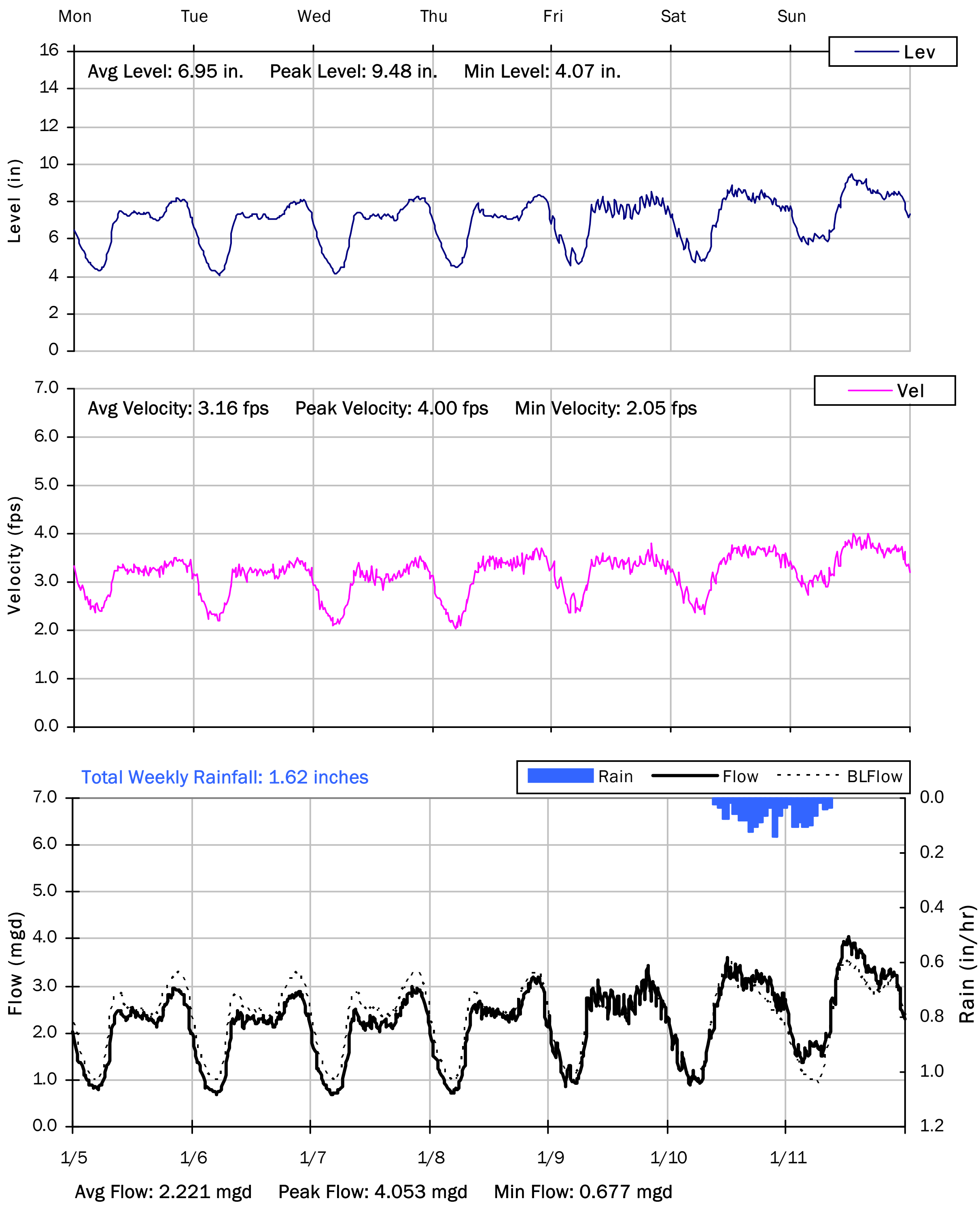




SITE 9

Weekly Level, Velocity and Flow Hydrographs

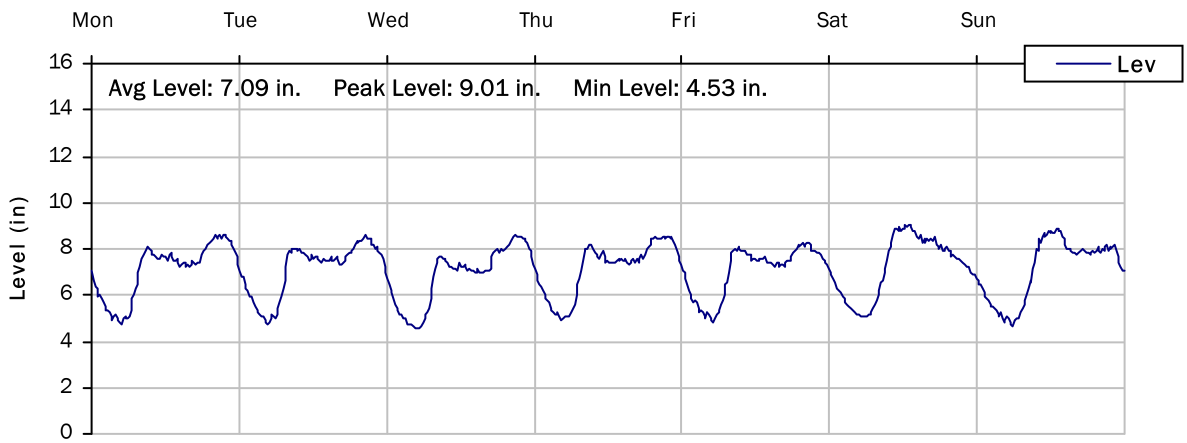
1/5/2015 to 1/12/2015

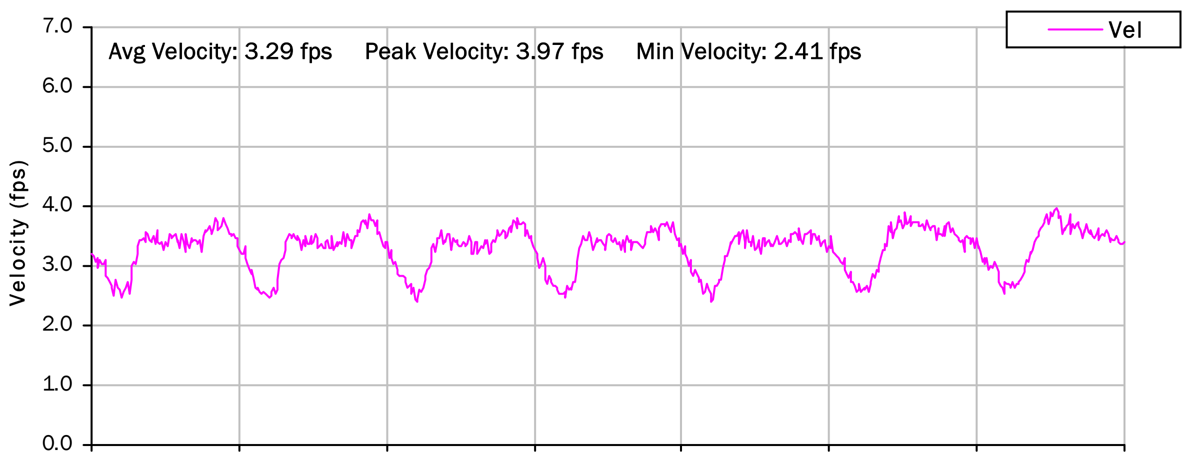


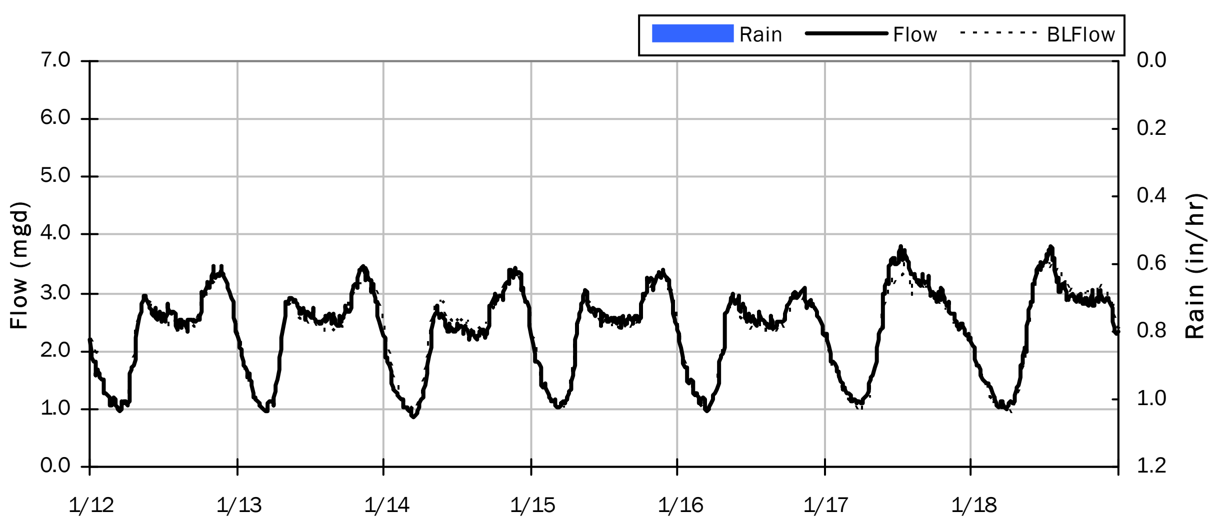
SITE 9

Weekly Level, Velocity and Flow Hydrographs

1/12/2015 to 1/19/2015

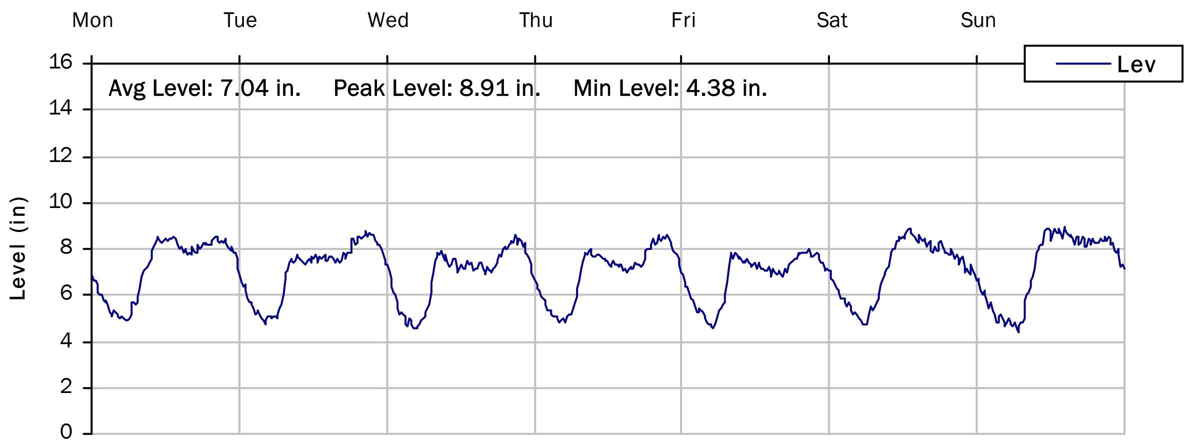


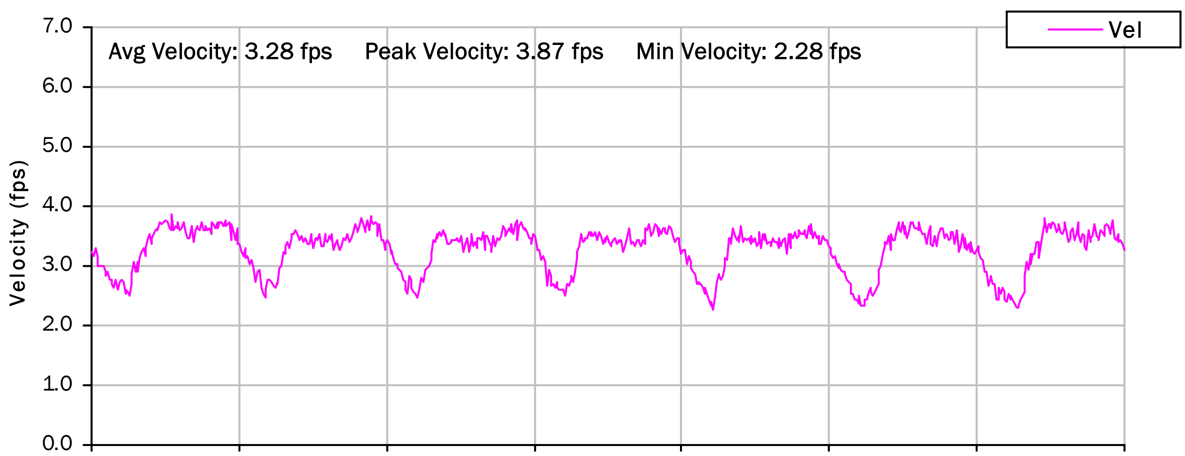


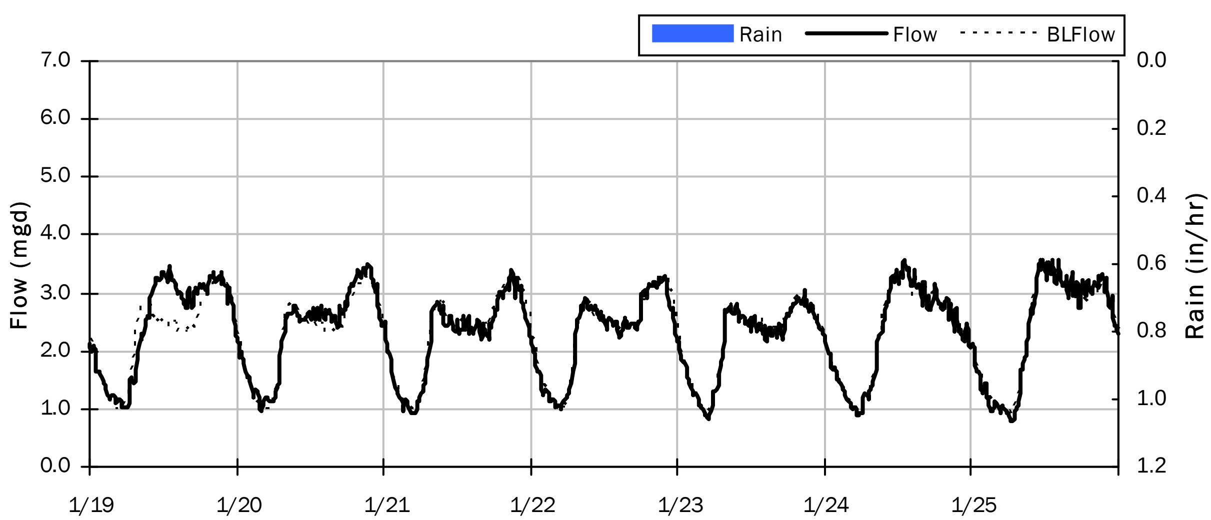


Avg Flow: 2.354 mgd   Peak Flow: 3.807 mgd   Min Flow: 0.871 mgd

SITE 9
Weekly Level, Velocity and Flow Hydrographs
1/19/2015 to 1/26/2015





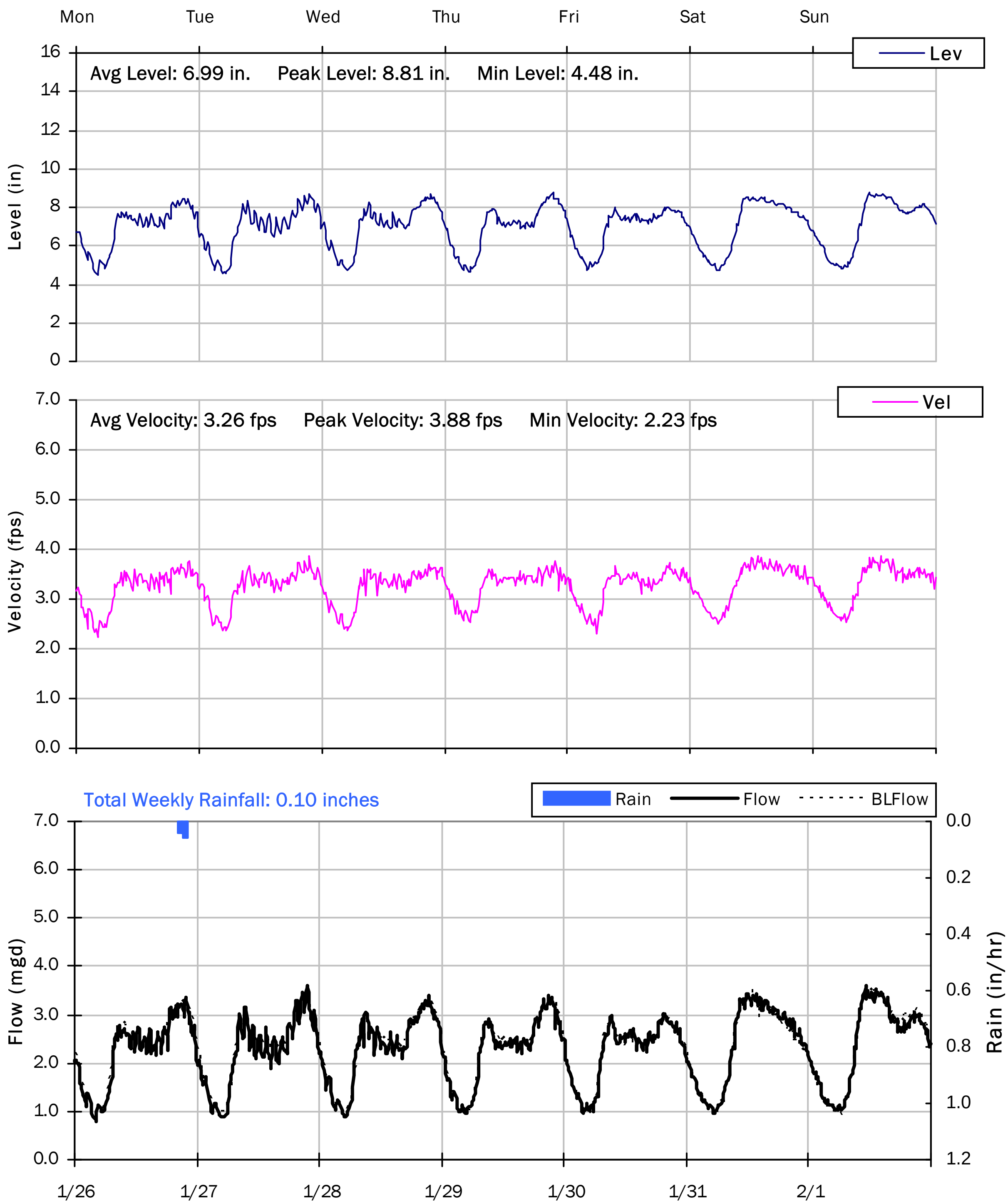


Avg Flow: 2.330 mgd   Peak Flow: 3.566 mgd   Min Flow: 0.792 mgd

SITE 9

Weekly Level, Velocity and Flow Hydrographs

1/26/2015 to 2/2/2015

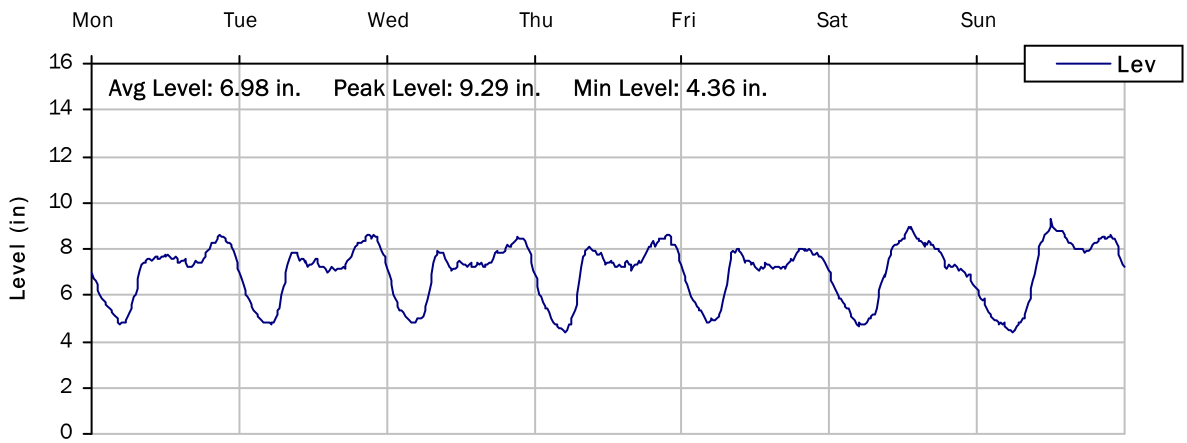


