CITY OF PORTLAND
ENVIRONMENTAL SERVICES
1120 SW Fifth Avenue, Room 1000, Portland, Oregon 97204 ▪ Nick Fish, Commissioner ▪ Dean Marriott, Director

August 28, 2014

Mr. Rob Burkhart
Oregon Department of Environmental Quality
NW Region Water Quality, Wastewater Division
2020 SW Fourth Avenue, Suite 150
Portland, Oregon 97201-4987

Subject: **Annual CSO and CMOM Report, FY 2014**
Columbia Boulevard Wastewater Treatment Plant NPDES Permit #101505

Dear Mr. Burkhart:

Enclosed, please find two copies of the *Annual CSO and CMOM Report, FY 2014*, submitted as required in the NPDES Permit for the Columbia Boulevard Wastewater Treatment Plant. This annual report provides a comprehensive review of Portland's integrated CSO system and CMOM Program for fiscal year 2014 and addresses the material outlined in section 12.4 of the *Nine Minimum Controls Update Report*, December 2010.

If you have questions regarding this year's report, please do not hesitate to call me at (503) 823-7866.

Sincerely,

Virgil C. Adderley

Virgil C. Adderley
CSO Program Manager

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NORTHWEST REGION

Enclosures (Annual CSO and CMOM Report, FY 2014)

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Annual CSO and CMOM Report
FY2014

REQUIRED BY NPDES PERMIT #101505

ENVIRONMENTAL SERVICES
CITY OF PORTLAND
working for clean rivers

Nick Fish, Commissioner

Dean Marriott, Director

Annual CSO and CMOM Report FY 2014

Required by NPDES Permit #101505
for CBWTP and CSO Systems

September 2014

City of Portland
Bureau of Environmental Services

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Glossary

CBWTP. Columbia Boulevard Wastewater Treatment Plant

CCTV. Closed-circuit Television

CIP. Capital Improvement Project (or Program)

CMMS. Computerized Maintenance Management System

CMOM. Capacity, Management, Operation, and Maintenance

CSCC. Columbia Slough Consolidation Conduit

CSO. Combined Sewer Overflow

DEQ. Oregon's Department of Environmental Quality

EPA. Environmental Protection Agency

FM. Force Main

FY. Fiscal Year (FY 2014 is July 1, 2013, through June 30, 2014)

IPS. Influent Pump Station (pumps water from the Columbia Slough Consolidation Conduit to the CBWTP)

MAO. Mutual Agreement and Order

NFAA. No Feasible Alternative Analysis

NMC. Nine Minimum Controls

NPDES. National Pollution Discharge Elimination System

SICSO. Swan Island CSO; used to refer to the pump station pumping water stored by the Willamette River's West Side and East Side CSO Tunnels.

SPCR. Spill Protection and Citizens' Response

SRRP. Sewer Release Response Plan

SSO. Sanitary Sewer Overflow

TCWTP. Tryon Creek Wastewater Treatment Plant

Executive Summary

The Annual CSO and CMOM Report for fiscal year 2014 (July 1, 2013, through June 30, 2014) provides a comprehensive review of Portland's integrated combined sewer overflow (CSO) system and the Capacity, Management, Operation, and Maintenance (CMOM) Program. The integrated CSO system includes the collection system, CSO facilities, and treatment systems at the Columbia Boulevard Wastewater Treatment Plant (CBWTP). As a result of the integration of CMOM with the combined sewer system, this report also provides the annual review for the CMOM Program, thereby addressing the reporting requirements in the CBWTP NPDES Permit for both programs.

This annual report documents the performance of the CSO control and treatment system, as well as the CMOM Program activities over the past fiscal year. The report includes a review of the major storm events that caused CSO to be discharged, and it examines the wet weather treatment performance at the CBWTP. In addition, the report documents the ongoing implementation of Portland's CMOM program, which overlaps with Portland's Nine Minimum Control (NMCs) elements of the CSO program.

As this is the first integrated CSO and CMOM Annual Report, the performance results and data presented will establish the baseline for many parameters, especially CMOM performance measures. Future follow-on reports will build on that baseline and will eventually show trends that demonstrate improvements or highlight areas requiring additional focus.

Integrated CSO System Performance. Fiscal year 2014 was a near-average year in which Portland received 40 inches of rainfall compared to the 37 inches per year average. The CSO system successfully captured all the combined sewage except during three storms that exceeded the 4-per-winter or 3-year summer criteria. Two of the three events were caused by summer storms, and one was caused by a winter storm:

1. **September 27-30, 2013:** 88 MG discharged over 7 hours on September 28-29 from the Willamette River CSO tunnels during this 10-year, 24-hour summer storm
2. **March 25-30, 2013:** 39 MG discharged over 3 hours on March 28 from Willamette River CSO tunnels during this 2-per-winter, 12-hour winter storm
3. **June 15-16, 2014:** 0.03 MG discharged over 12 minutes on June 16, due to CSO pumped from Alder Pump Station during a localized 3-year, 30-minute summer storm

Throughout the fiscal year, all active CSO outfalls were controlled to meet and exceed the permit requirements. In total, the system discharged 127 MG of CSO volume to the Willamette River, which is less than 2% of the total 7.1 billion gallons of wet weather combined sewage generated in the combined sewer system.

CSO Treatment Performance. During this fiscal year, the CBWTP system consistently met the permit's water quality based effluent limits for BOD and TSS mass loads at the Outfall 001 and 003 discharge points into the Columbia River. During February-March 2014, the 30-day concentration limit was exceeded although the total TSS mass load limit was achieved. CBWTP's consistent and good performance was disrupted during a wet weather period in February to March when the new secondary treatment improvement facilities were brought online, which caused new challenges and issues. The Max-Month and Peak-Week concentration values for the CBWTP outfalls are in Table ES-1.

Table ES-1 Outfall 001 + 003 Effluent Concentrations During Peak Mass-Loading Periods

Parameter	Permit Maximum Concentration	Average Actual Concentration
	(mg/l)	(mg/l)
Maximum 30-Day Performance		
BOD5	30	28
TSS	30	33
Peak 7-Day Performance		
BOD5	45	35
TSS	45	38

The Wet Weather Treatment Facility (WWTF), upgraded with Chemically Enhanced Primary Treatment (CEPT) system in the fall of 2012, continued to perform better with on-going improvements in operations. The improved operations of CEPT enabled CBWTP staff to achieve annual percent removals of 63% for bio-chemical oxygen demand (BOD) and 83% for total suspended solids (TSS) through the WWTF. This performance fully met the permit-required 50% BOD and 70% TSS annual removal rates.

Analysis of the FY 2014 CSO treatment data revealed that the CBWTP received 7.1 billion gallons of captured CSO. The operators were able to treat 64% of this CSO volume through the secondary system, with 36% treated in the WWTF. There were 27 events in which flows were sent through the WWTF. The average WWTF event lasted 33 hours and discharged 94 million gallons from the WWTF. During the events, the average flow rate treated by the dry weather/secondary system was 112 MGD, exceeding the 100 MGD required in the NPDES permit.

Nine Minimum Controls and CMOM Program. As envisioned in the permit, this report provides sufficient documentation of the on-going implementation activities for the NMCs and CMOM Programs, thereby eliminating the need for large periodic updating reports. In examining the requirements for NMC #1, Proper Operations and Maintenance, it is clear that the CMOM Program is the best way to fulfill EPA's requirements for managing the combined sewer system.

Portland's CMOM program has been designed to ensure that components of the collection system are cleaned and inspected at the right frequency and that preventive maintenance and repairs are performed to cost-effectively reduce the number of sewer releases, extend the useful life of the City's sewer infrastructure, and properly manage collection system operations. In FY 2014, the City of Portland's crews were able to:

- Inspect 1.1 million feet of sewer pipe, or about 11% of the mainline sewer system
- Clean 1.65 million feet of sewer pipe, or about 16% of the mainline sewer system
- Complete 400 mainline sewer repairs on 12,000 feet of pipe; 54% of the projects were in response to collection system problems such as a sewer release
- Repair 800 service laterals totaling about 10,500 feet of pipe; 70% of those repairs were in response to discovered problems
- Treat over 300,000 feet of pipe for roots using chemical root foaming and root saws

The priorities for the City's NMC and CMOM work are based on Asset Management principles that prioritize actions to reduce risks to public health and the environment. This approach has resulted in a strategic shift in capital and operating expenditures to maintenance-related projects:

- Capital expenditures in pipe rehabilitation programs have more than tripled since 2009 as the City implemented the Phase II Rehab Program to reduce structural risks in the sewer system. This trend continues into the next 10-year CIP, reflecting the City's focus on risk-based priorities for sewer capacity and condition.
- Expenditures for sewer capacity projects to relieve sewer backups by integrating grey and green infrastructure continue to be implemented on a steady basis. These projects were identified in the *Post-2011 CSO Facilities Plan* because they ensure a high level of CSO control by removing additional stormwater from the combined system.
- Treatment and Pump Station capacity and maintenance expenditures remain steady (about $28 million per year) to address increased capacity needs and aging facilities.

Monitoring. As shown in this report, Portland continues to carry out system monitoring, overflow monitoring, and water quality monitoring to ensure that permit requirements are achieved, human health is protected, and receiving streams meet water quality standards. Much of the monitoring data collected will be useful in updating the NPDES permit in 2016.

Section 1 Introduction

Portland's Annual CSO and CMOM Program Report provides an assessment of the combined sewer overflow (CSO) control system performance during the past fiscal year (FY 2014: July 1, 2013, to June 30, 2014), along with a summary of the sanitary sewer overflow (SSO) control performance and accomplishments through the Capacity, Management, Operation, and Maintenance (CMOM) program.

Portland's Columbia Boulevard Wastewater Treatment Plant (CBWTP) permit for discharging treated effluent includes requirements for the CSO system performance and requirements for managing the wastewater collection system. The National Pollutant Discharge Elimination System (NPDES) permit requires BES to submit annual CSO reports to the Oregon Department of Environmental Quality (DEQ) on the performance of the overall CSO system. The Annual CSO and CMOM report covers CSO capture, conveyance, overflow characteristics, treatment efficiencies, and on-going implementation of the Nine Minimum Controls (NMC).

Several of the Nine Minimum Controls overlap significantly with the elements of Portland's CMOM Program. Together, these two programs provide a comprehensive approach and view of how combined and separated sanitary sewage is managed, collected, conveyed, treated, and discharged throughout Portland's wastewater systems. The topics and overlap between the NPDES Permit, the CSO Program, and the CMOM Program is displayed in Table 1-1. To efficiently and comprehensively address these overlapping topics, Portland reports on the annual CSO performance and the CMOM program together in this integrated document.

Table 1-1 NPDES Permit, CSO, and CMOM Program Overlap

	Regulatory Document		
	NPDES Permit	EPA CSO Policy	CMOM Guidance
System	Treatment Plant	CSO Control System	Collection System
Regulatory Requirements Addressed by Regulatory Documents	Outfall Effluent Limits		
	Dry Weather Treatment		
	Wet Weather Treatment	Wet Weather Treatment	
	CSO Mixing Zones for WQS	CSO Event Control Levels	
		Nine Minimum Controls	
		NMC#1: Proper O&M	Maintenance Practices
	System Operating Plan	NMC#2: Maximize Storage	Operations
	Pretreatment Requirements	NMC#3: Pretreatment Requirements	
	System Operating Plan	NMC#4: Maximize Flow to POTW	Operations
	Sewage Overflow Prohibition	NMC#5: Eliminate DWOs	Minimize SSOs
		NMC#6: Control of Solids and Floatables	
		NMC#7: Pollution Prevention	
		NMC#8: Public Notification	Spill Response & Notification
	Monitoring	NMC#9: Monitoring	

1.1 Purpose

This report is intended to meet the CSO-related reporting requirements in the CBWTP NPDES permit and the annual reporting commitments contained in the 2013 CMOM Program Report. This annual report documents the performance of the CSO capture, conveyance, and treatment systems over the past fiscal year, as well as the activities performed by the City of Portland to improve on the already high level of CSO and SSO control. The report also examines the major storm events that caused CSO to be discharged and examines the wet weather treatment performance at CBWTP. In addition, the report documents the ongoing implementation of Portland's robust NMCs program, especially those controls that overlap with CMOM. The NMC program consists of appropriate and cost-effective best management practices that make up the EPA-specified NMCs, which have been integrated into the City's CSO Control Program.

CSO Control Program. The CSO Control Program is designed and operated to control the magnitude, frequency, and duration of wet-weather-induced CSO discharges in compliance with water quality standards. The permit requires CSO discharges into the Willamette River and the Columbia Slough to be controlled as follows:

- CSO discharges to the Columbia Slough are eliminated except during storms that are larger than the 5-year winter[1] and the 10-year summer[2] design storms.
- CSO discharges to the Willamette River are eliminated except during storms that are larger than the 4-per-winter and the 3-year summer design storms.

CMOM Program. The purpose of the CMOM program is to reduce the risks to public health, safety, and the environment due to sewage releases from the wastewater collection system. It ensures that the collection system is managed cost-effectively to address other potential risks of failure, such as a pipe collapse or sinkhole.

1.2 Regulatory Background for Report

The Annual CSO and CMOM Report provides a summary of important performance measures derived from five major CSO and CMOM regulatory and program documents:

- *2011 CBWTP NPDES Permit and Mutual Agreement and Order (MAO)*
- *NMC Implementation Update Report*, December 2010
- *2013 CMOM Program Report*
- *Post-2011 CSO Facilities Plan*, September 2010
- *No Feasible Alternative Analysis (NFAA) Report*, December 2009

These documents include components of the long-term CSO control and Asset Management procedures Portland has followed over the past 24 years. The first three documents direct the majority of the content of this performance report and are summarized in this section.

2011 CBWTP NPDES Permit and MAO. The Columbia Boulevard NPDES Permit (effective July 1, 2011) is the primary regulatory document that prescribes most of the Annual CSO Performance report content. Permit requirements include:

- Long-term CSO Control Program Performance (provided in Section 2 of this report)
- Wet Weather CSO Treatment Performance (Section 2.6)
- Nine Minimum Controls (Section 3 through Section 8)
- Post-Construction Monitoring Plan (Section 8)

[1] Winter is defined as November 1 through April 30

[2] Summer is defined as May 1 through October 31

The MAO attached to the CBWTP permit also required the City to implement specific wet weather and secondary treatment improvements, and to implement a monitoring and analysis program to measure the treatment effectiveness during wet weather conditions. The influent and effluent monitoring will occur after the major treatment improvements have been implemented and brought online.

2010 NMC Report. With full implementation of the CSO Control Program at the end of 2011, Portland effectively entered Phase III of EPA's NMC Program. In this phase, the NMCs continue to be implemented and adjusted to complement and enhance the control provided by the grey and green infrastructure developed as part of the CSO Control Program.

A key focus of this annual report is to integrate the CSO control information represented in the NMCs with the overlapping CMOM program elements for the collection system's management, operations, and maintenance. The major overlap between the CMOM program and the NMCs occurs with NMC #1 – Proper Operation and Maintenance; however, there is also overlap with:

- NMC #2: Maximize use of collection system for storage (operations controlled)
- NMC #4: Maximize flow to the POTW (operations controlled)
- NMC #5: Eliminate dry weather overflows (part of SSO reduction)
- NMC #9: Public Notification

This CSO and CMOM annual report provides summary tables and graphs for each of the NMCs to document their ongoing implementation.

It should be noted that the annual pretreatment report required by the permit and submitted separately contains information about the status and performance of the pollution prevention program. Consequently, this CSO and CMOM Annual Report does not include information about the City's pretreatment and pollution prevention programs.

2013 CMOM Program Report. Over several years, the City of Portland has implemented a CMOM program to reduce the likelihood of sewer releases by improving the overall reliability of the sanitary and combined sewer collection systems. The *CMOM Program Report* that was submitted to DEQ on June 28, 2013, explains BES's strategies and activities for the development, reinvestment, operation, and maintenance of the system. The report was developed to comply with Condition 3.b.(1)(B) of Schedule A of the CBWTP NPDES permit.

The CMOM program specifically addresses proper operation and regular maintenance of the collection system (NMC #1). The City's wastewater collection system includes main lines, trunk lines, interceptors, pump stations, and force mains. The City is generally responsible for service laterals from the sewer main up to the curb line, while service laterals extending behind the curb are the responsibility of the property owner. Portland's sewer collection system consists of a network of 2,569 miles of collection system piping (1,001 miles of sanitary sewer including force mains, 906 miles of combined sewer, and 662 miles of sewer laterals) and 40,248 sewer manholes. The system also includes two wastewater treatment plants and 97 pump stations (80 pump stations that are owned by the City, 6 pump stations that are owned by other public agencies and operated and maintained by the City under satellite or easement agreements, and 11 privately-owned septic tank effluent pumping systems that are maintained by the City under agreements with the property owners).

Commencing with this report for FY 2014, annual CMOM program updates will be included with CSO performance reporting. The effectiveness of BES's risk-based asset management approach to collection system operation and maintenance will be evaluated in this annual review of CMOM program actions and key performance indicators.

Section 2 Integrated CSO System Performance for FY 2014

The integrated CSO system consists of the combined sewer collection system, the CSO collection, storage and pumping system, and the CBWTP treatment system. This section reports on the performance of the overall integrated CSO system during FY 2014.

2.1 Expected Control Levels for Portland's CSO Outfalls

The NPDES permit requires all CSO discharges to be eliminated for storms less than specific return periods during the winter and summer seasons. The specific storm-return frequencies or levels of CSO control that Portland expects to achieve (which meet or exceed DEQ required levels) are summarized in Table 2-1.

Table 2-1 CSO Outfall Control Levels and Methods

Basin	CSO Outfall	Method of CSO Control	BES Control Standard[3]
Willamette River CSO Outfalls - Minimum Control Level			
Sheridan	7B	West Side CSO Facilities	4-per-Winter Storm and 3-Year Summer Storm
CBD/Ankeny	09	West Side CSO Facilities	
Nicolai	15	West Side CSO Facilities	
NW 110th	24	Cornerstone Projects and Linnton Pump Station Improvements	
Taggart	30	East Side CSO Tunnel	
Alder	36	East Side CSO Tunnel	
Wheeler	43	East Side CSO Tunnel	
Beech-Essex	46	East Side CSO Tunnel	
Riverside	47	East Side CSO Tunnel	
St. Johns B	52 and 53	Cornerstone Projects and System Improvements	

[3] The NPDES permit does not require floatables control devices on outfalls that are controlled to the 5-Year Winter Storm and 10-Year Summer Storm levels.

Basin	CSO Outfall	Method of CSO Control	BES Control Standard[3]
Willamette River CSO Outfalls - Highest Control Level			
Balch	17	West Side CSO Facilities, Balch Consolidation Conduit	5-Year Winter Storm and 10-Year Summer Storm
California	01	Sewer Separation, SWPI	
Carolina	03	Southwest Parallel Interceptor (SWPI)	
Sellwood	26A	Partial Separation, System Improvements	
Sellwood - Lents	27	Sellwood CSO Storage and Pumping System	
Columbia Slough CSO Outfalls - Highest Control Level			
St. Johns A	54	Expanded Separation and Downspout Disconnection	5-Year Winter Storm and 10-Year Summer Storm
Oswego	55	Sumps, Expanded Separation, and Downspout Disconnection	
Oregonian	56	Sumps, Expanded Separation, and Downspout Disconnection	
Fiske A	57	Cornerstone Projects and Columbia Slough CSO Facilities	
Chautauqua	58	Cornerstone Projects and Columbia Slough CSO Facilities	
Bayard	59	Cornerstone Projects and Columbia Slough CSO Facilities	
Kenton	60	Cornerstone Projects and Columbia Slough CSO Facilities	
Albina	62/62A	Cornerstone Projects and Columbia Slough CSO Facilities	
NE 13th	65	Cornerstone Projects and Columbia Slough CSO Facilities	

2.2 Rainfall Patterns for the Past Fiscal Year

FY 2014 was a moderate rainfall year for the City of Portland. The rainfall gauge at the CBWTP measured 40 inches over the year, compared with an average rainfall of 37 inches per year for Portland.

During this period, two winter storm events occurred that exceeded the 4-per-winter design storms, and three summer storms exceeded the 3-year summer storm depths for different durations. Three of the events were large enough to generate CSO discharges:

1. September 5-6, 2013 – No Overflows
2. September 27-30, 2013 – Summer CSO Event
3. February 14-18, 2014 – No Overflows
4. March 25-30, 2014 – Winter CSO event
5. June 15-16, 2014 – Summer CSO Event

2.2.1 Winter Storm Review

The two storms that exceeded the 4-per-winter NPDES Permit design depths are shown graphically in Figure 2-1 below. This graph is a "Depth-Duration" chart that displays the maximum depth of rainfall that occurred for the range of storm duration, from 1-hour to 48-hours. The one event that caused CSO to occur is shown with a red line, and the one storm that had no CSO is shown with a green line. The one CSO event is compared to the two NPDES Winter Design Storms (4-per-winter and 5-year winter[4]) shown with blue-tinted lines.

[4] 5-Year Winter Storm is included on the charts for the Willamette CSO System because it is a control standard in the permit for outfalls that are not required to have floatables control devices installed.

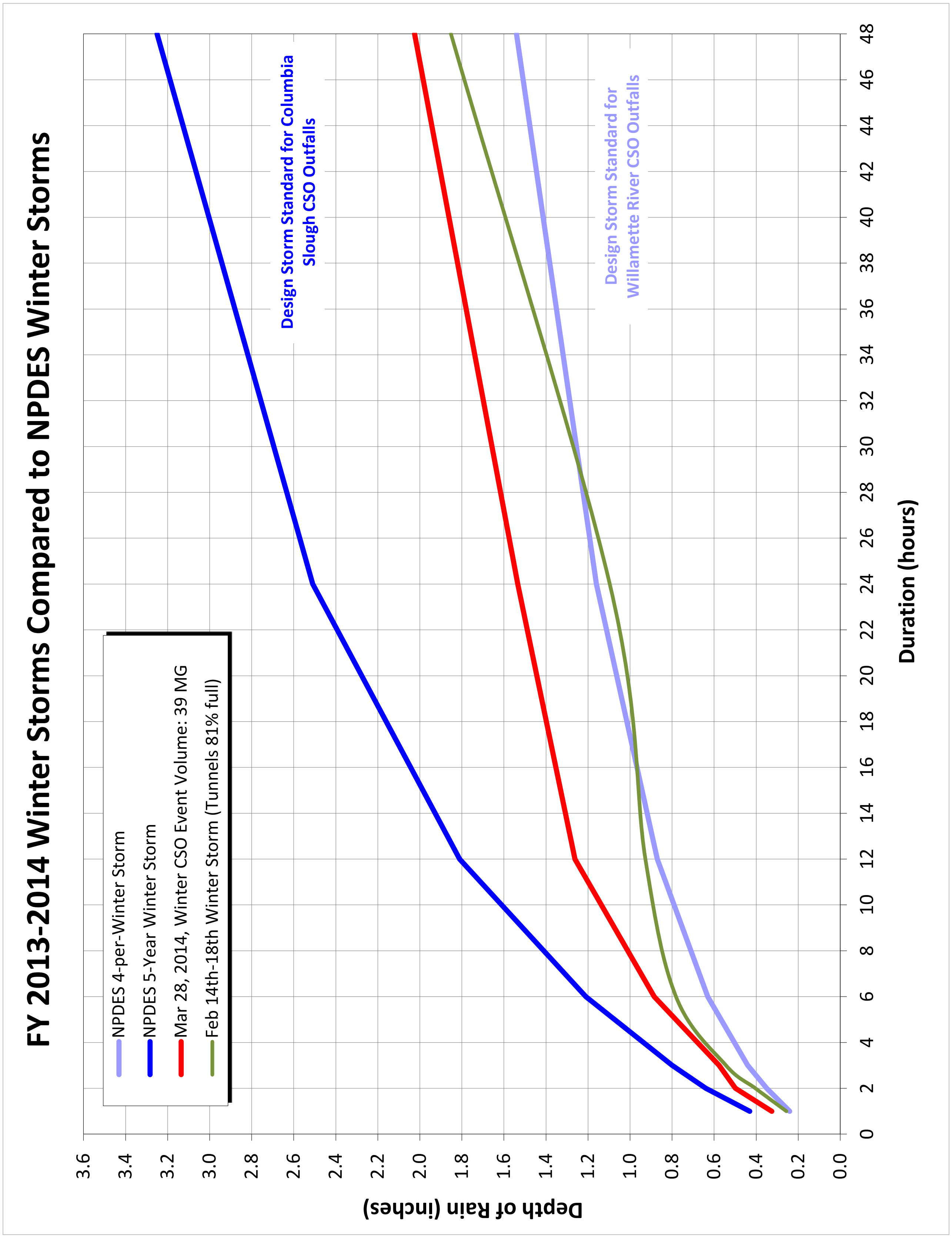

Figure 2-1 FY 2014 Winter Storms Compared to NPDES Permit Design Storms

The actual depth values used to create the chart are provided in Table 2-2 below.

Table 2-2 FY 2014 Winter Storm Comparison

Storm	Duration (hours)						Notes
	1	3	6	12	24	48	
Willamette River Winter Design Storms (inches)							
4-per-Winter Design Storm	0.24	0.44	0.65	0.89	1.19	1.53	
5-year Winter Design Storm	0.43	0.8	1.21	1.81	2.51	3.26	
Historical Storms - Average Rainfall over Willamette CSO Basin (inches)							
February 14-18, 2014	0.26	0.54	0.78	0.93	1.10	1.85	Exceeds 4-per-Winter 1-12 and 48 Hours
March 25-30, 2014 **CSO Event**	0.33	0.58	0.89	1.26	1.53	2.03	Exceeds 4-per-Winter 1-48 Hours

2.2.2 Summer Storm Review

Two of the three storms that exceeded the NPDES Permit 3-year Summer Storm design depths are shown graphically in Figure 2-2 below. This graph is a "Depth-Duration" chart that displays the maximum depth of rainfall that occurred for the range of storm duration, from 1-hour to 48-hours. The event that caused CSO to occur is shown with a red line, and the one storm that had no CSO is shown with a green line. The one CSO event is compared to the two Summer Design Storms (3-year summer and 10-year summer) shown with blue-tinted lines.

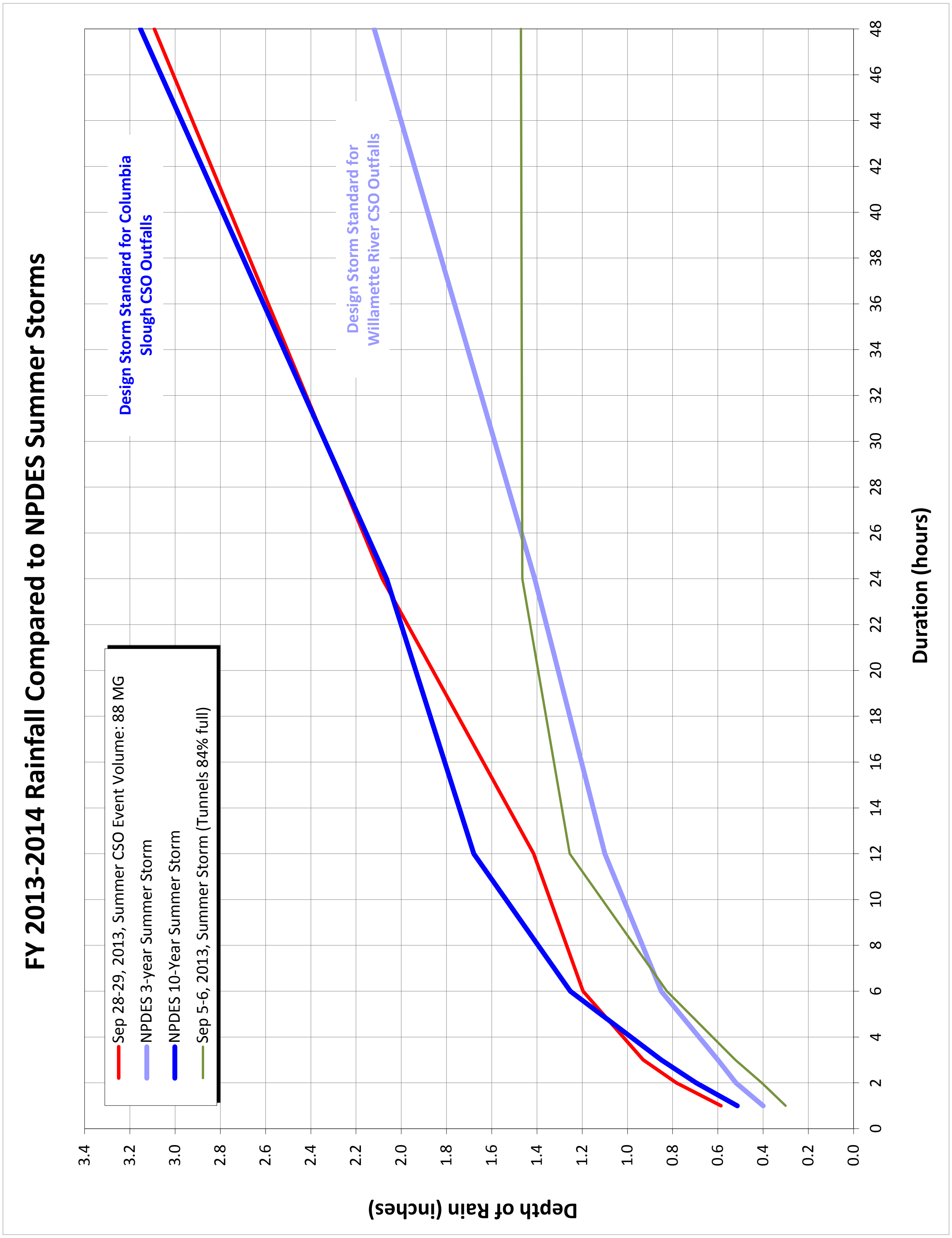

Figure 2-2 FY 2014 Rainfall Compared to NPDES Permit Summer Storms, Longer Durations

As Table 2-3 shows, the CSO event for September 27th-30th exceeded the 10-Year Summer Storm event for the 1-3 hour event duration.

