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

RECEIVED
AUG 30 2018
DEPT. OF ENVIRONMENTAL QUALITY

August 30, 2018

Mr. Mike Pinney
Senior Environmental Engineer
Oregon Department of Environmental Quality
Water Quality Program, NW Region
700 NE Multnomah Street, Suite 600
Portland, Oregon 97232-4100

Subject: **Annual CSO and CMOM Report, FY 2018**
Columbia Boulevard Wastewater Treatment Plant NPDES Permit #101505

Dear Mr. Pinney:

Enclosed, please find two copies of the *Annual CSO and CMOM Report, FY 2018*, 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 2018 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) 823-9803.

Sincerely,

Matthew Criblez
Environmental Compliance Manager

Enclosures (Annual CSO and CMOM Report, FY 2018)

CITY OF PORTLAND | BUREAU OF ENVIRONMENTAL SERVICES

Annual CSO and CMOM Report
FY 2018

REQUIRED BY NPDES PERMIT #101505

ENVIRONMENTAL SERVICES
CITY OF PORTLAND

working for clean rivers

Nick Fish, Commissioner

Michael Jordan, Director

Annual CSO and CMOM Report
FY 2018

Required by NPDES Permit #101505
for CBWTP and CSO Systems

September 2018

REGISTERED PROFESSIONAL ENGINEER
51420PE
OREGON
July 21, 1998
ARNEL M. MANDILAG
EXPIRES: 12·31·2018

City of Portland
Bureau of Environmental Services

Contents

Section Page

Tables

Figures

Acknowledgements

Asset Systems Management, CSO Technical Team

Issac Gardner
Arnel Mandilag
Nick McCullar
Mike Szwaya

CBWTP Operations

Mike Ciolli

Maintenance Engineering

Joe Dvorak
Randy Hess
Gary Irwin
Mary King

FOG Program

Ali Dirks
John Holtrop

Support

Adrienne Aiona
Dan Ashney
Gayle Bast
Megan Callahan
Amber Clayton
Diane Dulken
Sam Gould
Michael Hauser
Tim Kurtz
Jason Law
Alexandra Mejia
Nishant Parulekar
Kevin Ramey
Josh Robben
Grant Wright

Senior Review

Steve Behrndt
Jan Betz
Scott Clement
Matthew Criblez
Amanda Haney
Marveita Redding
Shannon Reynolds
Bill Ryan

Glossary

BOD. Biochemical Oxygen Demand

CBWTP. Columbia Boulevard Wastewater Treatment Plant

CCTV. Closed-circuit Television

CEPT. Chemically Enhanced Primary Treatment

CIP. Capital Improvement Program

CMMS. Computerized Maintenance Management System

CMOM. Capacity, Management, Operation, and Maintenance

COOP. Continuity of Operations Plan

CSCC. Columbia Slough Consolidation Conduit

CSO. Combined Sewer Overflow, especially as it pertains to discharge events. Note that during the CSO Program's implementation, "CSO's" were being captured into the new facilities such as the Willamette CSO Tunnels and the CSCC. Technically, CSOs are no longer being "captured" after the implementation completed—rather, the water that used to produce those events is now controlled within the augmented combined sewer system, and the term *CSO* is limited once again to discharges from the combined system to receiving waters.

CSS. Combined Sewer System

DEQ. Oregon's Department of Environmental Quality

DMR. Discharge Monitoring Report

DO. Dissolved Oxygen

EPA. Environmental Protection Agency

EMC. Event Mean Concentration

EWWPT. Enhanced Wet Weather Primary Treatment

FM. Force Main

FOG. Fats, Oils, and Grease

FY. Fiscal Year (FY 2018 is July 1, 2017, through June 30, 2018)