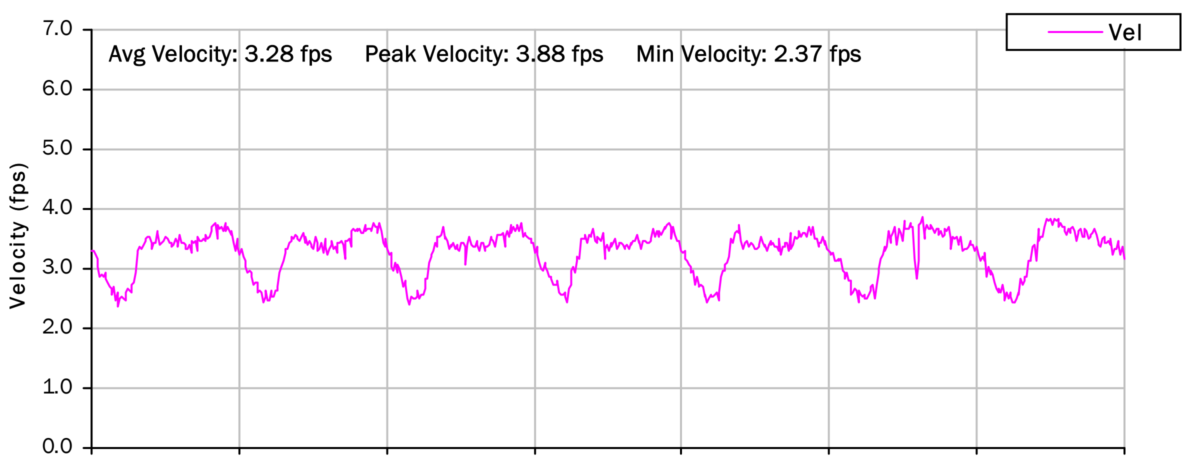
Avg Flow: 2.289 mgd Peak Flow: 3.598 mgd Min Flow: 0.793 mgd

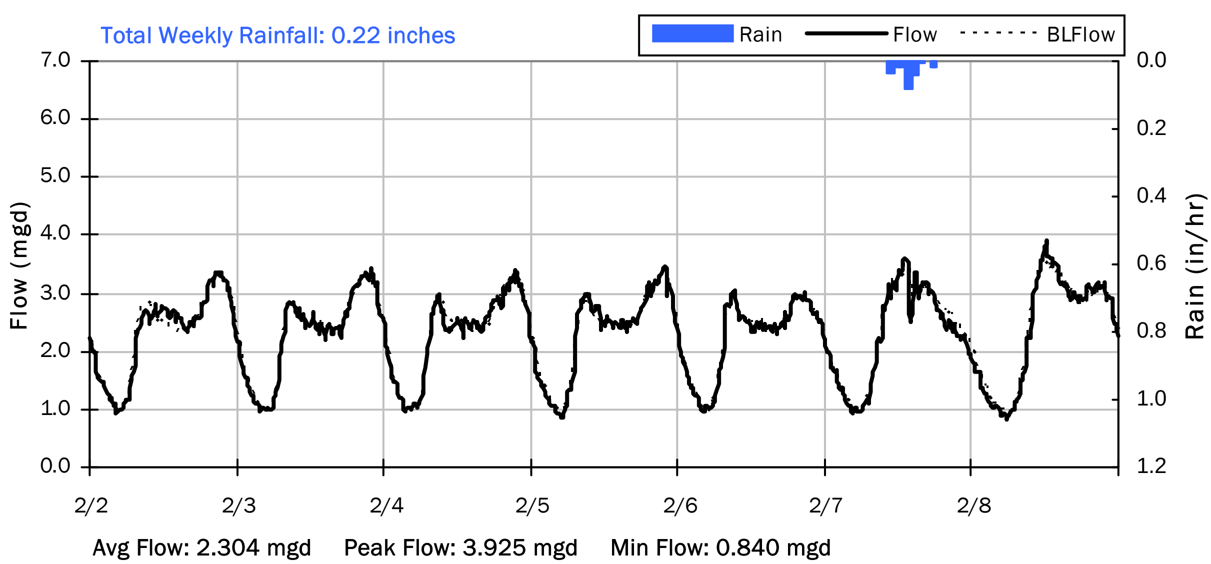
SITE 9

Weekly Level, Velocity and Flow Hydrographs

2/2/2015 to 2/9/2015

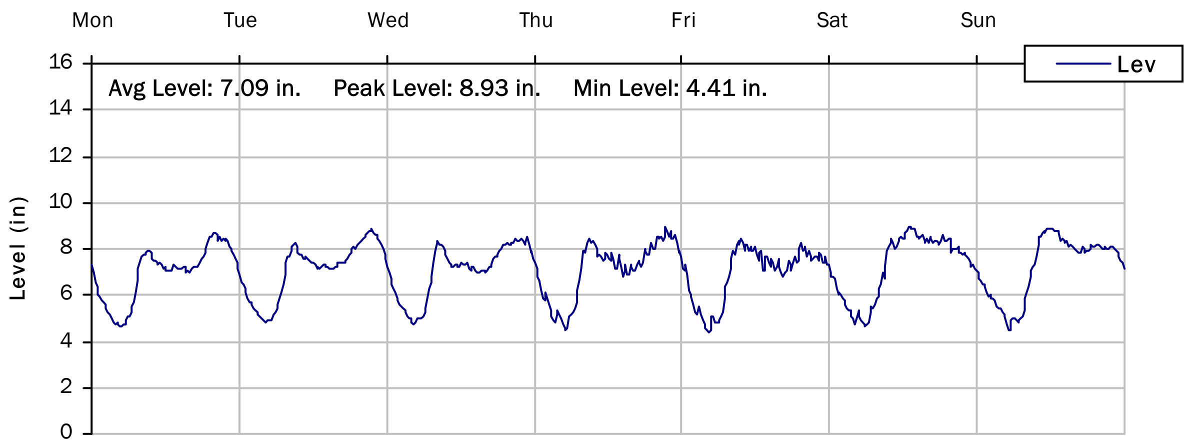


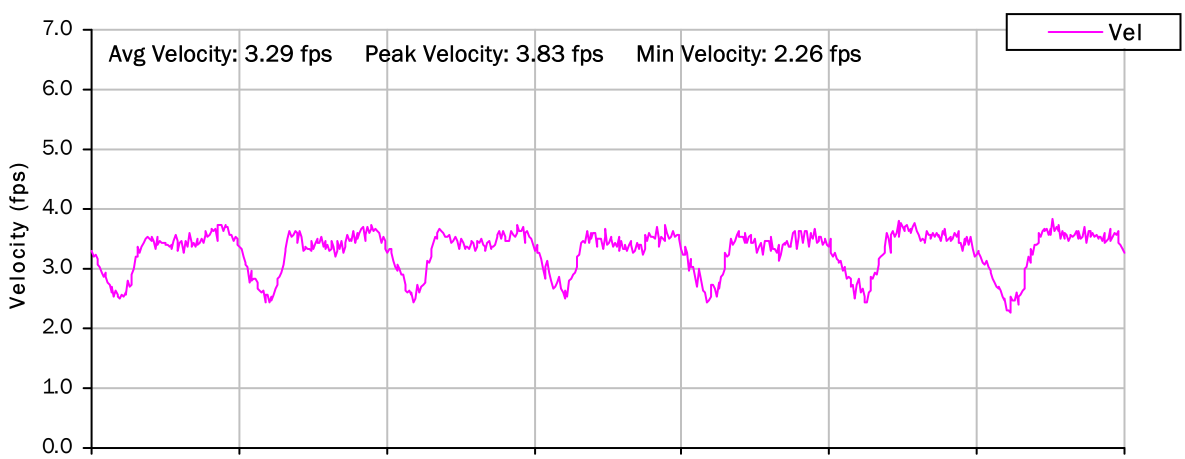


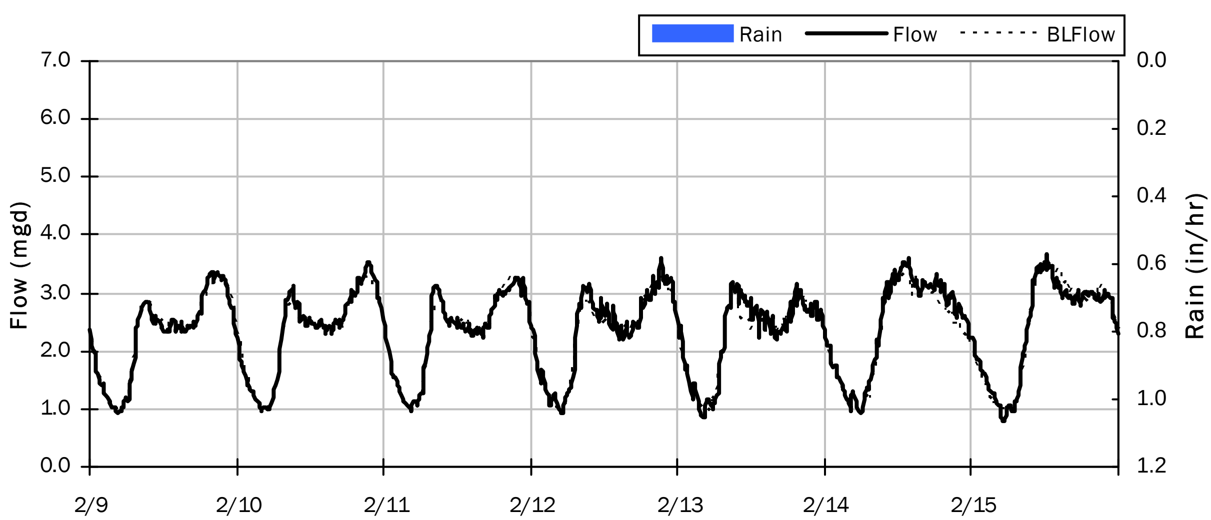


SITE 9

Weekly Level, Velocity and Flow Hydrographs
2/9/2015 to 2/16/2015

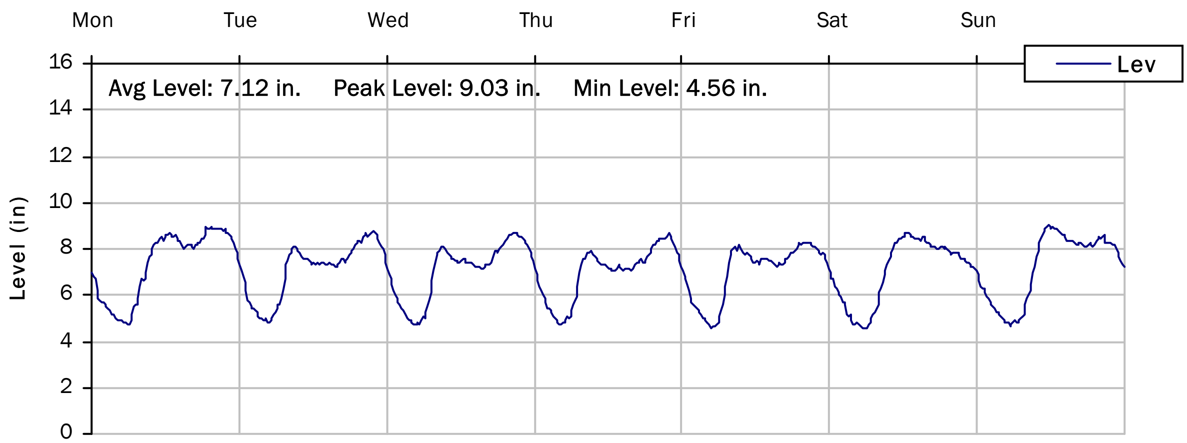


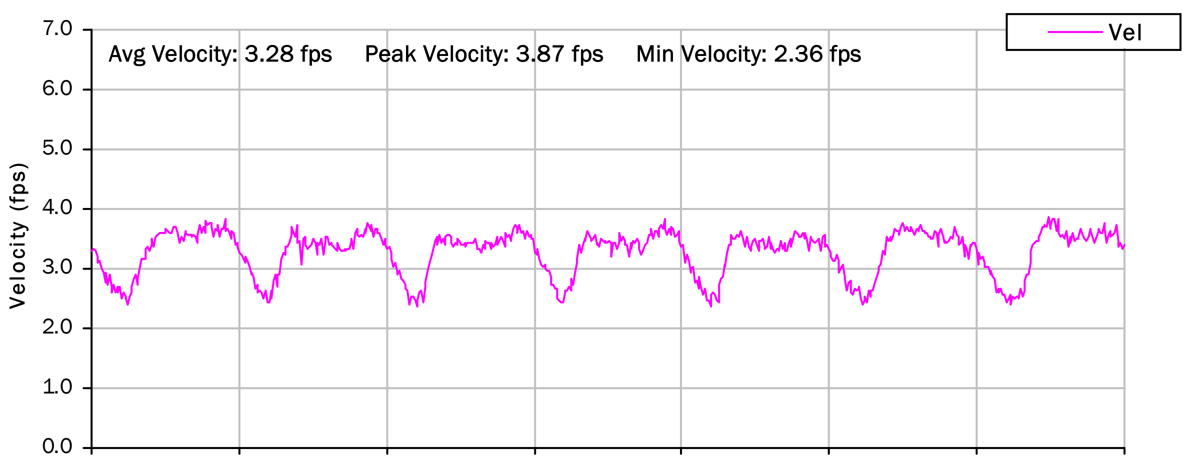


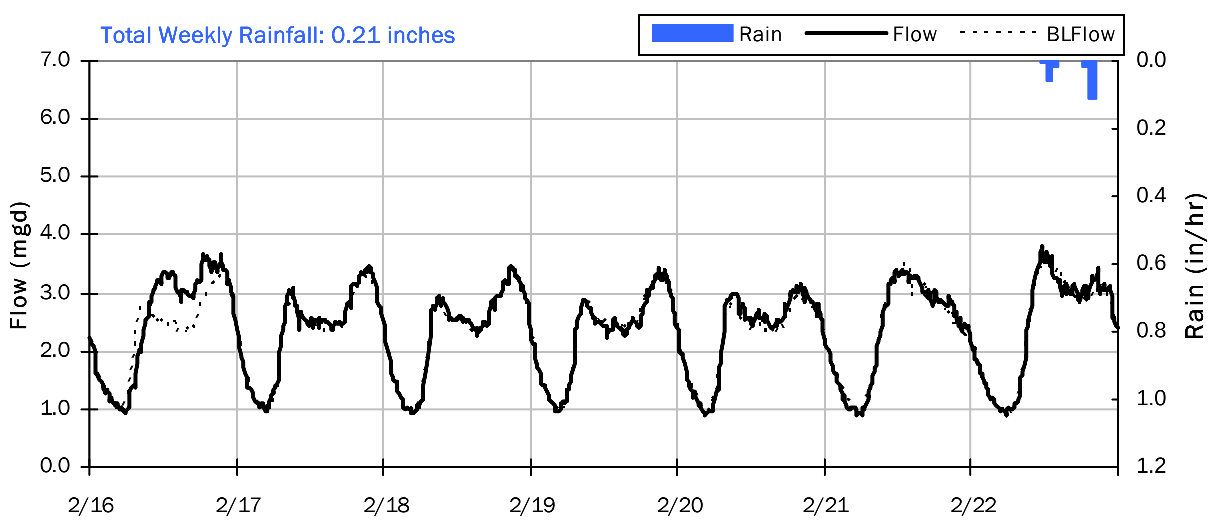


Avg Flow: 2.355 mgd Peak Flow: 3.667 mgd Min Flow: 0.792 mgd

SITE 9
Weekly Level, Velocity and Flow Hydrographs
2/16/2015 to 2/23/2015





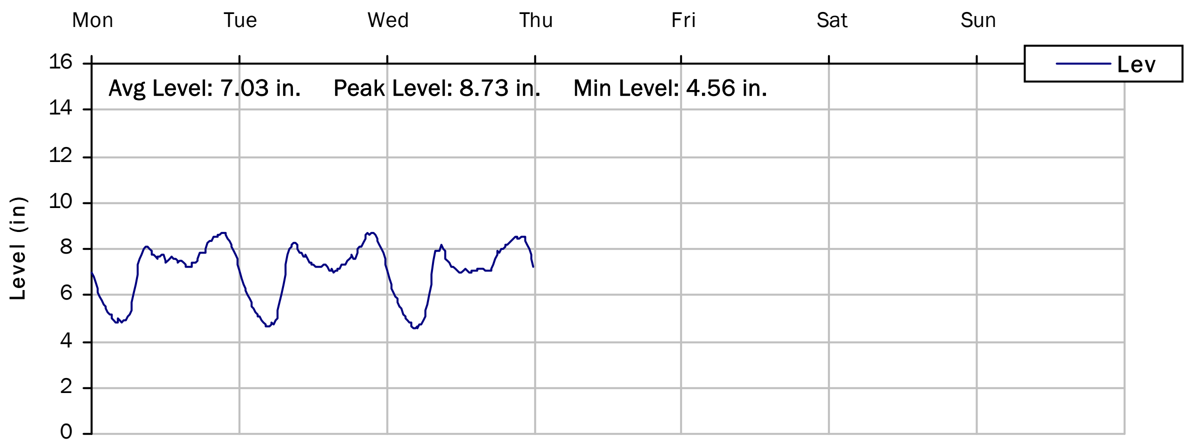


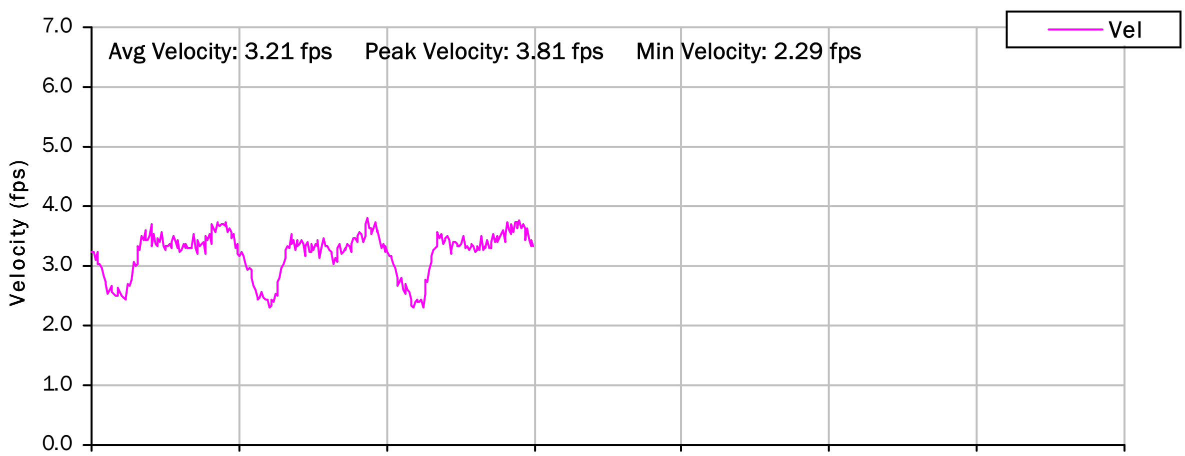
Avg Flow: 2.376 mgd   Peak Flow: 3.799 mgd   Min Flow: 0.878 mgd