Table 2-3 FY 2014 Summer Storm Comparisons

Storm	Duration (hours)						Notes
	1	3	6	12	24	48	
Willamette River Summer Design Storms (inches)							
3-Year Summer	0.40	0.60	0.85	1.10	1.41	2.12	
10-Year Summer	0.51	0.85	1.25	1.68	2.06	3.15	
Historical Storms, Average Rainfall over Willamette CSO Basin (inches)							
September 5-6	0.30	0.52	0.83	1.25	1.46	1.47	Exceeds 3-Year Summer Storm for the 6-24 hours
September 27-30 **CSO Event**	0.59	0.93	1.20	1.41	2.08	3.09	Exceeds 3-Year Summer Storm for all durations; 10-Year Summer Storm for 1, 3, 24 hours

The third summer storm occurred on June 15-16, 2014, and was a highly intense, short-duration event that impacted SE Portland. This storm's greatest intensity occurred within a 30-minute time span, as displayed in Figure 2-3. This storm's short duration requires a separate chart due to the short duration compared to the other two summer storms.

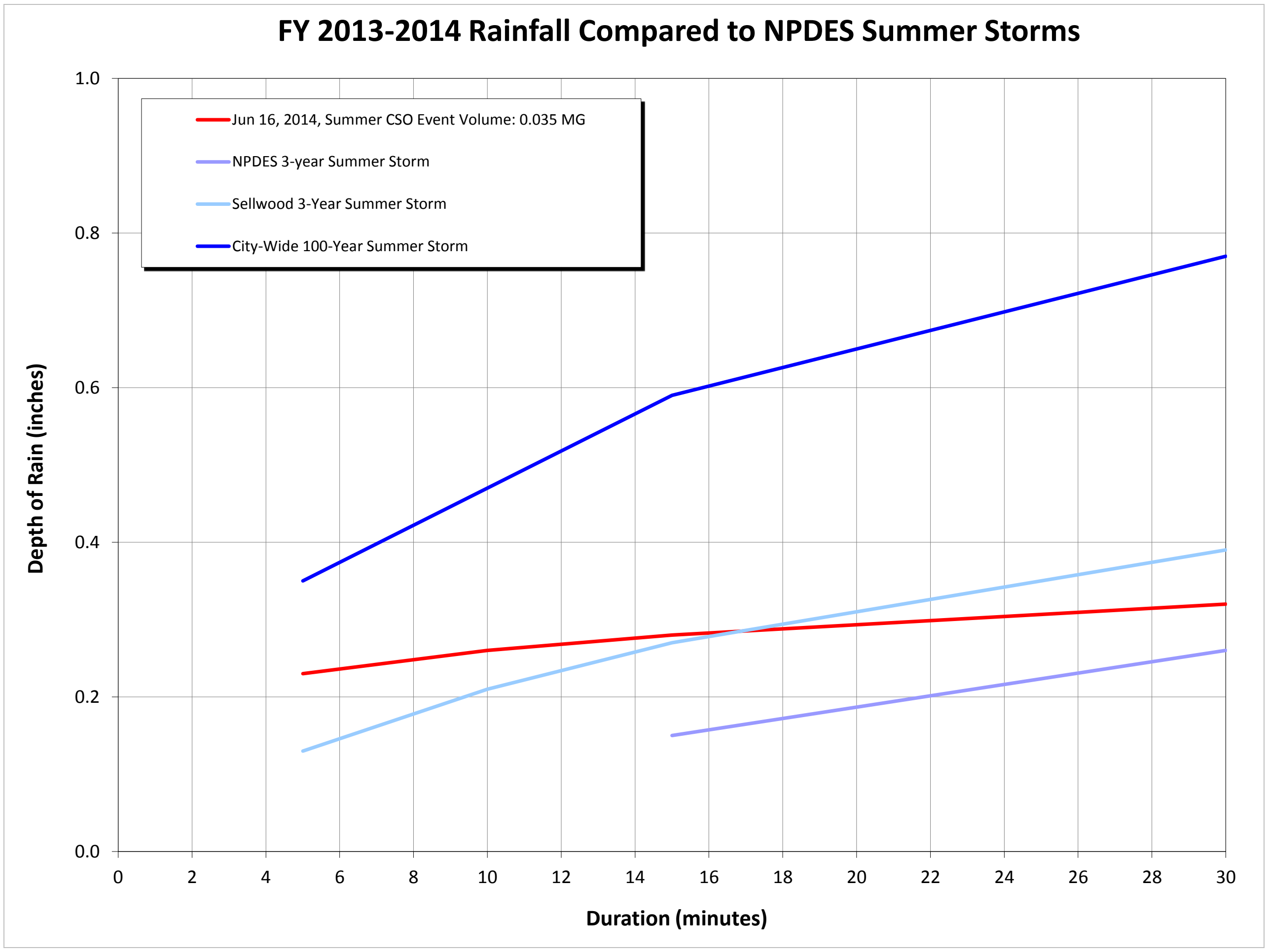

Figure 2-3 FY 2014 Rainfall Compared to NPDES Permit Summer Storms, Short Durations

Table 2-4 gives details on how this storm compares to several benchmark storms the City uses for gauging the validity of a short duration CSO event. Because of the highly localized nature of this event, the local 3-year summer design storm developed for the inner southeast area of Portland was also used for comparison. The comparison showed that event was caused by rainfall substantially more intense than either design storm.

Table 2-4 FY 2014 Short Duration Summer Storm Comparison

Storm	Duration (minutes)				Notes
	5	10	15	30	
Willamette River Summer Design Storms (inches)					
3-Year Summer (general, citywide)	N/A	N/A	0.15	0.26	Storm defined in 15-minute intervals, lesser durations not available
Sellwood 3-Year Summer Storm (inner Southeast)	0.13	0.21	0.27	0.39	
100-Year Summer (general, citywide)	0.35	0.47	0.59	0.77	
Historical Storms, Average Rainfall over Willamette CSO Basin (inches)					
June 15-16 (Gauge 181 – Multnomah Bldg) **CSO Event**	0.23	0.26	0.28	0.32	Exceeds Sellwood 3-year summer storm for 5-15 minutes and citywide 3-year summer storm for 30 minutes

2.3 CSO Discharges into the Willamette River and Columbia Slough

In FY 2014, there were no CSO discharges into the Columbia Slough. There were three storms large enough to exceed the capacity of the Willamette River CSO system:

- **September 27-30, 2013:** 88 MG discharged over a seven-hour period on September 28-29 from the East and West Side Willamette River CSO Tunnels. The storm included a peak 1-3 hour intensity that exceeded the 10-year summer storm criteria, as well as a 24-hour duration that exceeded the three-year summer storm.
- **March 25-30, 2014:** 39 MG discharged over a three-hour period on March 28 to the Willamette River. The large winter storm exceeded the four-per-winter design criteria, while portions of the service area saw precipitation exceeding the five-year winter storm.

- **June 15-16, 2014:** 34,500 gallons were pumped from southeast Portland's Alder Pump Station for a duration of 12 minutes on June 16. During this event, a short-duration thunderstorm exceeded the three-year summer storm for southeast Portland.

In FY 2014, a total of 127 MG of CSO was discharged from the completed CSO system. This volume represents 1.8% of the total 7.1 billion gallons of stormwater and CSO collected by the combined system in FY 2014. This means the CSO system captured and treated more than 98% of all the stormwater and sewage generated in the combined area.

A summary of the CSO discharges since December 1, 2011, is provided below in Table 2-5. Eight CSO events have occurred since the City first officially activated the East Side CSO system, which marked the completion of the Willamette CSO system.

The September 27-30, 2013, event listed in Table 2-5 (event 6) and displayed in Figure 2-2 reflects the fact that a power loss occurred at the Swan Island Pump Station for over two hours. Even though the event exceeded the 3- and 10-year summer criteria, the total volume of overflow would have likely been greatly reduced without the power outage. Additionally, as of the publication of this report, a major upgrade of the Ankeny Pump Station was not complete. Although substantial completion was reported prior to the March 25-30 event, it is likely that the upgraded system was not completely operational for the current reporting cycle. The pump station is expected to be fully operational early in FY 2015, after which time it is expected that the frequency and magnitude of CSO from this location will be reduced.

Table 2-5 Record of Willamette River CSO Events since December 2011

CSO Discharge Events			Storm Characteristics			System Totals		West Side Totals		East-Side Totals	
Event #	Dates of Storm / Overflow Events	Description	6-Hour Rainfall (inches)	12-Hour Rainfall (inches)	24-Hour Rainfall (inches)	Overflow (MG)	Duration (hours)	Overflow (MG)	Duration (hours)	Overflow (MG)	Duration (hours)
1	January 17-21, 2012	> 5-year 12-hour Winter Storm	1.48	2.15	2.32	304.9	10.3	86.4	10.3	218.5	10.3
2	May 26, 201 2	> 100-year, 30-minute storm (0.85" in 30-min)	-	-	-	0.17	0.42	-	-	0.17	0.42
3	November 17-21, 2012	5-year, 24-hour Winter Storm	1.22	1.65	2.44	176.4	9.5	44.0	9.5	132.4	9.3
4	November 24, 2012	3-per Winter, 24-hour Storm	0.61	1.09	1.49	0.5	0.8	0.5	0.8	-	-
5	May 23, 2013	3-year, 12-hour Summer Storm	0.9	1.22	1.5	26.3	2.3	11.9	2.3	14.4	1.8
6	September 27-30, 2013	10-year, 24-hour Summer Storm	1.2	1.41	2.08	88.5	7.0	27.0	7.0	61.5	5.4
7	March 25-30, 2014	2-per Winter, 12-hour Storm	0.89	1.26	1.53	43.1	3.0	14.3	3.0	28.7	3.0
8	June 15-16, 2014	3-year, 30-minute Summer Storm	-	-	-	0.03	0.2	-	-	0.03	0.2

Since being brought online in October 2000, the Columbia Slough Consolidation Conduit (CSCC) and associated CSO facilities have overflowed a total of twice – once in 2005 as a result of an operator error and again in May 2012 as a result of a storm exceeding the 100-year event for a short duration. Table 2-6 lists each CSO event from the CSCC.

Table 2-6 Record of Columbia Slough CSO Events since October 2000

CSO Discharge Events			Storm Characteristics	
Event #	Dates of Storm/Overflow Events	Description	Overflow (MG)	Duration (hours)
1	December 28, 2005	System overflow due to operator error[5]	0.28	0.65
2	May 26, 2012	> 100-year, 30-minute storm (0.85" in 30-min)	0.022	0.20

2.3.1 Dry Weather Overflow (DWO) Events and Additional Controls

Dry weather overflows (DWOs) have effectively been eliminated from the Portland system due to the completion of the CSO facilities in 2011. It is now extremely unlikely that a diversion structure can become blocked to the degree that it could cause a DWO because the overflow would instead be captured by the large CSO facilities downstream of the diversions. In addition, all overflow points (whether drop shaft structures or large diversion structures) that can overflow to the Willamette River or the Columbia Slough have level monitoring and alarms to signal if the water in the structure is approaching the overflow level. As a result, no dry weather overflows occurred in FY 2014.

2.4 Control of Floatables and Debris

All of the outfalls that experienced overflows during the reported events have specific floatables control systems, or are consistent with the CBWTP NPDES Permit requirements for outfalls that discharge without floatables control. Table 2-7 below details each of the outfalls that discharged during the reported events.

[5] Discharge event documented in January 20, 2006, letter to DEQ from CBWTP Manager Chris Mack.

Table 2-7 Floatables Control System Detail for Outfall Locations Experiencing CSO Events in FY 2014

Location	Outfall #	Floatables/Debris Control Type
Sweeney-Macadam/SW48	03	High Level of CSO Control[6]
Sheridan OF7B	07B	Bar Screen System
Ankeny OF09	09	WSCSO tunnel/overflow structure
Nicolai OF15	15	WSCSO tunnel/overflow structure
Riverside OF47	47	ESCSO tunnel/overflow structure
Beech OF46	46	ESCSO tunnel/overflow structure
Wheeler-River OF43	43	ESCSO tunnel/overflow structure
Alder OF36	36	ESCSO tunnel/overflow structure
Taggart OF30	30	ESCSO tunnel/overflow structure

Portland maintenance crews inspect and clean the bar screen within the Sheridan overflow structure (OF07B) following CSO discharge events. As can be seen in Table 2-8, which lists maintenance conducted at OF07B for this reporting cycle, the solids collected by the bar screen consist of a significant amount of natural debris with some litter. No visible sanitary material was reported to have been present following either of the CSO events.

Table 2-8 Sheridan Floatables Control System Event Maintenance Summary[7]

CSO Event Date(s)	Maint. Date	Description of Maintenance
September 28-29, 2013	9/30/2013	Removed 20 gallons of debris consisting of leaves/sticks, plastic, and paper.
March 28, 2014	4/10/2014	Vactored 30 gallons of debris including leaves, paper, and plastic.

2.5 CSO Facilities Operations Monitoring Information

2.5.1 Annual Operations Review

The CSO System configuration experienced a number of temporary and permanent changes that affected the integrated system operations during FY 2014. In general, the system changes were for operation performance and system maintenance purposes. Note that the changes are consistent with the primary directive of CSO systems operations – maximizing the volume of wet weather flows sent to the CBWTP.

[6] The NPDES permit does not require outfalls controlled up to the 5-year winter or 10-year summer storms to have floatable control devices.

[7] The Sheridan structure did not overflow during the June 16, 2014, CSO event, and therefore no maintenance activity was needed.

Table 2-9 below provides a summary of the total dry and wet weather volume pumped from the Swan Island CSO pump station through its three force mains, as well as the volume pumped from the CBWTP Influent Pump Station (IPS) that serves the Columbia Slough Consolidation Conduit (CSCC).

The system changes and their effect on operations can be summarized as follows:

- **Ankeny Pump Station remodel (BES CIP #E07833).** This project upgraded the four main pumps that convey sewage across the Willamette River to the Peninsular Tunnel. A number of other systems within the station were upgraded as well, particularly instrumentation, control, and communications.

  Construction on the facility remodel began in March 2012 and is anticipated to be substantially complete by the end of summer 2014. During construction, the Ankeny Diversion Structure was configured to direct combined sewage to the Ankeny Drop Shaft, the West Side CSO Tunnel, and finally Swan Island CSO Pump Station.

  The primary effect on CSO system operations was the temporary elimination of flow pumped across the river to the Peninsular Tunnel while being diverted to Swan Island. As Ankeny and Sullivan pump stations are given priority to the available capacity in the Peninsular Tunnel, the elimination of flow from Ankeny allowed the Swan Island CSO PS to discharge more flow to the Peninsular Tunnel.

- **Transition from Peninsular Lead to Portsmouth Lead.** The Swan Island CSO pump station has seven variable speed pumps connected to three force mains that convey combined sewage from the West Side and East Side CSO tunnels to the Peninsular and Portsmouth tunnels.

  The concept of “Peninsular Lead” and “Portsmouth Lead” establishes which of the force mains and related pumps will be used to convey combined sewage to the CBWTP. Compared to the Peninsular Lead operation, Portsmouth Lead further optimizes CSO storage management by reducing the time the SICSO pump station is not operating at its full available capacity.

- **IPS – CSO Pumping.** Total flow from the IPS – CSO pump station is lower than previous years. This reduction is due to a change in operating procedure for the NE 13th Flow Control structure (FCS).

  The NE 13th FCS was designed to split flow between the Lombard Interceptor and the CSCC at the uppermost end of the conduits. It also allows excess flows in the Lombard Interceptor to be relieved to the CSCC during peak storm conditions.

The FCS is not operated automatically and must be physically adjusted by BES staff. In previous years, the gate was left open during dry and wet weather conditions to allow all flow to enter the CSCC. The gate was closed to retain dry weather flows in the Lombard Interceptor for flushing/self-cleaning purposes. The CSCC is utilized during peak storm conditions only.

Table 2-9 FY 2014 Volume Pumped from CSO Tunnels

CSO Tunnel Pumping	Total Pumped Volume (MG)	
Swan Island CSO Pump Station		
Forcemain 1 (Peninsular Dry Weather)	5,642	
Forcemain 2 (Peninsular Wet Weather)	958	
Forcemain 3 (Portsmouth Wet Weather)	1,225	
Total Swan Island CSO Pumping		7,825
IPS – CSO Pump Station		1,128
Total Volume Pumped to CBWTP from Tunnels		8,953

The total volume pumped from the CSO tunnels (9,000 MG) compares in magnitude to the CSO-stormwater volume delivered to CBWTP (7,078 MG) as presented below in Section 2.6.1. This comparison indicates the degree to which the dry and wet weather flows arriving at CBWTP are coming from CSO pumping systems versus the gravity inputs from the older combined system.

2.5.2 CSO Event Operations Review

Three CSO events occurred over the period between July 1, 2013, and June 30, 2014. The following sections provide a summary of the CSO system operations during these events.

2.5.2.1 September 27-30, 2013

The amount of rainfall that fell during the September 27-30, 2013, storm exceeded the 3-year and the 10-year Summer Storm design criteria for short durations and for long (2-day) durations. The amount of CSO generated was relatively small (88 MG) over a short period (seven hours) when considered in context of the storm that was extremely large for September and lasted for multiple days.

A significant operational problem occurred when the two (dual-feed) electrical sub-stations serving the Swan Island CSO Pump Station (SICSO) went out during the storm on Sunday evening. Sustained winds of 20 to 30 mph with gusts up to 50 mph resulted in severe outage problems in Portland General Electric's system across North Portland and Northeast Portland throughout the weekend.

At about 7:00 PM on September 29th, power was lost to the Swan Island Pump Station for over two hours, until 9:20 PM. The level of water in the Willamette CSO tunnel was falling below elevation -5 feet (23-feet below the overflow level; 113 feet depth) when the power to the station went out at 7:00 PM. The level then rose to the point of overflowing and was at about elevation 19-feet (1-foot above the overflow level; 133 feet depth) when the power was restored.

As a follow-up to the event, Portland staff were able to revise the connections between the dual-feed systems to ensure a more reliable switch-over to the better power system should a similar situation occur in the future.

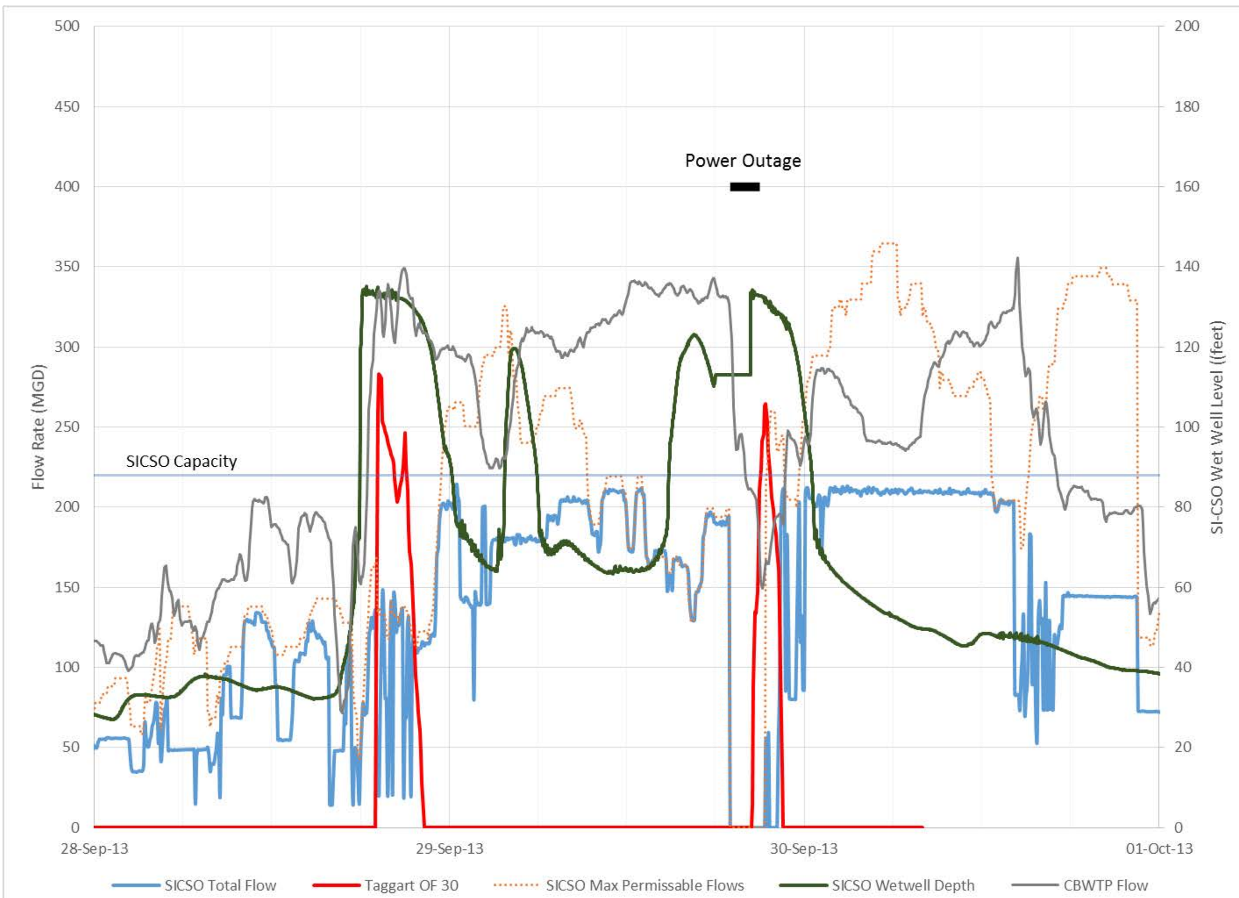

Figure 2-4 CSO System Performance Data for September 27-30, 2013, Storm

Table 2-10 below provides a summary of the volume treated through CBWTP during the late September 2013 storm. CBWTP received an average of 206 MGD for the four day period. An average of 133 MGD (65%) received secondary treatment and the remainder, 73 MGD, was directed to the wet weather treatment system. During this storm, only 35% of the flow to CBWTP was sent to the WWTF. The columns to the right in Table 2-10 provide summary data for all the flow generated in the combined system during the four day storm. The volume of CSO represents only 9% of the total flow generated in the combined system during that storm.

Table 2-10 CSO System Capture and Treatment Performance for September 27-30, 2013, Storm

	Avg. Flow Rate (MGD)	% of Flow to CBTWP	Volume (MG)	% of Total to Combined System
Total Flow to Combined System	n/a	-	930	100%
Total Flow to CBWTP	206	100%	842	91%
Total Flow to CBWTP Secondary System	133	65%	542	58%
Average Dry Weather Flow[8]	50	25%	207	22%
Wet Weather Flow Treated	83	40%	335	36%
Total Flow to CBWTP Wet Weather System	73	35%	300	32%
Total CSO Overflow	n/a	n/a	88	9%

2.5.2.2 March 25-30, 2014

The March 25-30, 2014, storm was a large winter storm that exceeded the 4-per winter design storm criteria for the Willamette River CSO control standards. Portions of the service area (central inner southwest and southeast) exceeded the 5-year Winter Storm.

Figure 2-5 shows system flows, including flow to the treatment plant, the allowable and actual pumping rate and wet well level at Swan Island CSO (SICSO) Pump Station, and the CSO discharge to the Willamette River. In order to protect the treatment plant system and continue to meet effluent limits, the SICSO Pump Station was restricted in how much it was allowed to pump, even during the period when CSOs were occurring on March 28. SICSO total pump rates matched the reduced allowable pump rates set by CBWTP operators between 4:30 PM and 10:30 PM.

Table 2-11 below provides a summary of the volume treated through CBWTP during the March 2014 storm. CBWTP received an average of 154 MGD for the four day period. An average of 108 MGD (70%) received secondary treatment and the remainder, 46 MGD, was directed to the wet weather treatment system. During this storm, only 30% of the flow to CBWTP was sent to the

[8] Based on CBWTP Flow during Sept. 14-21, 2013

WWTF. The columns to the right in Table 2-11 provide summary data for all the flow generated in the combined system during the four day storm. The volume of CSO represents only 6% of the total wet weather flow generated during that storm.

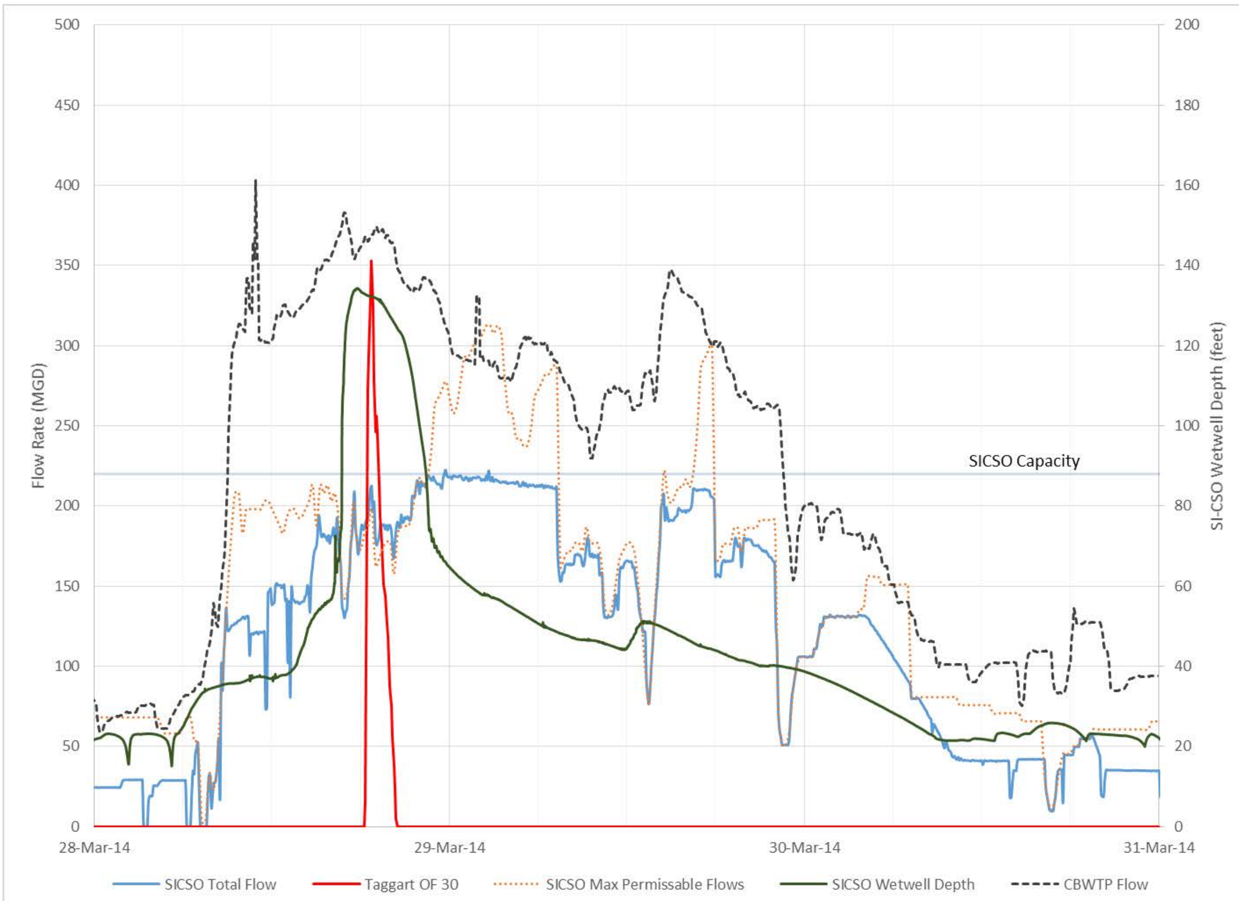

Figure 2-5 CSO System Performance Data for March 25-30, 2014, Storm

Table 2-11 CSO System Capture and Treatment Performance for March 25-30, 2014, Storm

	Avg. Flow Rate (MGD)	% of Flow to CBTWP	Volume (MG)	% of Total to Combined System
Total Flow to Combined System	n/a	-	704	100%
Total Flow to CBWTP	154	100%	665	94%
Total Flow to CBWTP Secondary System	108	70%	466	66%
Average Dry Weather Flow[9]	62	40%	267	38%
Wet Weather Flow Treated	46	30%	199	28%
Total Flow to CBWTP Wet Weather System	46	30%	199	28%
Total CSO Overflow	n/a	n/a	39	6%

2.5.2.3 June 15-16, 2014

The rainfall that occurred between June 15 and 16, 2014, exceeded the 3-year summer storm criteria for SE Portland, specifically during the short durations (30 minutes and less). The intense rainfall occurred during a thunderstorm that covered the inner east side sewer area served by Alder Pump Station, overwhelming its sanitary (dry weather) design capacity. The Alder Pump Station pumped about 34,500 gallons of CSO to the Willamette River in about twelve minutes. No other outfalls discharged CSO during this storm.