IPS. Influent Pump Station

MAO. Mutual Agreement and Order

MGD. Million Gallons per Day

MG. Million Gallons

NFAA. No Feasible Alternatives Analysis

NMC. Nine Minimum Controls

NPDES. National Pollution Discharge Elimination System

PIO. Public Information Officer

RDII. Rainfall Derived (also, Dependent) Infiltration and Inflow

SICSO. Swan Island CSO Pump Station

SPCR. Spill Protection and Citizen Response

SRRP. Sewer Release Response Plan

SSO. Sanitary Sewer Overflow

SWMM. Stormwater Management Manual

TCWTP. Tryon Creek Wastewater Treatment Plant

TSS. Total Suspended Solids

WWTF. Wet Weather Treatment Facility

Section 1 Introduction

The Annual CSO and CMOM Report for fiscal year 2018 (FY 2018: July 1, 2017, through June 30, 2018) provides a comprehensive review of Portland's integrated combined sewer overflow (CSO) system and the Capacity, Management, Operation, and Maintenance (CMOM) Program during FY 2018. This report provides updates to the previous report submitted for FY 2017.

1.1 Changes from FY 2017 Report

This report has one structural change compared to last year:

- The FY 2017 report included a section providing an update on the Public Notification Program. There was no material change to this program in FY 2018, so this section was removed.

1.2 Programs

CSO Program. The City of Portland (City) completed its CSO long-term control plan implementation in 2011. The City is currently proceeding with implementing its *Post-2011 Combined Sewer Overflow Facilities Plan*, published in 2010. This plan looked at ways to cost-effectively exceed the level of control specified in the 1994 Amended Stipulation and Final Order agreement with Oregon's Environmental Quality Control Commission. This additional work is necessary to handle the pressure on the combined sewer system (CSS) facilities' capabilities to control CSOs due to increased population and development.

CMOM Program. 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 Columbia Boulevard Wastewater Treatment Plant (CBWTP) National Pollution Discharge Elimination System (NPDES) permit #101505, currently administratively extended while the permit renewal application is under review by DEQ.

The CMOM program specifically addresses proper operation and regular maintenance of the collection system (Nine Minimum Controls, or 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 the building or private sewer laterals extending behind the curb are the responsibility of the property owner. Portland's sewer collection system consists of a network of 2,629 miles of collection system piping (1,004 miles of sanitary sewer including force mains, 913 miles of combined sewer, and 712 miles of sewer laterals) and 40,949 sewer manholes.

The system also includes two wastewater treatment plants and 98 pump stations. There are 83 City-owned and operated pump stations, 5 pump stations owned by other public agencies that are operated and maintained by the City under satellite or easement agreements, and 10 privately-owned septic tank effluent pumping systems that are maintained by the City under agreements with the property owners.

This annual update for FY 2018 provides a review of CMOM program actions and key performance indicators, and an evaluation of the effectiveness of BES's risk-based asset management approach to collection system operation and maintenance.

1.3 Summary of CSO and CMOM Performance

1.3.1 CSO Program Achievements

FY 2018 was a year with average total rainfall depth, but composed of long dry periods interspersed with wet ones. An average of 37.6 inches fell over the combined service area. Normally, 36-43 inches falls over the city in any given year. Three CSOs were recorded, and all met or exceed the permit's minimum requirements for storm return periods during CSO events.

A 7-day exceedance in biochemical oxygen demand (BOD) and total suspended solids (TSS) effluent concentrations at the CBWTP secondary effluent outfall occurred at the end of February 2018 due to a plant upset. This was reported to DEQ in the *Columbia Boulevard Wastewater Treatment Plant Monitoring Report February 2018* issued in mid-March 2018. For FY 2018, maximum 7-day concentrations were 62 mg/L for BOD and 48 mg/L for TSS; 45 mg/L is the permitted effluent limitation. There was no exceedance for either of the maximum 30-day performance limits: 28 mg/L for BOD and 22 mg/L for TSS were calculated, and 30 mg/L is the permitted limitation.

The Wet Weather Treatment Facility (WWTF) with Chemically Enhanced Primary Treatment (CEPT) continues to operate well, having achieved 67% BOD removal and 85% TSS removal in the wet weather flow stream, compared to 50% BOD removal and 70% TSS removal targets.