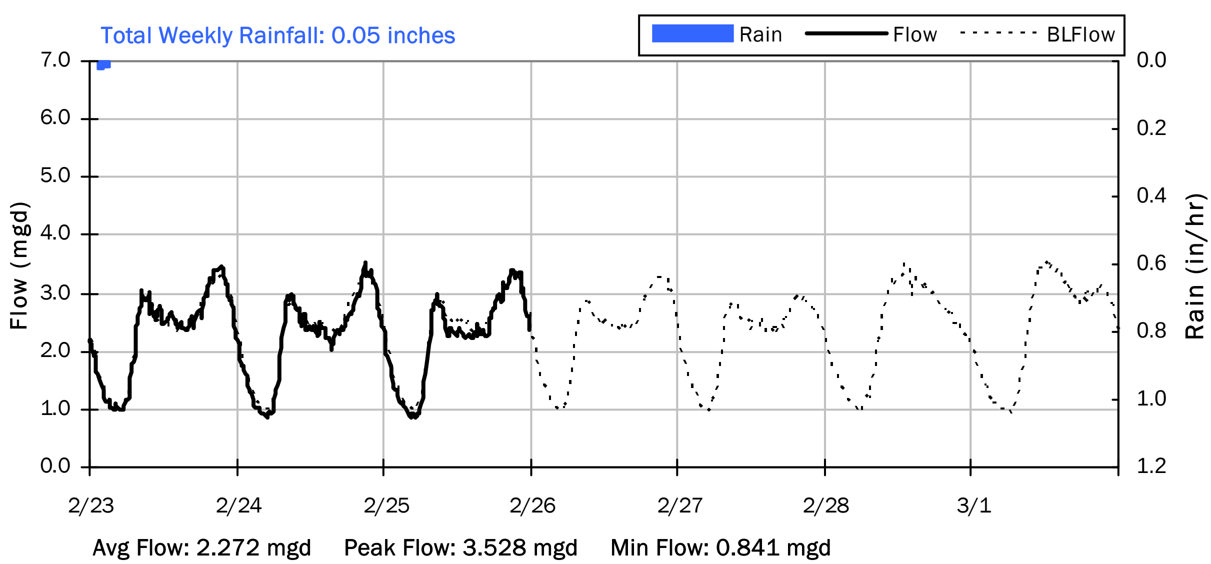
SITE 9

Weekly Level, Velocity and Flow Hydrographs

2/23/2015 to 3/2/2015







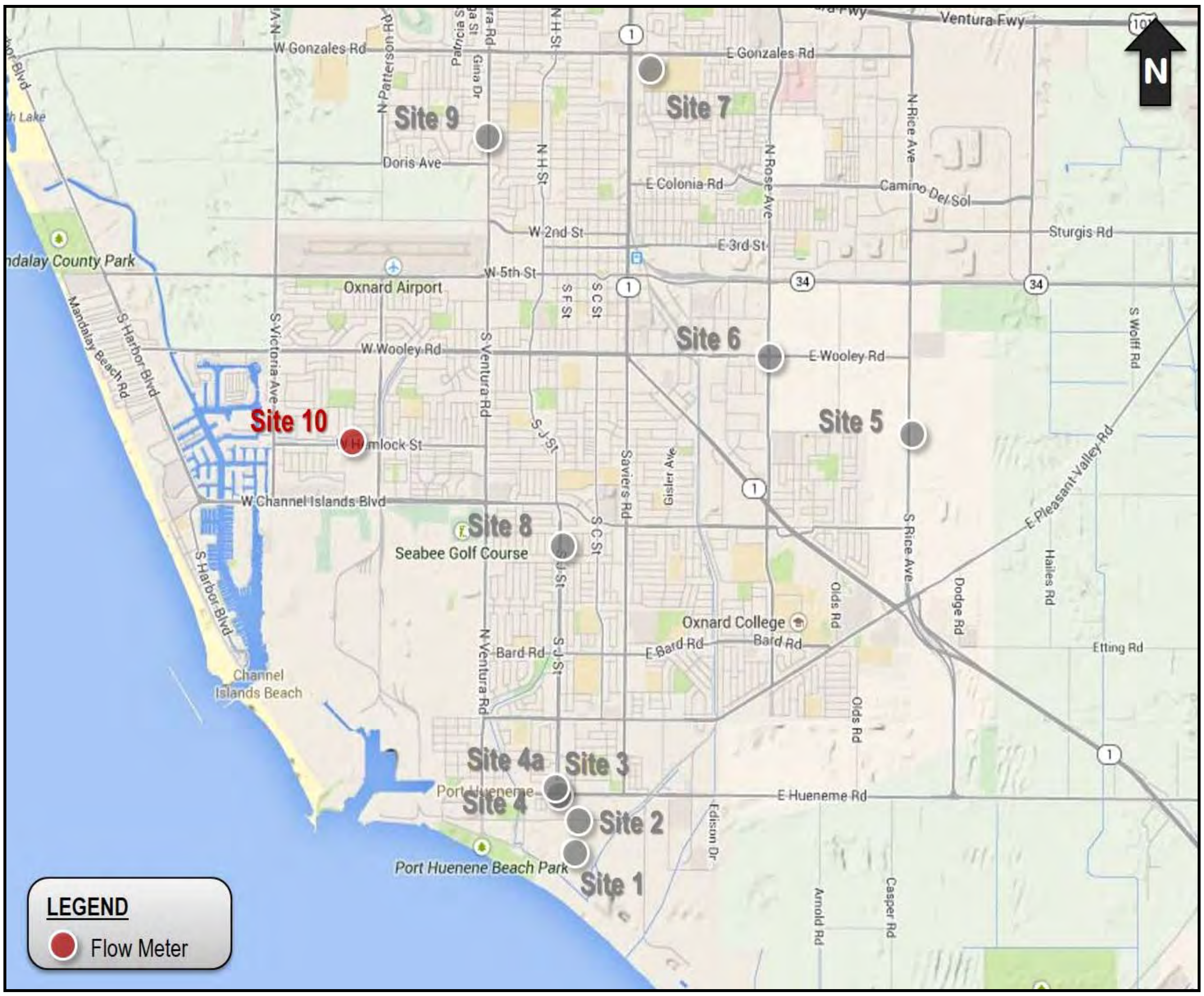
City of Oxnard

Sanitary Sewer Flow Monitoring
Temporary Monitoring: December, 2014 through February, 2015

Monitoring Site: Site 10

Location: West of W Hemlock Street and Jetty Street

Data Summary Report



Vicinity Map: Site 10

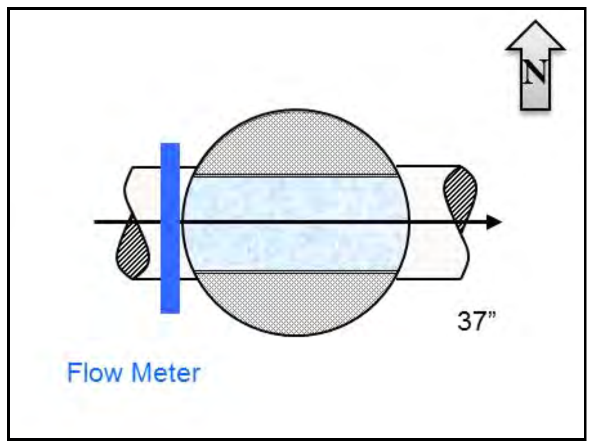
SITE 10

Site Information

Location:	West of W Hemlock Street and Jetty Street
Coordinates:	119.2116° W, 34.1812° N
Rim Elevation:	16 feet
Pipe Diameter:	37 inches
Baseline Flow:	2.128 mgd
Peak Measured Flow:	4.024 mgd

Satellite Map

Sanitary Map



Flow Diagram


Street View


Plan View

SITE 10

Additional Site Photos

Effluent Pipe

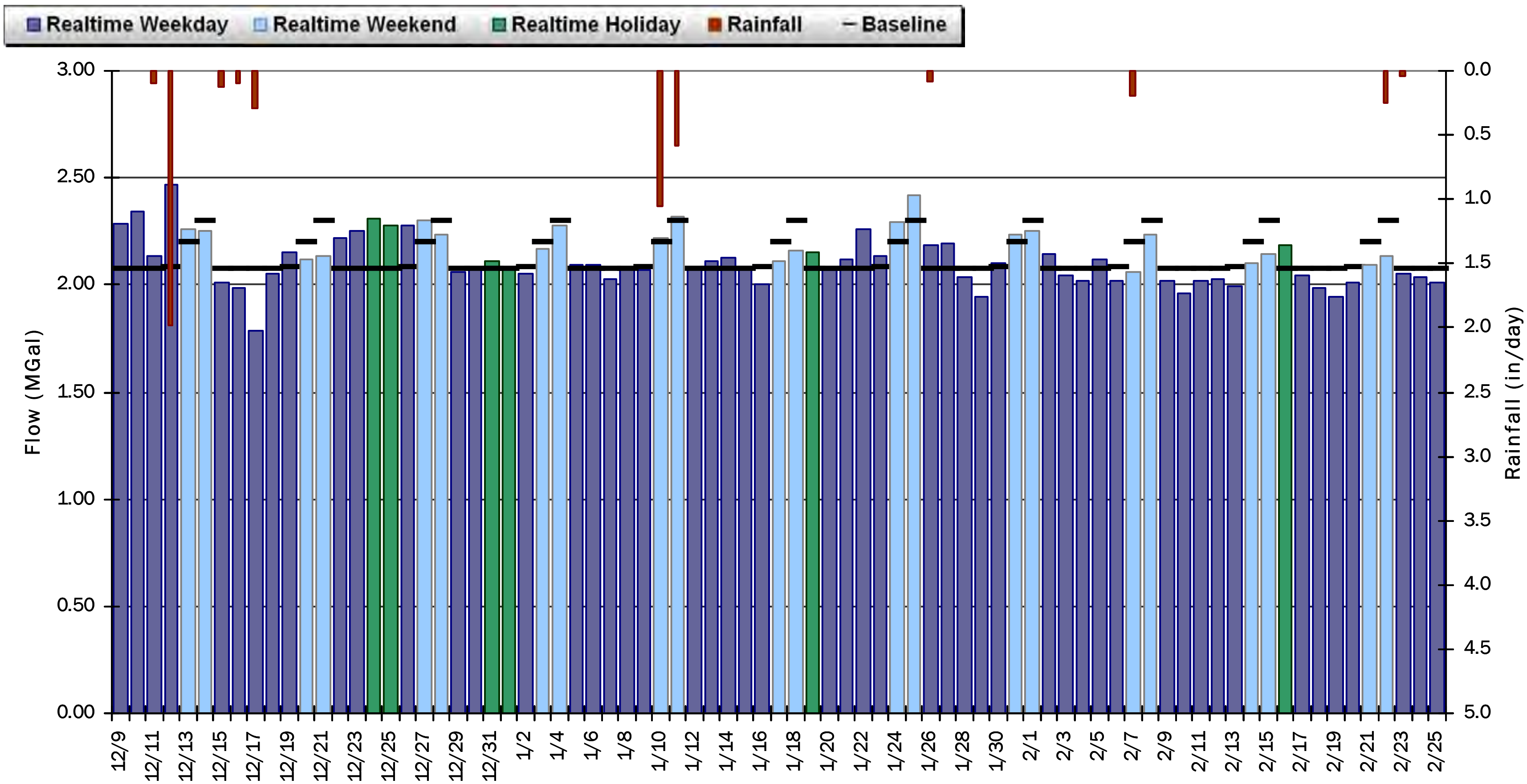
Influent Pipe

SITE 10

Period Flow Summary: Daily Flow Totals

Avg Period Flow: 2.128 MGal **Peak Daily Flow: 2.467 MGal** **Min Daily Flow: 1.786 MGal**

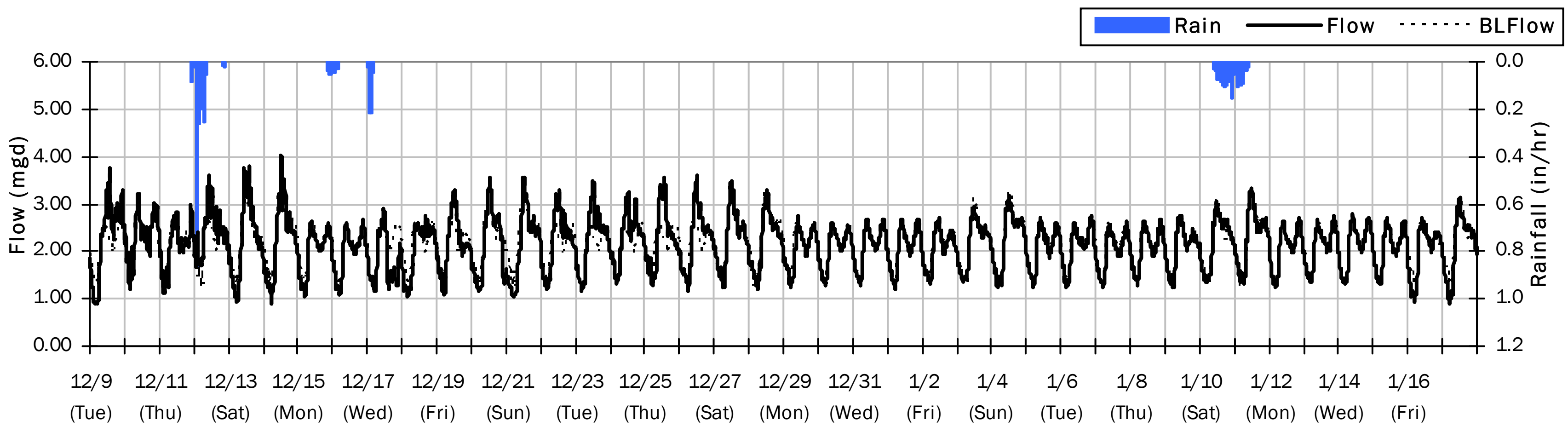
Total Period Rainfall: 4.81 inches

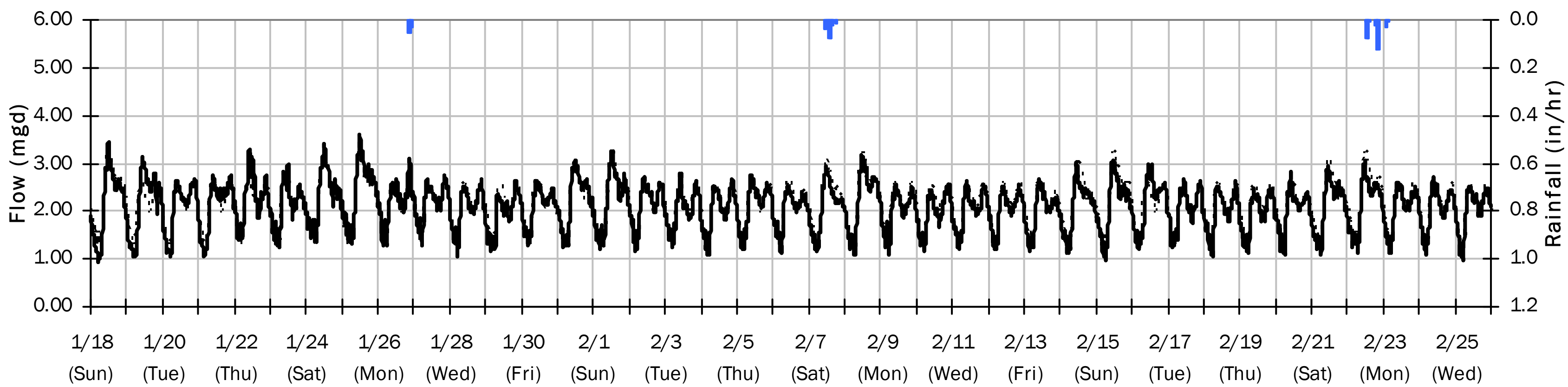


SITE 10

Flow Summary: 12/9/2014 to 2/25/2015

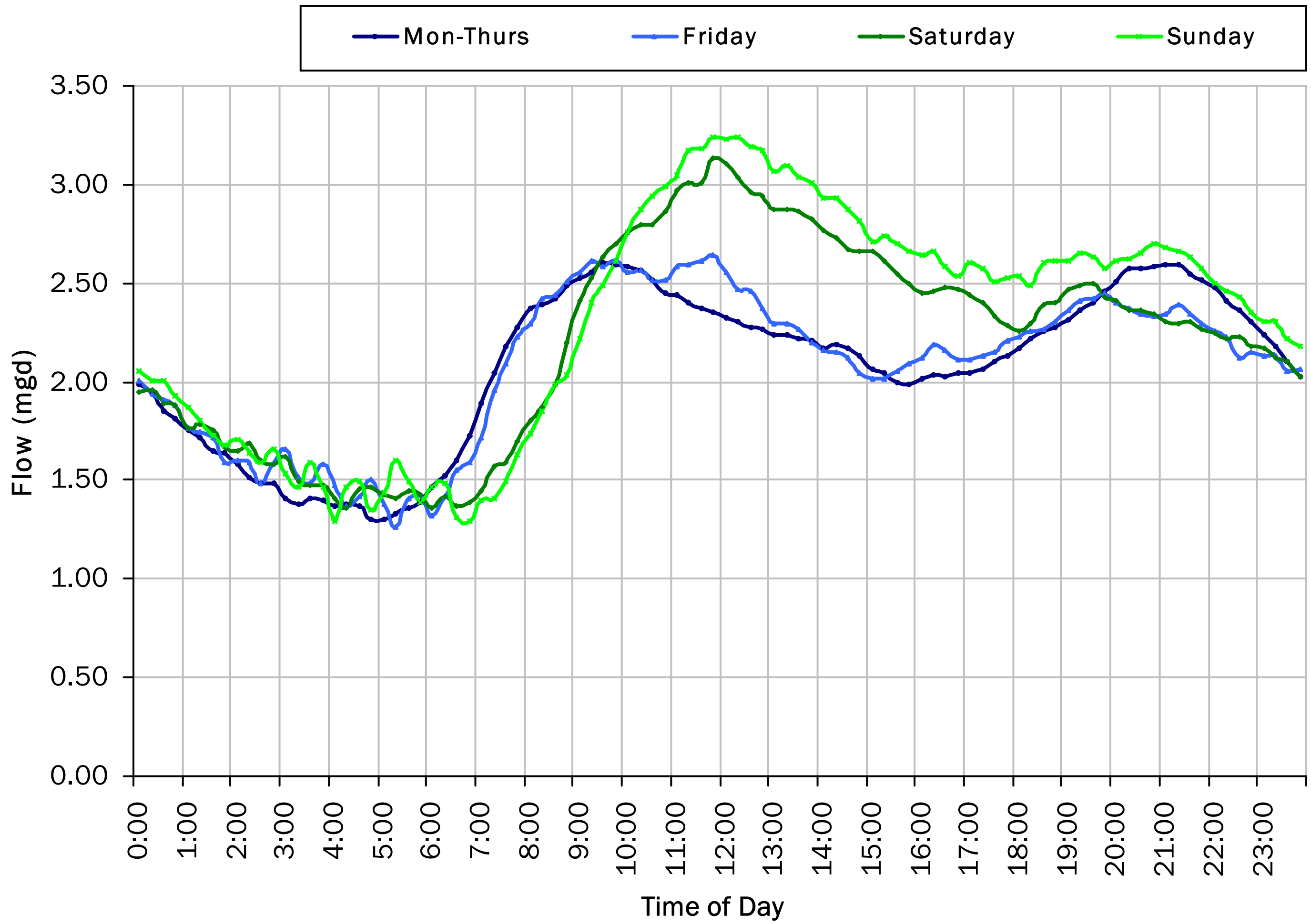
Total Period Rainfall: 4.81 inches   Avg Flow: 2.128 mgd   Peak Flow: 4.024 mgd   Min Flow: 0.876 mgd