This CSO event was unusual in that it was a highly localized event that did not result from the CSO tunnel filling. This CSO was caused by intense rainfall generating enough combined sewage to exceed Alder Pump Station's sanitary (dry weather) capacity, causing the Alder storm pumps to discharge to the river. The two dry weather pumps continued to pump to the interceptor system throughout the storm, and the storm pumps operated as expected. Storm pumping (at a rate of 3,000 gallons per minute for each pump) lasted for twelve minutes on June 16, between 4:11 PM to 4:22 PM, and discharged about 34,500 gallons to the Willamette River. This storm pumping function is necessary to prevent sewer backups and flooding in the local area during extreme storms

BES recognizes the possibility that during significant storm events, Alder's sanitary pump capacity limitation could potentially result in a local CSO. To address this issue, flow relief structures were installed to divert combined sewage away from the pump station and into the tunnel system. The structures constrict flow to the Alder Pump Station enough to prevent the storm pumps from discharging CSO during storms less than the 3-year summer design storm as

[9] Based on CBWTP Flow during March 16-25, 2014

required in the NPDES permit. During the June 16th CSO event, the system performed as designed and did not discharge CSO until the rainfall exceeded the 3-year summer storm criteria.

Table 2-12 below provides a summary of the volume treated through CBWTP during the June 2014 storm. CBWTP received an average of 90 MGD for the 26 hour period. An average of 81 MGD (90%) received secondary treatment and the remainder, 9 MGD, was directed to the wet weather treatment system. During this storm, only 10% of the flow to CBWTP was directed to the WWTF. The columns to the right in Table 2-12 provide the summary data for all the flow generated in the combined system during the 26 hour storm. The volume of CSO represents less than 0.01% of the total wet weather flow generated during that storm.

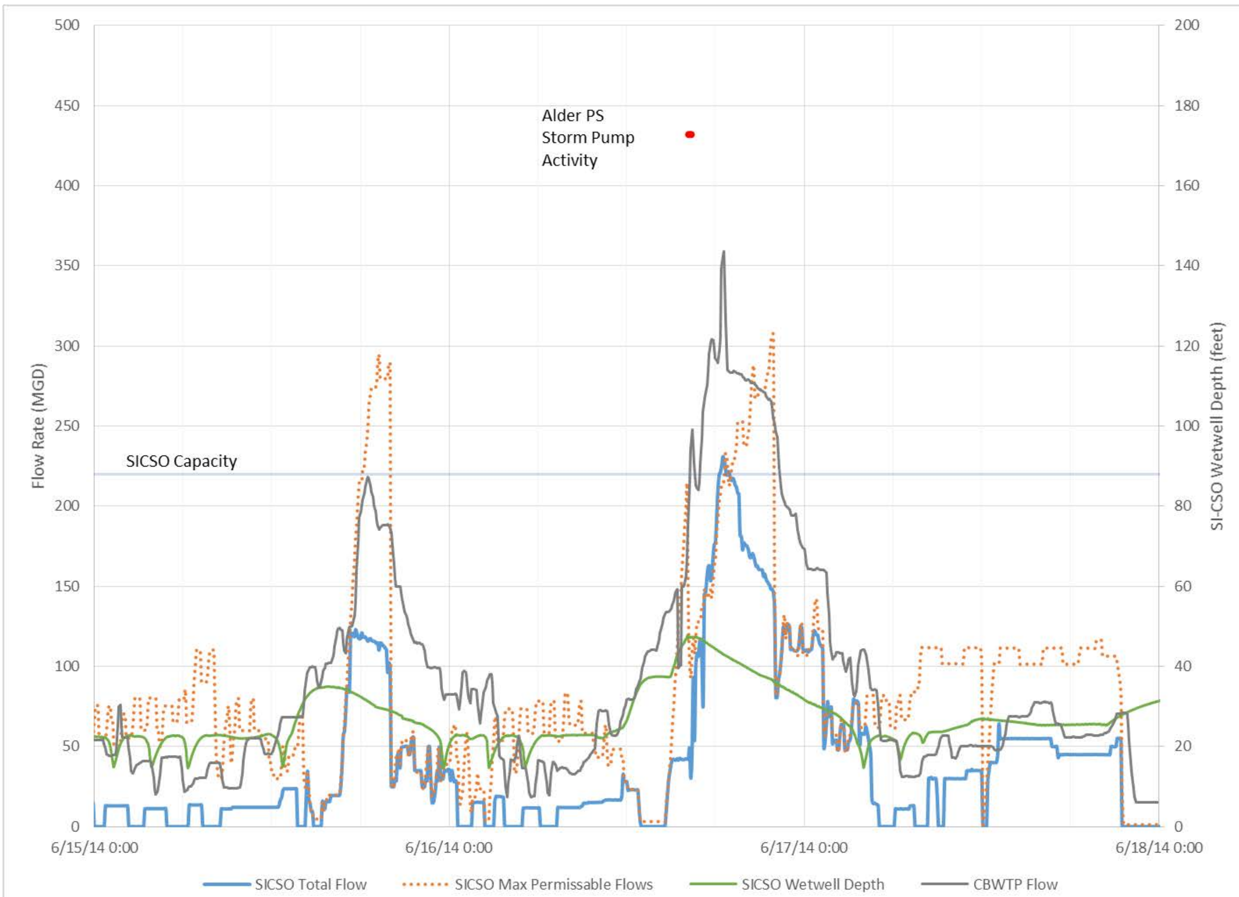

Figure 2-6 CSO System Performance Data for June 15-16, 2014, Storm

Table 2-12 CSO System Capture and Treatment Performance for June 15-16, 2014, Storm

	Avg. Flow Rate (MGD)	% of Flow to CBTWP	Volume (MG)	% of Total to Combined System
Total Flow to Combined System	n/a	-	99	100%
Total Flow to CBWTP	90	100%	99	>99%
Total Flow to CBWTP Secondary System	81	90%	89	90%
Average Dry Weather Flow[10]	59	66%	54	55%
Wet Weather Flow Treated	22	24%	35	35%
Total Flow to CBWTP Wet Weather System	9	10%	10	10%
Total CSO Overflow	n/a	n/a	0.03	<1%

2.6 Wet Weather Treatment Performance and Effluent Quality

2.6.1 Annual CSO Treatment Characteristics

The key parameters for the treatment system annual performance are derived from the NPDES permit, which specifies annual percent removal efficiencies. The parameters are based on Portland's No Feasible Alternative Analysis (NFAA). The NFAA relied on computer models that simulated average year conditions and identified expected levels of treatment through the secondary system, the number of bypass events, and the expected effluent quality from the blended wet weather and secondary systems.

Table 2-13 summarizes the main annual treatment performance measures for the CBWTP systems. Portland's CSO system has been completed for nearly three years as of July 2014, with some treatment components in place for less than two years. Table 2-13 lists the values for this fiscal year and compares them against the NPDES permit and the model (NFAA) expected values. The key parameters are highlighted in blue text. The results from the table show:

- Secondary treatment rate was maximized during periods of bypass. The average rate of secondary treatment of 112 MGD was more than 10% above the permit minimum requirement of 100 MGD.
- Percent of Captured CSO Treated through Secondary significantly exceeded the model target level (64% compared to 54%).

[10] Based on CBWTP Flow during June 1-15, 2014

- BOD and TSS Removal Efficiencies for the Wet Weather System exceeded the permit's annual requirements: BOD removal was 63% compared to the permit-required 50%, and TSS removal was 83% compared to the permit's 70% requirement.

The annual performance data indicates that the CSO system operations strategy enabled improved performance under various weather conditions throughout the year. In addition, Portland's use of CEPT has resulted in a significant reduction in BOD and TSS from the Wet Weather Treatment Facility.

Table 2-13 CBWTP Annual Treatment Performance Summary Data

Annual Treatment Characteristics	Average Year Model / Permit	*No CEPT* FY 2012	*With CEPT* FY 2013	*With CEPT* FY 2014	Trend
Annual Rainfall Depth (inches/year)	37	46.8	40.2	40.0	
Flows to CBWTP					
Influent Volume (MG/Year)	28,300	28,800	26,625	26,549	
Dry Weather Sanitary Volume (MG/Year)	22,100	20,200	19,496	19,471	
Captured CSO Flow - Volume (MG/Year)	6,200	8,600	7,129	7,078	
Total Volume Treated Thru Secondary (MG)	25,443	25,662	24,197	24,002	
% of Plant Flow Treated Through Secondary System	90%	89%	91%	90%	
WWTF (Secondary Bypass) Events					
Rate to DW / Secondary During Bypass (MGD)	100	120	126	112	
Number of Events / Year	32	29	22	27	
WWTF Volume / Year	2,857	3,138	2,429	2,546	
Amount of Captured CSO Treated via Secondary (%)	54%	64%	66%	64%	
Duration of WWTF Events (hours)	919	706	668	904	
Calendar Days of WWTF Discharges (days)	---	66	50	65	
Blended Effluent (OF001 & 003) Treatment					
BOD Loading (pounds / year)	2,510,000	4,000,000	2,957,783	3,472,307	
BOD Average Concentration (mg/l)	27	16.6	13.3	15.7	
Total Plant BOD Removal Efficiency (%)	---	93%	95%	94%	
TSS Loading (pounds / year)	2,440,000	5,050,000	3,585,748	4,055,479	
TSS Average Concentration (mg/l)	27	21.0	16.1	18.3	
Total Plant TSS Removal Efficiency (%)	---	92%	94%	93%	
Wet Weather Treatment Facility					
BOD TO Wet Weather Facility (pounds/year)	---	2,290,000	1,638,460	2,361,933	
BOD FROM Wet Weather Facility (pounds/year)	---	1,510,000	726,541	874,387	
Wet Weather BOD Removal Efficiency (%)	50%	34%	56%	63%	
TSS TO Wet Weather Facility (pounds/year)	---	4,030,000	2,257,182	3,048,027	
TSS FROM Wet Weather Facility (pounds/year)	---	1,480,000	520,375	520,252	
Wet Weather TSS Removal Efficiency (%)	70%	63%	77%	83%	

2.6.2 CBWTP Max-Month and Peak-Week Treatment Performance

The CBWTP NPDES permit lists 1) effluent limits for the CBWTP outfalls and 2) performance requirements for the dry-weather/secondary system and the wet-weather treatment trains for monthly and weekly extreme weather conditions. Table 2-14 and Table 2-15 below summarize effluent BOD and TSS concentrations and loads during the most extreme periods in FY 2014 for the overall plant site (Outfalls 001 and 003), the Secondary Effluent, and the Wet Weather Effluent.

The maximum 30-day treatment results for BOD and TSS during the past fiscal year are provided in Table 2-14. The maximum 30-day period was determined by searching a moving window of 30 days to find the highest mass loading. After this period was identified, the flow rate and concentrations were calculated for that period. Table 2-14 shows that the effluent discharged to Outfalls 001 and 003 during the maximum 30-day period met the permit's BOD concentration and mass load limit. TSS concentrations exceeded the permit requirement for the combined outfall, but the total TSS mass loadings for the 30-day limit was within the permit requirements.

Table 2-14 CSO Max-Month (30-days maximum solids loading) Treatment Performance[11]

Parameters	Maximum Monthly (30-Day)						
	Avg Concentration During Maximum Month for Mass Loading			Mass Loading			
	Permit Monthly (mg/l)	Max 30-Day (mg/l)	30-Day Avg Flow (MGD)	Permit Monthly (lbs/day)	Max 30-Day (lbs/day)	Date of 30th Day	Notes
Columbia Boulevard WWTP - Outfalls 001 and 003 Effluent Quality							
BOD5	30	28	126	45,000	29,524	10-Mar-14	9.2 inches of rain in 30 days
TSS	30	**33**	126	45,000	34,516	10-Mar-14	
Secondary Biological Treatment - 100 MGD Minimum Instantaneous							
BOD5	30	22	93	22,500	17,231	10-Mar-14	9.3 inches of rain in 30 days
TSS	30	**35**	93	22,500	27,256	10-Mar-14	
Wet Weather / CEPT System - Intermittent Discharges							
BOD5	45	23	65	22,500	12,294	9-Mar-14	9.2 inches of rain in 30 days
TSS	45	13	65	22,500	7,260	9-Mar-14	

The Peak Week 7-day period was determined by examining a 7-day continuous record of pollutant loads to the outfalls and selecting the consecutive seven days with the highest mass load. Table 2-15 shows the flow rates, concentrations, and mass loads for the 7-day peak period that occurred in February of 2014. The results indicate that the treatment performance for the

[11] As stated in the DMRs, Portland applies the System-Based Performance Requirements for Secondary and WWTF as in-plant guidelines. Permit compliance is required for the combined OF001 and OF003 effluent.

final effluent discharged from OF001 and OF003 met the permit's BOD and TSS concentration and mass load criteria.

Table 2-15 CSO Peak-Week (7-days maximum solids loading) Treatment Performance[12]

Parameters	Peak Week (7-Day)						
	Avg Concentration During Peak Mass Loading Week			Mass Loading			
	Permit Weekly (mg/l)	Max 7-Day (mg/l)	7-Day Avg Flow (MG)	Permit Weekly (lbs/day)	Max 7-Day (lbs/day)	Date of 7th Day	Notes
Columbia Boulevard WWTP - Outfalls 001 and 003 Effluent Quality							
BOD5	45	35	179	118,800	52,840	20-Feb-14	3.6 inches of rain in 7 days
TSS	45	38	179	118,800	56,234	20-Feb-14	
Secondary Biological Treatment - 100 MGD Minimum Instantaneous							
BOD5	45	36	84	37,500	25,335	25-Feb-14	0.8/3.6 inches of rain in 7 days
TSS	45	**51**	84	37,500	35,692	20-Feb-14	
Wet Weather / CEPT System - Intermittent Discharges							
BOD5	65	46	73	81,300	28,400	20-Feb-14	3.6 inches of rain in 7 days
TSS	65	34	73	81,300	20,542	20-Feb-14	

2.6.3 Wet Weather Treatment Performance for Bypass Events

The performance of the CSO wet weather treatment system is best evaluated by examining the events in which the WWTF discharged treated effluent. The NPDES permit refers to these events as "bypass events" because they do not receive secondary treatment. CSO is not required by federal or state regulations to receive secondary treatment; therefore, Portland generally refers to these events as WWTF discharge events or simply WWTF events. Table 2-16 summarizes the WWTF events that occurred in FY 2014. The full list of events is provided in Table 2-17 on the following page.

12 As stated in the DMRs, Portland applies the System-Based Performance Requirements for Secondary and WWTF as in-plant guidelines. Permit compliance is required for the combined OF001 and OF003 effluent.

For this analysis, a WWTF begins when the wet weather system discharges effluent, and ends after either of the following:

- No WWTF discharge AND the plant inflow remains below 80 MGD for 6 hours. This was changed from prior years due to plant operations now increasing return activated sludge flow to the secondaries, and therefore secondary flow is no longer a clear indicator for these events.

OR

- No WWTF discharge occurs for 48 hours (helps to define the end of an event during Portland's long winter storms).

Table 2-16 FY 2014 WWTF Events (Secondary Bypass) Summary

		CBWTP Flows		WWTF Flows				WWTF Effluent			
	Events	Avg Influent During Bypass (MGD)	Avg Flow to Dry Weather-Secondary During Bypass (MGD)	Avg WWTF Flow (MGD)	WWTF Discharge Volume (MG)	Duration of WWTF Discharge (hrs)	Calendar Days WWTF Discharge Occurred	Event BOD Load Discharged (lbs)	Event TSS Load Discharged (lbs)	EMC BOD (mg/L)	EMC TSS (mg/L)
Total	**27**				**2,546**	**904**	**65**	**874,387**	**520,252**		
Average/Event		**184**	**112**	**66**	**94**	**33.5**	**2.4**	**32,385**	**19,269**	**53**	**24**

The event summary in Table 2-16 illustrates key aspects of the wet weather system performance:

- Volume of WWTF discharge for the year was 2.5 billion gallons. This represents about 10% of the total volume received at CBWTP for the year (see Table 2-13).
- There were about 900 hours of discharge (about 10% of the year) and 65 calendar days per year when discharge occurred (about 1.25 days per week average), which underscores the intermittent nature of the wet weather system discharge.
- The average event mean concentration (EMC) for BOD of 53 mg/l and 24 mg/l for TSS compare very well with the expected values obtained during the pilot testing of the CEPT system.

Table 2-17 lists the WWTF events that occurred during FY 2014, in which excess captured CSO was routed to the Wet Weather Treatment Facility.

- During periods of bypass, operators were able to maintain an average secondary treatment rate of 112 MGD, compared to the permit required 100 MGD.

- The Average/Event rate of 112 MGD treated via the secondary system indicates that 61% of the total influent (112 MGD of 184 MGD) arriving at the plant during a WWTF event was treated through the secondary system.
- WWTF events lasted about 33 hours on average and typically occurred across two calendar days.

The EMC over the past couple years varied in relationship to volume discharged as shown in Figure 2-7 (BOD) and Figure 2-8 (TSS). Small events tended to have higher BOD and TSS concentrations, and larger volume events had lower concentrations. This highlights the challenge for good CEPT performance during small storms. The CEPT design intent was to ensure 50% BOD and 70% TSS removal annually, achieved by focusing on larger storms in which the majority of pollutant mass arrived at the plant, not small events.

Table 2-17 Wet Weather Treatment Events - Detailed Information

		CBWTP Flows		WWTF Flows				WWTF Effluent			
Date & Time Bypass Event Started	Event #	Avg Influent During Bypass (MGD)	Avg Flow to DW-Secondary During Bypass (MGD)	Avg WWTF Flow (MGD)	WWTF Discharge Volume (MG)	Duration of WWTF Discharge (hrs)	Calendar Days WWTF Discharge Occurred	Event BOD Load Discharged (lbs)	Event TSS Load Discharged (lbs)	EMC BOD (mg/L)	EMC TSS (mg/L)
9/6/13 3:00	1	257	113	126	122	23.3	2	44,760	32,327	44	32
9/23/13 22:15	2	117	103	8	8	25.0	2	5,138	1,327	79	20
9/28/13 11:15	3	243	113	119	407	82.0	4	101,278	99,194	30	29
11/2/13 5:45	4	191	111	81	29	8.8	1	15,114	15,114	61	61
11/5/13 2:30	5	149	121	5	1	3.5	1	315	217	52	36
11/6/13 20:00	6	161	117	36	41	27.5	2	19,714	7,852	57	23
11/19/13 9:30	7	220	121	93	35	9.0	1	31,959	7,263	110	25
12/1/13 22:45	8	185	120	62	51	19.8	2	15,797	10,741	37	25
1/7/14 21:00	9	188	111	75	27	8.5	2	15,698	3,688	71	17
1/8/14 18:30	10	212	120	82	29	8.5	2	21,087	7,721	87	32
1/11/14 7:00	11	201	120	78	111	34.3	2	28,112	19,413	30	21
1/29/14 4:45	12	189	120	59	13	5.3	1	6,509	2,511	61	23
2/11/14 2:45	13	170	110	58	557	230.0	10	240,672	160,251	52	34
2/24/14 12:45	14	175	119	46	13	6.8	1	6,490	2,689	60	25
2/27/14 14:30	15	155	89	54	15	6.5	1	7,120	2,629	58	21
3/2/14 12:00	16	164	97	67	310	110.5	6	97,849	42,994	38	17
3/8/14 19:30	17	203	116	86	81	22.8	2	13,886	7,439	20	11
3/16/14 21:30	18	249	120	128	75	14.0	2	16,472	12,023	26	19
3/28/14 9:30	19	196	109	87	343	94.3	5	79,722	45,375	28	16
4/9/14 2:00	20	169	120	41	17	10.3	1	5,916	2,058	41	14
4/17/14 14:45	21	175	93	64	19	7.3	1	12,961	3,312	80	20
4/22/14 3:00	22	129	102	24	98	96.0	5	40,494	14,594	50	18
5/8/14 22:30	23	193	118	76	19	6.0	2	6,951	3,229	44	20
5/18/14 6:45	24	183	115	73	75	24.8	2	16,521	7,006	26	11
6/15/14 19:30	25	115	100	14	4	6.0	2	2,591	1,394	88	47
6/16/14 17:30	26	221	118	97	39	9.5	2	18,370	6,998	57	22
6/27/14 16:15	27	159	120	38	7	4.5	1	2,891	893	49	15
Total	**27**				**2,546**	**904**	**65**	**874,387**	**520,252**		
Avg/Event		**184**	**112**	**66**	**94**	**33**	**2.4**	**32,385**	**19,269**	**53**	**24**

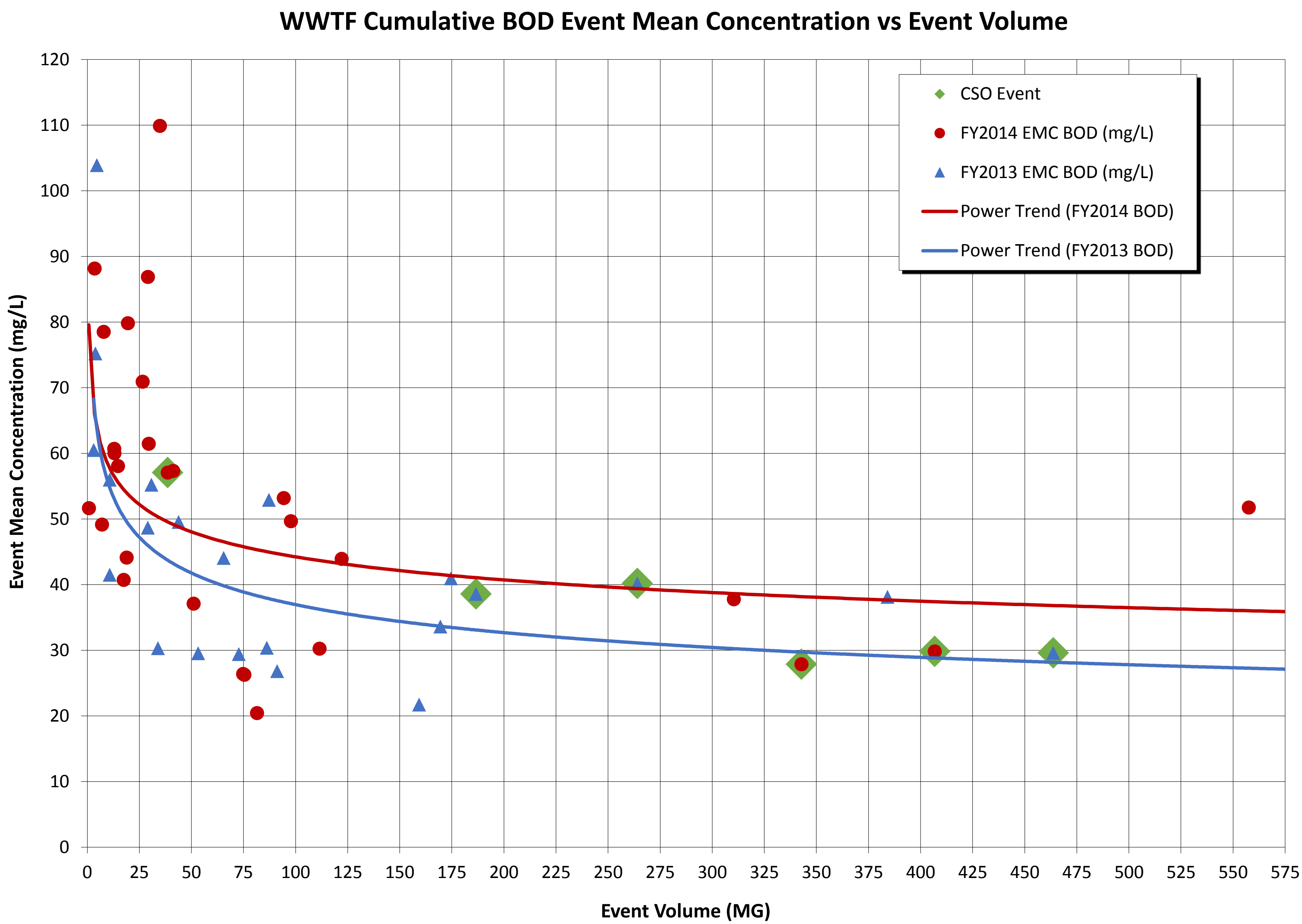

Figure 2-7 WWTF Cumulative BOD Event Mean Concentration vs Event Volume

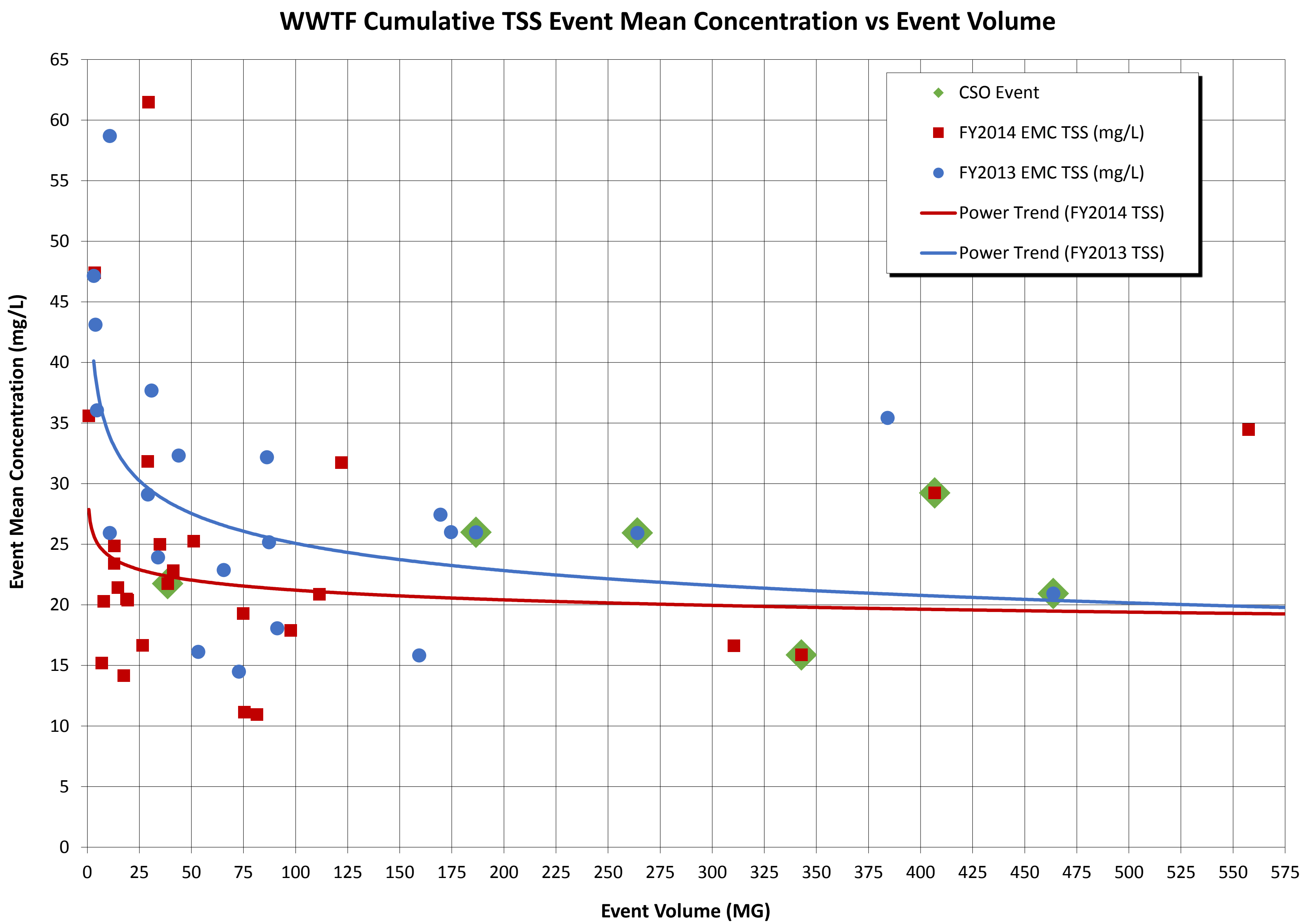

Figure 2-8 WWTF Cumulative TSS Event Mean Concentration vs Event Volume

Section 3 CMOM Program Implementation

The City of Portland's CMOM program has been designed to ensure that components of the collection system are cleaned and inspected at the right frequency and that preventive maintenance and repairs are performed to cost-effectively reduce the number of sewer releases, extend the useful life of the City's sewer infrastructure, and properly manage collection system operations. This annual summary for FY 2014 provides a brief overview of collection system operation and maintenance programs and practices as context for evaluation of the effectiveness of CMOM activities. Section 4 of this report includes sewer release analysis and performance.