Combined removal for all plant flows during wet weather events was 86% for BOD and 91% for TSS. Combined removal for all plant flows at all times was 95% for BOD and 94% for TSS.

Evidence of the long dry periods is shown in the lowest volume of flow captured by the Willamette and Columbia Slough storage facilities since the facilities became fully operable: 5.2

billion gallons. Operators managed the integrated collection system to treat 64% of this volume through the secondary system, with 36% treated through the WWTF. There were 36 events in which flows were sent through the WWTF. The average WWTF event lasted 17 hours and discharged 52 million gallons from the WWTF. During the events, the average flow rate treated by the dry weather/secondary system was 117 MGD, exceeding the 110 MGD minimum required in the NPDES permit.

1.3.2 CMOM Program Achievements

Portland's CMOM program was 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. CMOM program accomplishments in FY 2018 include:

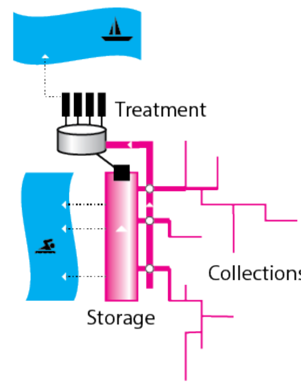
- Inspection of 0.62 million feet (117 miles) of sewer pipe, or about 6% of the mainline sewer system
- Cleaning of 1.25 million feet (236 miles) of sewer pipe, or about 12% of the mainline sewer system
- Completion of mainline sewer maintenance repairs on 8,429 feet of pipe; 58% of the repairs were in response to collection system problems
- Repair of 536 service laterals totaling about 7,095 feet of pipe; 57%of those repairs were in response to discovered problems
- Treatment of nearly 150,000, feet (28 miles) of sewer pipe for roots using chemical root foaming
- Completion of 546 inspections of manholes considered to be at greatest risk of failure (Tier 2—see Section 3.1.5).
- Completion of four Capital Improvement Program (CIP) projects repairing and rehabilitating portions of the sanitary and combined collection system during the 2017 calendar year, resulting in an estimated risk reduction of $14.7 million. Maintenance activity on mainlines and service laterals also resulted in an estimated risk reduction of $2.9 million.[1]

[1] These numbers are reported on a calendar year basis due to reporting lag times.

The number of sewer releases from the City-maintained sanitary and combined sewers decreased slightly in FY 2018. The number of sewer releases per 100 miles of sewer was 6.4 in FY 2018, which was an improvement over FY 2017 but still fell short of BES's target of 5.0 or fewer releases per 100 miles.

Sewer emergency response crews arrived on site within the City's 2-hour response time target 96% of the time during FY 2018, which is the best response time performance since annual CMOM program reporting began in FY 2014.

Section 2 Integrated CSO System Performance for FY 2018



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 2018.

2.1 Rainfall Patterns for the Past Fiscal Year

FY 2018 was an average rainfall year for the City of Portland. The area weighted average rainfall for the Willamette CSO area measured 37.6 inches over the year, which is close to the average rainfall of 37 inches for Portland.

During this period, one winter storm generated a CSO discharge after exceeding the 4-per-winter design storm. Two summer storms generated CSO discharges after exceeding the 3-year summer design storm.

- September 17-20, 2017 – Summer CSO event
- October 18-22, 2017 – Summer CSO event
- April 6-8, 2018 – Winter CSO event

Two other winter storms were large enough to have caused a valid CSO, although no CSO occurred. CSOs were avoided for the following events.

- November 15-17, 2017 – Winter storm event
- November 19-23, 2017 – Winter storm event

2.1.1 Winter Storm Review

One winter storm exceeded the 4-per-winter NPDES Permit design depths and caused a CSO discharge. That storm is shown graphically in Figure 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 event that caused a CSO to occur is shown as a solid red line. The

CSO event is compared to the two NPDES Winter Design Storms (4-per-winter for Willamette River CSO outfalls and 5-year winter for Columbia Slough CSO outfalls) shown with blue-tinted dashed lines. The two storms that exceeded the 4-per-winter design storm but did not result in CSOs are shown in grey. Details for the rainfall for the winter overflow events are provided in Table 1 below.