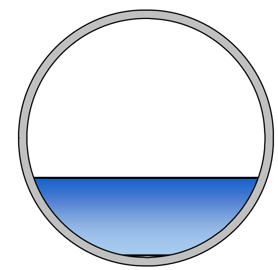
SITE 10

Baseline Flow Hydrographs



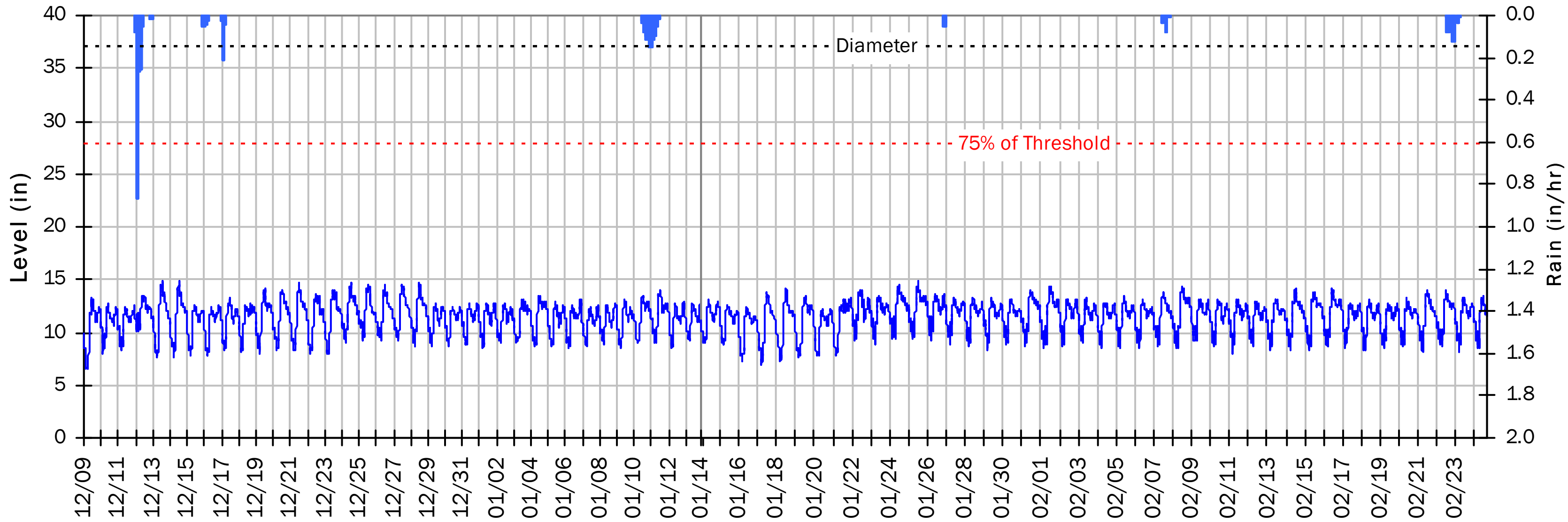
Baseline Flow:

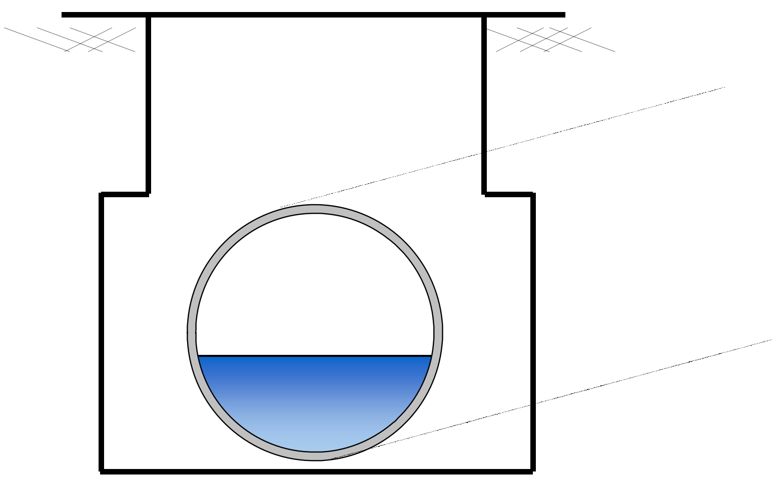
2.13 *mgd*



SITE 10
Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Monitoring Period

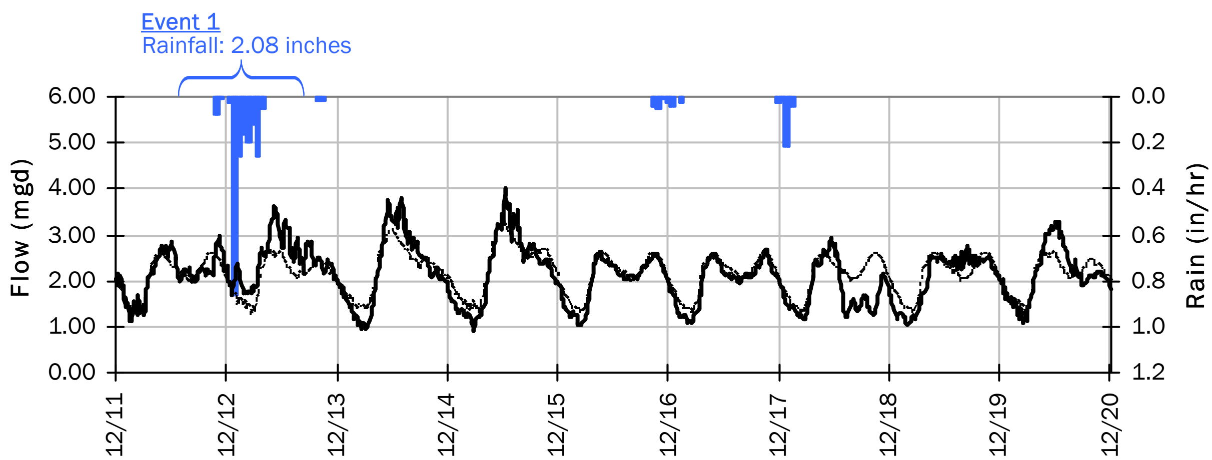




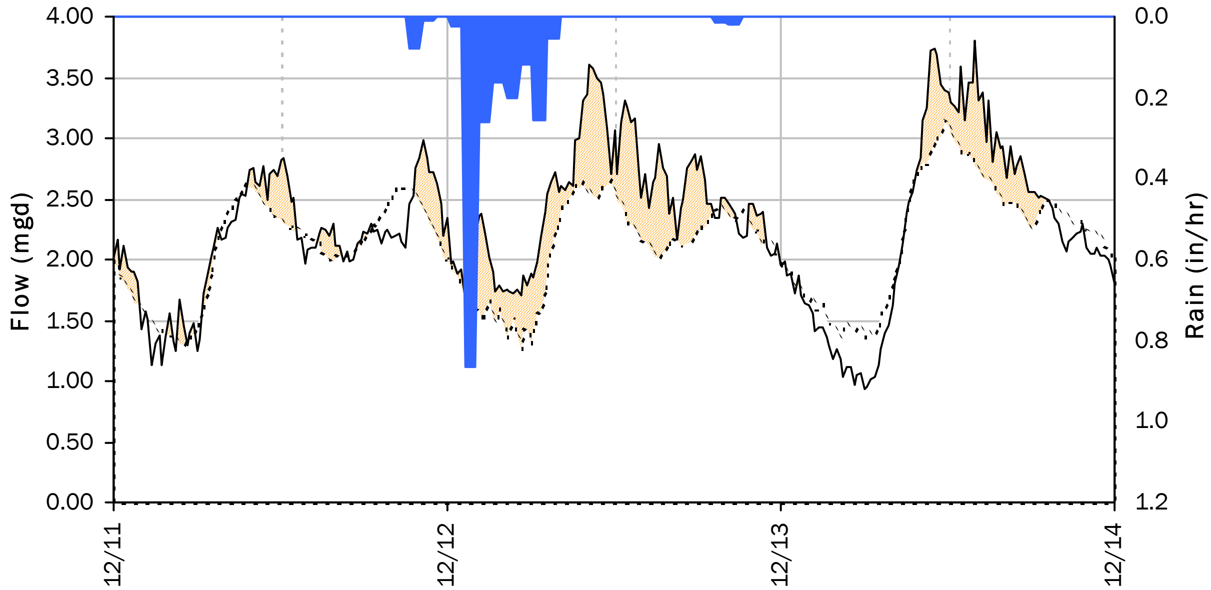
Pipe Diameter:	37	*inches*
Peak Measured Level:	14.9	*inches*
Peak d/D Ratio:	0.40	

SITE 10
I/I Summary: Event 1

Baseline and Realtime Flows with Rainfall Data over Monitoring Period



Event 1 Detail Graph

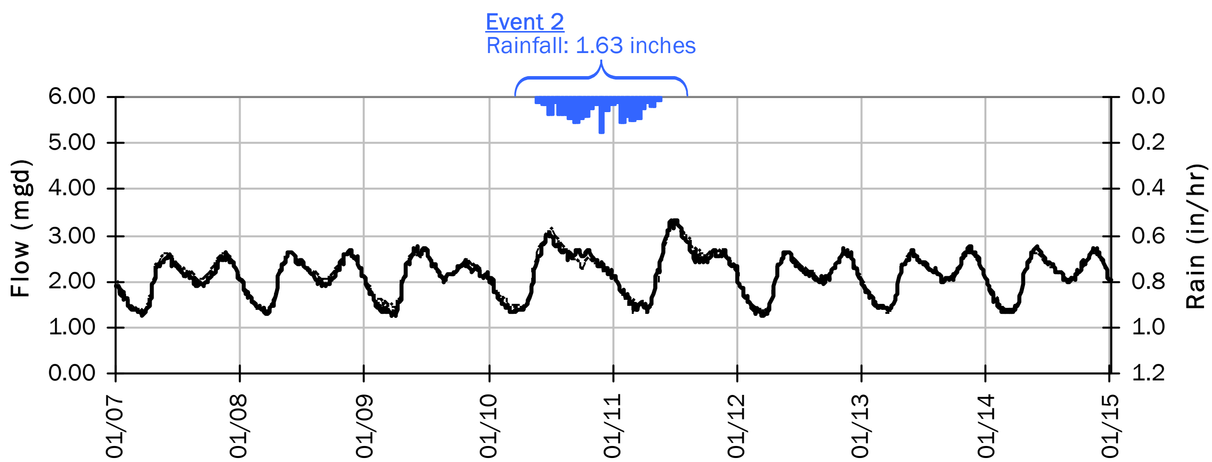


Storm Event I/I Analysis (Rain = 2.08 inches)

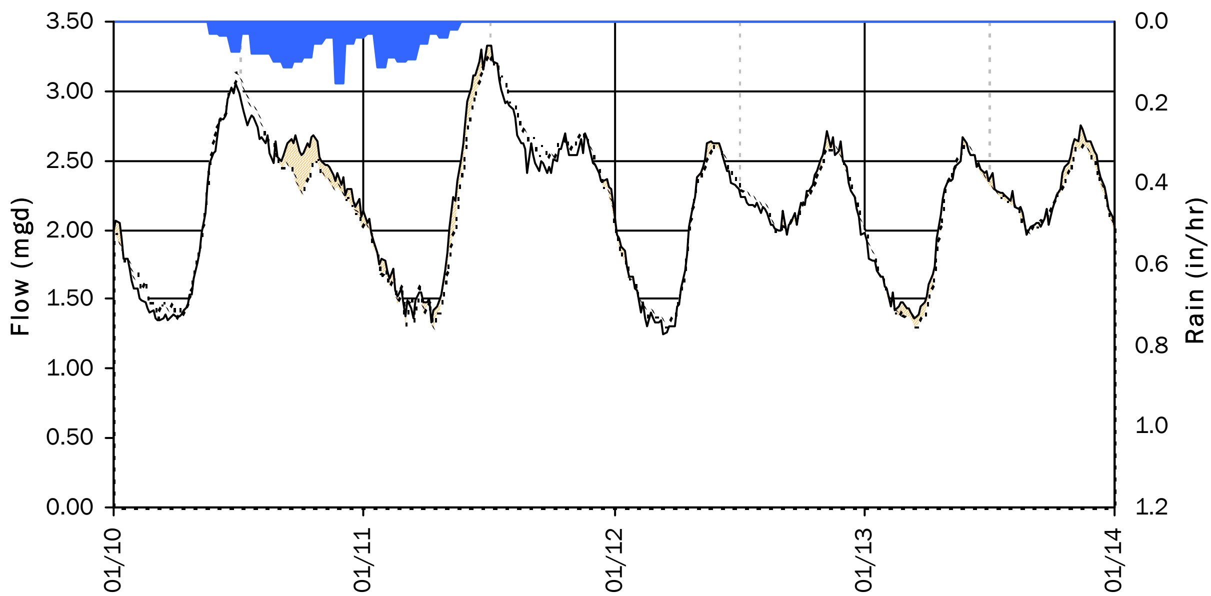
Capacity		Inflow / Infiltration	
Peak Flow:	3.80 *mgd*	Peak I/I Rate:	1.05 *mgd*
PF:	1.78	Total I/I:	477,000 *gallons*
Peak Level:	14.84 *in*		
d/D Ratio:	0.40		

SITE 10
I/I Summary: Event 2

Baseline and Realtime Flows with Rainfall Data over Monitoring Period



Event 2 Detail Graph



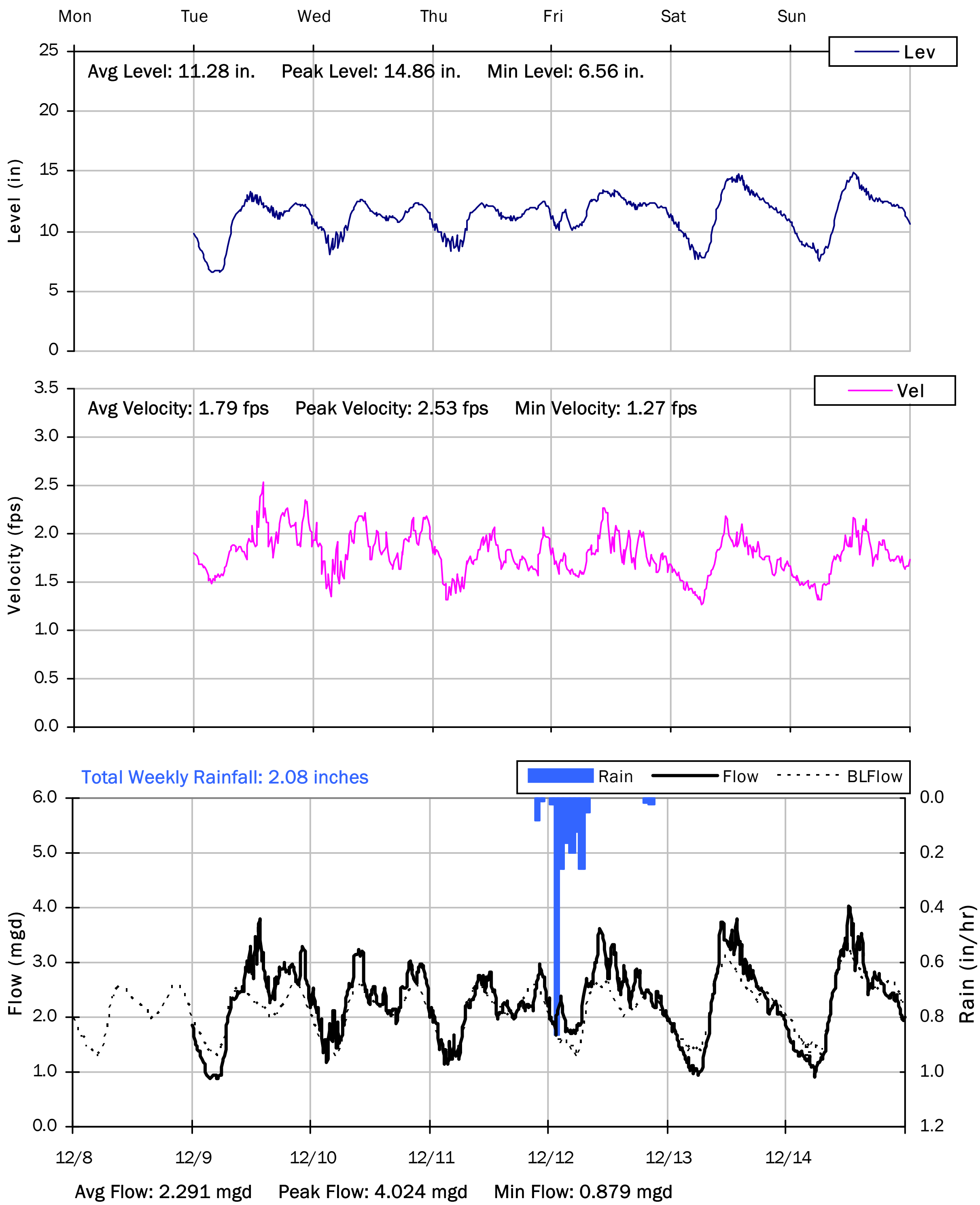
Storm Event I/I Analysis (Rain = 1.63 inches)

Capacity		Inflow / Infiltration	
Peak Flow:	3.33 *mgd*	Peak I/I Rate:	0.34 *mgd*
PF:	1.57	Total I/I:	31,000 *gallons*
Peak Level:	13.98 *in*		
d/D Ratio:	0.38		