3.1 Collection System – Gravity Sewers Operation and Maintenance

BES has programs in place to ensure that gravity sewers and manholes are properly inspected, cleaned, and repaired. Closed-circuit television (CCTV) inspection activities are key for an accurate determination of the structural and operational condition of collection system assets. Cleaning helps maintain asset condition and hydraulic capacity, enhances the effectiveness of inspections, and helps to control odors. Repairing structural deterioration protects the community's infrastructure investment and reduces the potential for catastrophic failures.

3.1.1 Sewer Inspections and Cleaning

The *Collection System Inspection and Cleaning Plan* submitted to DEQ in December 2012 provides detailed information about the City's "needs-based" maintenance strategy for prioritizing maintenance, inspection and cleaning activities and expenditures. The inspection and cleaning programs contain both preventive maintenance and unplanned work.

In FY 2014, the sewer inspection program inspected 1,092,757 lineal feet of mainline sewer pipe, which corresponds to approximately 11 percent of the mainline sewer system. Sewer mainlines are inspected for general preventive maintenance, special investigations in support of the chemical root and grease management programs and in response to sewer problems, and in support of Capital Improvement Program (CIP) projects. In FY 2014, approximately 11 percent of the work orders in the inspection program were considered unplanned work; that is, work in response to special sewer investigations or collection system problems. The remainder of the program was dedicated to general preventive maintenance and support of the City's CIP Sewer Rehabilitation Program. The CCTV inspection program provides the condition assessment information that is instrumental to the risk prioritization process used to drive the CIP Rehabilitation Program work.

In FY 2014, the sewer cleaning program maintained 1,646,408 feet of sewer pipe, which corresponds to approximately 16 percent of the mainline sewer system. The sewer cleaning program includes preventive maintenance, chemical root treatment, accelerated cleaning in grease management areas, special investigations related to collection system problems, and CIP projects for pipes generally up to 15 inches in diameter. In addition to the City's sewer cleaning crews, a specialty contractor was utilized to clean select larger diameter sewers with known sediment accumulation.

In FY 2014, approximately 94 percent of mainline cleaning work orders were considered planned maintenance; that is, the cleaning was performed for general preventive maintenance, to support a planned CCTV inspection, cleaning of grease management areas, and cleaning to support root treatment activities.

Compared to aging sewer mainline pipes, the majority of manholes in the combined and sanitary collection systems have not been shown to pose inordinate structural or infiltration and/or inflow hazards. Therefore, in keeping with the City's risk-based asset management strategy, manholes are inspected and cleaned during preventive maintenance of sewer mains.

3.1.2 Sewer Assessment and Repairs

Maintaining the wastewater collection system in good repair is a core service BES provides to its ratepayers. The City has a well-established sewer and manhole repair program. Priority codes in Hansen[13] are assigned when work orders are created. The priority codes are used when scheduling and assigning work and to help manage the backlog of open work orders to ensure that repairs are completed according to their relative risk and consequence of failure (e.g., top priority is given to SSO- and hazard-related repairs). The *CMOM Program Report* includes descriptions of how sewer repair crews are allocated maintenance activities, as well as the equipment they use and activities they perform.

During FY 2014, for minor urgent or emergency repairs BES relied preferentially on services from City crews for sewer cleaning, investigation, inspection, and repair. However, for larger urgent or emergency projects BES Maintenance Engineering coordinated closely with BES Engineering Services to conduct work under the BES Small Maintenance Capital contracts or emergency CIP projects.

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[13] *Hansen* refers to Infor Public Sector, © 2013 Infor. All rights reserved. www. infor.com

City crews completed 400 mainline sewer repairs totaling nearly 12,000 lineal feet. Approximately 54 percent of these repairs were considered to be unplanned. Repairs are considered unplanned if the work is in direct response to a collection system problem, such as a sewer release or surface cavity, or if the severity of the problem is significant enough to warrant the deployment of repairs within a week. The majority of planned repairs occur from either defects identified by the preventive maintenance CCTV inspection program or when additional repairs on a line are made in conjunction with an unplanned repair. Repairs on mainline sewers are localized spot repairs where pipe sections are excavated and replaced or renewed using cured-in-place pipe (CIPP) liners.

City crews completed 800 service lateral repairs totaling approximately 10,500 lineal feet. Approximately 70 percent of these repairs were unplanned. Unplanned service lateral repairs are almost always in response to a sewer system problem. Planned service lateral repairs generally occur in conjunction with adjacent repairs on mainline sewers. Service lateral repairs typically involve the complete replacement of the lateral and the addition of a cleanout at the curb for improved future maintenance.

3.1.3 Root Management and Control Actions

Portland is renowned for its urban forest and must balance the need to protect both trees and sewer infrastructure. During FY 2014, BES Maintenance Engineering continued to manage the chemical root control program using a third-party service provider that uses a dense herbicidal foam that kills roots on contact without harming trees or surface vegetation. The City's Root Control Program uses a priority ranking system so that sewers with the greatest need for chemical root treatment are addressed first. During FY 2014, 312,440 lineal feet of mainline sewer were chemically treated for roots. In addition to chemical root foaming, City crews utilize mechanical root saws to locally remove roots in support of sewer inspection and cleaning activities as well as in response to sewer system problems.

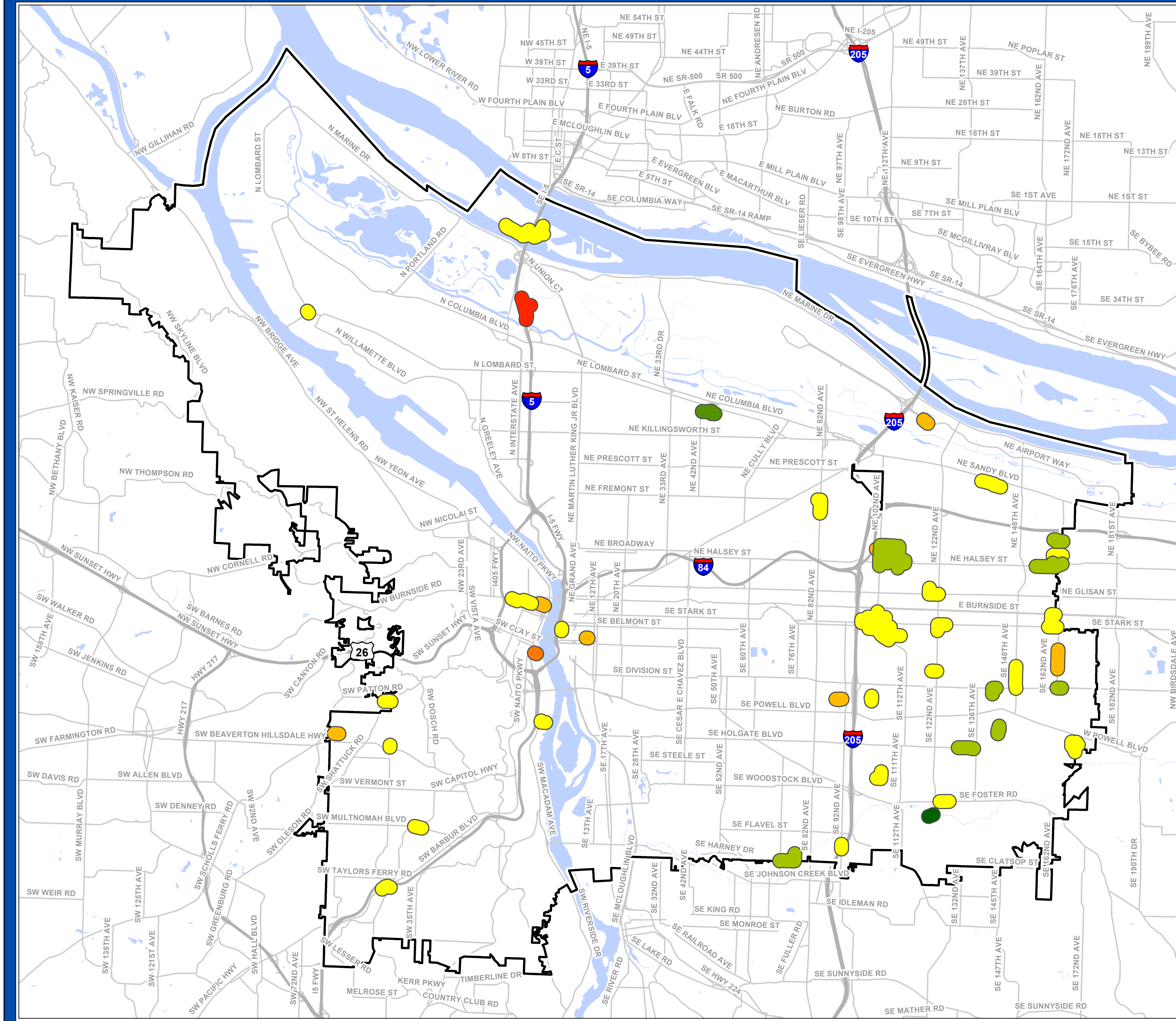
3.1.4 Grease Management and Control Actions

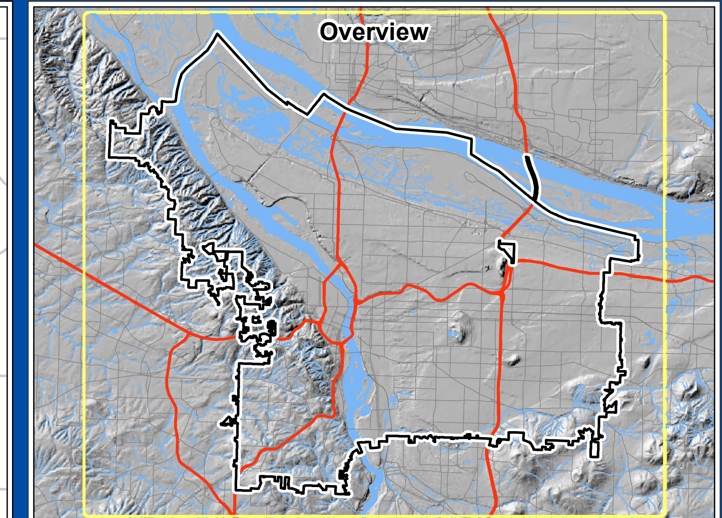
The *City of Portland Grease Management and Control Program* document that was included in the *CMOM Program Report* explains how BES Pollution Prevention Services administers the City's program to control fat, oils, and grease (FOG). This program uses a broad participatory and collaborative approach between City maintenance, engineering, public involvement, and compliance representatives to effectively identify all areas of the collection system that are vulnerable to FOG buildup and blockages.

Major changes to the FOG management program, initiated in 2009, have resulted in a very proactive food service establishment (FSE) inspection program for installation and operation of grease interceptors. Additionally, new Enforcement Administrative Rules have proven to be very effective at improving the handling of FOG operations and maintenance of grease interceptors at FSEs. The FOG Coordination Team continues to meet quarterly to improve FOG-related activities performed by work groups responsible for FOG inspection and compliance, maintenance engineering, sewer cleaning and maintenance, pump station operations and maintenance, and asset management and data management.

Accelerated Grease Cleaning Areas (AGCAs) are established based on grease problems identified through maintenance activities, preventive maintenance cleaning and CCTV inspections, and sewer release response activities. Based on CCTV inspection results, the FOG Coordination Team determined that over 4,500 feet of sewer could be removed from the accelerated cleaning list. The AGCAs as of the end of FY 2014 are shown in Figure 3-1.

Special investigations performed by City maintenance crews provided evidence used in numerous FOG enforcement actions in FY 2014. When a FOG discharge is identified, the City issues a Notice of Violation with civil penalties, and requires the FSE to eliminate all FOG discharges, which is generally achieved by retrofitting the facility to install a grease interceptor and plumbing all fixtures to it. In addition, the City requires all new and redeveloping FSEs to install grease interceptors and to plumb all fixtures to the interceptors. This aggressive inspection and enforcement mechanism, along with the proactive retrofitting requirement for all new and redevelopment FSEs, significantly minimizes the potential for future FOG buildup and blockages in City sewers from these facilities.





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- Rivers and Lakes
- Streets

Cleaning Frequency Time Interval

- Quarterly (3 months) - 1 area, 2,538 feet
- Triannual (4 months) - 1 area, 191 feet
- Semi-annual (6 months) - 7 areas, 4,461 feet
- Annual (12 months) - 26 areas, 36,037 feet
- Biennial (24 months) - 8 areas, 16,404 feet
- 3-Year (36 months) - 1 area, 1,346 feet
- 5-Year (60 months) - 1 area, 438 feet

1 inch = 9,000 feet

0 9,000 18,000 Feet

N E S W

Figure 3 - 1
Fats, Oils, and Grease Accelerated Cleaning Areas through FY 2014

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08/14/2014

Produced by Asset Systems Management: Map Request 7062 (KDR) August 14 2014 \\Cassio\CSOProgram\Sewage_Releases\Data_Requests\forMaryKing\Mxd\Accelerated_Cleaning_FY2014_2.mxd

3.1.5 Rainfall Derived Inflow and Infiltration Assessment and Removal

BES uses detailed hydrologic models along with extensive flow monitoring to identify and quantify sources of rainfall derived infiltration and inflow (RDII). The annual *I&I Reduction Status Report* submitted to DEQ is developed in coordination with the City of Lake Oswego to comply with Schedule C, Compliance Conditions and Schedules, of the NPDES Permit for the Tryon Creek Wastewater Treatment Plant (TCWTP).

Elements of the RDII Program include developing policies for private property access and repair, performing field assessment and source detection using smoke testing and other methods, analyzing alternatives for stormwater conveyance and discharge facilities for redirecting inflow sources, and performing post-project flow monitoring and modeling to verify the effectiveness of RDII-reduction activities. During FY 2014, several pilot projects aimed at reducing the possibility of sewer releases in southwest Portland were in design and construction. These projects will help determine how effective different approaches are in reducing RDII.

3.1.6 Sewer Backflow Prevention Program Actions

The City of Portland passed an ordinance in 1975 establishing a program to reimburse building owners for part of the cost of installing a sewer backflow prevention device in an existing building on a combination sewer line in an area vulnerable to sewer backups. In FY 2014, new administrative rules were developed to clarify the decision-making criteria and procedures followed by BES Maintenance Engineering for managing the sewer backflow device reimbursement program. Along with an increase in the number of extreme weather events, BES received an increase in the number of inquiries about the program in FY 2014 compared to recent years. Reimbursement payments were made to five applicants in FY 2014 to mitigate vulnerability to sewer backups.

Section 4 Sewer Release Analysis and Performance

The City of Portland's *Sewer Release Response Plan* (SRRP), submitted to the Oregon Department of Environmental Quality (DEQ) in December 2011 and adopted on January 1, 2012, establishes the process for responding to sewer releases from the City's combined and sanitary sewer system and reporting to DEQ as required by the National Pollutant Discharge Elimination System (NPDES) permit. The *CMOM Program Report* further describes the organizational structure for implementing the SRRP.

BES has a long history of implementing best management practices for collection system operation and maintenance to reduce the number and severity of sewer releases. Under the CMOM program, additional emphasis is placed on understanding why releases have occurred and how to prevent future releases.

4.1 Sewer Release Tracking and Reporting

The BES Spill Protection and Citizen Response (SPCR) Section is responsible for coordination of the overall response to sewer release events, maintaining official City sewer release records, and carrying out reporting to DEQ. BES SPCR routinely provides SRRP training to ensure that every report of a sewer release is dispatched for immediate response and investigation, reported as required by the NPDES permit, and documented completely and accurately. Each month SPCR prepares the report of sewer releases that is submitted to DEQ with the monthly discharge monitoring report for the Columbia Boulevard Wastewater Treatment Plant.

In 2013, BES integrated sewer release data into the Hansen computerized maintenance management system (CMMS), which has created a connection to the work history of assets. Better data controls have been added to help manage work orders, such as more specific problem codes and standardization of planned and unplanned maintenance work types. Well-defined work order priority codes are used to ensure that work related to sewer releases receives top priority. The resources the City uses for operation and maintenance planning are explained in the *CMOM Program Report*.

BES has developed a standardized list of causes to facilitate tracking and analysis of sewer releases, as shown in Table 4-1. Additional terminology has been developed for weather-related sewer releases, as shown in Table 4-2, to more directly associate these releases with the City's levels of service established through the BES Asset Management Improvement Program.

Table 4-1 Sewer Release Cause Descriptions

Sewer Release Cause	Description
Structural Defect	Release caused by a physical failure of the pipeline
Equipment Failure	Release directly resulting from equipment failure typically either at a pump station or during a bypass pump around
Maintenance	Release caused by a City-related maintenance activity
Weather Event	Release caused by hydraulic capacity issues associated with weather (there are three subcategories described in Table 9-3)
Grease	Release caused by a blockage due primarily to grease
Debris	Release caused by a soft blockage due to sediment or other material
Roots	Release caused by a blockage due primarily to roots
Water Bureau Break	Water main break that surcharges the BES collection system
Cause Unknown	A release where the investigation does not identify a specific cause

Table 4-2 Weather-related Sewer Release Terminology

Term	BES Definition
Hydraulically overloaded system	Rainfall less than or equal to the 5-year, 24 hour storm (the BES level of service is to prevent sewer releases to surface waters for all storm events up to a 5-year frequency)
Extreme weather	Rainfall in excess of the 5-year, 24 hour storm but less than or equal to the 25 year storm
Force majeure	Rainfall exceeds 25 year storm (the BES level of service is to convey sewer to prevent releases to buildings or streets up to a 25-year storm frequency)

4.2 Sewer Release Key Performance Indicators

Striving for continuous improvement is a cyclical process of evaluating current practices, identifying needed improvements, and measuring performance. BES has developed a set of key performance indicators to gauge the effectiveness of the CMOM program.

4.2.1 SSOs per Hundred Miles of Pipe

SSOs provide a good measure of the overall effectiveness of maintenance programs for controlling roots, fats, oils, and grease, structural failures, and pump station performance. By tracking SSOs per 100 miles of sewer, BES has a succinct metric for gauging overall success toward minimizing SSOs.

BES owns and maintains approximately 1,907 miles of main line sanitary and combined sewers, and 662 miles of sewer laterals. The City is typically responsible for maintaining the portion of the service lateral extending from the main sewer to the curb. In FY 2014 BES refined the method for determining the total length of sewer laterals by calculating the sum of the length of all sewer laterals in the City-maintained portion of the BES collection system map layers. During FY 2014, the City experienced 226 sewer releases over the 2,569 miles of collection system, which is approximately 8.8 releases per 100 miles of sewer. This number will serve as a baseline for future comparisons.

4.2.2 Response to Urgent Health and Safety-Related Service Requests

The City's goal is for a sewer emergency crew to be on site within two hours of receiving the initial call reporting an urgent sewer release. BES SPCR is responsible for maintaining electronic records of sewer releases, and their records are used to assess the response time of the on-site emergency crew. Under certain circumstances, such as when the caller is reporting a release that occurred in the past or is requesting to meet the City crew at a prearranged time, a sewer release is considered non-urgent, and the two-hour on-site response goal does not apply.

Response time performance for FY 2014 is shown in Table 4-3. Response time performance was very good during FY 2014, with the exception of a large storm event on May 18, 2014, when crews were unable to keep up with the large volume of calls received.

Table 4-3 SSO Response Time and Counts for FY 2014

FY 2014 Total Urgent Calls Sewer Release Calls	Number of Calls	Percent of Total
Urgent Calls with Response Time Less Than 2 Hours	385	89
Urgent Calls with Response Time 2 Hours or More	46	11
Total	431	100

4.3 Analysis of Causes and Locations of Sewer Releases

During FY 2014, the City experienced 226 releases from the sanitary and combined sewer systems. One weather-related release event in FY 2014 that exceeded the design capacity of the collection system (referred to as *force majeure*) was intentionally excluded for the purposes of analyses and tracking trends, although this release was included in reporting to DEQ.

A chart summarizing the causes of these releases is shown in Figure 4-1. The release data shown are for releases due to problems in the City-maintained portion of the collection system (excluding releases due to causes resulting from problems in privately-owned sewers or laterals). The locations of the sewer releases in FY 2014 are shown in Figure 4-2.

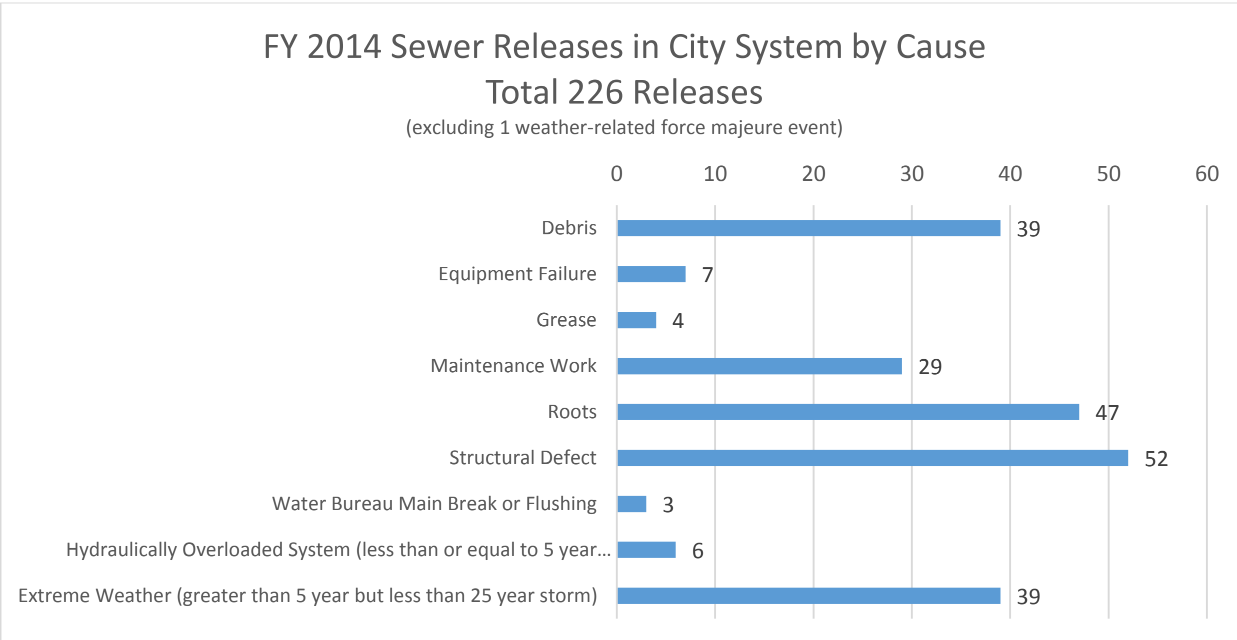

Figure 4-1 Summary of Causes of FY 2014 Sewer Releases

Several factors have likely contributed to the releases that were reported in FY 2014. Increased awareness about the necessity and value of reporting all sewer releases has resulted in more reports. City crews responded to 524 sewer service requests (431 urgent calls), compared to 312 requests (261 urgent calls) in FY 2013.

Releases that previously may have been construed as *de minimis* are now being routinely self-reported by City crews, which reflects better understanding of how to characterize maintenance and operational releases. About one-third of the sewer releases in the City system in FY 2014 were less than 10 gallons and about two-thirds were less than 100 gallons. Also contributing to better reporting of sewer releases, customers who anecdotally describe events to staff that may in fact be related to sewer releases (e.g., odor complaints or basement seepage) are being asked to report these events using the Communications Center hotline or City website.

Similarly, more releases are now being identified through CCTV inspections performed by private contractors. As noted in the *CMOM Program Report*, City repair crews often work with a property owner's contractor to coordinate work done on private laterals and/or private sewers to avoid extra costs and inconvenience associated with excavation work. Accordingly, it has become commonplace for private contractors to seek assistance from City sewer maintenance staff to either be present on site as a sewer is being inspected, or to review CCTV results to confirm the location and type of problems or issues.