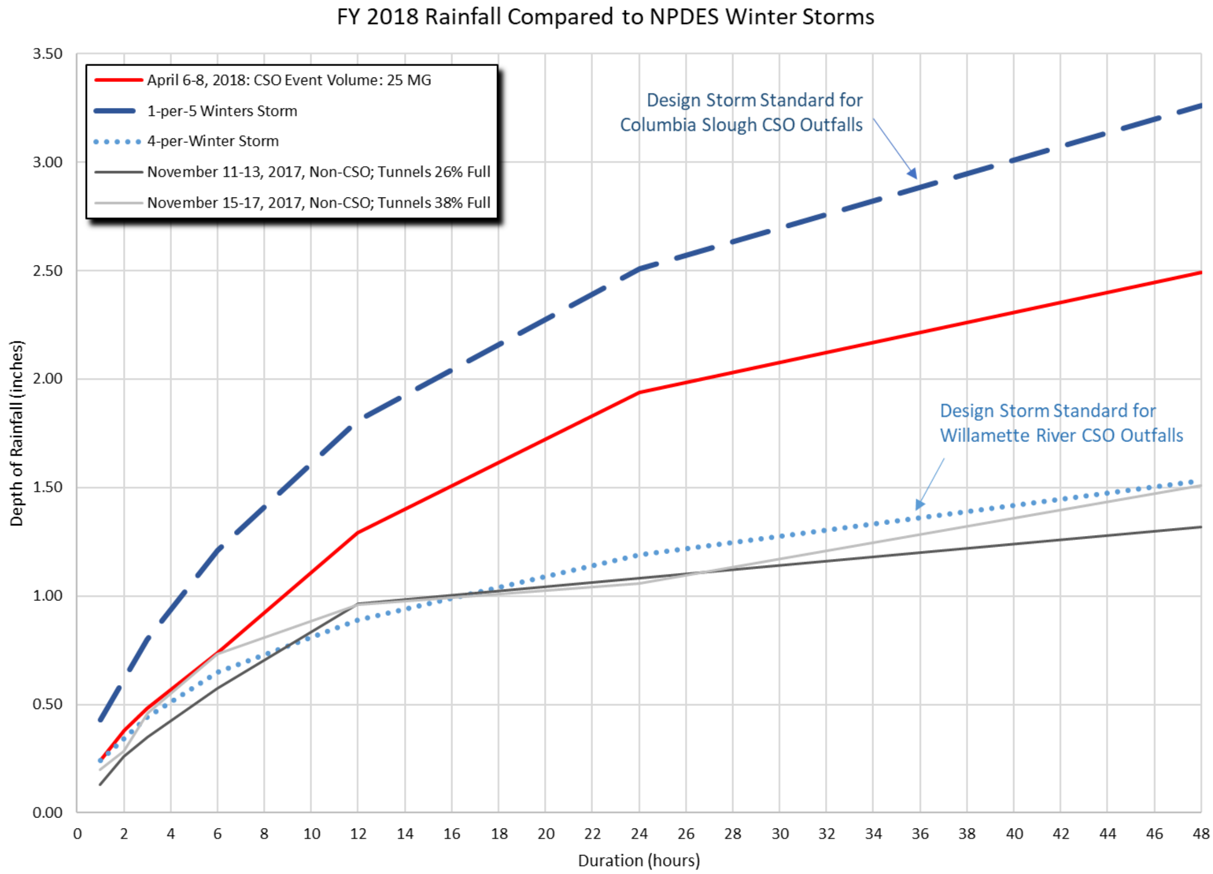


Figure 1 FY 2018 CSO Winter Storms Compared to NPDES Winter Storms

Table 1 FY 2018 Winter Storm Comparisons

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	0.80	1.21	1.81	2.51	3.26	
FY 2017 Winter Storms - Average Rainfall over Willamette CSO Basin (inches)							
April 6-8, 2018	0.24	0.48	0.74	1.29	1.94	2.49	Exceeds 4-per-winter design storm 1-48 hours.