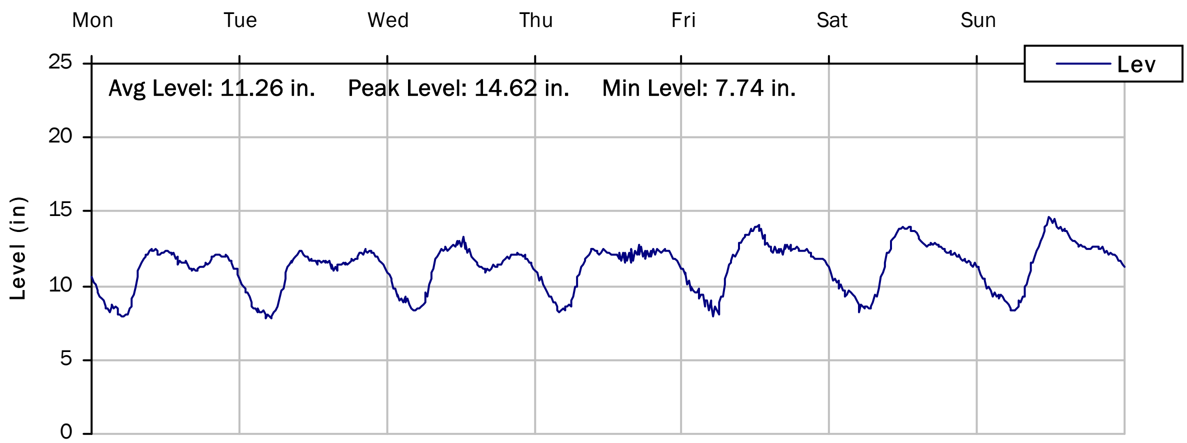
SITE 10

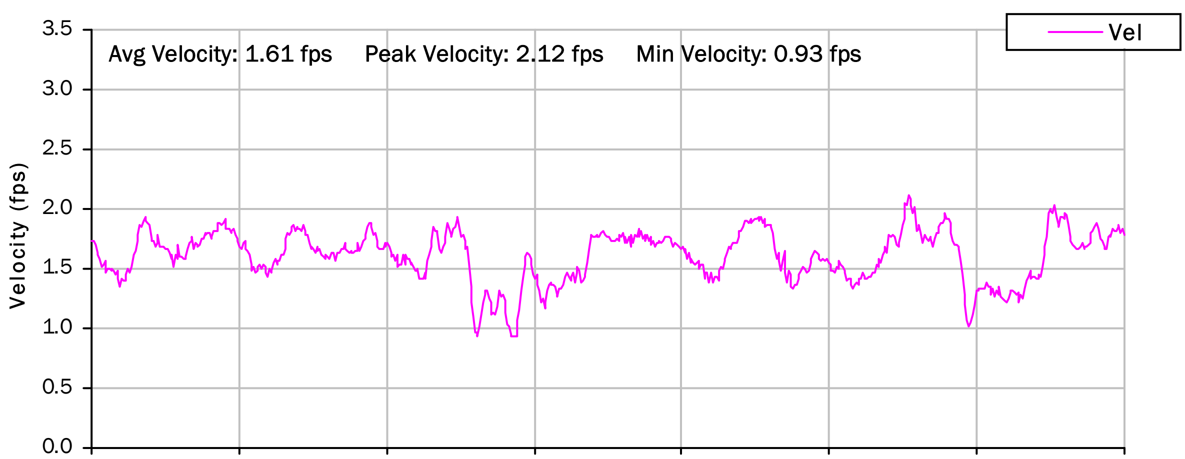
Weekly Level, Velocity and Flow Hydrographs

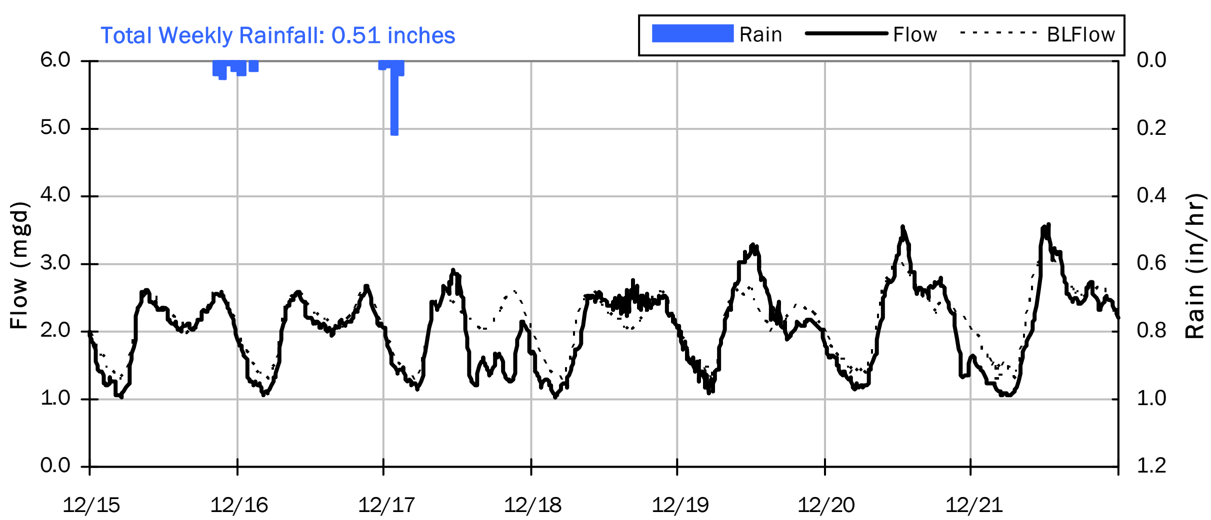
12/8/2014 to 12/15/2014



SITE 10
Weekly Level, Velocity and Flow Hydrographs
12/15/2014 to 12/22/2014





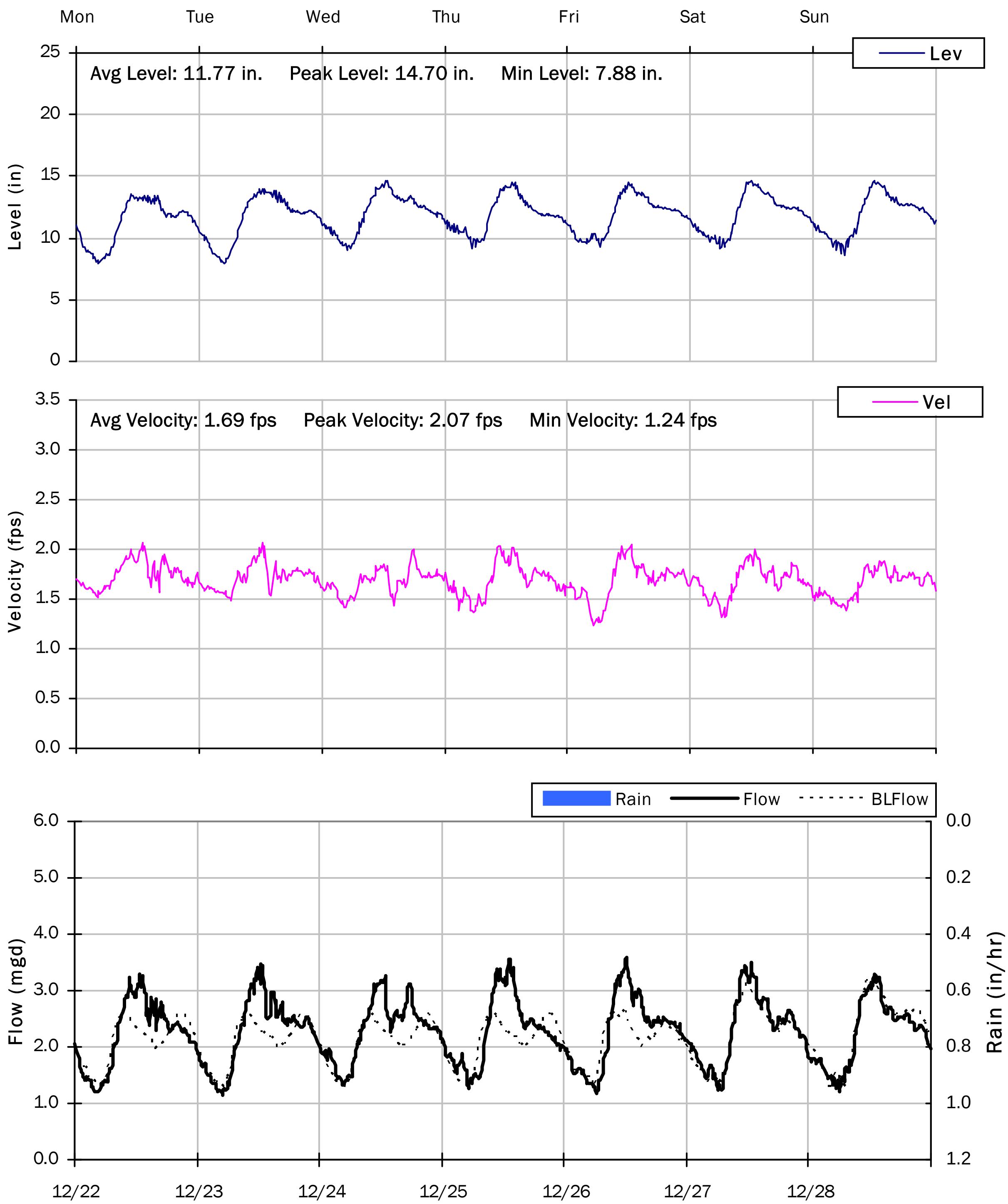


Avg Flow: 2.035 mgd Peak Flow: 3.577 mgd Min Flow: 1.026 mgd

SITE 10

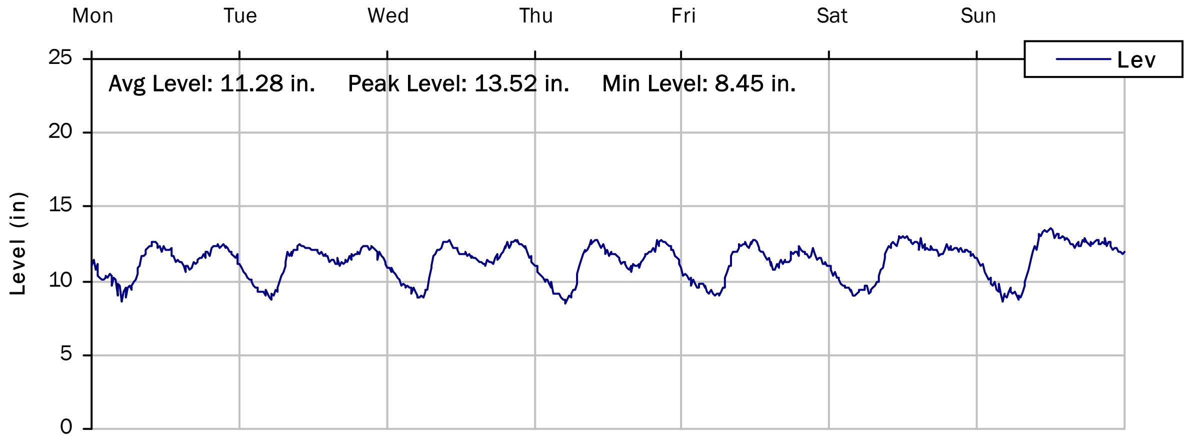
Weekly Level, Velocity and Flow Hydrographs