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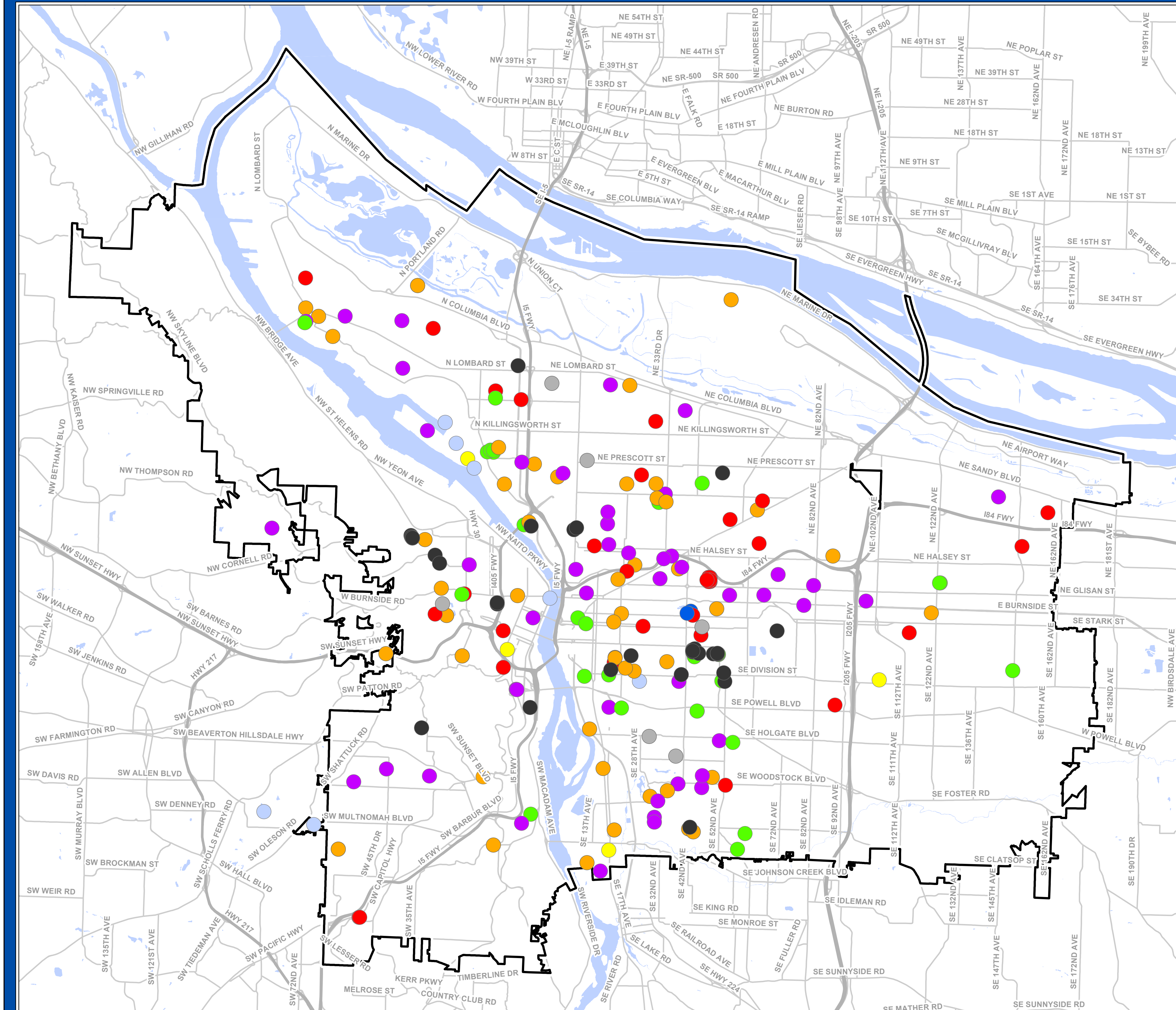

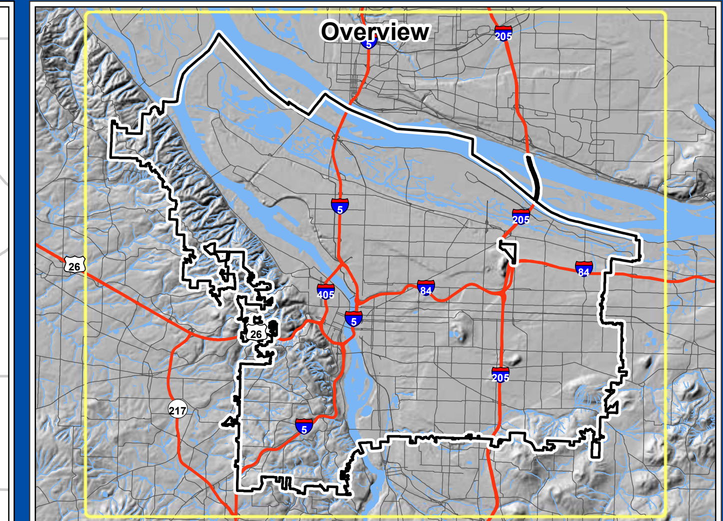

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Events By Cause

- Debris [39]
- Equipment Failure [7]
- Grease [4]
- Maintenance Work [29]
- Roots [47]
- Structural Defect [52]
- Water Bureau Break [3]
- Hydraulically Overloaded System (less than 5 year storm event) [6]
- Extreme Weather (5 year to 25 year storm event) [39]

1 inch = 9,000 feet

0 9,000 18,000 Feet

N E S W

Figure 4 - 2
Sewer Releases in City System by Cause
FY 2014

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Several high-intensity storms resulted in flows that nearly approached the design capacity of the system resulting in releases due to extreme weather; these storms also exacerbated the effects of debris entering and causing blockages in the system that resulted in releases and basement backups.

Another likely reason for the increased number of releases associated with maintenance work is that many CIP rehabilitation projects are now underway throughout the city. These projects are correcting deficiencies on system assets that pose the highest risk and consequence of failure, and thus are often the most challenging to fix. Expenditures on CIP projects for collection system structural upgrade and replacement projects totaled approximately $34 million in FY 2014.

4.3.1 Sewer Release Causes for FY 2014

In addition to the rigorous investigatory research conducted by BES SPCR to determine the cause of sewer releases, improvements have been made to facilitate the use of the Hansen CMMS to track initial and actual problem codes on work orders. This enhanced capability provides a clearer understanding of the underlying reasons why a problem occurred or why work on (or near) an asset was required. For example, a work order may have an initial problem code “REL” for a release, or “SBU” for a sewer backup such as a plugged line. An actual problem code such as “GRS” (for grease) or “ROOTS” is also recorded on the work order and is typically based on the findings of the field crew, supervisor, or engineer.

These problem codes supplement the City’s customized coding system used to characterize CCTV operators’ observations and the degrees of severity (for structural defect, debris, roots, grease, etc.), as explained in the *CMOM Program Report* and the *Collection System Inspection and Cleaning Plan*. This broader array of information sources will become more useful over time, as asset histories can be more closely aligned with system performance.

Structural Defects. The majority of sewer releases associated with structural defects occurred in service laterals. Although recent investments in more effective lateral launch CCTV equipment have enabled City crews to become more efficient at investigating laterals, the work tends be reactive in response to problems and does not match the effectiveness of preventive maintenance inspections for proactively identifying and prioritizing problems in sewer mains and manholes. The risk of releases associated with structurally defective laterals should decrease as the large number of sewer repair, rehabilitation, and replacement CIP projects currently in design or under construction are completed.

Maintenance. In FY 2014, there were 29 releases associated with maintenance activities. Eleven releases were reported due to “blow back” incidents where pressure from City sewer cleaning operations resulted in releases from plumbing on private property; most of these releases were "bowl water" from toilets and the volume was less than 10 gallons. While precautions are taken to prevent these occurrences, some private plumbing systems lack adequate venting and the configuration of some City sewers makes it very challenging for cleaning equipment operators to work in some locations.

Three releases involved CIPP liners installed by City crews: one liner that failed and two instances where laterals were lined over inadvertently. Two releases occurred when sewer lines were damaged during maintenance activities conducted by the City's Water Bureau. Other maintenance-related releases were caused by contractors working for the City. As previously noted, many CIP projects are under construction to correct problems in some of the City's assets that are in the poorest condition, often in locations where working conditions are difficult. In several instances, flow diversion pumping systems that were in place to prevent disruption of service to customers during construction were overwhelmed when large stormwater flows discharged to the combined sewer system during storm events.

Extreme Weather. Although the City's sophisticated system for integrating treatment plant and collection system operation has successfully reduced CSOs to the Willamette River and Columbia Slough, localized high-intensity rainfall events nonetheless resulted in releases. In particular, on the weekends of September 28 and 29, 2013, and May 18 and 19, 2014, releases were clustered in locations where the quantity of stormwater runoff approached the 25-year storm frequency and the capacity of the collection system was challenged by significant flows generated by these extreme weather events.

Debris. There were 39 releases caused by debris in FY 2014. A cluster of 13 releases occurred in northeast Portland during the large storm event on May 18 and 19, 2014, when a piece of rope and other entangled debris in the combined sewer system resulted in basement backups.

Roots. During FY 2014, of the 47 releases caused by roots, 9 were in sewer mainlines and 38 (approximately 80 percent) were in service laterals. The majority of laterals where releases occurred in FY 2014 have been repaired by City crews using CIPP liners, or were excavated and replaced, thereby reducing the risk of future root intrusion.

Water Bureau Break/Flushing. This release cause was developed to track water main breaks that release large volumes of water to the collection system. BES Maintenance Engineering has a program in place to work with Portland Water Bureau to issue permits for potable water batch discharges using approved best management practices. Three releases were assigned this cause in FY 2014 when the Water Bureau conducted unscheduled hydrant flushing in response to a complaint, which resulted in residential basement backups.

4.3.2 Sewer Releases to Surface Water in FY 2014

Sewer releases to surface water occurred at five locations in FY 2014. The circumstances of these release events are described below.

4729 SW Humphrey Park Road (release to an unnamed creek): On August 21, 2013, the City reported a sewage release (approximately 1 gallon per minute) to a small unnamed creek. An emergency repair crew responded to the scene and completed a temporary repair by late afternoon; a permanent repair was completed on October 29, 2013.

98 SW Naito Parkway (release to the Willamette River): On October 29, 2013, there was a sewage release to the Willamette River from the Ankeny Pump Station (estimated volume 40 gallons). Maintenance crews stopped the discharge at about 11:00 a.m. The release was likely associated with a water main break earlier in the day on SW 4th Avenue at W Burnside Street.

6107 SW Knightsbridge (releases to Ash Creek): On December 16, 2013, the City reported a sewage release to Ash Creek from a broken 10-inch sewer line (estimated volume 200 gallons). Emergency crews responded immediately and completed a temporary repair. On January 30, 2014 BES Field Operations staff observed sewage leaking in the area of the temporary repair; a new temporary repair was completed within hours of discovery of the release, and a permanent repair was completed on March 3, 2014.

5001 N Columbia Boulevard (release to the Columbia Slough): On the morning of February 25, 2014, a sewer release (estimated volume 1,560 gallons) to the Columbia Slough occurred from the 30-inch Inverness force main underneath the pedestrian bridge adjacent to the Columbia Boulevard Wastewater Treatment Plant. The release was stopped at 10:30 a.m. on February 26, 2014. The City took the force main out of service to stop the leak while planning a repair project. On June 27, 2014, City staff discovered that a leaky shutoff valve was dripping (estimated rate of 1 gallon per hour) from the force main to the slough. The crew immediately drained and isolated the line to stop the drip.

Manhole adjacent to I-84 near NE 21st Avenue (release to the Willamette River): On March 31, 2014, an estimated 6,000 gallons of sewage discharged via the stormwater system to Willamette River. City investigation determined that vandals had dumped a significant quantity of refuse and debris into a manhole, blocking the main sewer. The debris was removed from the sewer and a homeless camp in the area was dismantled and vegetation was cleared to deter future incidents.

4.4 Conclusions and Follow-On Actions for Sewer Release Reduction

The City of Portland's CMOM program is now being fully implemented. Shifting toward risk-based operation and maintenance of the collection system should, over time, result in a positive trend toward planned, proactive maintenance and fewer sewer releases. BES continues to develop and improve the Hansen CMMS to facilitate work prioritization and asset management in the gravity collection system. Although BES's CMOM program effectively incorporates the essential elements and best management practices for proper operation and maintenance of the collection system, analysis of sewer releases in FY 2014 has highlighted several opportunities for potential improvement.

Roots in service laterals receive some degree of treatment during application of root foaming agents in sewer mainlines; however, the amount of treatment varies and is not a reliable treatment for service laterals. To proactively prevent sewer releases from laterals, CIP projects for replacement, repair, and rehabilitation of sewer mainlines include inspection and repair/replacement of service laterals based on the risk of structural or operational failure. The majority of laterals where releases occurred in FY 2014 have been repaired by City crews using CIPP liners, or were excavated and replaced, thereby reducing the risk of future root intrusion. Additionally, when City crews repair service laterals because of releases caused by roots, cleanouts at or near the curb are routinely installed to facilitate future maintenance, including chemical root treatment. The City will continue to utilize opportunities for making cost-effective improvements to laterals.

BES anticipates that the number of releases attributable to structural defects will continue to decrease as CIP projects under construction and in design are completed. These projects to replace, repair, and rehabilitate collection system assets that pose the highest risk and consequence of failure will position the City to be better able to provide proactive rather than reactive maintenance. The methodology used for risk-based prioritization of CIP projects was presented in the *Collection System Assessment and Rehabilitation Plan* that was submitted to DEQ in December 2012. BES Construction Services has begun conducting "lessons learned" presentations upon completion of CIP projects. By sharing information about what has and has not worked, construction project managers and inspectors are in a better position to advise City contractors on how to reduce the likelihood of sewer releases associated with flow-diversion pumping systems, problems with reconnecting laterals as existing sewers are replaced or rehabilitated, and how to maintain positive control over minor releases of sewage that may accompany the performance of a repair or maintenance project.

Overall, continued implementation of the *BES System Plan—Combined and Sanitary Sewer Elements*, dated March 2012, will address condition and capacity risks in both the combined and separated sanitary sewer systems. The System Plan's consolidated system-wide approach for prioritizing reinvestment and business risk reduction through CIP projects should also reduce the potential for sewer releases.

Section 5 Maximize Storage in the Collection Systems

The purpose of this control is to ensure that combined sewage is kept in the sewer system for as long as possible using available in-system storage without adding new storage facilities. The available storage is used for minimizing secondary bypasses and overflow events. Portland's CSO tunnels and consolidation conduits have provided significant additional storage volume that is effectively managed through the system operating plan. This NMC originally focused on keeping sewers free of blockages to allow full utilization of sewer capacity; removing clean stormwater from the collection system also contributes to maximizing available storage and conveyance capacity.

5.1 Collection System and CSO Storage

5.1.1 Trunkline and Interceptor Storage

Prior to completing the CSO control system, Portland maintained high weirs at pump stations and relief structures in order to surcharge the interceptor pipes and utilize as much in-system storage as possible. These practices helped reduce CSO discharges to the receiving streams, but also resulted in increased risk of basement backups and street flooding when the trunklines and interceptors were overloaded during large storms. Such events are considered sanitary sewer overflows (SSOs).

As a result of full implementation of the CSO system at the end of 2011, the frequency of CSO discharges has been reduced dramatically. Since the full system has been operational, keeping the relief weirs at a high setting is no longer necessary. In contrast, the "SSO risk" created by having the relief weirs too high and surcharging the interceptor system is a concern in certain locations. For this reason, relief structures are being modified as needed to provide local hydraulic relief where the risk of SSO is high enough to justify the insignificant risk of sending the excess wet weather flow into the tunnel system.

In FY 2014, a new relief structure was built at SE Alder and 7th to relieve the large 36-inch trunkline where it connects into the SE Interceptor. This measure will reduce the level of surcharge in the interceptor and reduce the risk of SSOs in the Oak and Alder local collection systems without measurably impacting the ongoing reduction of CSO.

5.1.2 CSO System Storage

The CSO tunnel and consolidation conduit system storage are designed to be fully utilized and filled to elevation 18.0 feet before discharges to the Willamette River can occur. The use of storage capacity to minimize CSO discharges is part of the balance between maximizing the system storage volume and maximizing flow to the treatment plant. The potentially conflicting CSO and treatment objectives are optimized in the CSO System Operating Plan, which is discussed more fully in Section 6, *Maximize Flow to the POTW*.

The CSO system is designed to ensure that the tunnels are almost always completely full before overflows can occur. This result was accomplished by designing both the consolidation conduits that connect the outfalls to the drop shafts and the drop shafts themselves to convey the 25-year storm peak flow rates into the tunnels. This system has worked successfully for all events but two that have occurred since December 2011, as listed in Table 2-5 above: the 100-year storm that occurred on May 26, 2012, and a localized 3-year summer storm cloud burst on June 16, 2014, that caused the Alder Pump Station to pump CSO to the river to avoid basement backups (SSOs). A project upgrading the Alder Pump Station is currently in design and will provide more storage capacity to resolve its vulnerability to highly localized storms.

5.2 Stormwater Management Program Accomplishments

Portland's major objective for stormwater management in the combined sewer area is to continue reducing stormwater runoff into the combined sewer system. This effort reduces basement backups, retains a high level of CSO control, and provides stormwater as a natural resource for vegetated systems that capture and infiltrate water into the ground.

5.2.1 Downspout Disconnection Program (1993-2011)

The Downspout Disconnection Program ended active outreach in June 2011 after 18 years of partnering with property owners, contractors, and community organizations to disconnect downspouts in Eastside combined sewer basins. The final accomplishments include over 54,500 disconnected downspouts at more than 26,500 properties. In addition, more than 35,000 properties were found to have one or more downspouts already disconnected or were already managing stormwater onsite. In total, the Downspout Disconnection Program implemented or documented 1.2 billion gallons of stormwater removed per year from the combined sewer system.

Although the Downspout Disconnection Program is no longer doing active outreach and has ended all financial incentives for disconnection work, the Program continues to provide customer service support and technical assistance to property owners in the program area. Program staff are also systematically tracking redevelopment at properties in the program area, as the requirements for redevelopment will provide an even higher level of stormwater management.

To ensure that downspouts disconnected through the program remain disconnected, the Downspout Disconnection Program conducts maintenance and reliability outreach. This effort includes sending maintenance postcards to all past program participants and doing spot surveys of previously completed work. In FY 2013, the neighborhoods surveyed indicated a disconnection rate of about 77%. This mix of neighborhoods were from the northern parts of the City. In FY 2014, the neighborhoods surveyed from the central areas of the east side of the City indicated a disconnection rate of about 73%. See Figure 5-1 for a map of the areas surveyed. The program's disconnection rates at the end of the CSO Program's implementation in 2011, based on data gathered as disconnections occurred, indicated an overall disconnection rate of about 71.3%. Based on the combined sample data from the past two fiscal years in the above neighborhoods, the current overall disconnection rate is estimated at 72.6% (with 95% certainty of that disconnection rate being between 68% and 77%). So overall, the City is still seeing an increase in disconnected roof area.

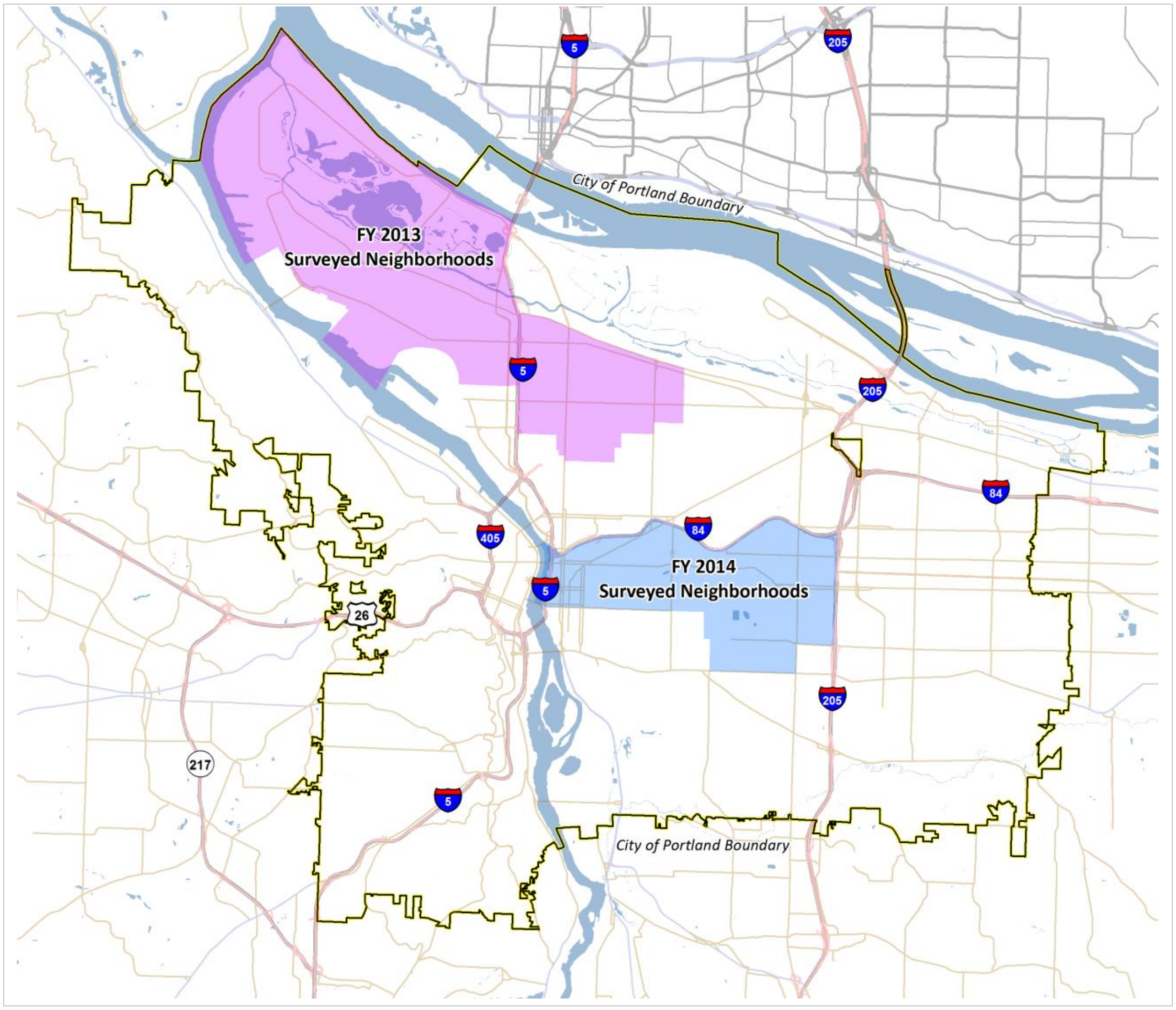

Figure 5-1 Neighborhoods Surveyed for Downspout Disconnections

5.2.2 Private Property Retrofit Program (2010-Current)

The 2012 Combined Sewer System Plan recommends stormwater facilities on private property as an approach to solve local capacity problems. In implementing the recommended projects, BES works with targeted private property owners to retrofit their on-site stormwater facilities to keep runoff out of the combined sewers. These stormwater facilities help reduce local sewer capacity problems and reduce CSO flows. BES assists property owners to install rain gardens, stormwater planters, swales, ecoroofs, and pervious pavement on sites that meet program criteria. Participation is voluntary and all stormwater facilities are privately owned and maintained, backed by an enforceable Operations and Maintenance agreement on the property's title and deed. For completed projects, maintenance outreach includes personal follow up for two years and seasonal maintenance task reminder postcards.

For FY 2014, one acre of impervious surfaces was managed by thirty-three private property stormwater retrofit projects. An examples of a private property stormwater retrofit project is shown in Figure 5-1 below.

Figure 5-2 Example rain garden, installed in FY 2014

5.2.3 Private Development and Redevelopment

The Stormwater Management Manual protects CSO system capacity by implementing a stormwater infiltration and discharge hierarchy. The Stormwater Management Manual (SWMM) applies to all development and redevelopment proposals that create or redevelop over 500 square feet of impervious area. Permit applicants must first consider feasibility of onsite infiltration or offsite discharge to storm-only systems prior to offsite discharge to the combined sewer system. In FY 2014, 489 stormwater facilities managing 55.8 acres of private impervious area were required by the SWMM in combined sewer basins (including the ecoroof control discussed in Section 5.2.4.1). City staff continued multiple efforts in FY 2014 to improve design and long-term performance of private stormwater management facilities, including:

- Adopting a revised Stormwater Management Manual, including stronger infiltration testing requirements and updated soil specifications to support flow control and plant establishment.
- Continuing to implement the Maintenance Inspection Program, which conducts post-construction inspections of private stormwater management facilities to ensure compliance with recorded operations and maintenance plans.

5.2.4 Sustainable Stormwater Projects in Combined Sewer Area

In addition to the Downspout Disconnection Program, Portland is a leader in implementing various sustainable stormwater programs that use green infrastructure stormwater controls in the public right-of-way, as well as on private properties through partnerships with private and institutional property owners. These stormwater controls use natural vegetated facilities to act as small constructed wetlands that capture stormwater for infiltration and evapotranspiration.

City staff and residents promote the use of green street facilities for the protections they afford for local sewer capacity relief, public health, and water resources, as well as for providing community benefits including green space and habitat connectivity, enhancement of the bicycle and pedestrian environment, and neighborhood livability and vitality.

5.2.4.1 Ecoroofs

Ecoroofs replace conventional roofing with a layer of vegetation over a growing medium on top of a synthetic, waterproof membrane. An ecoroof significantly decreases stormwater runoff, saves energy, reduces pollution and erosion, absorbs carbon dioxide, and reduces heat island effects.

The City of Portland strongly supports the installation of ecoroofs through the City's Green Building Policy, Stormwater Management Manual, and developer floor area ratio bonuses in specific portions of the city.

As of June 2014, Portland has over 410 ecoroofs installed throughout the city, managing almost 23 acres of roof. Approximately 280 of those ecoroofs are in the combined sewer area.

During FY 2014, 7 new ecoroofs were installed in the combined sewer area, managing approximately 0.68 acres of roof. This roof area represents 680,000 gallons of rainfall to the combined system annually, and Portland's monitoring data indicate that approximately 340,000 gallons are retained by the roofs and returned to the atmosphere through evapotranspiration.

5.2.4.2 Green Streets

As of June 2014, Portland has implemented over 1,400 green streets in the right-of-way, with approximately 800 in the combined sewer area. The Post-2011 Combined Sewer Overflow Facilities Plan identifies specifically how Portland will continue to implement both public and private stormwater controls to further reduce stormwater entering the combined sewer system and thereby increase the storage available for capturing CSO discharges.

During FY 2014, 50 new green street facilities were installed in the combined sewer area. Some projects were implemented by private development, some were CIP-budgeted cost-beneficial combined sewer system plan projects, and some were PBOT projects that required stormwater management. Collectively, these facilities manage approximately 5 acres of impervious area that generates 5.0 million gallons of stormwater to the combined sewer system annually. Based on the City's performance monitoring of green street facilities, these facilities will remove approximately 3.5 million gallons of runoff annually from the combined sewer system through infiltration and evapotranspiration.

City staff also continued multiple efforts in FY 2014 to improve design and long-term performance of green street facilities, including:

- Investigating soil characteristics for all facilities and drainage systems for infiltration and lined facilities to improve overall flow control.
- Developing forebay designs for facilities in high sediment drainage areas to minimize maintenance and ensure expected facility performance.
- Continued outreach and growth of the Green Street Stewards program which allows members of the public – individual property owners, business associations, or neighborhood associations – to adopt green street facilities and perform basic maintenance tasks. Neighborhood involvement provides a local presence and more day-to-day facility observation to ensure that facilities are functioning at peak efficiency during storm events. To date, 232 green street facilities have been adopted by 111 Stewards.

Section 6 Maximize Flow to the POTW

Maximizing flow to the treatment plant, as well as maximizing the use of storage, are both part of the overall integrated system operations strategy. The method by which these elements of the NMCs are implemented must be viewed in the context of the overall CSO system operating strategy that achieves multiple prioritized objectives.

6.1 CSO System Operating Plan – December 2011

The CSO System Operating Plan (originally submitted to DEQ in December 2011) was updated in December 2013 with the latest control strategy and procedures for operating Portland's CSO controls by integrating three major systems – the collection system, the CSO facilities and the CBWTP treatment trains. Two major regulatory documents—the CBWTP NPDES Permit and EPA's Guidance for CSO Programs—set out the objectives for the System Operating Plan.

6.1.1 CSO Operating Objectives by Priority

Nine System Operating Objectives were developed and prioritized based on risk to human health and the environment. Prioritization is important because objectives for the collection system, CSO control, and wastewater treatment can often conflict, and operations staff must have clear direction to determine what is most important to achieve when conflicts arise.

The prioritized objectives protect the treatment processes as the top priority, followed by protecting the public from exposure to sewage exposure, and then protecting the environment from CSO. Protection of the treatment processes is the first priority because the highest risk across the integrated system is the risk of damaging the treatment processes. If the treatment plant is compromised by washing out the biosolids or flooding, then major harm could occur in the environment, to human health, and to worker safety. Similarly, the collection system must be controlled to keep sewage away from the public. As a result, minimizing CSO is a midlevel priority.

The nine prioritized objectives are as follows:

1. Protect and Maintain Biological System and Meet Effluent Discharge Limits
    - Maintain and/or limit flow to 100 or 110 MGD through secondaries in wet weather

- Meet secondary effluent limits: Maximum Month: < TSS 30 mg/l; < BOD 30mg/l

2. Capture and convey all dry weather flow
    - Treat all dry weather flow through primary and secondary system
3. Prevent Releases to Streets and Basements (SSOs)
    - Control pumping rates to keep sewage away from human contact
4. Capture and convey maximum volume of wet weather flow to treatment
    - Optimize capacity of conveyance and storage systems
    - Treat all CSO via screening, primary treatment and disinfection at a minimum
5. Protect Columbia Slough (Sensitive Area)
    - Prevent CSO discharges to the sensitive area by giving priority to the Columbia Slough Influent Pump Station to pump high rates when needed and close the Argyle gate to shut-off inflows from the Willamette system
6. Treat as much CSO through secondary as possible
    - Dewater CSO tunnels slowly enough to treat more through secondary system but soon enough to avoid septic conditions (within 24 hours)
7. Minimize sedimentation / settling in tunnels and maintenance problems
    - Keep flows at high rate through interceptors and tunnels to prevent sedimentation
    - Employ self-cleaning cycles at CSO pump stations soon after wet weather events
8. Minimize Odor problems via Operations
    - Direct dry weather sewage away from neighborhoods and odor generating facilities
    - Activate odor control facilities when pumping through neighborhoods
9. Minimize energy usage and pumping costs
    - Keep flows moving through the collection system at the highest elevation possible and prevent sending flow to tunnel where possible
    - Pump at rates and times that reduce chemical and electrical costs

The comprehensive communications and controls that serve the collection system, CSO system and the treatment system have been programmed to follow these prioritized objectives. The detailed strategy for controlling specific facilities and sub-systems within these larger systems is presented fully in the December 2013 CSO Systems Operating Plan.