2.1.2 Summer Storms Review

Two storms exceeded the NPDES Permit 3-year Summer Storm. The two storms are shown graphically in Figure 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 24-hours. The events are shown as solid red and green lines. The two comparison Summer Design Storms (3-year summer for Willamette River CSO outfalls and 10-year summer for Columbia Slough CSO outfalls) are shown with blue-tinted lines. Table 2 provides rainfall details for this event.

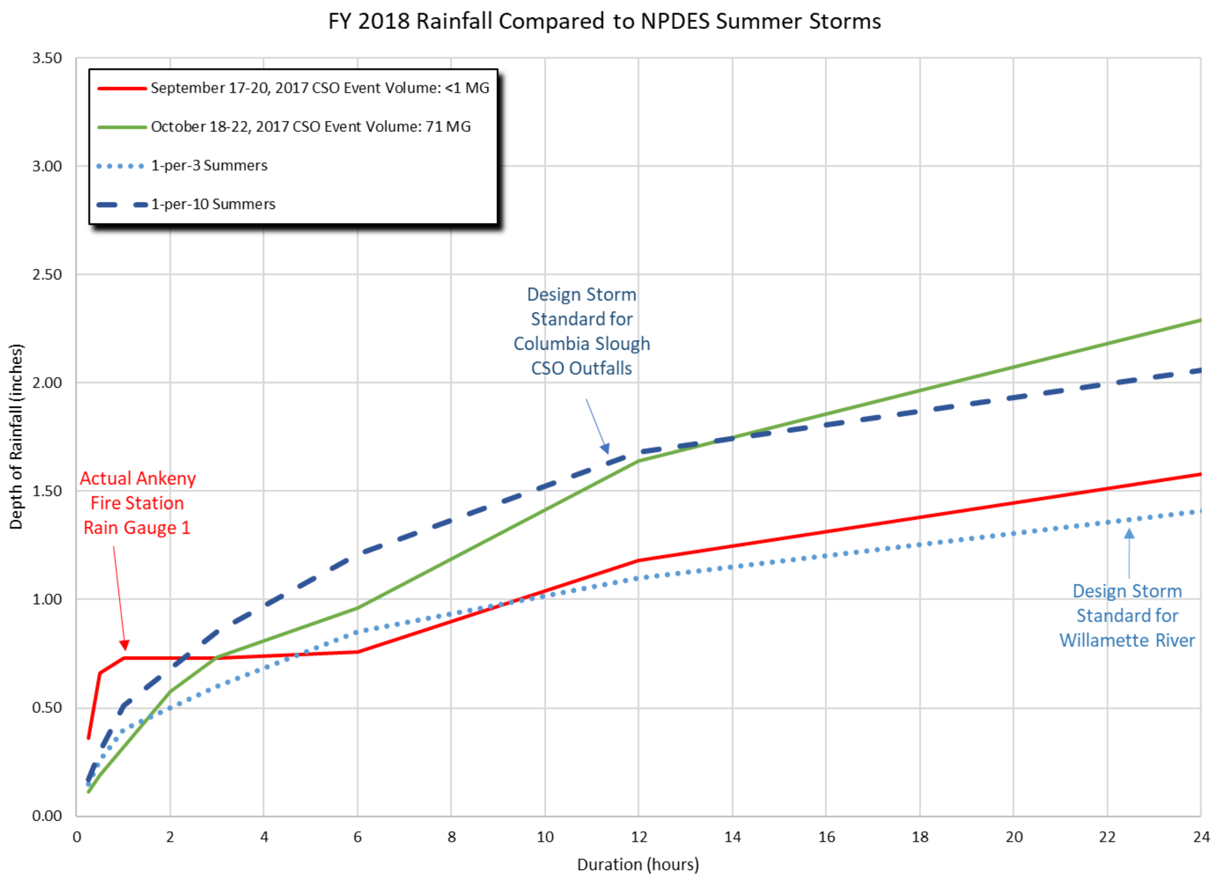


Figure 2 FY 2018 Rainfall Compared to NPDES Summer Storms

Table 2 FY 2018 Summer Storm Comparisons

Storm	Duration (min)		Duration (hours)						Notes
	15	30	1	3	6	12	24	48	
Willamette River Summer Design Storms (inches)									
3-Year Summer Design Storm	0.15	0.26	0.40	0.60	0.85	1.10	1.41	2.12	
10-Year Summer Design Storm	0.17	0.30	0.51	0.85	1.21	1.68	2.06	3.15	
FY 2017 Summer Storms - Average Rainfall over Willamette CSO Basin (inches)									
September 17-20, 2017	0.36	0.66	0.73	0.73	0.76	1.18	1.58	1.91	Ankeny Fire Station Rain Gauge 1. Exceeds 10-year summer design storm for 15-30 minutes.
	0.28	0.41	0.50	0.54	0.78	0.92	1.35	1.62	Multnomah Rain Gauge 181. Exceeds 10-year summer design storm for 15-30 minutes. Exceeds 3-year summer design storm for 15-60 minutes.
October 18-22, 2017	0.11	0.19	0.32	0.73	0.96	1.64	2.29	2.51	Exceeds 10-year summer design storm for 24 hour, 3-year summer design storm for 3-48 hours.

2.2 CSO Discharges into the Willamette River and Columbia Slough

2.2.1 Discharge Events

In FY 2018, there were three separate CSO discharge events, with all three contributing discharges only to the Willamette River. Please consult the compliance letters submitted to DEQ for details on the circumstances and validation of the events as allowed by the NPDES permit for CBWTP.