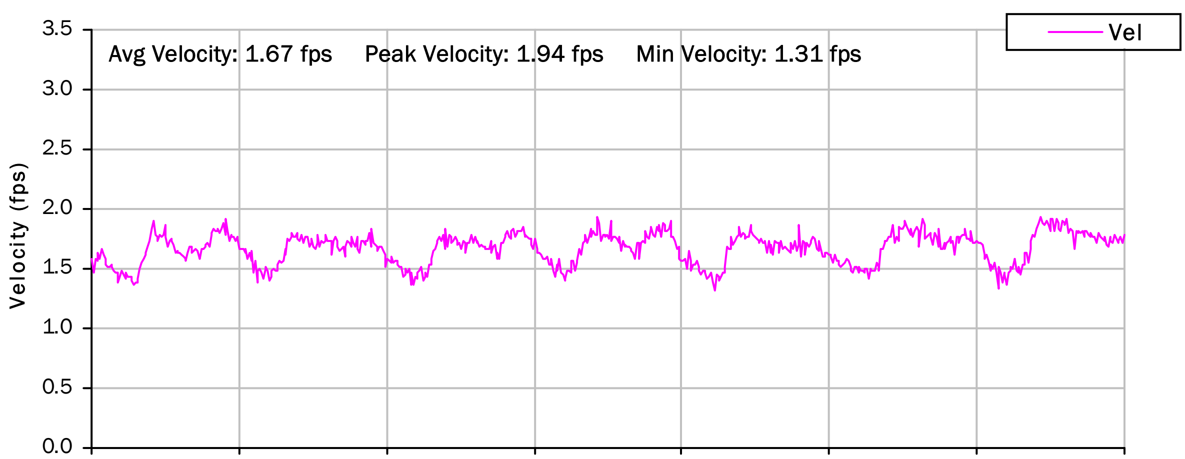
12/22/2014 to 12/29/2014

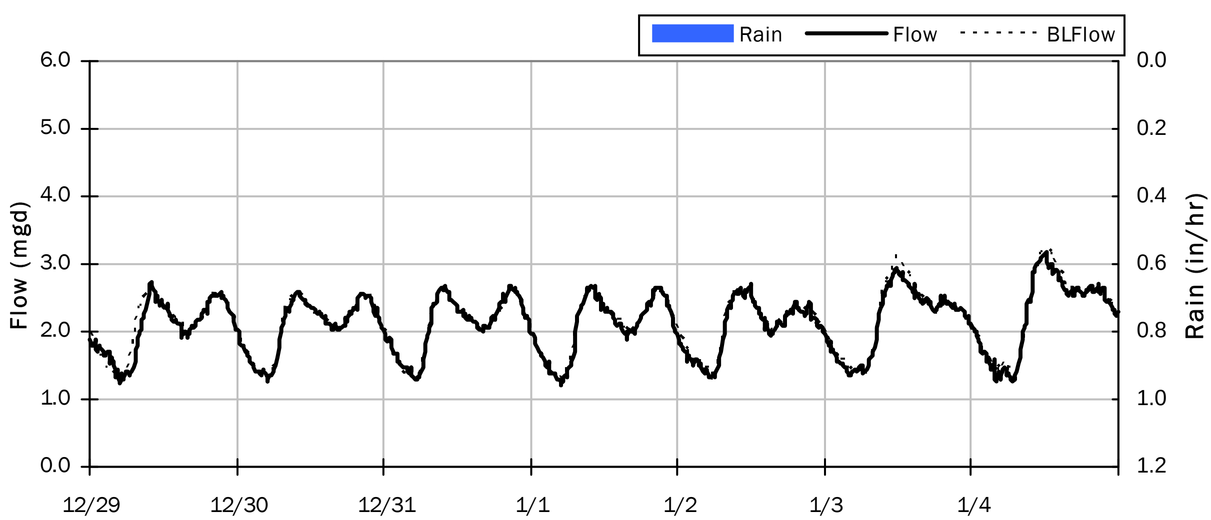


Avg Flow: 2.268 mgd Peak Flow: 3.596 mgd Min Flow: 1.157 mgd

SITE 10
Weekly Level, Velocity and Flow Hydrographs
12/29/2014 to 1/5/2015

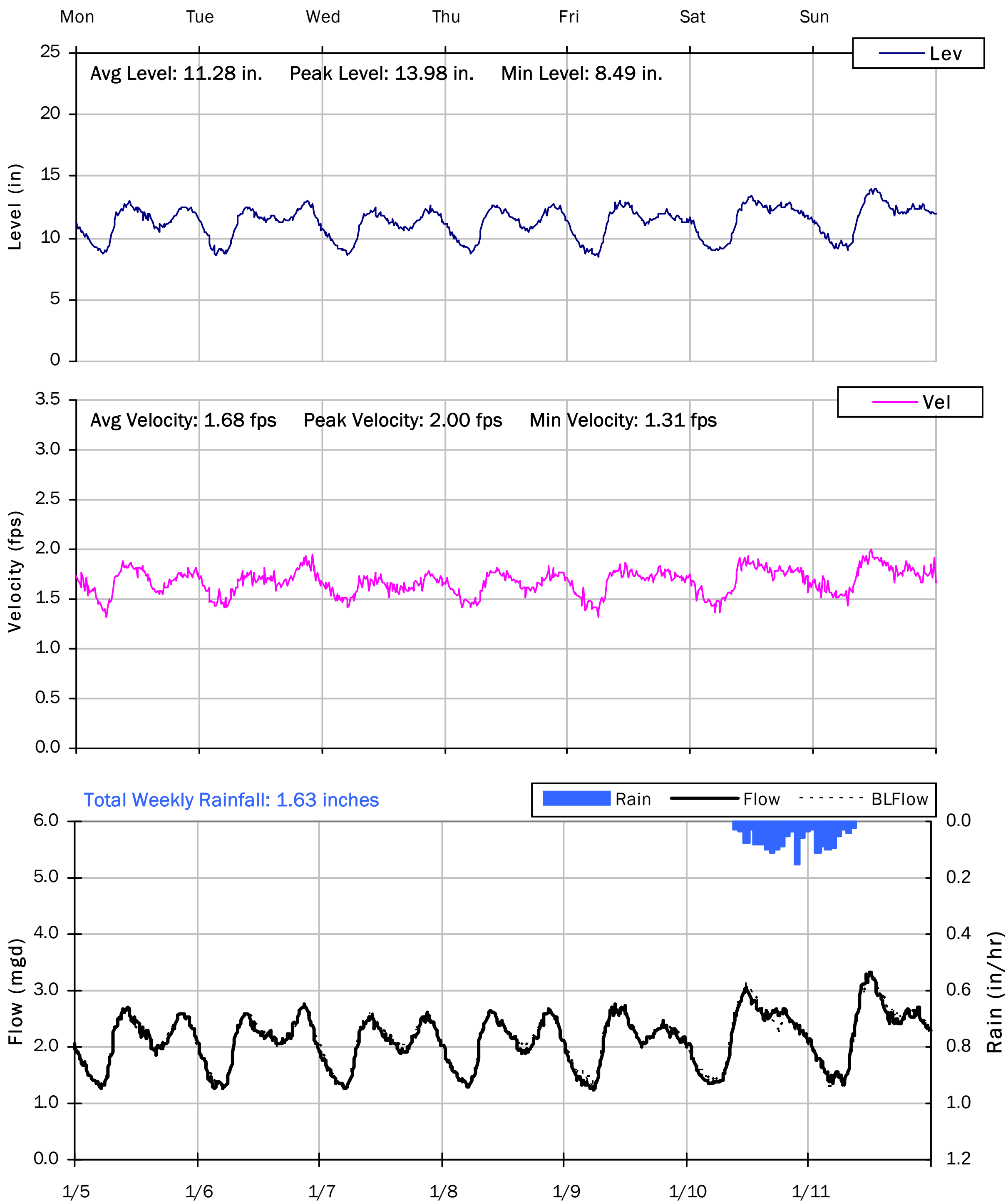






Avg Flow: 2.118 mgd Peak Flow: 3.162 mgd Min Flow: 1.213 mgd

SITE 10
Weekly Level, Velocity and Flow Hydrographs
1/5/2015 to 1/12/2015

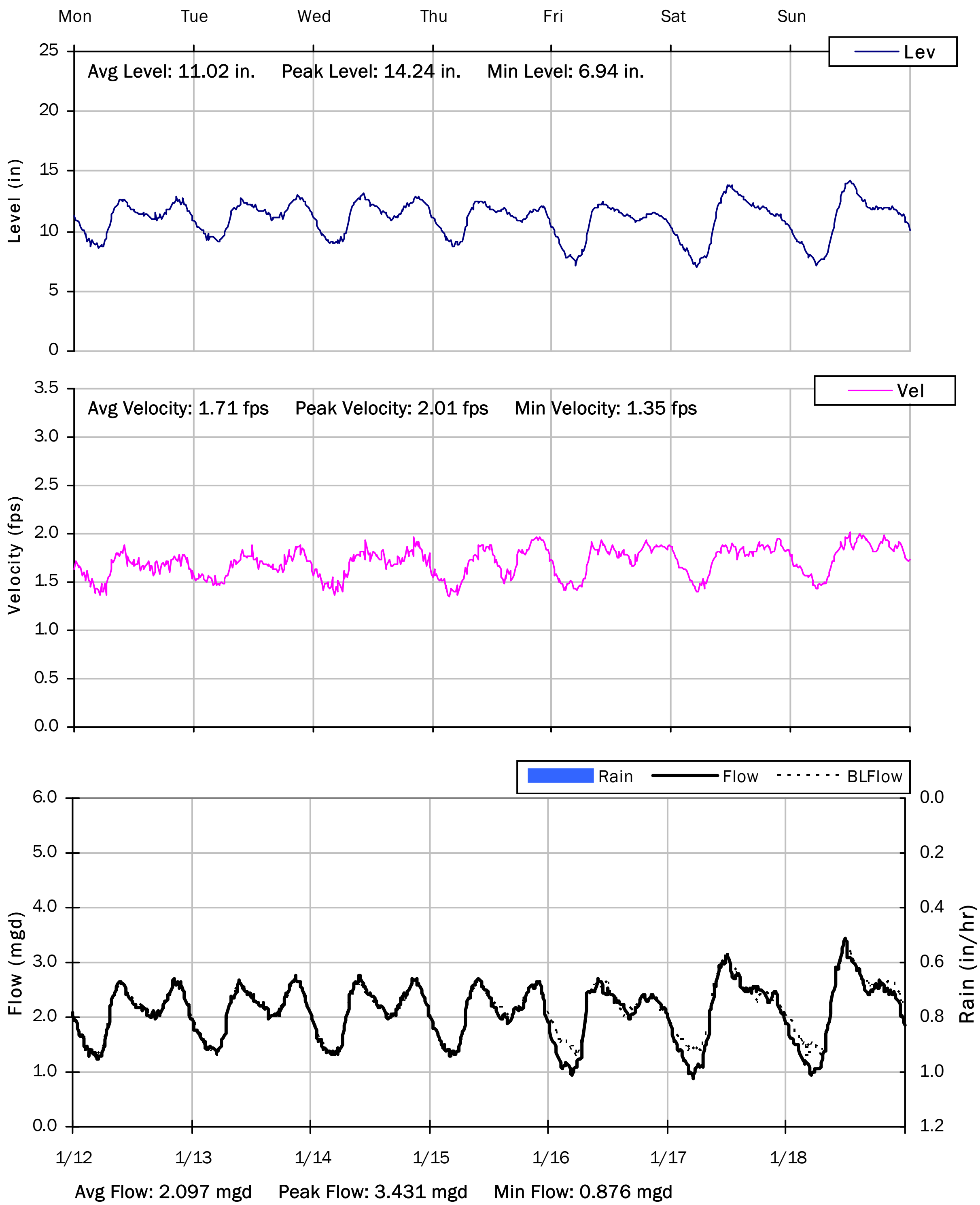


Avg Flow: 2.128 mgd Peak Flow: 3.330 mgd Min Flow: 1.240 mgd

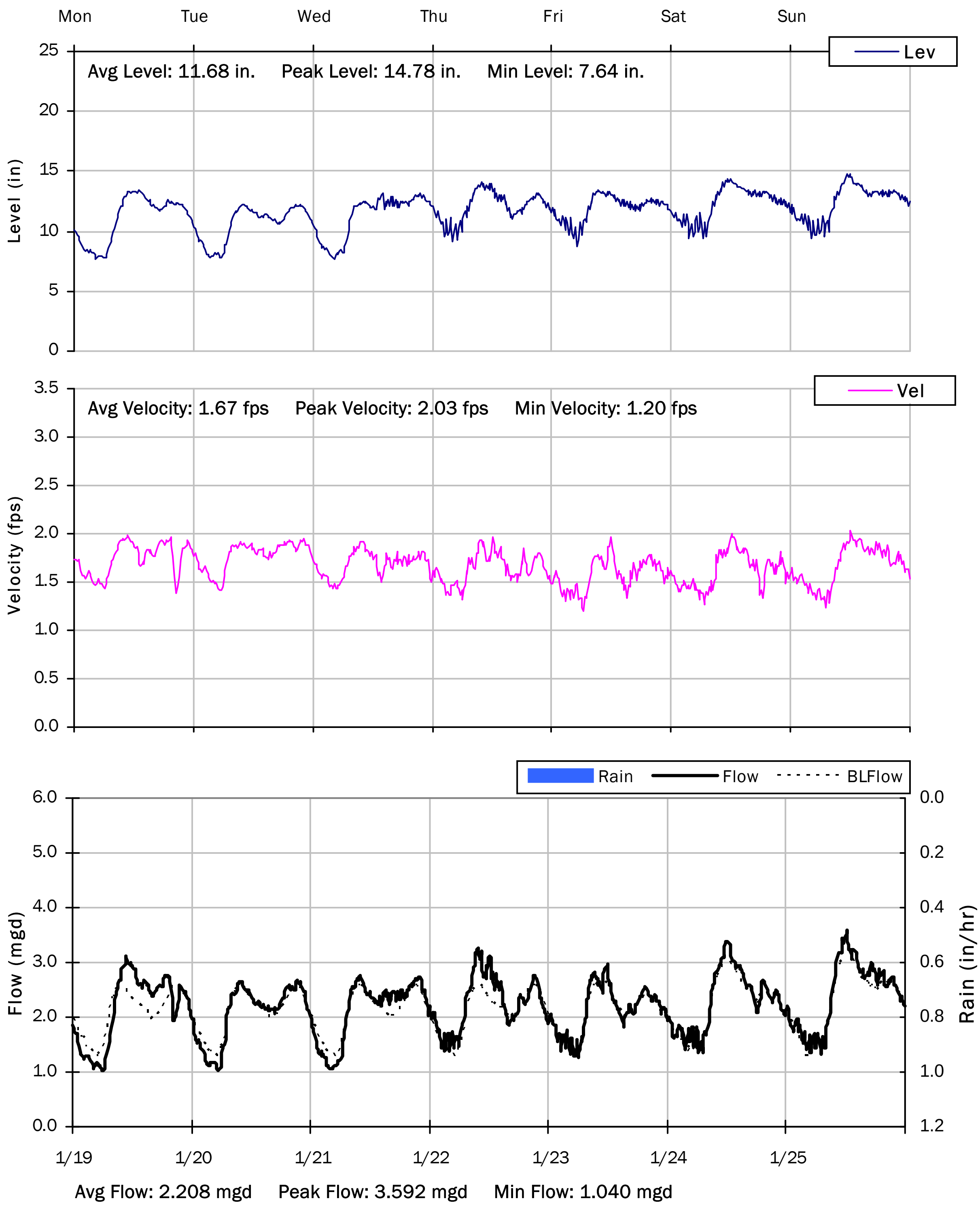
SITE 10

Weekly Level, Velocity and Flow Hydrographs

1/12/2015 to 1/19/2015



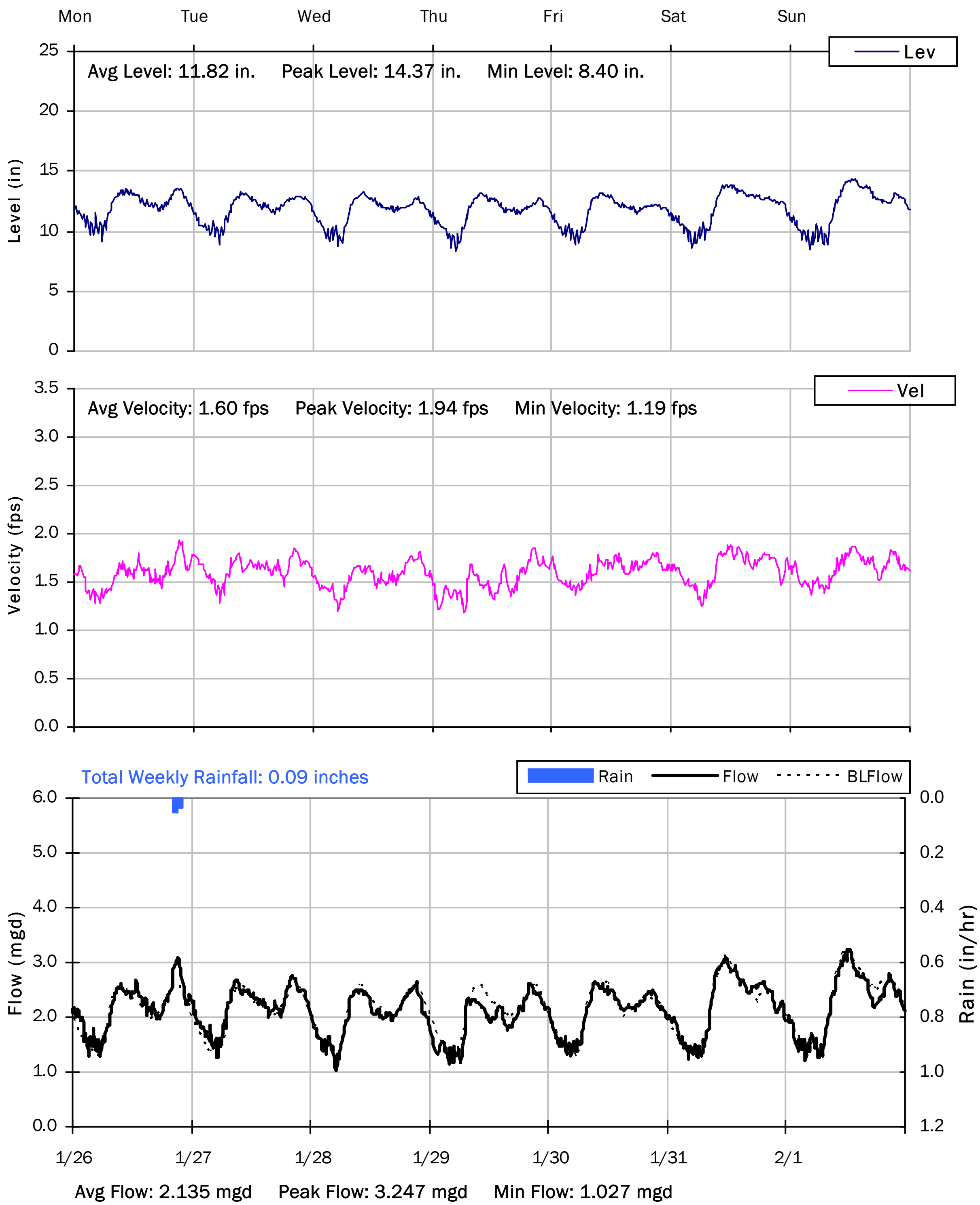
SITE 10
Weekly Level, Velocity and Flow Hydrographs
1/19/2015 to 1/26/2015



SITE 10

Weekly Level, Velocity and Flow Hydrographs

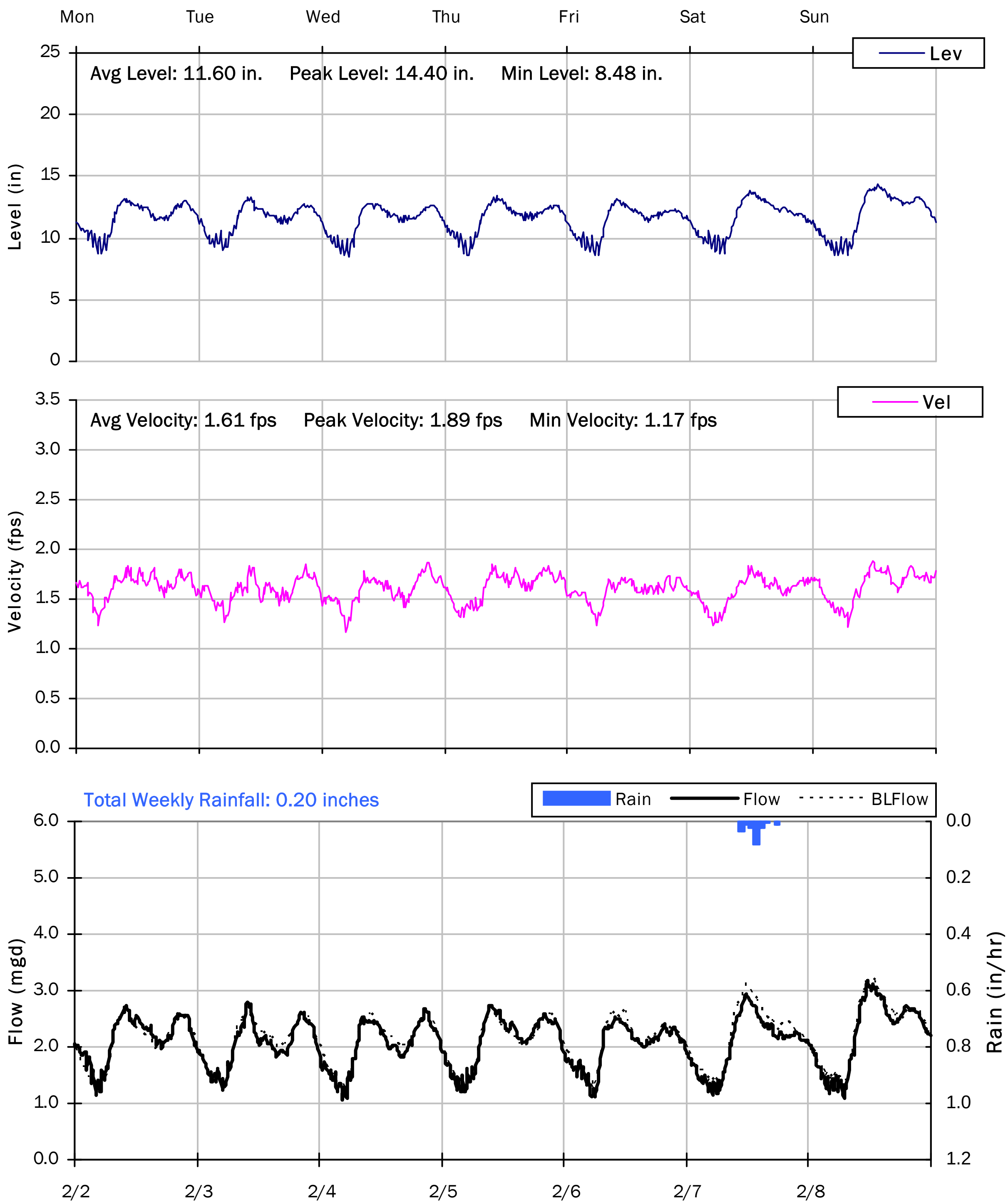
1/26/2015 to 2/2/2015



SITE 10

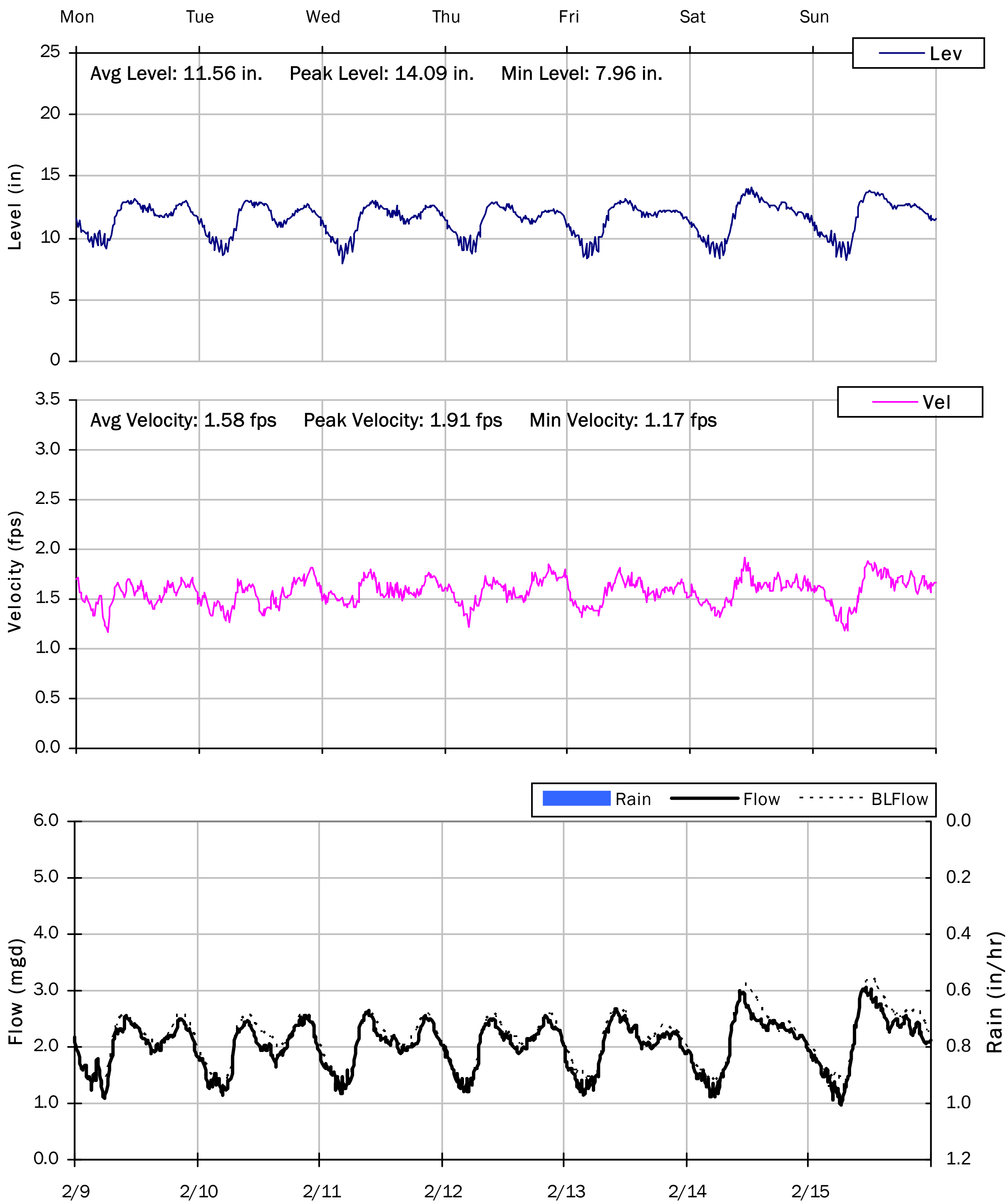
Weekly Level, Velocity and Flow Hydrographs