6.1.2 Integrating Permit and Regulations via CSO Operating Strategy

The CSO system operating strategy is Portland's most reliable method to achieve the CBWTP NPDES permit requirements, the Nine Minimum Controls, and the operational elements of the CMOM Program. These regulatory requirements are addressed in the nine prioritized objectives as follows:

CBWTP NPDES Permit Requirements

1. Protect and maintain treatment systems performance – *Meet Permit Effluent Limits*
2. Capture and convey all dry weather flow to secondary treatment – *Meet Permit Technology Requirements*
3. Prevent sewage releases to streets or basements – *Prevent SSOs*

EPA CSO Policy and Nine Minimum Controls

4. Capture and convey maximum wet weather flow (CSO) to treatment – *NMC #4*
5. Protect sensitive areas from overflows – *EPA CSO Policy*
6. Provide high quality treatment of wet weather flows – *EPA CSO Policy*

CMOM Requirements and Asset Management

7. Minimize sedimentation / maintenance in tunnels - *CMOM*
8. Minimize odor problems - *CMOM*
9. Minimize energy usage and chemical costs – *Asset Management*

These prioritized objectives are implemented through a decision-making hierarchy that Operators follow before, during and after storms such that the regulatory requirements are considered and addressed at all times. The decision hierarchy can be represented as four sequential decisions or questions to be answered in the following order:

1. "What flow rate can CBWTP treat?"
    - Determine the maximum flow the facility can accept without causing problems to the secondary or wet weather systems.

2. "What flow rate can the downstream system convey?"
   - Determine the maximum flow rate the Peninsular and Portsmouth Interceptors can receive without overflowing to streets or basements.
3. "What pumping rate should be used to drain the system protecting the sensitive area?"
   - Determine the pump-out rate of the Columbia Slough Influent Pump Station to prevent CSO discharges to the sensitive Columbia Slough.
4. "What pump-out rate should be used to drain the Willamette CSO tunnels?"
   - Determine the rate at which the SI-CSO should pump to control CSO while being constrained by Decisions 1 through 3.

The results from the past three years of integrated system operations show excellent performance in achieving the objectives, providing good flexibility across the integrated system, and steadily increasing CSO capture and treated effluent quality.

6.2 CSO System Performance Review

This annual report provides a significant amount of technical information regarding the performance of specific facilities during individual storms and over the year. This section provides summary evaluations of the information to determine how the overall integrated system performed during FY 2014. The analyses generally follow the system operating objectives by simply asking – Were the major objectives achieved during the year?

6.2.1 Summary of Analysis for CSO Events

How well were CSO events controlled? The CSO discharges for FY 2014, which was a near-average year, were clearly less than one would expect both in terms of frequency and volume. In terms of frequency, there were only two major CSO events in which the Willamette tunnels filled, and one minor event that impacted only one outfall. Similarly, the volume of CSO discharged was 127 MG, or only about 1.8% of the total wet weather CSO volume generated by the entire system. This equates to 98.2% CSO control, which far exceeds the 94% level of control expected.

Were wet weather flows maximized to the plant? The answer can be seen by examining the charts provided in Section 2.5 (Figures 2-4 through 2-6) for the three CSO events. For the integrated system, flows to the plant are maximized when Swan Island pumps at its top capacity or at the "Maximum Permissible" rate when restricted by the available treatment capacity at CBWTP or flow capacity in Peninsular Tunnel. As seen in the charts and discussed in Section 2.5, the only time that SICSO was not pumping at maximum available capacity was when the station was switching from Peninsular Lead over to Portsmouth Lead to convey the peak wet weather flows. Therefore, the flows to CBWTP were indeed maximized.

Was system storage maximized? The CSO system was designed and configured to ensure that the available storage was fully utilized before a CSO discharge could occur, and that continues to be the case. The tunnels and consolidation conduits must physically fill before the water level can rise high enough to overflow the weirs set at elevation 18.0 feet. The benefit of this configuration is that CSO volume is always minimized and the frequency of events is minimized. This can be seen in the near-filled events displayed in Figure 2-1 for winter events and Figure 2-2 for summer events. Figure 2-1 shows a winter storm (February 2014) that exceeded the 4-per-winter storm criteria, and Figure 2-2 shows a summer storm (September 5-6, 2013) event that exceeded the 3-year summer criteria. Both storms exceeded the design criteria during short (3-12) hour durations, which would cause the CSO system to store the peak flows until they could be pumped to CBWTP. Neither storm caused a CSO discharge, but only filled the tunnels to 81-85% full.

6.2.2 Summary of Analysis for Wet Weather Treatment

Were wet weather / CSO flows treated to a high quality? The annual performance results for the Wet Weather Treatment Facility show that in FY 2014 the wet weather flows were treated to the highest quality observed so far since the WWTF was implemented. Using the fine screening and aggressive CEPT, the operations staff were able to achieve 83% TSS removal and 63% BOD removal, which is significantly higher than previous years as well as the permit required levels.

Were flows to secondary treatment maximized? Wet weather flows were successfully maximized to secondary system during FY 2014 in a manner consistent with previous years. As shown in Table 2-13, the volume of CSO sent to the secondary system was around 64%, which is similar to the levels achieved in the last two years. The rate of flow directed to the dry weather[14] and secondary treatment system during periods of bypass was 112 MGD, or about 12% above the require 100 MGD minimum.

Were effluent limits achieved at OF001 and OF003? In general, the CBWTP permit effluent limits were achieved for the Wet Weather Treatment Facility, the secondary treatment system, and the blended effluent from OF001 and OF003. The exception was the unusually high

[14] Previous years calculated the flow to the secondary system based on the flow measured in the secondary treatment train. Due to operational changes for improved secondary capacity, this flow rate now includes significant return activated sludge (RAS), and so is not an appropriate measure for determining the flows directed to the dry weather and secondary system.

solids loading that occurred during February and March 2014 from the secondary treatment system. Table 2-14 shows that the 30-day TSS loading from the secondary system resulted in exceeding the 30-day TSS effluent standard for OF001 and OF003. Similarly, Table 2-15 shows that the 7-day TSS loading from the secondary system resulted in the 7-day TSS effluent limit being exceeded for OF001 and OF003.

These unusually high mass loadings were a result of a temporary configuration for implementing the components of the Secondary Process Improvements Project. These improvements include implementing SVI controls and the Step-Feed method for treating wet weather flows more effectively. The goal is to increase the secondary treatment capacity beyond 100 MGD and up to 140 or possibly 160 MGD. As can be expected, these significant changes to an operating facility run the risk of a process upset during the implementation, and that is essentially what happened on a temporary basis in February and March 2014.

Section 7 Update of the Public Notification Program

The goals of the CSO public notification program are to:

1. Make the public aware that the City has a combined sewer system that can overflow.
2. Explain what a CSO is and how it impacts water quality and can threaten public health.
3. Inform the public when a CSO has occurred and warn against contact with the receiving waters.
4. Raise public awareness of the benefits to the community of the City's investment in CSO Control.

When the CSO Policy was adopted, this element of the NMC focused mostly on outreach through brochures and public meetings and posting warnings at public access points on the Willamette River and Columbia Slough.

With changing communication technology, public notification is more diverse.

Portland's CSO notification procedures changed with completion of the CSO abatement program in December 2011. Throughout the 20-year program, the City relied on its HYDRA System to measure rainfall and trigger the CSO notification process. As of December 2011, all combined sewer outfalls that can discharge are monitored and public notification takes place when an overflow is measured at a specific location.

7.1 Public Notification/River Alert Program

The River Alert system notifies the public of CSO events. The system includes ten permanent, folding signs installed at public access points to the Willamette River. A contractor travels the river by boat and opens the warning signs each time there is a CSO. Forty-eight hours after each CSO event ends, the contractor closes the warning signs. Signs identifying CSO outfall pipes are posted at each outfall.

The warning signs display the phone number of the River Alert Hotline, a 24-hour recorded message the public can call to learn if a CSO advisory is in effect. The hotline number is 503-823-2479.

The River Alert program notifies the media by email every time there is CSO event. Internet users can go to http://www.portlandorgon.gov/bes/overflow (Figure 7-1) to learn if a CSO advisory is in effect.

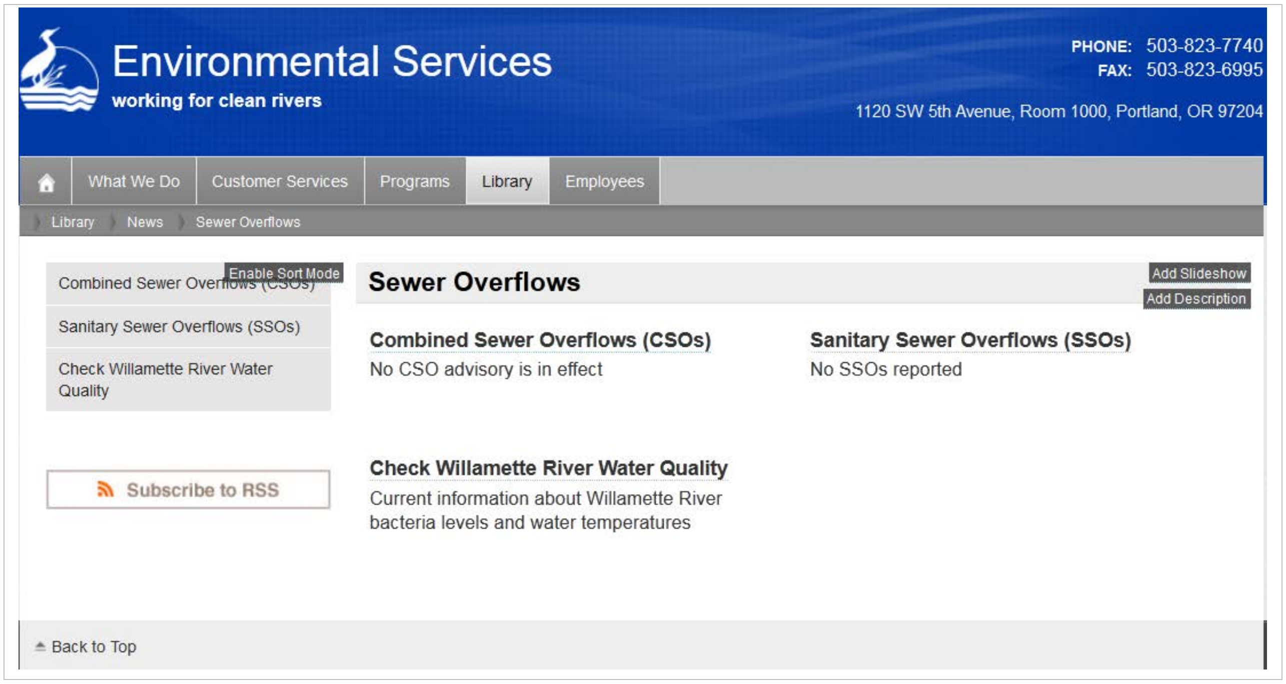

Figure 7-1 Clean River Program Web Page with CSO Advisory Information, http://www.portlandoregon.gov/bes/36989

Internet users can also subscribe to automatic email notification (Figure 7-2) each time BES issues a CSO advisory by going to http://www.portlandoregon.gov, signing in or creating an account, choosing "subscribe" in the footer of the web page and selecting "Sewer Overflow Notification." BES issues CSO alerts on https://twitter.com/BESPortland and the notifications are re-tweeted by PublicAlerts.org.

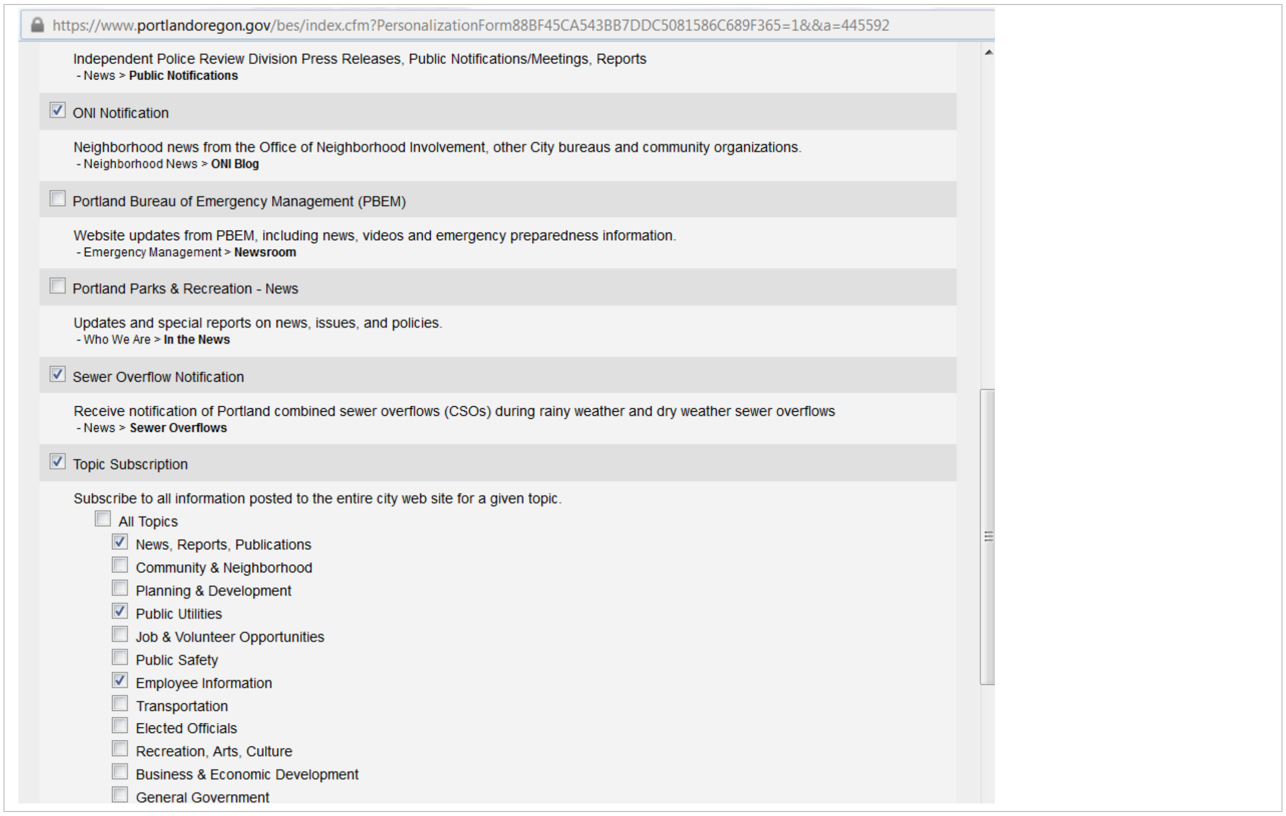

Figure 7-2 River Alert E-Mail Subscribe Web Page

In addition to public CSO notification, other activities that include public information and education about CSOs have also been extensively implemented by BES since 2003. In spring 2012, the city began posting water quality information on portlandoregon.gov (Figure 7-3):

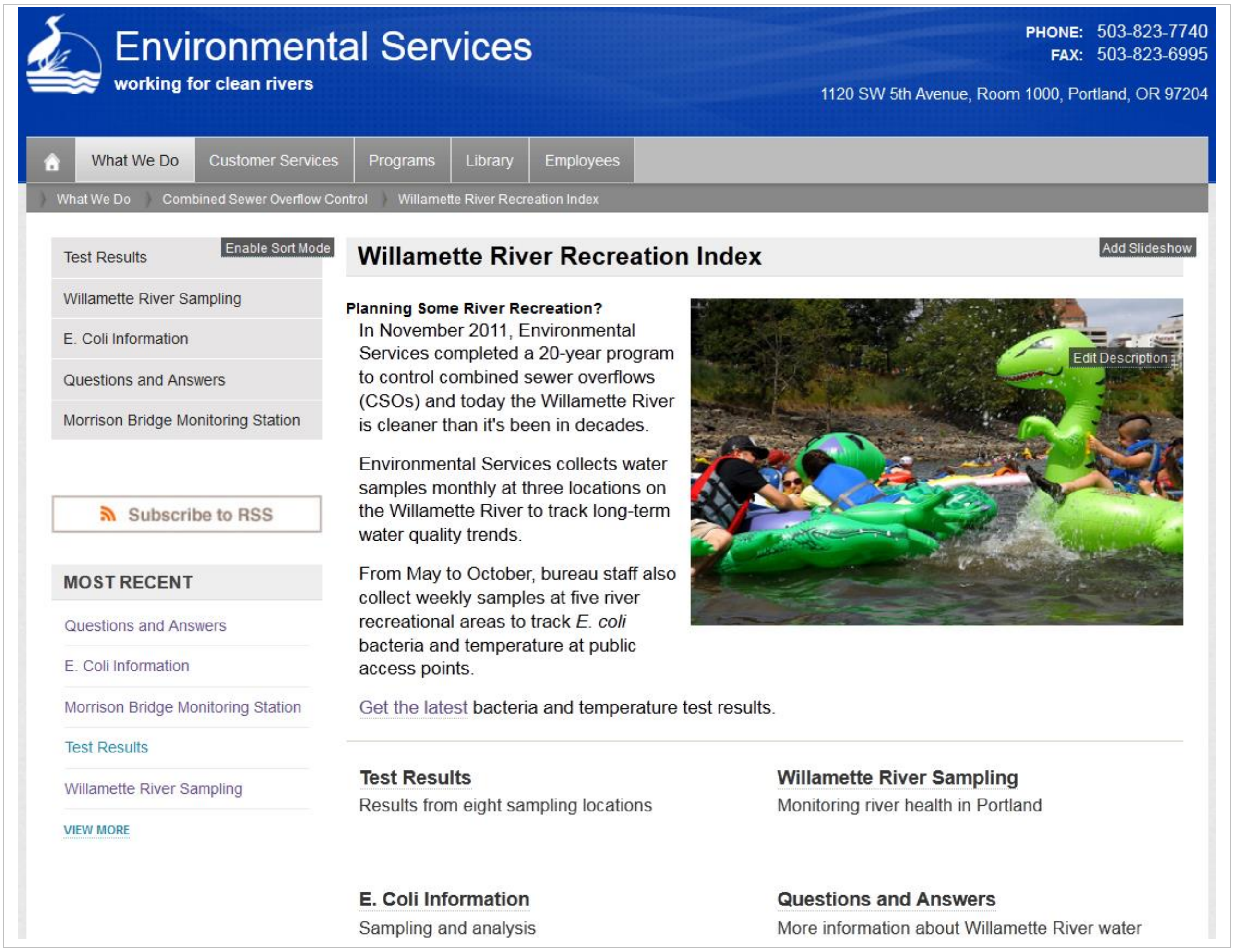

Figure 7-3 Water Quality Monitoring Web Page: http://www.portlandoregon.gov/bes/57781

Section 8 CSO System and Water Quality Monitoring

The NPDES Permit and the MAO require that specific Post-Construction Monitoring Program (PCMP) activities be implemented to ensure that the CSO Control Program complies with the NPDES permit and water quality standards. The PCMP includes monitoring for:

- Rainfall across the service area for comparison against design storm event frequency criteria for compliance
- CSO discharges with alarms to determine occurrence, duration, volume and peak rates
- CSO system and treatment facilities operations to confirm performance compared to design expectations and permit limits
- Separated sanitary flows into the combined sewer system (new requirement in MAO)

In addition to CSO discharge monitoring, CSO system operations and treatment process monitoring discussed earlier in this report, the PCMP also includes three areas of water quality monitoring:

- Water quality sampling of CSO discharges at overflow structures to confirm that water quality will be achieved outside of permitted mixing zones.
- Routine monthly in-stream water quality sampling in the Willamette River to support analysis of completed CSO control facilities, and to demonstrate compliance with water quality standards and TMDL allocations, as applicable.
- Routine monthly in-stream water quality sampling in the Columbia River to demonstrate efficacy of the CSO treatment system and compliance with water quality standards.

The NPDES permit requires receiving stream sampling to be conducted as described in the December 2010 Nine Minimum Controls Update report. The Willamette River in-stream sampling program is to continue for five years after controlling all CSO outfalls to the required performance standard.

8.1 Separated System Flow Monitoring (Required by MAO)

One of the goals of the Monitoring and Analysis Program in the MAO is to "Provide data to inform CBWTP Facilities Plan Update and the NFAA for determining adequate secondary capacity." Part of achieving that goal is to reliably quantify the dry and wet weather flows from the separated portion of sanitary sewer collection systems that send flows directly into the combined sewer system. These sanitary basins are shown in Figure 8-1 below. The basins that flow into the CBWTP system are listed in Table 8-1 along with the mechanism by which the sanitary flows are being measured, including flow monitors installed by the June 30, 2012, deadline.

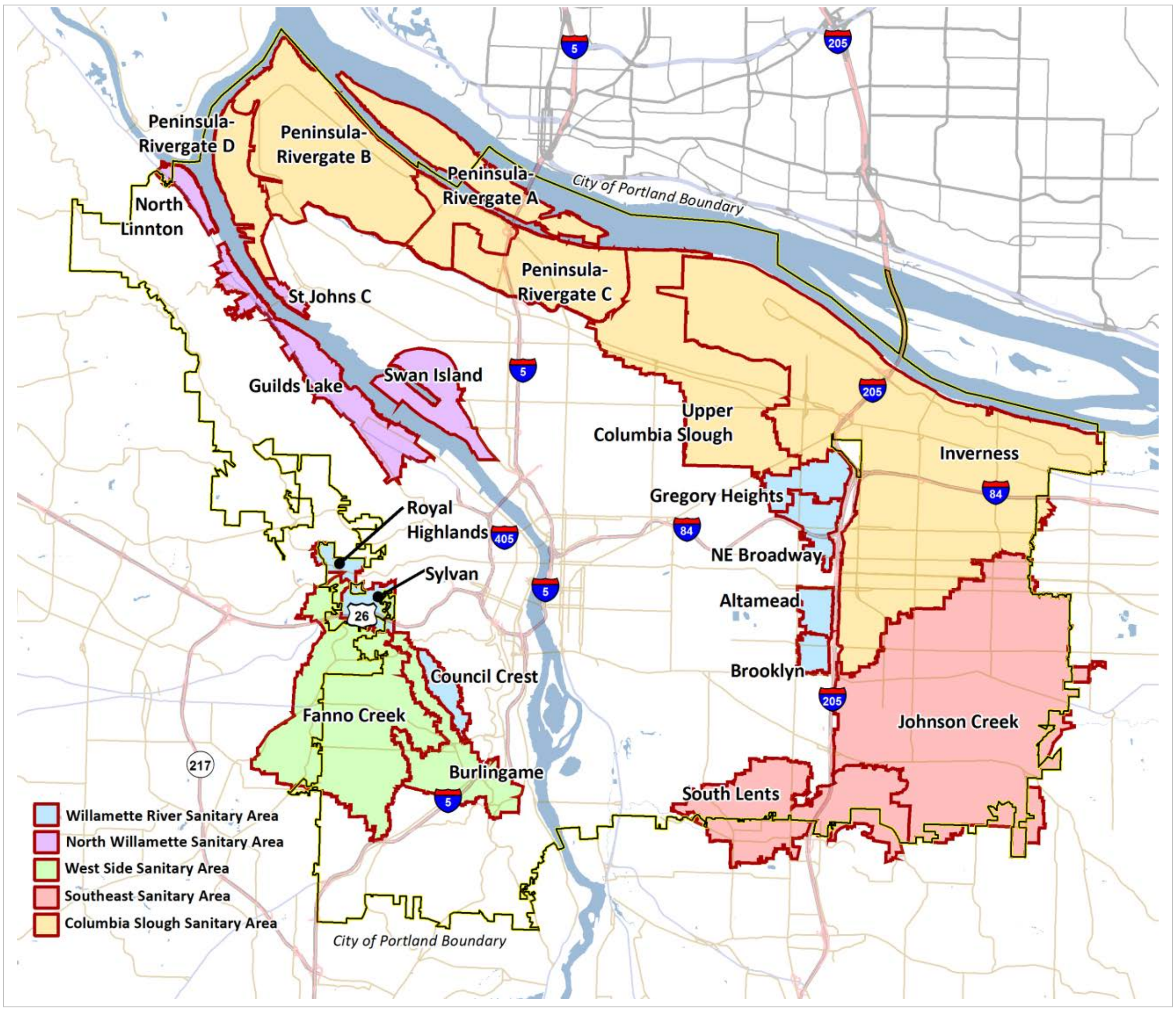

Figure 8-1 Sanitary Basins

Table 8-1 Sanitary Flow Monitoring for Separated Areas Contributing to CBWTP (MAO Requirement)

Sewer Basin Name	Discharge Mechanism	Flow Rate Measurement Mechanism	Notes
Willamette River Sanitary Area			
Royal Highlands	Royal Highlands PS to NW Interceptor	n/a	Too small of separated area to justify monitoring; use model to estimate flows
Sylvan	Gravity to combined system	n/a	More a part of the combined sewer system than separated
Council Crest	Gravity to combined system	n/a	Too small of separated area to justify monitoring in SW Capitol Hwy; use model to estimate flows
Brooklyn	Brooklyn PS to combined sewer system	Cycle data	SE Brooklyn & 89th: 2 pumps, 1000 gpm each, 1000 gpm FIRM
Altamead	Altamead PS to combined sewer system	Cycle data	2 pumps, 1900 gpm each, 1900 gpm FIRM
NE Broadway	NE Broadway PS to combined sewer system	Cycle data	Broadway & 87th PS: 3 pumps @ 1300 gpm each; 2600 gpm FIRM
Gregory Heights	Fremont PS to combined sewer system	Cycle data	Fremont PS: 3 pumps @ 800 gpm each; 1600 gpm FIRM
North Willamette Sanitary Area			
Guilds Lake	GLPS pumps to Portsmouth Tunnel	Cycle data, then new Mag meters	GLPS: 3 pumps; 2 pumps @ 12000 gpm; 1 pump @ 5000 gpm; 30 MGD FIRM
North Linnton	Pumps to GLPS	GLPS	Measured via Guilds Lake PS
Swan Island	Mocks Bottom PS to Swan Island PS (sanitary)	Cycle data	SIPS: 4 pumps @ 2800 gpm; 6300 gpm FIRM
St Johns C	St. Johns PS pumps to St. Johns Interceptor	Cycle data	SJPS: 3 pumps @ 650 gpm; 1300 gpm FIRM
West Side Sanitary Area			
Burlingame	Drains into Burlingame Trunk	Flow meter in SWPI	SWPI project (E09171) currently has monitor in best location
Fanno Creek	FABA PS pumps into Burlingame Trunk	FABA PS Mag meters	
Southeast Sanitary Area			
South Lents	Gravity to Lents Trunk	HYDRA SLRT and temporary flow monitor	HYDRA added velocity meter to Lents Trunk SLRT #35 in 57-inch pipe. Field Operations installed two temporary flow monitors: one on the 21-inch pipe leaving ACZ091 to the south, and the second further upstream on the Lents Trunk (ACU090)
Johnson Creek	Johnson Creek Interceptor gravity to Lents Trunk	Temporary flow monitor	Field Operations installed temporary monitor in ACU211

Sewer Basin Name	Discharge Mechanism	Flow Rate Measurement Mechanism	Notes
Columbia Slough Sanitary Area			
Inverness	Inverness pumps to CBWTP	Inverness Mag meters	
Upper Columbia Slough	Gravity to Lombard Interceptor, NE 59th PS, 33rd Ave PS, and Argyle & 13th PS	Temporary flow monitor, cycle data for PS	Field Operations installed a temporary flow monitor into AAK923 in 24-inch interceptor in Lombard east of NE 13th. Cycle data from Argyle & 13th for full sanitary flow measurement.
Peninsula-Rivergate A	Force PS pumps to Columbia Interceptor	Cycle data	Force PS: 2 pumps @ 1400 gpm; 1400 gpm FIRM
Peninsula-Rivergate B	Oregonian, Refuse, and Lombard PSs	Cycle data	Oregonian: 2 pumps @ 650 gpm; 650 gpm FIRM Refuse Disposal: 2 pumps @ 350 gpm; 350 gpm FIRM Lombard PS: 2 pumps @ 6700 gpm; 6700 gpm firm
Peninsula-Rivergate C	Montana and Schmeer PSs	Cycle data	Montana PS: 3 pumps: 2 @ 1500 gpm, 1 @ 1650 gpm; 2950 gpm FIRM
Peninsula-Rivergate D	Rivergate and Shipyard PSs	Cycle data	Rivergate PS: 3 pumps @ 250 gpm; 500 gpm FIRM Shipyard PS: 2 pumps @ 1200 gpm; 1200 gpm FIRM

8.2 CSO Discharge Sampling

The CBWTP NPDES permit requires opportunity-based sampling of CSO discharges to the Willamette River. The purpose of this sampling is to confirm that the remaining CSO discharges protect beneficial uses and provide for attainment of the Willamette River water quality standards consistent with permit requirements for overflows from storms exceeding the CSO control standards. In the years that the sampling is performed, the results are to be included in the annual CSO report.