- **September 17-20, 2017:** 0.097 MG (97,000 gallons) discharged over a total of 38 minutes from the East Side Willamette River CSO Tunnels at OF36 by Alder Pump Station. This storm consisted of a 3-day period of sporadic showers that was capped with heavy rain followed by a short, intense thunderstorm on September 20, 2017. The two nearest rain gauges to the Alder Pump Station service area experienced intensities that exceeded 1-per-10 summers storm levels for durations between 15 minutes and 2 hours.

- **October 19-22, 2017:** 70.5 MG discharged over 6 hours from East and West Side Willamette River CSO Tunnels. This CSO event was caused by atmospheric river weather conditions associated with a very large moisture complex extending across the Pacific Ocean. Willamette average rainfall for this event exceeded the 1-per-3 summers design storm for durations 2-8 hours and the 1-per-10 summers design storm for the 24-hour duration.

- **April 6-8, 2018:** 24.7 MG discharged over 2.5 hours from the East and West Side Willamette River CSO Tunnels. This storm was characterized by a slow-moving low pressure system that generated moderate-to-heavy rainfall across the region. The storm featured peak 1-hour to 48-hour intensities that exceeded the 4-per-winter design storm, and just exceeded the 1-per-winter design storm for the 24-hour duration.

The entire historical record of CSOs discharged from the City's CSO facilities is provided in Appendix A.

2.2.1.1 How Well Were CSO Events Controlled?

System rainfall was close to average during the current reporting period. The system experienced three overflows (two in the summer, one in the winter) out of a total of 50 distinct storm events. Approximately 3,500 MG were stored in the CSO Tunnels during these events.

Total CSO discharge for the year was about 95.3 MG, which was about 1.8% of the wet weather volume handled by the combined and sanitary collection systems. This equates to 98.2% volume control, exceeding the 94% level of control expected from the system.