2/2/2015 to 2/9/2015



Avg Flow: 2.091 mgd   Peak Flow: 3.163 mgd   Min Flow: 1.071 mgd

SITE 10
Weekly Level, Velocity and Flow Hydrographs
2/9/2015 to 2/16/2015

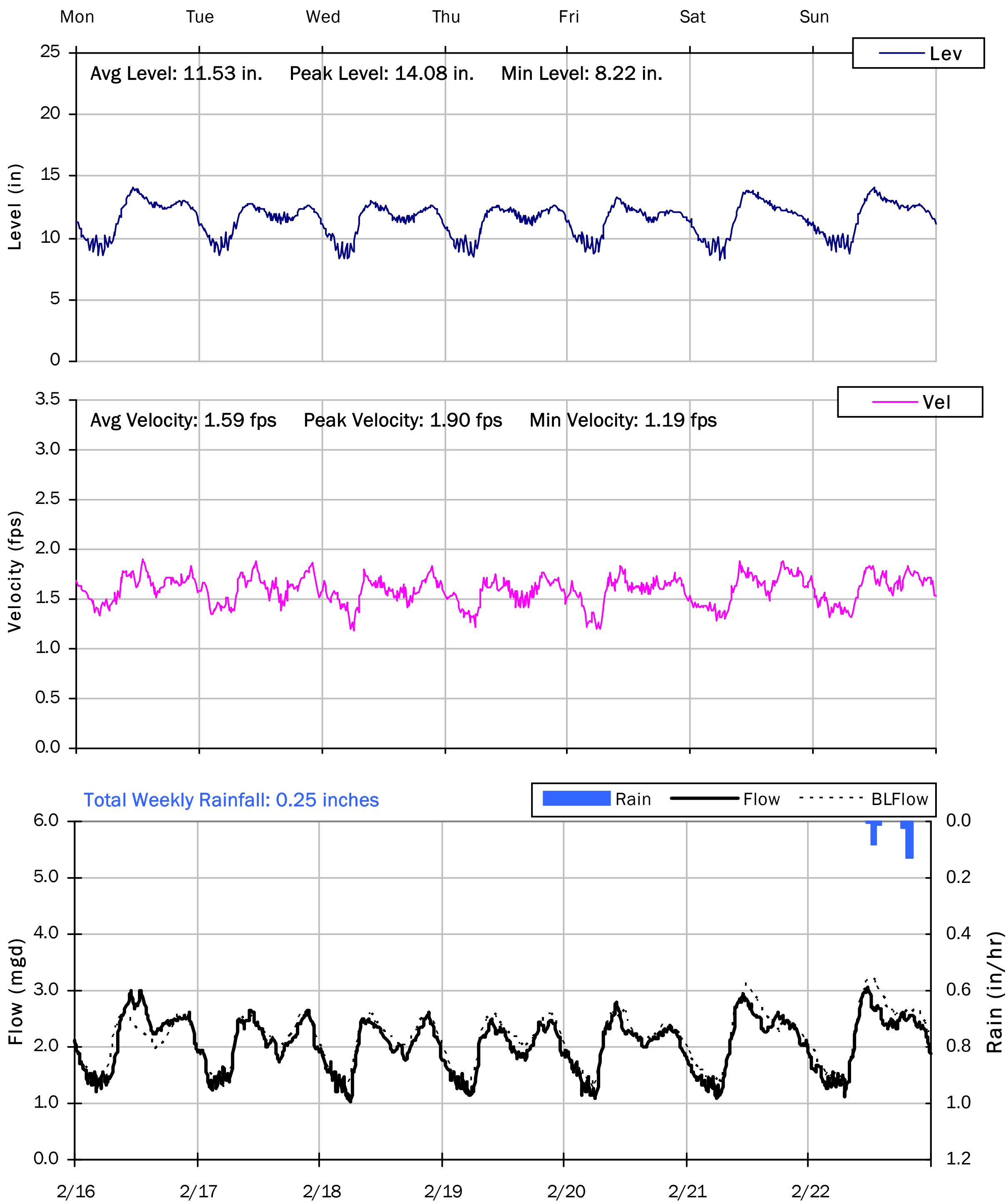


Avg Flow: 2.038 mgd Peak Flow: 3.056 mgd Min Flow: 0.969 mgd

SITE 10

Weekly Level, Velocity and Flow Hydrographs

2/16/2015 to 2/23/2015

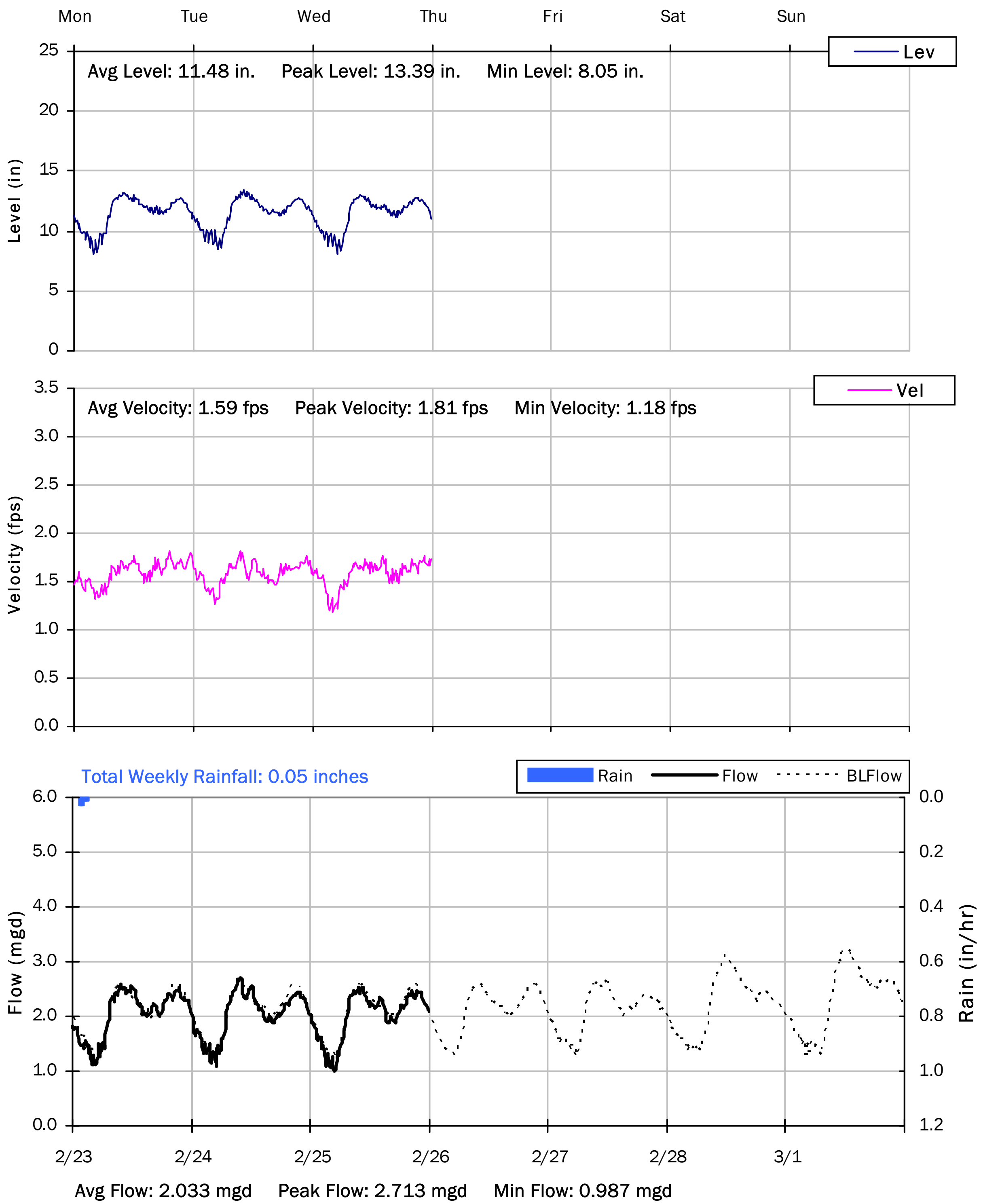


Avg Flow: 2.058 mgd Peak Flow: 3.046 mgd Min Flow: 1.029 mgd

SITE 10

Weekly Level, Velocity and Flow Hydrographs

2/23/2015 to 3/2/2015



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City of Oxnard

Public Works Integrated Master Plan

WASTEWATER

PROJECT MEMORANDUM 3.12
BIOSOLIDS MANAGEMENT

REVISED FINAL DRAFT
September 2017

Engineers...Working Wonders With Water™

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PREFACE

The analysis and evaluations contained in these Project Memorandum (PM) are based on data and information available at the time of the original date of publication, December 2015. After development of the December 2015 Final Draft PMs, the City continued to move forward on two concurrent aspects: 1) advancing the facilities planning for the water, wastewater, recycled water, and stormwater facilities; and 2) developing Updated Cost of Service (COS) Studies (Carollo, 2017) for the wastewater/collection system and the water/distribution system. The updated 2017 COS studies contain the most recent near-term Capital Improvement Projects (CIP). **The complete updated CIP based on the near-term and long-term projects is contained in the Brief History and Overview of the City of Oxnard Public Works Department's Integrated Planning Efforts: May 2014 – August 2017 section.**

At the time of this Revised PWIMP, minor edits were also incorporated into the PMs. Minor edits included items such as table title changes and updating reports that were completed after the December 2015 original publication date.

City of Oxnard

Public Works Integrated Master Plan

WASTEWATER

PROJECT MEMORANDUM 3.12
BIOSOLIDS MANAGEMENT

TABLE OF CONTENTS

Page No.

LIST OF TABLES

BIOSOLIDS MANAGEMENT

1.0 INTRODUCTION

The purpose of this project memorandum (PM) is to define and summarize the available solids end use and treatment alternatives that were considered as part of this Public Works Integrated Master Plan's (PWIMP's) analysis of solids disposal and beneficial use options. Options were considered to satisfy Scenario 2 (Energy Efficiency, as described in *PM 3.7.1-Wastewater System - Treatment Alternatives*), as well as the Oxnard Wastewater Treatment Plant (OWTP) and the City of Oxnard (City) goals. Scenario 2, defined in PM 3.7.1, focuses on incorporating projects that promote energy efficiency at the OWTP (e.g., introduction of FOG to the digesters and installation of photovoltaic cells on rooftops).

1.1 PMs Used for Reference

The alternatives outlined in this PM are made in concert with recommendations and analyses from other related PMs:

- PM 3.1 – Wastewater System – Background Summary.
- PM 3.5 – Wastewater System – Condition Assessment.
- PM 3.7.1 – Wastewater System – Treatment Alternatives.

2.0 BACKGROUND

The City of Oxnard owns and operates the OWTP and the associated wastewater collection system. The City provides wastewater treatment to Oxnard and several surrounding communities (see *PM 3.1 - Wastewater System - Background Summary* for details). The solids handling facilities at the OWTP currently consist of two gravity thickeners for primary sludge thickening, two dissolved air flotation thickeners (DAFTs) for waste activated sludge (WAS) thickening, three anaerobic digesters, and four belt filter presses (BFPs) for dewatering.

Sludge thickening processes concentrate solids and reduce the hydraulic load on downstream digesters, thereby minimizing required digestion volume. The main purpose of anaerobic digestion is to stabilize primary and secondary sludge, reducing pathogens, odors, and volatile solids. Because the digestion process reduces the mass of volatile solids in the sludge, the quantity of solids requiring dewatering and hauling is also reduced. Maximizing volatile solids destruction and minimizing solids loads on the dewatering and hauling operations are necessary to control associated operating costs. Anaerobic digestion also produces digester gas as a byproduct of the microbial processing of volatile solids.

This digester gas, which typically consists of approximately 60-percent methane can be cleaned and used for onsite cogeneration systems or other beneficial uses. The City currently operates their cogeneration system utilizing all of the onsite produced digester gas, in addition to some natural gas.

Anaerobically digested sludge is sent to the dewatering belt filter presses to increase solids concentration from 1 - 3 percent to 19 - 20 percent on average. Removing water reduces the volume of biosolids that must be hauled to the Toland Landfill in Ventura County for final disposal. The biosolids are either directly landfilled, or dried in a dryer to approximately 70 percent solids and used as alternative daily cover (ADC) at the landfill.

As shown in Table 1 (below) and described in *PM 3.5 - Wastewater - Condition Assessment*, the gravity thickeners, DAFTs, anaerobic digesters, and BFP structures and equipment are at or near the end of their useful life. Furthermore, regulations could potentially limit currently practiced solids disposal methods and certain land application options. For these reasons, the City is considering alternative solids management strategies that achieve long-term goals within the plant's available footprint.

Table 1 OWTP Solids Handling Equipment and Year of Installation
Public Works Integrated Master Plan
City of Oxnard

Criteria	Equipment	Condition	Year Installed
Gravity Thickening (primary solids)	2 - 59-foot diameter thickeners; Polymer and ferric chloride system for thickening, thickened sludge pump station	3 - 5	2 GT – 1980
Dissolved Air Flotation (secondary solids thickening)	2 - 25-foot diameter thickeners; Polymer system for thickening	3 - 4	2 units - 1990
Anaerobic Digestion	3 digesters, 2 at 90-foot diameter and 1 at 110-foot diameter; Heat exchanger, mixer, recirculation pumps, fixed cover, gas collection system, digested sludge pumping	3 - 5	90-foot dia.– 1980 110-foot dia. – 1990
Belt Filter Press (Dewatering)	4 - 2.2-m units; Polymer system for sludge conditioning	3 - 5	4 BFPs – 1990
Cogeneration	3 - 500-kW generators; Waste heat recovery system	3 - 5	1980

Note:
(1) Source: OWTP (WW-1), Operation and Maintenance Manuals (WW-7 to WW-12), and comments from Mark Moise.

As described in *PM 3.5 - Wastewater - Condition Assessment*, the condition of each asset was evaluated on a one-through-five ranking scale, based on the International

Infrastructure Management Manual (IIMM). In the IIMM, condition is expressed in terms of the amount of repair needed to bring an asset to “like new” condition. The definitions for the one-through-five condition ranking system from the IIMM are presented in Table 2.

Table 2 Asset Condition Ranking
Public Works Integrated Master Plan
City of Oxnard

Score(1)	Description(1)	Required Rehabilitation Percentage(1,2)
1	Very Good	0%
2	Good	1-10%
3	Fair	11-20%
4	Poor	21-50%
5	Very Poor	>50%

Notes:
(1) Adapted from the International Infrastructure Management Manual.
(2) Percentage of asset requiring rehabilitation: The percentage of the asset value needed to return the asset to a condition ranking of one.

In addition to the OWTP's goals stated in *PM 3.7.1 - Wastewater System - Treatment Alternatives*, the City has a Sustainability mission:

> *“To develop policies and programs that nurture a balanced connection between natural resource conservation, economic vitality, and a quality of life that meets the needs of current and future residents of the City of Oxnard*.”

This mission is supported by the Community Energy Action Plan (EAP), which provides a road map for enhancing energy efficiency throughout the City's residential, commercial, and industrial communities. As part of the EAP, the City has decided to participate in Southern California Edison's (SCE) Energy Leader Partnership (ELP) Program and pursue the “Gold Level” which targets a 10 percent kWh reduction for City Government facilities.

A 10 percent kWh reduction target would significantly help the City achieve California Air Resources Board’s (CARB’s) recommended 15 percent reduction in *community* greenhouse gas (GHG) emissions for all sectors combined. As part of the Oxnard Climate Action and Adaptation Plan, the City intends to examine all sectors for community GHG reduction opportunities, including land use, transportation, vehicle miles traveled, local generation and use of alternative energy, and solid waste management. The EAP identified the OWTP as the City's largest power consumer in 2010, and targeted the plant for a reduction in power consumption. The EAP called for the OWTP and MRFs to increase on-site electricity generation by 2020, offsetting purchased electricity.

Another major goal of the City is diversion of materials going to the landfill, in order to meet current and future Assembly Bills (AB) 939 and 341 and other diversion-related requirements. The City is also considering a compressed natural gas (CNG) fueling station for City vehicles, which would be fueled by biogas generated at landfills or the OWTP.

3.0 OPTIONS FOR SOLIDS END USE OR DISPOSAL

Biosolids contain nitrogen, phosphorous, micronutrients and energy that can be harnessed through various processes and end uses. Currently, dewatered cake is hauled for disposal at the landfill, so there is no recovery of these resources. The PWIMP will compare disposal options and more beneficial use alternatives relative to resource recovery objectives and compliance with existing and potential future regulations. Options for beneficial use of the solids depend on material quality, solids treatment, and management methods relative to the Code of Federal Regulations Title 40 Chapter I Subchapter O Part 503 (40 CFR 503) and California's General Order (GO). See *PM 3.1 - Wastewater System - Background Summary* for a more detailed description of 40 CFR 503 requirements.

The level of treatment the solids require will ultimately be based on the selected end use alternative. The end use options considered for the City of Oxnard are summarized in Table 3 and include:

- Landfill Disposal: Direct landfill of solids, use of biosolids as an alternative daily cover (ADC), or ash disposal resulting from thermal conversion of solids (either by fluidized bed incineration, gasification, or pyrolysis).
- Land application of biosolids meeting Class A or Class B requirements under 40 CFR 503.
- Production of marketable products from biosolids.
- Exporting solids to an off-site, regional solids processing facility and/or facility operated via public-private partnership (PPP).

Table 3 Comparison of End Use and Disposal Options
Public Works Integrated Master Plan
City of Oxnard

Option	Estimated Remaining Life	Reason	Issue/Driver
Landfill Disposal			
Direct Disposal ADC Ash	Uncertain Uncertain Indefinite	Organics & GHGs Organics & GHGs Small volume, no organics	CalRecycle plans to eliminate organics from landfills
Land Application			
Class B Class A	Uncertain Indefinite with successful marketing	Perception is poor quality for Class B, less so for Class A	Counties implementing bans; Limited sites in proximity to the plant

Table 3	Comparison of End Use and Disposal Options Public Works Integrated Master Plan City of Oxnard		
Option	**Estimated Remaining Life**	**Reason**	**Issue/Driver**
Marketable Products			
Compost Dried Biosolids	Indefinite with successful marketing	Growing demand for local compost & fertilizer	Local, sustainable, phosphorous need
Other Opportunities			
Regional Solids Processing Facility	Indefinite	Planned as long term	Diversification
PPP	Indefinite	Planned as long term	Diversification

While impossible to know exactly what will change in the future, there is regulatory pressure to divert organics from landfills. This may result in further restrictions on direct disposal of biosolids in landfills or using them as ADC. Hence, it appears that these options may not be viable long-term. Landfill disposal of inorganic ash is less problematic due to its relatively small volume and elimination of organics.

There is considerable public opposition to land application of Class B solids in California. The numerous injunctions throughout the state that restrict or prohibit Class B land application threaten this option for beneficial use within California. Many agencies in Southern California contract with haulers that transport Class B solids to nearby states for land application because this practice is still accepted in Arizona, the Midwest, and many other states.

Land application of Class A products is generally more acceptable to the public and has a more positive outlook in California. There are a few counties that have restricted all land application of biosolids, regardless of Class. Outside of those counties, land application of Class A solids is typically acceptable due to lower odors and higher levels of stabilization compared to Class B products.

Public perception of biosolids drives the viability of these end use alternatives and this perception can shift with time. Due to public pressure, biosolids-derived soil amendments cannot currently be used for cultivation of certified organic foods. On the other hand, wastewater agencies around the country have started successful public outreach and media relations programs that highlight the benefits of Class A biosolids-derived soil amendments. In those communities, branded soil amendments have been accepted by the public. Long term, reliable options for biosolids include collaborating with industry partners and developing marketable products in conjunction with efforts to educate the public and engage community stakeholders.