The sampling program will be implemented for five different events throughout the 5-year permit cycle, and is focused on storms that last at least four hours in order to provide sufficient time to mobilize the sampling crew. Grab samples are to be taken and analyzed for the CSO Pollutants of Concern: E-coli, Total Lead and Total Copper. Zinc is typically included in the analyses, but it has not been identified as a CSO Pollutant of Concern.

CSO discharges are considered protective of beneficial uses and do not preclude attainment of water quality standards when monitoring results do not exceed the appropriate numeric standards for the Pollutants of Concern. Standards take into account a 10:1 dilution in the mixing zones with the exception of E. coli, for which a mixing zone is not allowed.

Portland was able to obtain two grab samples for FY 2014, bringing the total to three event samples for the current permit cycle (five are required, if possible). Figure 8-2 shows the laboratory analysis report for the September 28, 2013, CSO discharge, and the grab sample was collected near Outfall 46 (Beech-Essex). The second grab sample was collected near Outfall 36 (Alder) for the March 28, 2014, CSO discharge, and the laboratory analysis report is provided in Figure 8-3.

City of Portland
Water Pollution Control Laboratory
6543 N. Burlington Ave. / Portland OR 97203 (503) 823-5600 fax (503) 823-5656

LABORATORY ANALYSIS REPORT

Project:	**CSO Permit**	Client:	Asset Management
Work Order:	**W13I209**	Project Mgr:	Virgil Adderley
Received:	9/28/13 20:52		
Submitted By:	Field Operations		

Sample	Laboratory ID	Matrix	Type	Sample Collection Date Start	Sample Collection Date End	Qualifier
CSO46	W13I209-01	Stormwater	Grab	09/28/13 20:25	09/28/13 20:25	

Analyte	Result	Units	MRL	Dil.	Batch	Prepared	Analyzed	Method	Qualifier
Microbiology									
E. coli by Colilert Quantitray									
CSO46 : W13I209-01									
E. coli	>24000	MPN/100 mL	10	1	B13I451	09/29/13 07:07	09/30/13	Colilert QT	Z0
CSO46 : W13I209-01RE1									
E. coli	170000	MPN/100 mL	100	1	B13I451	09/30/13 08:40	10/01/13	Colilert QT	H2, Z0a
Total Metals									
Total Metals by ICPMS									
CSO46 : W13I209-01									
Copper	19.7	ug/L	0.200	1	B13J023	10/02/13	10/03/13	EPA 200.8	
Lead	16.9	ug/L	0.100	1	B13J023	10/02/13	10/03/13	EPA 200.8	

Figure 8-2 September 28, 2013, CSO Discharge Water Quality Sample Result - OF 46

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LABORATORY ANALYSIS REPORT

Project:	**CSO Permit**	Client:	Asset Management
Work Order:	**W14C229**	Project Mgr:	Virgil Adderley
Received:	3/28/14 20:44		
Submitted By:	Field Operations		

Sample	Laboratory ID	Matrix	Type	Sample Collection Date Start	Sample Collection Date End	Qualifier
CSO36	W14C229-01	Stormwater	Grab	03/28/14 19:17	03/28/14 19:17	

Analyte	Result	Units	MRL	Dil.	Batch	Prepared	Analyzed	Method	Qualifier
CSO36 : W14C229-01									
Microbiology									
E. coli	46000	MPN/100 mL	100	1	B14C457	03/29/14 07:30	03/30/14	Colilert QT	Z0
General Chemistry									
Total suspended solids	193	mg/L	2		B14C452	03/29/14	03/29/14	SM 2540D	
Total Metals									
Total Metals by ICPMS									
Copper	16.4	ug/L	0.200	1	B14D063	04/04/14	04/11/14	EPA 200.8	
Lead	37.8	ug/L	0.100	1	B14D063	04/04/14	04/11/14	EPA 200.8	

Figure 8-3 March 28, 2014, CSO Discharge Water Quality Sample Result - OF 36

8.3 Willamette River Instream Water Quality Sampling

Since the beginning of the CSO Control Program, Portland has implemented an extensive in-stream water quality monitoring effort to characterize the impacts of CSO and track the benefits of implementing the CSO facilities. Improved water quality in the Willamette is one of the measurable outcomes of Portland's 20-year, $1.4 billion CSO Control Program.

Figure 8-4 through Figure 8-8 below show the water quality trends along the Portland stretch of the Willamette River for five parameters: zinc, lead, copper, TSS, and *E. coli*. These metals and bacteria parameters are the pollutants of concern for Portland CSO discharges. The figures provide a view of the four different transects of sampling taken across the river at the far upstream (Waverly), the center of the CSO area (Morrison Bridge), the downstream end of the CSO area (St Johns Bridge), and near the end of the city limits (Kelly Point).

As the Willamette River water quality sampling results show, there continues to be a steady improvement (reduction) in the concentrations measured for these four parameters for the long-term trending period.

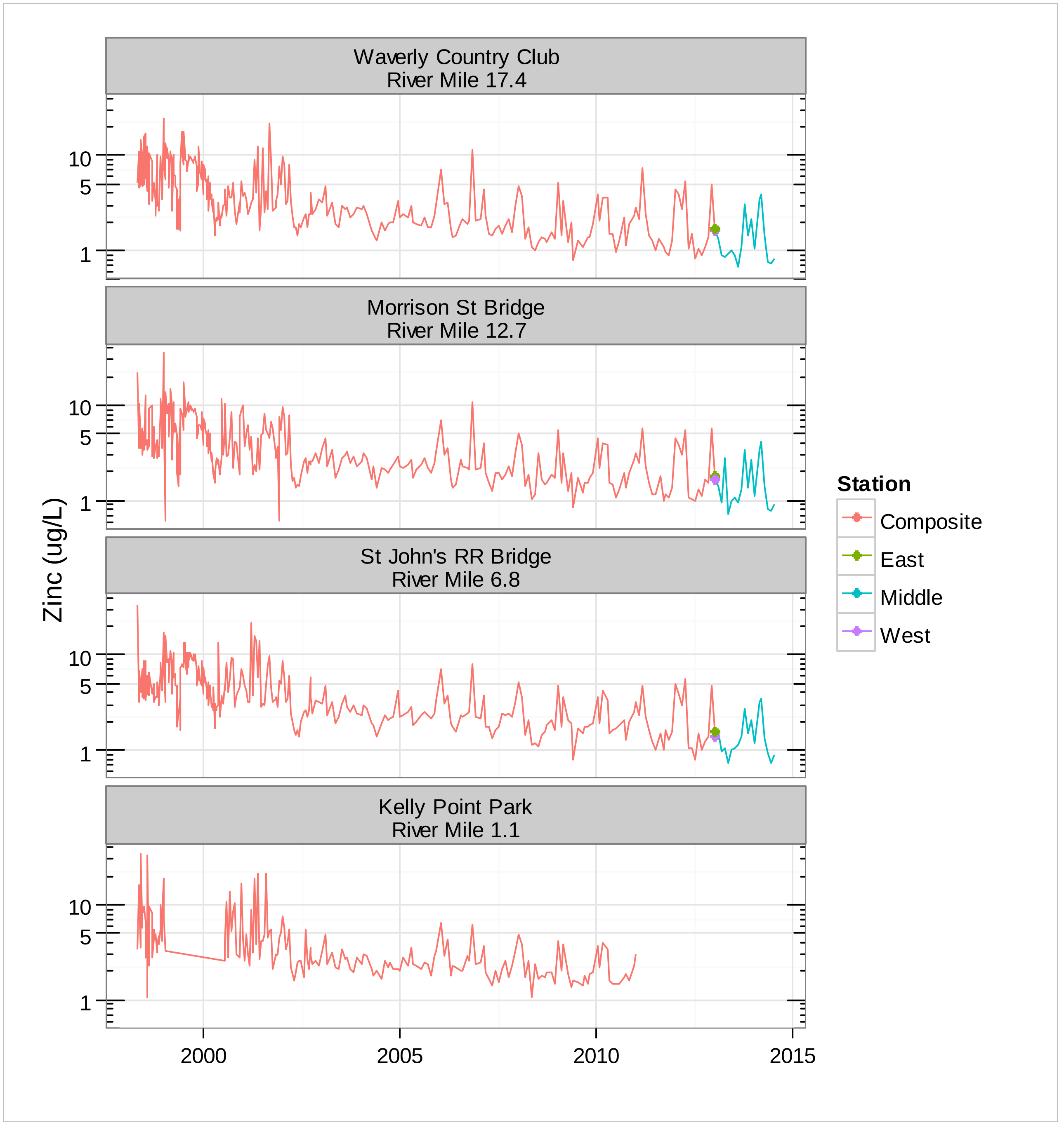

Figure 8-4 Willamette River Monitoring Results for Zinc: Pre and Post Ultra-Clean Change

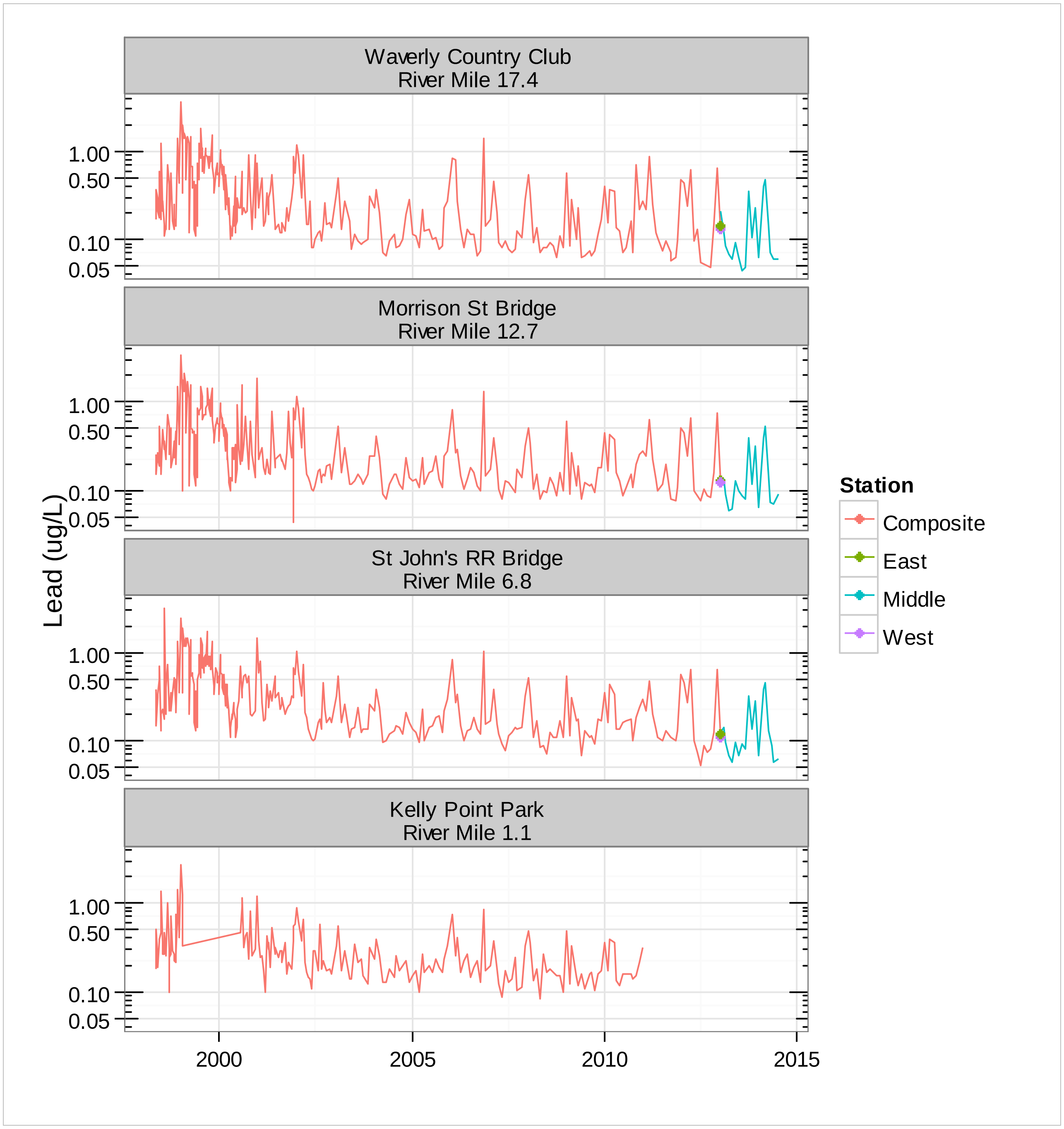

Figure 8-5 Willamette River Monitoring Results for Lead: Pre and Post Ultra-Clean Change

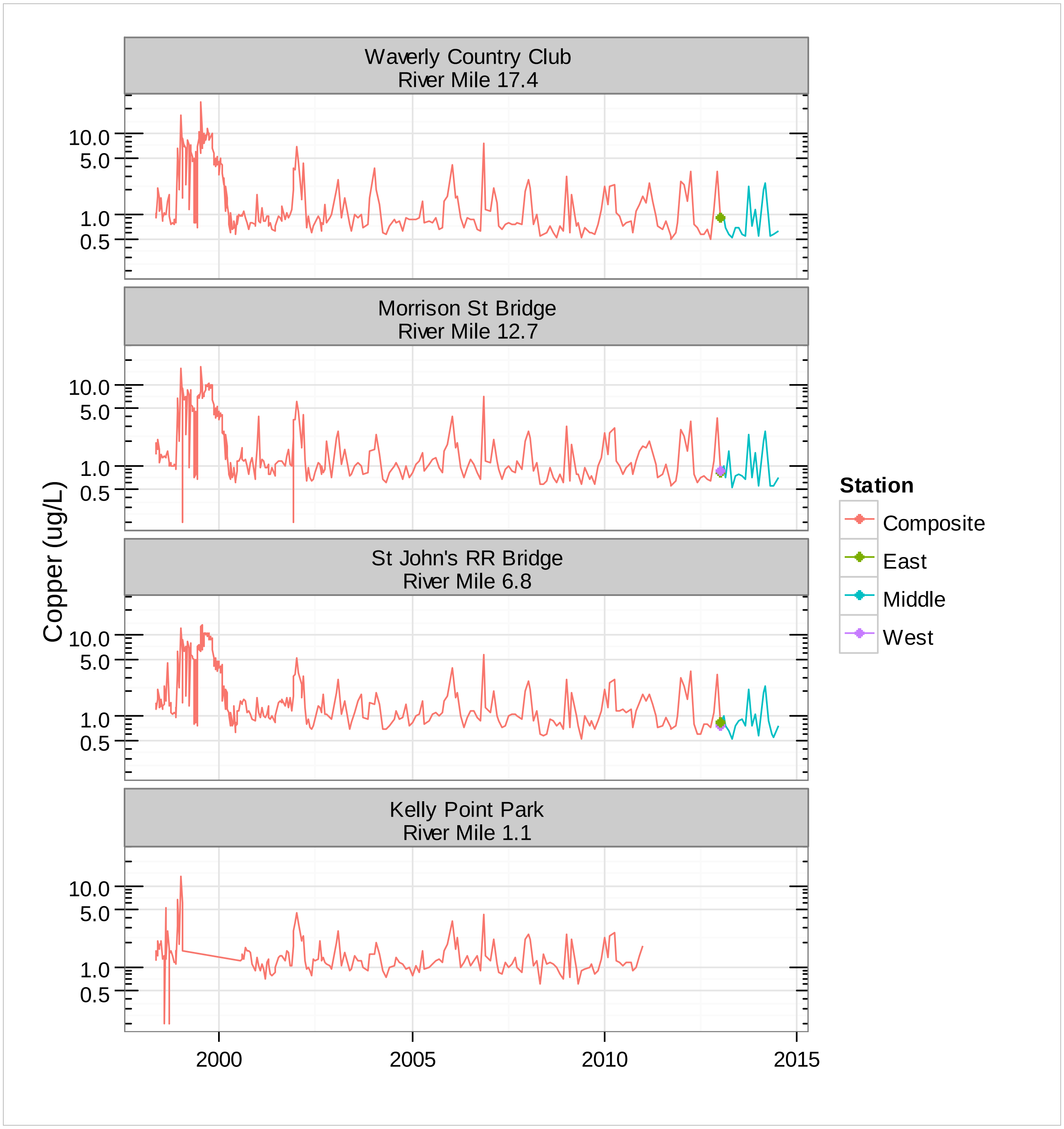

Figure 8-6 Willamette River Monitoring Results for Copper: Pre and Post Ultra-Clean Change

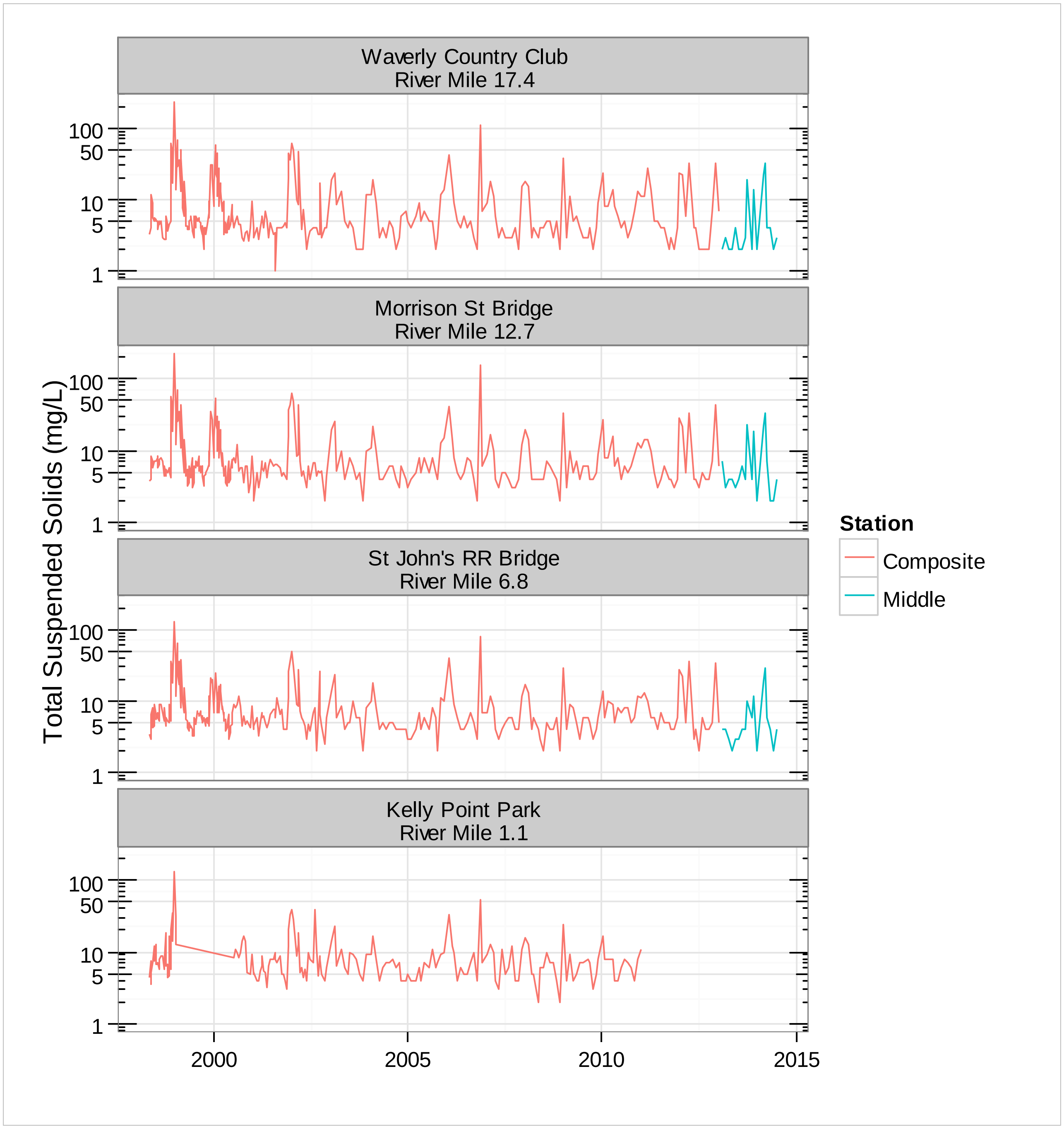

Figure 8-7 Willamette River Monitoring Results for TSS: Pre and Post Ultra-Clean Change

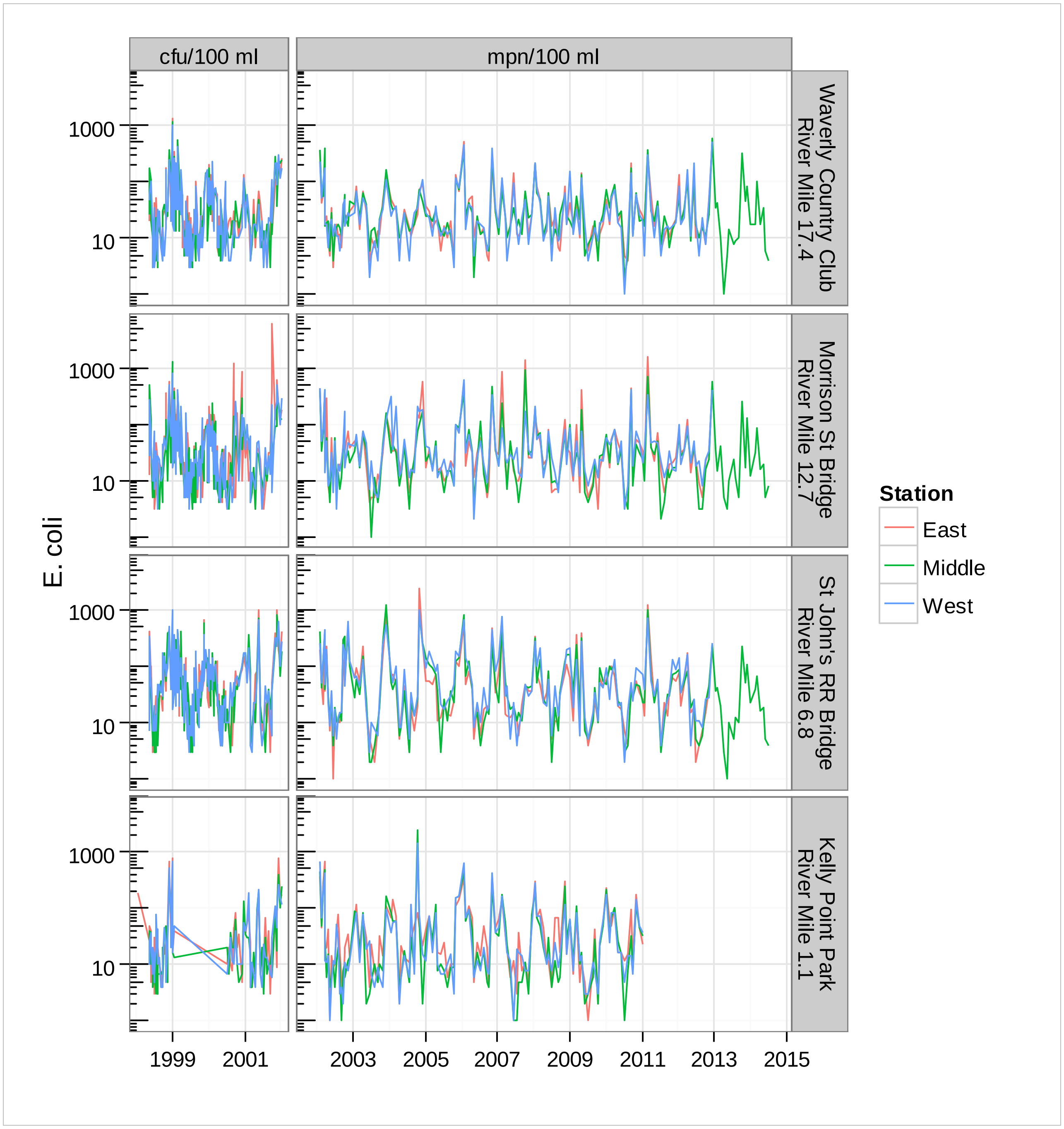

Figure 8-8 Willamette River Monitoring Results for E. coli

8.4 Columbia River Instream Water Quality Sampling

Portland also has been monitoring the Columbia River water quality upstream and downstream of Outfall 001 and 003 to assess impacts of increased treated CSO effluent to the river. The first sets of results were reported to DEQ in the December 2009 NFAA report to demonstrate that CSO treatment systems at CBWTP meet water quality standards and are protective of beneficial uses.

The main parameters of interest related to CSO treatment and the Columbia River are *E. coli*, TSS, copper, lead, and zinc. The results of a comparison of measurements from upstream of the combined mixing zone versus downstream of the mixing zone (measuring impact of the effluent on the water quality) are provided in Figure 8-9 through Figure 8-13 below. In addition to sampling data, the chart shows the relevant numeric water quality standard for each parameter. For the metals, the range of chronic WQS values is based on the measured total hardness of the river, which varies from a low of 45 to a high of 78; the chart shows the reasonable range of chronic standards based on the hardness values measured in the river during that sampling period.

As can be seen in the charts below, all parameters are well below the numeric water quality standards. In general, apart from noise in the data, there is little difference in the values from upstream to downstream of the Outfalls 001 and 003 combined mixing zone.