2.2.1.2 Were Wet Weather Flows Maximized to the Plant?

During the three CSO events, flows through the Swan Island CSO Pump Station (SICSO) were maximized to the greatest extent possible, but were limited from the theoretical maximum rates due to the CSO System Operating Plan's higher priorities of protecting the plant, preventing basement sewer backups, and preventing Columbia Slough overflows. During these heavy storm events, the integrated CSO system experienced:

- Bottlenecking of flow at the Peninsular Tunnel at N Mississippi & Knott Ave. (increased pumping at SICSO would have endangered basement sewers with high hydraulic grade lines)
- Reaching the maximum rating at the CBWTP of 450 MGD (SICSO pumping rates had to be throttled to prevent blowout of the secondary treatment system)

2.2.1.3 Was System Storage Maximized?

One of the events was due to a local system becoming overwhelmed from local rainfall (September 17-20, 2017). The other two events involved discharges after the tunnels were filled and the rainfall intensity exceeded permit levels. For all non-CSO-sized storms (less intense than 4-per-winter or 1-per-3 summers), tunnel storage levels did not exceed more than 28% of the tunnel capacity. For the CSO-sized storms that did not overflow, tunnels peaked at 38% of the tunnel capacity.

2.2.2 Dry Weather Overflow Events

No dry weather overflow events from the combined system outfalls were recorded in FY 2018.

2.2.3 Control of Floatables and Debris

City maintenance crews inspect and clean the bar screen within the Sheridan overflow structure (OF07B) following CSO discharge events when conditions allow. Other bar screens are cleaned when CSOs are discharged through them, but no such discharges occurred in FY 2018.

Table 3 Floatables Control System Event Maintenance Summary

CSO Event Date(s)	Maint. Date	Location	Description of Maintenance
September 17-20, 2017	No discharge from Sheridan OF07B		
October 19-22, 2017	10/23/2017	Sheridan OF07B	50 gallons of sticks, leaves, and trash
April 6-8, 2018	8/8/2018	Sheridan OF07B	3 gallons of sticks, leaves, and trash

2.3 Wet Weather Treatment Performance and Effluent Quality

2.3.1 CSO Facilities Operations

The CSO System configuration experienced no major changes in FY 2018. The system experienced a nearly average year in terms of total rainfall, having received about 37.6 inches. Influent volumes to CBWTP were reduced by 20% from FY 2017, and the percentage treated by the secondary system increased to 93%. The percentage of captured CSO treated via secondary also increased from 57% in FY 2017 to 64% in FY2018. Overall BOD and TSS removal efficiencies continue to exceed 90% at the plant's two outfalls, OF001 and OF003. TSS removal efficiencies reached a high of 94%, while BOD removal efficiencies were even higher at 95%. These numbers indicate that the plant reliably exhibits satisfactory performance year over year.

Table 4 shows the total volume pumped from the two major CSO pump stations in the system, SICSO, which drains the Willamette River system, and the Influent Pump Station (IPS), which drains the Columbia Slough system. About 5,200 MG of captured CSO reached the plant (see Table 5). About 6,300 MG of tunnel flow was pumped, representing 121% of that captured volume. The additional pumped flow is the net of CSO volume reaching CBWTP via the combined collection system and flow diverted to the tunnels during rehabilitation work for the Southeast Interceptor.

Table 4 FY 2018 Volume Pumped from CSO Tunnels

CSO Tunnel Pumping	Total Pumped Volume (MG)
Swan Island CSO Pump Station	
Force main 1 (Peninsular Dry Weather)	3,597
Force main 2 (Peninsular Wet Weather)	274
Force main 3 (Portsmouth Wet Weather)	1,380
Swan Island CSO Pump Station Subtotal	5,251
Influent Pump Station Total	1,036
Total Volume Pumped to CBWTP from Tunnels	6,287

2.3.2 Annual Treatment Performance for CBWTP

2.3.2.1 Annual CSO Treatment Characteristics

Key parameters for the treatment system's annual performance are derived from the NPDES permit for the CBWTP, which specifies annual percent removal efficiencies[2]. These parameters were based on Portland's No Feasible Alternative Analysis (NFAA) report, submitted to DEQ in 2009. Table 5 summarizes the main annual treatment performance measures for the CBWTP systems. This seven year record provides a comparison of the performance against the average year model and permit values. Key parameters are in blue text. For FY 2018,

- Secondary treatment achieved 117 MGD, 6% higher than the 110 MGD minimum required by the permit after FY 2014.
- Percent of wet weather volume treated through secondary exceeded the model target level (64% compared to 54%).
- BOD and TSS removal efficiencies for the wet weather system exceeded the permit's annual requirements: BOD removal was 67% compared to the permit's requirement of 50%, and TSS removal was 85% compared to the permit's requirement of 70%.