4.0 PROCESS ALTERNATIVES FOR SOLIDS TREATMENT

This section describes various solids treatment processes necessary to produce the end-use products summarized in Table 3. For the purposes of developing solids treatment alternatives, it is assumed that the solids treatment and handling operations (i.e., gravity thickeners, DAFTs, anaerobic digesters, and BFPs) will undergo repair and/or replacement to meet existing and anticipated future level of treatment requirements under Scenario 1 and satisfy wastewater treatment goal number one as described in *PM 3.7.1 - Wastewater System - Treatment Alternatives*. Projects to optimize operations and maintenance are included in Scenario 1 as are projects that adopt newer technologies in place of aging equipment (e.g., replacing gravity thickeners with co-thickening at the DAFTs and replacing the BFPs with centrifuges).

4.1 Baseline (Landfill, ADC, and Land Application)

The baseline consists of continuing existing solids treatment operations onsite. These processes allow for continued transport of biosolids to the Toland Landfill (where they are either added to the landfill or dried in an onsite dryer to be used as ADC) or land application of the biosolids as a Class B soil amendment.

This alternative would not improve (i.e., decrease) energy use onsite, but could offset energy consumed by others for the production of synthetic fertilizer if the Class B biosolids are land applied.

4.2 Thermal Drying

Thermal drying is a well-established solids treatment technology resulting in a Class A product. Thermal drying reduces the moisture content of biosolids using direct or indirect auxiliary heat to increase the evaporation rate. Either digested or undigested biosolids can be dried. While drying undigested solids leaves more of the fuel and fertilizer value in the dried product (pellet), there are greater public perception and odor issues as a result of the drying process and rewetting of the final product.

The most common energy sources to provide heat for thermal dryers are natural gas, digester gas, landfill gas, fuel oil, and waste heat from nearby combustion sources. There are two general categories for thermal drying: direct and indirect.

Direct drying uses forced convection to transfer heat to biosolids. This process involves circulating heated air over the biosolids, accelerating the evaporation process, and drying the biosolids. The exhaust gas is condensed to remove moisture and particulate matter. The resultant gas, along with odors, is typically combusted in a regenerative thermal oxidizer. Direct dryers are generally used in larger WWTPs. Direct dryer alternatives include rotary drum, fluidized beds, and belt dryers.

Indirect drying uses conduction to transfer heat to biosolids. This process involves contacting biosolids directly with a heated surface. Heat mediums, such as oil or steam, are used to heat surfaces that evaporate moisture from the biosolids. Exhaust vapors are condensed and typically drawn through an odor control system before direct discharge to atmosphere. Indirect dryers are typically used in smaller WWTPs. Indirect dryer alternatives include auger drying, disk paddle/screw drying, and multiple-stage tray drying.

In drying systems that produce pellets, such as rotary drums and multiple stage tray dryers, fines and oversized particles in the dried biosolids are screened. Fines and crushed oversized particles are typically recycled back to the dryer as seed material for the agglomeration phase where the particles are formed before entering the dryer.

Dryer technologies and dried pellet-storage systems have the potential to explode or catch fire. Manufacturers include safety measures to prevent such events, such as inert purge blankets, pressure reliefs, and various safety interlocks included with the dryers. Similar precautionary equipment is available for dried-product storage systems.

There is limited opportunity for energy production using heat recovery from a dryer. Depending on dryer type, waste heat from other processes (e.g., engine heat recovery) could be used to supplement the heat demand of dryers. Although dryers can require considerable input of fuel, the product (i.e., dried solids) can be used as a biogenic fuel source for use in coal or coke-fired power plants or cement kilns for example.

4.2.1 <u>Thermal Dryer Selection</u>

Rotary drum and fluidized bed dryers were considered since many large municipal WWTPs in the U.S. use thermal drying technology.

4.2.1.1 Rotary Drum Dryer (Direct Drying)

Rotary drum drying systems recycle a significant portion of product to mix with the dewatered cake in a mixer. Dewatered cake coats pellets before being dried in a rotating drum. Heated air comes in contact with the biosolids and evaporates water, producing a dry hard pellet. The granules or pellets are then graded into different size categories. Those that do not fit the product specifications are crushed and recycled back into the dryer system. The pellets that meet the specifications are either recycled as seed material for pellet formation or cooled and stored prior to distribution.

A rotary drum dryer system for the City would be fueled by biogas and/or natural gas and the dryer exhaust heat could be recovered to provide additional hot water supply for OWTP. The rotary drum dryer system would not use the cogeneration engines exhaust gases as a heat supply because it has oxygen content above 10 percent. Oxygen levels in the dryer must be maintained below 5 percent to reduce the ignition potential of the solids. Rotary drum dryers operate at approximately 900 °F and dry the solids to approximately 95 percent solids.

4.2.1.2 Fluidized Bed Dryer (Hybrid - Direct and Indirect Drying)

In fluidized bed dryers, moisture removal is achieved predominantly by convective heat transfer. A natural gas or biogas fired furnace heats oil or other heating media. The oil is pumped into a heat exchanger where the heat is transferred to the fluidizing air. The heated fluidizing air comes into direct contact with the cake solids, causing the water to evaporate. Fluidized bed dryers are equipped to produce a high-quality biosolids product consisting of uniform, hard, spherical pellets similar in appearance (with the exception of color and odor) to commercial inorganic fertilizer products.

Dewatered biosolids are pumped directly into the dryer. An extrusion and cutting system is used to form pellets for the drying process. Heated, fluidized air is blown through the bed of the dryer. Once the pellets are dried, they are discharged from the fluidized bed. The pellets are separated from the air stream and conveyed to storage.

Air from the dryer is conveyed to a bag house to remove particulate matter. The solids from the bag house are collected and mixed with a stream of cake solids fed to the dryer. The remaining air is condensed and recycled to heat the fluidization air.

4.3 Compost Offsite (Co-Compost with Green Waste)

Composting is a stabilization process normally performed after biosolids are dewatered and after subsequent mixing with a bulking agent (e.g., green waste). The bulking agent raises the initial solids content of the mixture and provides a carbon source for the organisms and bulk porosity important for maintaining aerobic conditions. High temperatures achieved during the microbial decomposition reduce pathogenic organisms in the solids. When composting is complete, the compost material is typically screened to retrieve a portion of the bulking agent. The product is then allowed to cure for several days and the resulting humus-like material can be used as a soil amendment. As identified in the 40 CFR 503 regulations, composting operations can meet either Class A or Class B pathogen reduction requirements dependent upon time and temperatures met during the process.

In general, compost products are considered the most acceptable beneficial use products available to the public. This is because compost products are associated with food, yard, and agricultural wastes that the public is more familiar with, and so are more likely to accept biosolids compost. In addition, biosolids compost does not have an objectionable odor or sludge-like appearance.

Due to the limited land available on-site, existing off-site composting operations at a City-run Contracted Materials Recovery Facility (MRF) are considered.

This alternative would not improve (i.e., decrease) energy use onsite; however, if the composted product (Class A or B biosolids) is land applied, it will offset fossil-fuel based energy consumption from the production of synthetic fertilizer that would otherwise be used as a soil amendment to improve soil health. Land applying composted biosolids also contributes to carbon sequestration and improves water retention in the soil below. Soil amendments are also being examined for their potential to assist with recovery of forest lands from fire damage and to prevent future fires, which would result in a potential reduction in black carbon emissions.

4.4 Fluidized Bed Incineration

Fluidized bed incineration (FBI) is a well-established sludge treatment technology in the U.S. It is the preferred technology for new incineration systems because they are more energy efficient, easier to control, and produce fewer air emissions than multiple hearth furnaces (MHFs). Fluidized bed incinerators are refractory-lined steel cylinders with three distinct zones: 1) a windbox, 2) the bed section typically composed of sand, and 3) the freeboard. Combustion air is preheated and introduced into the windbox, which distributes air to an orifice plate. The plate separates the windbox from the fluidized bed, provides structural support for the sand bed, and is comprised of air distribution tubes. Fluidizing air is passed through the tubes to the bed section, which fluidizes the sand. Dewatered cake is fed into the fluidized sand bed, the water in the solids is evaporated, and the combustible matter is oxidized in seconds. Oxidation gas and water from this process flow upward into the freeboard where the gas combusts and completes the process.

The operating temperature range for the freeboard is 650 to 850 degrees Celsius. A high-pressure spray system is located in the freeboard zone to control process temperatures.

Air from the incineration process is recycled to preheat the combustion air. Prior to discharging the air to the atmosphere, it is treated to remove pollutants. Federal regulations for incinerators may become more stringent in the future and could impact the cost of emissions control technologies and the overall viability of incineration. Carbon is injected upstream of a baghouse filter to remove mercury from the air stream. The air is conveyed to the baghouse filter where the mercury-containing carbon is removed as it passes through the filter. These steps are followed by a tray scrubber and wet electrostatic precipitator to remove the particulate matter (ash). The ash can either be used as a cement substitute, or may need to be disposed of at a landfill (depending on the ash contents). The air is condensed to remove moisture and clean air is discharged to the atmosphere.

Energy and heat recovery from an FBI system would typically consist of a waste heat recovery boiler to generate steam that is used to turn either process equipment (such as pumps or blowers) or a generator. Based on discussions with vendors, for a facility the size of the OWTP, it may not be cost effective to incorporate energy recovery/generation. Inherent to the FBI system is recirculation of the heated air to reduce energy input required for operation. This reduction in energy is included in the overall energy required for operation of the FBI system.

4.5 Gasification

Gasification of sludge/biosolids is an emerging technology. There was only one installation in the U.S. (in Sanford, Florida) processing wastewater sludge, however it is no longer in operation due to the manufacturer filing for bankruptcy. The Sanford installation was intermittently operated between 2010 and mid-2014, during which they tested and optimized the gasification process. The process involved applying a controlled amount of air (to supply a small amount of oxygen) to control the heat to a fuel rich sludge providing a temperature-controlled environment (greater than 800 degrees Celsius). Most of the volatile portion of the sludge is converted into synthesis gas, also called “syngas.” However, complete combustion is not realized in the gasifier because gasification operates in an oxygen-starved environment. An estimated 80 percent of the solids are converted to syngas. The remaining ash has little value and is usually disposed of similar to incinerator ash, though there were studies evaluating its use as a fertilizer.

Dewatered sludge is fed into a dryer to reduce the moisture content to approximately 10 percent. Dried solids are conveyed into the gasifier at a controlled rate to optimize syngas production. The majority of the volatile content of the solids is converted to syngas and conveyed to a thermal oxidizer where it is blended with air and burned. The heated flue gas from the thermal oxidizer is used to heat the solids dryer. Flue gas is conveyed through a baghouse filter and scrubber prior to atmospheric discharge. In addition, flue gas from the solids dryer is conveyed to an odor control system prior to atmospheric discharge.

While the syngas produced in a wastewater solids gasification process has a high fuel value, it can be utilized to dry the solids prior to the gasification unit. Because of this, there is little remaining recoverable energy, and the unit is actually a net user of power since electrical power is used for dewatering, conveyance, and odor control. However, there is potential for it to be energy neutral.

4.6 Pyrolysis

Pyrolysis is an emerging technology with two demonstration facilities in the U.S., one located at the Encina Wastewater Authority (EWA) and one at the Los Angeles County Sanitation District (LACSD). The process is similar to gasification in that it involves applying a controlled amount of heat to sludge except that it operates in an oxygen free environment. Because it operates in this type of environment, there is little or no combustion. The incomplete combustion of the sludge produces a biochar, a pyrolysis oil (i.e., "bio-oil"), and a gas similar to syngas created with gasification. The biochar, bio-oil, and biogas from pyrolysis can be used to fuel a waste-to-energy facility or as a fuel alternative for cement kilns. In addition, the biochar can be used as an organic fertilizer/soil amendment.

Similar to the gasification process, dewatered cake is dried to 90 percent solids and fed into the pyrolysis system. The cake is subjected to high temperatures (less than 700 degrees Celsius) in the absence of oxygen - biochar, bio-oil, and biogas are created from this process. The air pollution control system for pyrolysis would consist of equipment similar to a gasification process.

When considering the energy efficiency for this alternative, EWA has observed multiple benefits through the addition of the pyrolysis process to their existing anaerobic digestion process. By co-digesting the bio-oil with sewage sludge they have observed an increase in biogas production by 25 to 30 percent, a reduction in the mass of the dewatered sludge by approximately 8 times through use of the pyrolysis process, and the resulting biochar has concentrated nutrients for use as an organic soil amendment (offsetting the use of fossil-fuel energy intensive synthetic fertilizer).

5.0 ADDITIONAL CONSIDERATIONS

5.1 Public-Private Partnerships (PPP)

The City may consider PPPs for the operation and management of the selected solids treatment alternative. Public-private partnerships are contractual arrangements making use of private partner resources to finance public projects and enable municipalities to outsource the management and operation of portions of or all of their wastewater or biosolids processing system. For example, the private partner may provide:

- Treatment supplies (e.g., chemicals).
- Design and construction services.
- Maintenance of a portion of the collection and/or treatment system under a contract in compliance with all applicable federal, state, and local environmental regulations.
- Meter reading, billing, and customer service.

The risks and rewards are shared while providing access to additional capital resources and the public partner maintains ownership of the assets, controls the management of the assets, and establishes user rates.

An example project for which the City may consider a PPP is the addition of a pyrolysis system onsite at the OWTP. As this is an emerging technology in the wastewater sector, the OWTP staff could benefit from contracting with an experienced private partner to install, operate, and manage the pyrolysis system. Since there are benefits of operating this system alongside anaerobic digestion, the private partner could work closely with public partner (i.e., OWTP) staff to optimize management of both systems. The terms of the contract would clarify the responsibilities of the private partner. An example entity the City may consider for a PPP with pyrolysis system experience could be Anaergia Inc. Anaergia is a private company currently managing two demonstration pyrolysis system projects at EWA and LACSD, and they are currently in a PPP with Victor Valley Wastewater Reclamation Authority supporting their Omnivore™ digester system.

5.2 OWTP Location and Biosolids Processing Layout

If the OWTP remains in its existing location, recommendations for optimizing biosolids related facility locations within the OWTP site are provided in Section 3 of *PM 3.7.1 - Wastewater System - Treatment Alternatives*.

5.3 Alternative Biogas Utilization

The OWTP currently uses the biogas it produces to generate electricity and heat onsite through its cogeneration system. This electricity and heat is beneficially used by OWTP facilities, thereby offsetting purchased electricity and heat. If the OWTP produces biogas in excess of the facility's demand (e.g., through receipt of fats, oils, and grease) or would like to consider other ways to utilize the biogas, there are two other options that may be viable and good options for satisfying potential future restrictive air emissions limits on stationary combustion units:

- Processing the biogas into a compressed natural gas (CNG) to be used as a transportation fuel.
- Processing the biogas into a pipeline grade fuel for injection into a natural gas pipeline.

While the technology and expertise for processing biogas into transportation fuel already exists, newly developed regulations and goals geared toward greenhouse gas (GHG) emissions reductions are providing newfound incentives for implementing these types of projects making them more feasible in California. Not only do these projects produce a renewable fuel with low carbon content, they also offset the use of and dependence on fossil fuel consumption and reduce emissions of GHGs and local air pollutants.

Digester gas to CNG fuel projects consist of anaerobic digesters, a gas conditioning system, a compressor system, a gas storage system, and a fueling station, as well as a fleet of vehicles or trucks nearby that can make use of the fuel. Nearby industries (e.g., the New Indy Containerboard Company that manufactures and supplies recycled containerboard to the corrugated box industry) are ideal candidates for using CNG in their distribution vehicles.

Standards and incentives are also being developed in California for the processing and injection of biogas into existing natural gas pipelines. The City should determine if there are nearby Southern California Gas Company pipelines and discuss the advantages (e.g., reducing or eliminating onsite stationary combustion) and disadvantages (e.g., current costly interconnection fees and digester gas sampling/testing requirements) of injecting conditioned biogas into a pipeline. The California Public Utilities Commission is leading the effort to examine barriers to injecting conditioned biogas in order to make this a more viable option in the future.

6.0 ADVANTAGES AND DISADVANTAGES OF SOLIDS TREATMENT ALTERNATIVES

Table 4 summarizes the advantages and disadvantages of the solids treatment and management alternatives discussed above. Table 4 also ranks each alternative against the goals and objectives for the PWIMP, as noted in Section 2 of *PM 3.7.1- Wastewater System - Treatment Alternatives*. The City should consider the future viability of each disposal or end use option, the OWTP site flexibility, the constructability of each alternative, and the flexibility of each alternative relating to future conditions and the regulatory environment. While Table 2 currently shows composting offsite and pyrolysis in a better position to satisfy wastewater treatment goals, the City should consider a suite of options and include diversification in their solids portfolio to avoid risk.

Table 4 Advantages and Disadvantages of Solids Treatment and Management Alternatives
Public Works Integrated Master Plan
City of Oxnard

	Baseline (Landfill)	Baseline (ADC)	Baseline (Land Application)	Thermal Drying	Compost (Offsite)	FBI	Pyrolysis	Gasification
Goal 1: *Compliant, reliable, flexible system*	Low	Low-Moderate	Low-Moderate	Moderate	High	Moderate	Low	Low
Goal 2: *Economic sustainability*	Moderate	Moderate	Moderate	Moderate	Moderate	Low	Moderate	Low
Goal 3: *Mitigate/adapt to climate change*	Low	Low	Low	Low-Moderate	Moderate	Moderate	Moderate	Moderate
Goal 4: *Resource sustainability*	Low	Low	Moderate	Moderate	High	Moderate	Moderate-High	Moderate
Goal 5: *Energy efficiency*	High	High	High	Low	High	Low-Moderate	Moderate-High	Moderate
Advantages	No impact to OWTP footprint Low $	No impact to OWTP footprint Low $ Beneficial use of product	No impact to OWTP footprint for Class B Low $ for Class B Beneficial use of product Offset use/production of synthetic fertilizer	Marketable pelletized product Reduces solids volume and hauling costs Beneficial use of product	No impact to OWTP footprint Low $ Marketable product (more publicly accepted) Beneficial use of product	Potential net energy recovery (unlikely) Reduces solids volume and hauling costs Potential beneficial use of product (ash in cement)	Potential net energy recovery Marketable product (biochar) Reduces solids volume and hauling costs Beneficial use of product(s) - biochar, biogas, bio-oil	Potentially energy neutral Reduces solids volume and hauling costs Potential beneficial use of product (ash in cement)
Disadvantages	Option threatened by regulatory and public perception drivers No beneficial use of product	Option threatened by regulatory and public perception drivers	Class B land application option threatened by regulatory and public perception drivers Limited land application sites	Marketing of pelletized product requires public buy-in and public relations efforts Potential hazard (explosive dust particles) Increase in energy use Product quality desired by end user can drive additional upstream processes Additional footprint Med $$ (capital, O&M)	Can be difficult to site and permit if public is against compost process May require additional emissions measurement	Additional process and equipment to operate/maintain Can be difficult to site and permit if public is against process Air pollution control requirements/costs Existing and future limiting regulations Additional footprint High $$$ (capital, O&M)	Additional process and equipment to operate/maintain New application of technology - only two demonstration facilities in operation Additional footprint High $$$ (capital, O&M)	Additional process and equipment to operate/maintain (including pre-drying) Installation in U.S. is no longer in operation Additional footprint $$$ (capital, O&M)

* An alternative is ranked "high" if it satisfies the goal, "moderate" if it partially satisfies the goal, and "low" if it does not satisfy the goal.