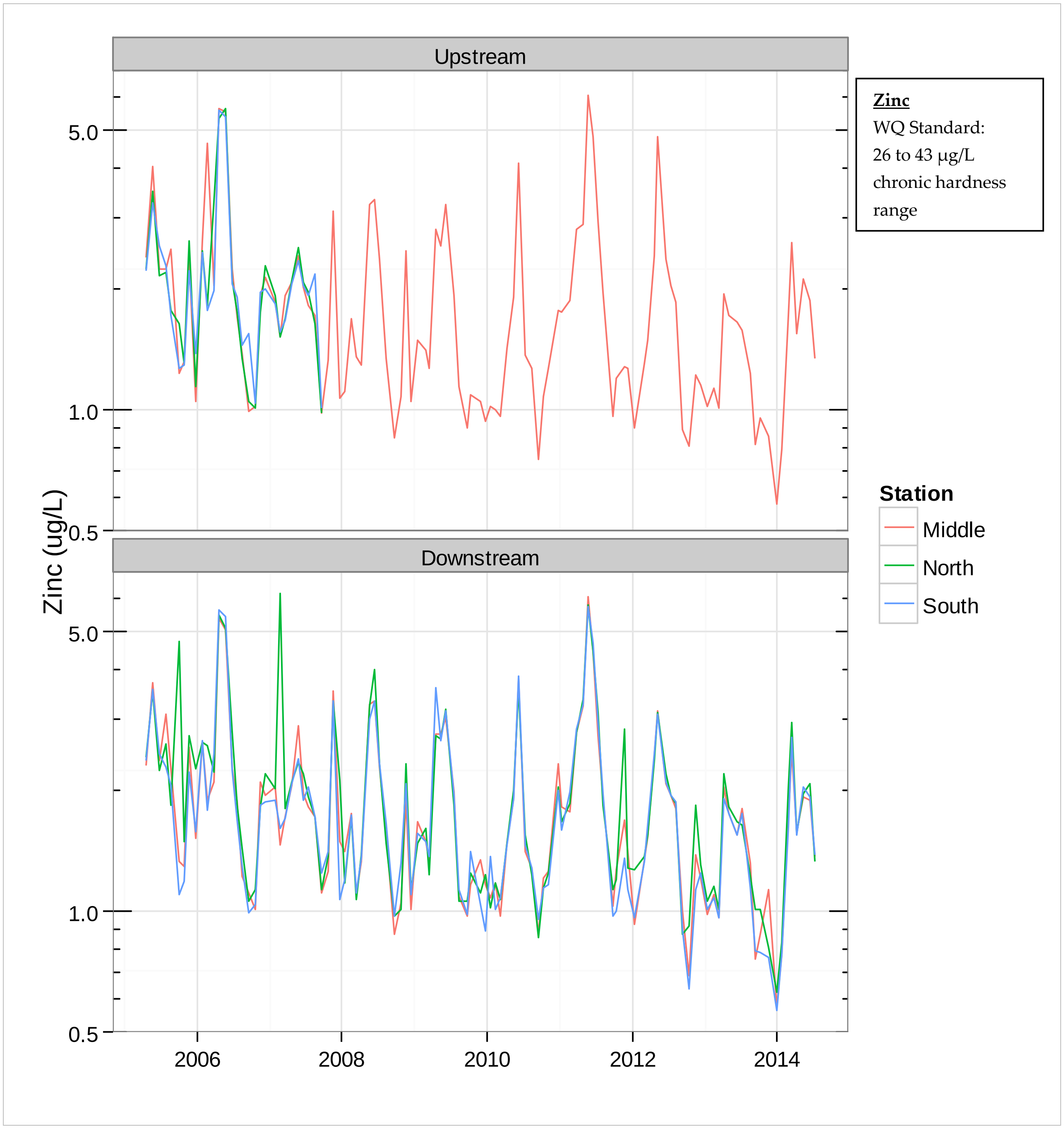

Figure 8-9 Columbia River Mixing Zone Sampling for Zinc

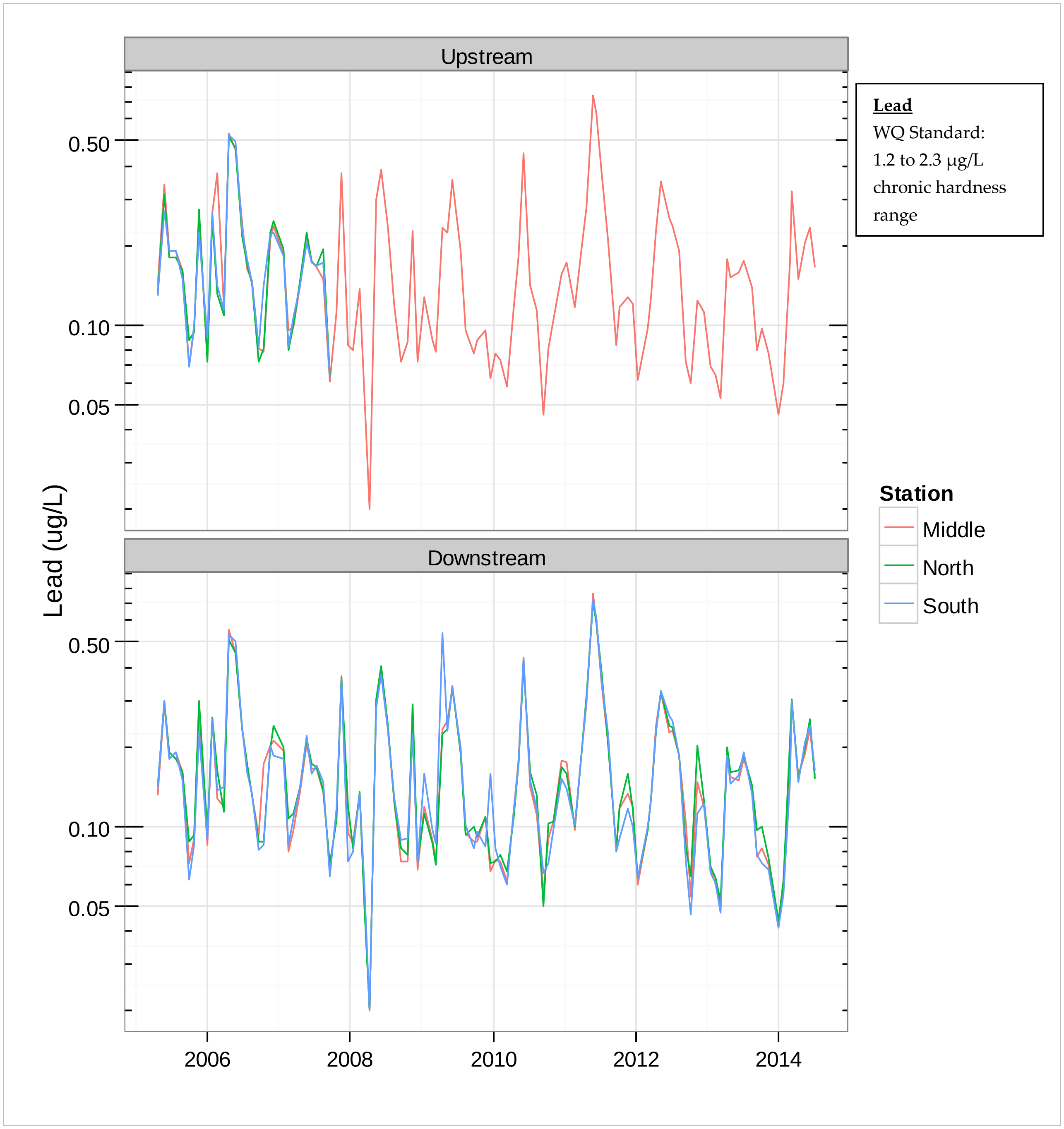

Figure 8-10 Columbia River Mixing Zone Sampling for Lead

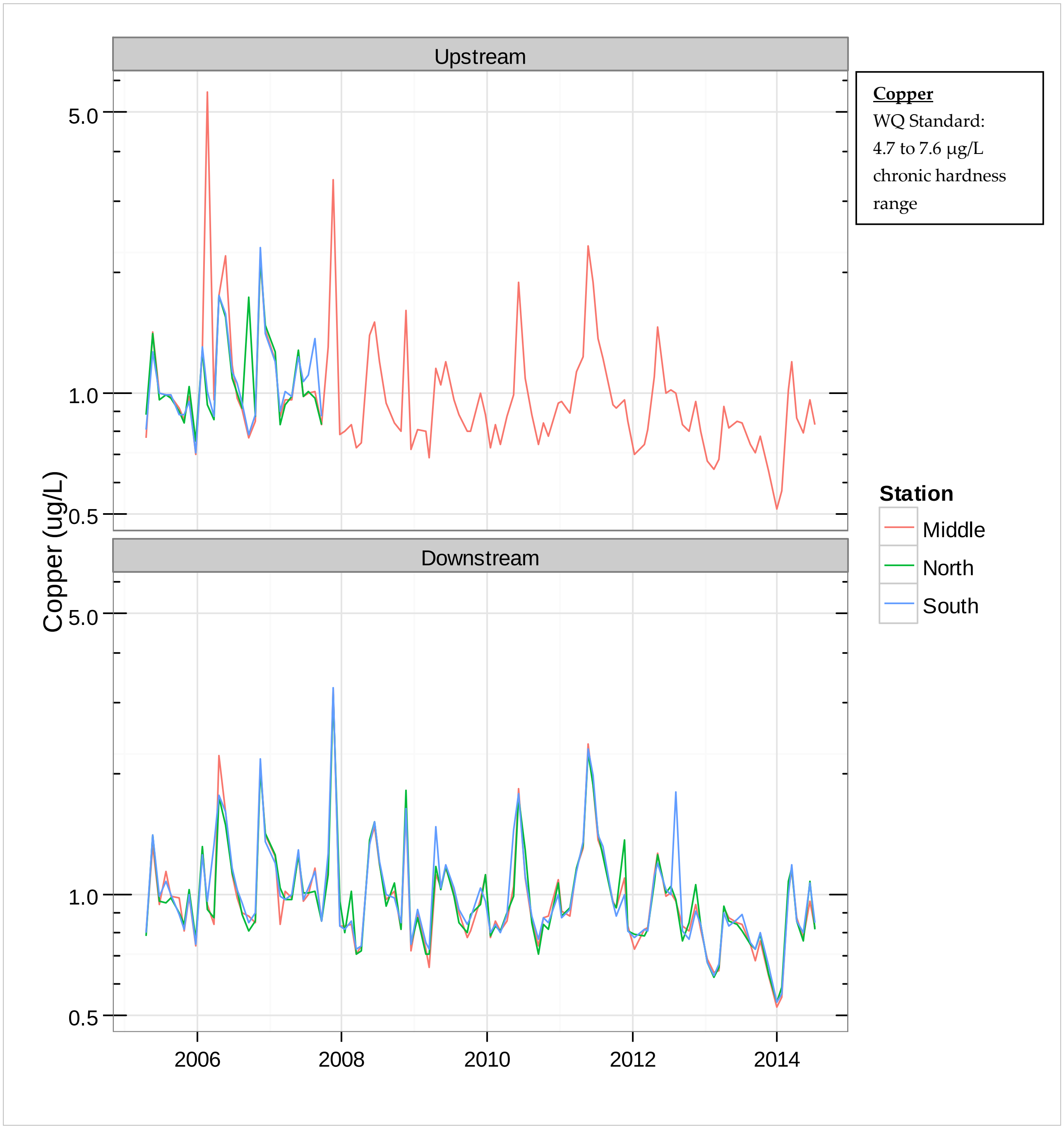

Figure 8-11 Columbia River Mixing Zone Sampling for Copper

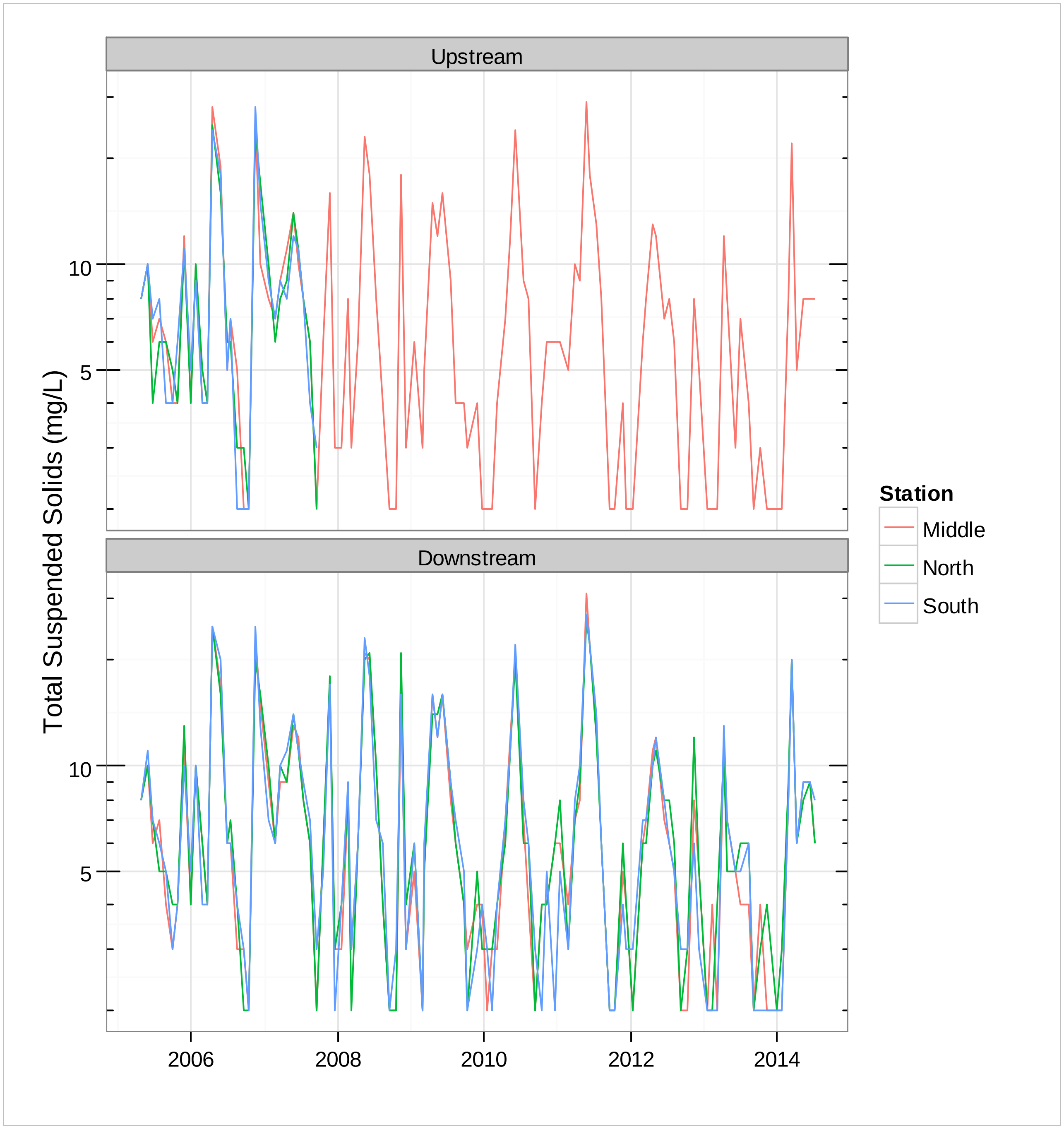

Figure 8-12 Columbia River Mixing Zone Sampling for TSS

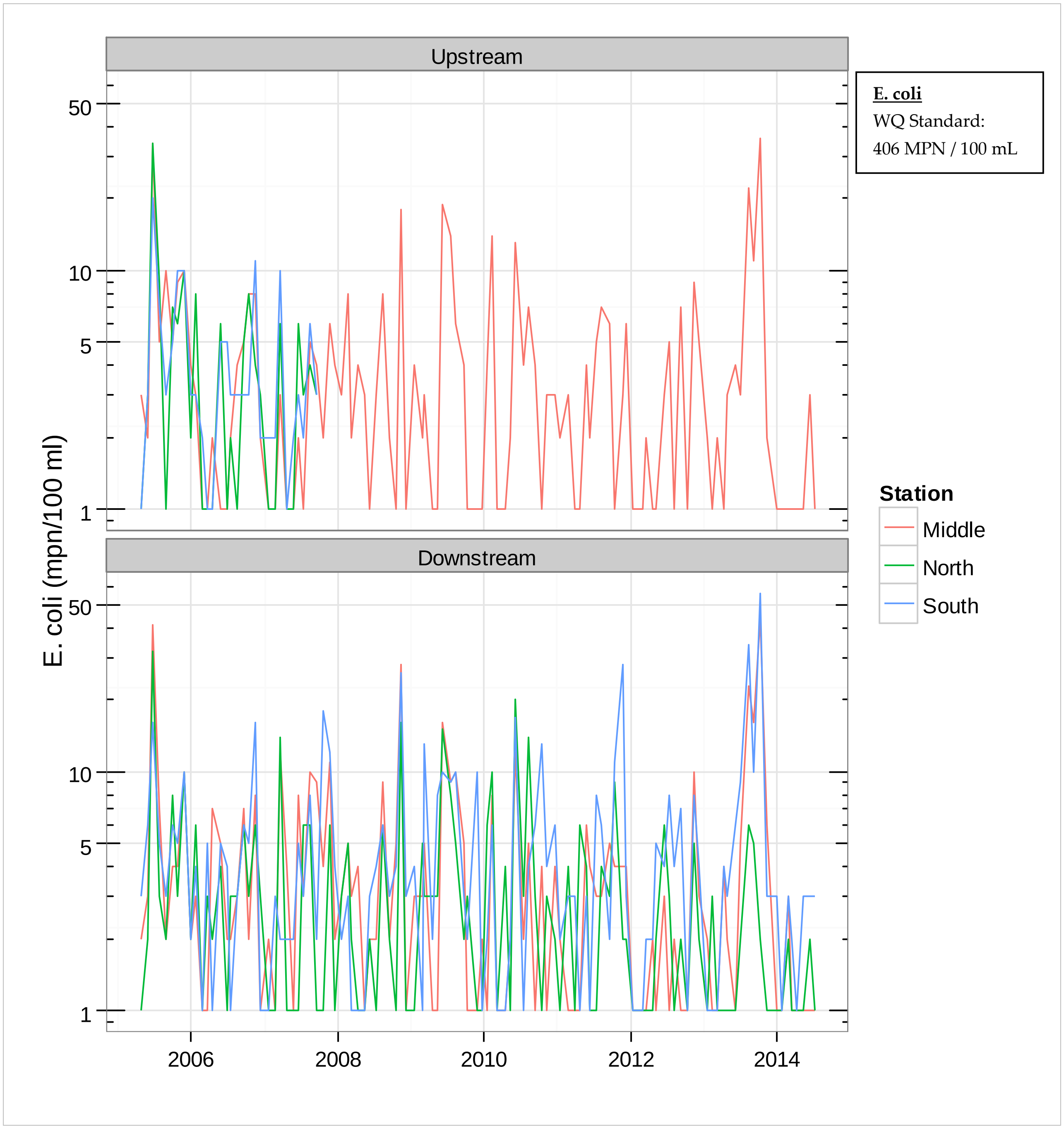

Figure 8-13 Columbia River Mixing Zone Sampling for E. coli

8.5 Field Study for Outfall 001 Mixing Zone

The NPDES Permit (Schedule D - Special Conditions) required the City to submit a plan for a field study to validate the Outfall 001 modeled dispersion, mixing, and dilution characteristics under critical flow conditions. This plan was submitted to DEQ on December 30, 2011, and later approved in March 2012. The field study was conducted during the next available low river flow period (October 2012), and the report[15] was submitted within two years of completing the study.

The overall objectives of the field study include the following:

- **Outfall and Mixing Zone Characteristics.** Develop a plan view and diagram of the outfall diffuser including the location of the mixing zone and zone of immediate, or initial, dilution (ZID) boundaries.
- **Discharge Characteristics.** Determine effluent flow characteristics for defined effluent critical flows, effluent temperature, and density data.
- **Ambient Receiving Water Characteristics.** Determine river flow and stage statistics for critical low-flow and off-design conditions, stream cross-sectional profile at outfall site, receiving water velocities, temperatures, and densities for low-flow and off-design conditions.
- **Environmental Mapping.** Develop an environmental map of the region near the outfall diffuser, including estimates of fish spawning/rearing habitat; the presence, habitat, and migration pathways of threatened and endangered species; cold water refugia; presence of physical structures; drinking water intakes; and locations of other NPDES discharges within ½ mile.
- **Mixing Zone Modeling Analysis.** Provide the basis for model selection, modeling inputs and output, and field measurements used for input data.
- **Reporting.** Provide a detailed technical report that summarizes the data collected, modeling, water quality temperature standards compliance evaluation, and associated data in appendixes.

As required, the report was submitted to DEQ in 2014.

[15] Outfall 001 Mixing Zone Study, Columbia Boulevard Wastewater Treatment Plant, City of Portland, Oregon. NPDES Permit No. 101505. Prepared for City of Portland by CH2M-Hill.

Section 9 System Reinvestment and Risk Reduction

9.1 Expenditures for CSO, Collection System, and Treatment Systems

Portland implements a significant portfolio of maintenance projects for both the collection system (pipes and pump stations) and the treatment systems. Even during the peak of the CSO program capital expenditures -- when the large tunnels, CSO pump stations and expanded treatment works required most of the CIP budget -- Portland still invested in maintenance of non-CSO systems to ensure that public health and the environment were protected and regulatory requirements were met.

Now that major investment in the CSO system has ended, expenditures for maintenance of the collection and treatment systems have increased. The record of the maintenance-related CIP expenditures for the past five years is summarized in Table 9-1. Notably, this table demonstrates that maintenance-based expenditures over the past five years have increased, especially for pump stations and the collection system. Capital investment for collection, pumping, and treatment systems maintenance expenditures continues to grow from a 3-year average of about $47 million per year to the most recent 3-year average of $61 million per year.

Table 9-1 Capital Expenditures for System-wide Maintenance

Component	Expenditures per Fiscal Year (Millions of Dollars)							
	2009	2010	2011	2012	2013	2014	Total	Average
Ankeny Pump Station	$0.20	$2.59	$1.80	$1.33	$3.32	$3.06	$12.31	$1.85
Guilds Lake Pump Station	$0.11	$0.22	$0.37	$0.24	$2.36	$0.30	$3.60	$0.66
Fanno Basin Improvements	$3.83	$7.53	$20.33	$10.65	$6.54	$8.65	$57.52	$9.77
All Other Pump Stations	$1.06	$1.95	$2.96	$2.12	$1.00	$2.02	$11.10	$1.82
Pump Station Total	***$5.20***	***$12.28***	***$25.45***	***$14.34***	***$13.22***	***$14.03***	***$84.53***	***$14.10***
Treatment Plants	***$3.50***	***$11.62***	***$15.20***	***$16.18***	***$25.11***	***$13.94***	***$85.55***	***$14.32***
Collection System - Rehab	$7.80	$12.16	$19.22	$10.02	$13.78	$34.20	$97.18	$12.60
Collection System - Capacity	$2.23	$15.38	$11.27	$8.61	$7.00	$13.28	$57.78	$8.90
Collection System Total	***$10.0***	***$27.5***	***$30.5***	***$18.6***	***$20.8***	***$47.5***	***$154.96***	***$21.50***
System Total	***$18.7***	***$51.4***	***$71.2***	***$49.1***	***$59.1***	***$75.5***	***$325.0***	*$46.5*
System Total 3-Year Averages	***$47.1***			***$61.2***				

9.2 Risk Reduction through CIP Projects

The Bureau of Environmental Services uses an asset management framework to prioritize investments in projects that reduce the risks of failing to deliver wastewater collection and conveyance services. In the collection system, there are two dominant modes of failure: capacity failure and structural failure. Both types of failures can result in sewage releases to basements, streets, or to surface waters. In addition, the structural failure mode can cause sinkholes, thereby increasing the potential consequences for human health and safety.

BES's risk-based decision making process focuses on cost-effective risk reduction of projects. It is not sufficient to merely invest in improving high-risk assets; rather, it is necessary to invest in projects that actually reduce the risk exposure of those assets to the degree that the risk reduction is greater than the project costs.

Portland's method for addressing capacity and structural condition risks in the collection system was presented in the 2013 *CMOM Program Report* - Chapter 8: System Evaluation for Structural Condition and Capacity Assurance. That chapter summarized the more extensive information for evaluating and selecting projects based on risk that is provided in the March 2012 Combined and Sanitary Sewer System Plan. Both documents list the capacity and pipe rehabilitation projects recommended for CIP funding.

Although the System Plan's recommended CIP projects address both pipe capacity and structural condition at the same time, it is possible to calculate the capacity risk reduction achieved by a project, and then separately calculate the structural risk reduction accomplished by the same project. For example, a project that results in replacing a poor condition, highly surcharged pipe with a new, larger diameter pipe will address both types of risk.

The two types of risk reduction accomplished by CIP projects during the past fiscal year are discussed below.

9.2.1 Capacity and Flooding Risk

The major capacity and basement flood relief projects that were implemented during this past fiscal year include:

- Tabor-to-the-River (Taggart D) Projects, consisting of green streets and pipe upsizing for capacity improvements, as well as pipe rehabilitation for structural condition.
- Oak Basin Relief, consisting of pipe upsizing and pipe rehabilitation
- Bike Boulevard Projects, in which green streets are installed in areas that can improve pipe capacity concerns

- Burlingame Infiltration and Inflow (I&I) Reduction Projects, consisting of pipe structural repairs to stop I&I from entering sewers which causes capacity problems and potential sewage releases.

The amount of capacity risk reduction achieved through the components of these projects that have been completed in FY 2014 can be calculated through detailed modeling while also tracking the specific pipe improvements through design (which can change the recommended plan) and construction. The capacity projects implemented during FY 2014 did not yet include the 2012 System Plan projects that were recommended through risk-based evaluations. The FY 2014 projects would require additional modeling to determine the amount of capacity risk reduction accomplished. In addition, the necessary processes to track an asset through design and construction are currently being developed. The time and resources necessary to determine the capacity risk reduction achieved in FY 2014 exceeded the staff availability. BES expects that as the System Plan projects (which have risk reduction already calculated) make their way through the CIP process, the task of calculating capacity risk reduction will be more efficient and part of the Bureau's standard practices.

9.2.2 Structural Condition Risk

Some of the pipe rehabilitation and replacement projects implemented during this past fiscal year completed the early Phase I Pipe Rehabilitation projects, but most of the FY 2014 projects were the first wave of the large scale Phase II Pipe Rehabilitation Program projects. These large-scale, geographic projects are presented in the 2013 *CMOM Program Report*. Several emergency pipe repair projects were completed in FY 2014 as well.

The amount of structural risk reduction achieved through the CIP projects completed in FY 2014 can be determined from the pipe structural risk model (in GIS format) and by tracking the pipe-related activities through design and construction. It is necessary to track the pipe information because the estimate of risk reduction will change as information about the pipe is updated. For example:

- CCTV inspections obtained during design can increase (or decrease) the likelihood of failure and therefore change the risk reduction achieved.
- Decisions during design and in the field can result in repairing more or fewer pipes, depending on the condition and location of the pipe as observed in the field. Adding or removing pipes from the project results in a change to the estimated risk reduction.

9.3 Updated Budgets for CSO, Collection System, and Treatment Projects

BES's 10-year capital improvement program (CIP) budget is summarized graphically in Figure 9-1. The 10-year CIP clearly anticipates ongoing and significant investments for all the collection system, pumping, and treatment facilities necessary to maintain the functioning and useful life of these systems.

Figure 9-1 shows that over the next 10 years, BES plans to invest approximately $85 million per year on average for improving, repairing, and rehabilitating the wastewater collection, conveyance, and treatment systems. The collection system capacity and rehabilitation projects are focused on cost-effective risk reduction actions that were identified in the Combined and Sanitary Sewer System Plan, and most recently in the Phase II and Phase III Pipe Rehabilitation planning efforts. The projected CIP also shows an increase in expenditures for treatment plant improvements based on the Tryon Creek Wastewater Treatment Plant facilities plan, as well as the upcoming CBWTP facilities plan update expected in late 2016.

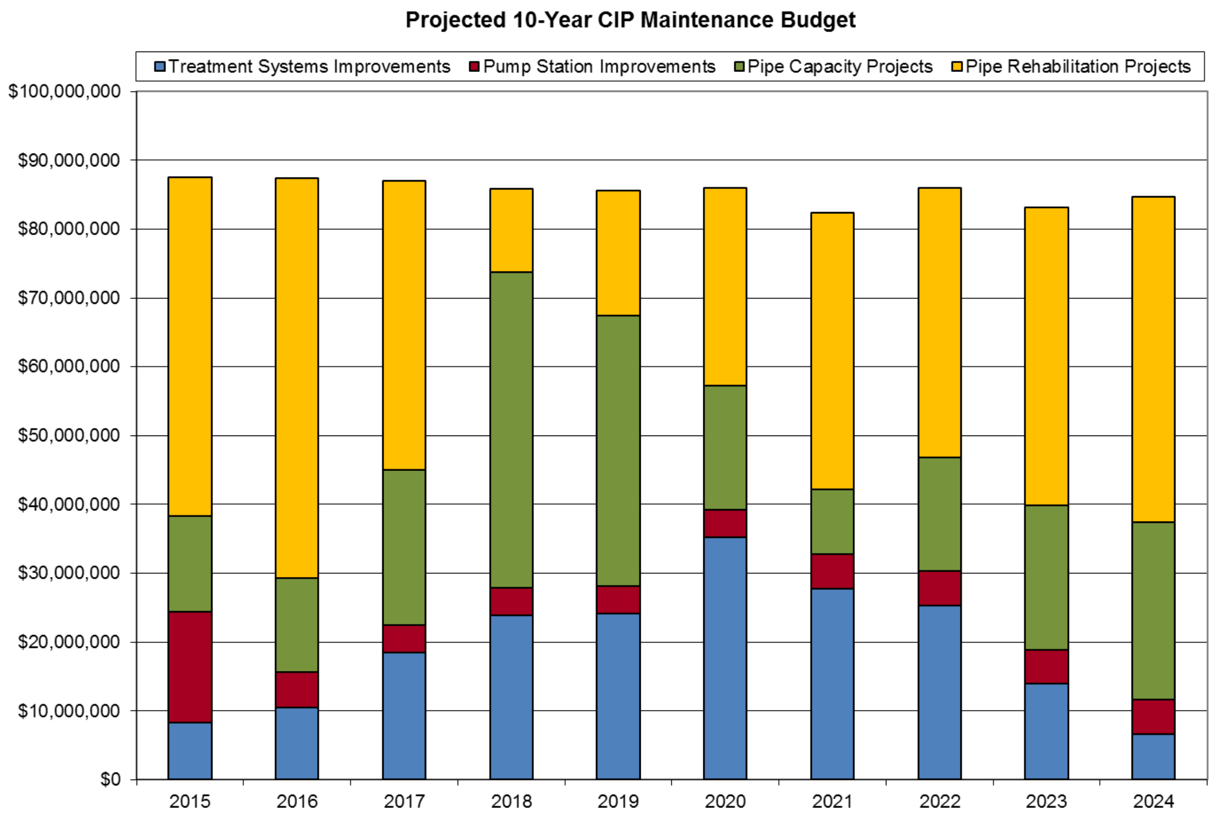

Figure 9-1 Projected 10-Year CIP Budget for System Maintenance

WT 1407