When evaluating wet weather treatment, BES asks three questions:

- **Were wet weather flows treated to a high quality?** Yes. This is according to the observed numbers in comparison with permit requirements. See Section 2.3.2.2.
- **Were flows to secondary treatment maximized?** Yes. See Section 2.2.1.2.

[2] NPDES Permit #101505 filed with DEQ, Schedule A

- **Were effluent limits achieved at OF001 and OF003?** Yes, except for a plant upset event in late February 2018 that showed exceedance of 7-day limits. The numbers indicate that the system is producing the proper annual treatment results.

Examination of the annual results indicate that the CSO system operations strategy continues to sustain desired performance and can handle various conditions throughout the year, even with large changes in rainfall amounts year over year. Portland's use of CEPT continues to keep BOD and TSS discharges from the Wet Weather Treatment Facility at consistently reduced levels.

Table 5 CBWTP Annual Treatment Performance Data[3]

CBWTP Annual Treatment Performance									
Annual Treatment Characteristics	**Average Year Model / Permit**	*No CEPT* **FY 2012**	*With CEPT* **FY 2013**	*With CEPT* **FY 2014**	*With CEPT* **FY 2015**	*With CEPT* **FY 2016**	*With CEPT* **FY 2017**	*With CEPT* **FY 2018**	**Trend**
Annual Rainfall Depth (inches/year)	37	46.8	40.2	40.0	33.9	53.4	59.5	37.6	
Flows to CBWTP									
Influent Volume (MG/Year)	28,300	28,800	26,625	26,549	25,760	30,665	33,544	26,844	
Dry Weather Sanitary Volume (MG/Year)	22,100	20,200	19,496	19,471	19,609	20,179	22,358	21,635	
Captured CSO Flow - Volume (MG/Year)	6,200	8,600	7,129	7,078	6,151	10,485	11,187	5,209	
Total Volume Treated Thru Secondary (MG)	25,443	25,662	24,197	24,002	23,221	26,301	28,765	24,947	
% of Plant Flow Treated Through Secondary System	90%	89%	91%	90%	90%	86%	86%	93%	
WWTF (EWWPT) Events									
Rate to DW / Secondary During EWWPT (MGD)	100	120	126	112	112	117	119	117	
Number of Events / Year	32	29	22	27	27	39	41	37	
WWTF Volume / Year	2,857	3,138	2,429	2,546	2,540	4,363	4,779	1,897	
Amount of Captured CSO Treated via Secondary (%)	54%	64%	66%	64%	59%	58%	57%	64%	
Duration of WWTF Events (hours)	919	706	668	904	591	1241	1333	602	
Calendar Days of WWTF Discharges (days)	---	66	50	65	51	92	99	65	
Blended Effluent (OF001 & 003) Treatment									
BOD Loading (pounds / year)	2,510,000	4,000,000	2,957,783	3,472,307	4,176,834	3,871,106	4,554,872	3,046,966	
BOD Average Concentration (mg/l)	27	16.6	13.3	15.7	19.4	15.1	16.3	13.6	
Total Plant BOD Removal Efficiency (%)	---	93%	95%	94%	93%	93%	92%	95%	
TSS Loading (pounds / year)	2,440,000	5,050,000	3,585,748	4,055,479	4,413,412	4,910,264	5,248,619	3,738,873	
TSS Average Concentration (mg/l)	27	21.0	16.1	18.3	20.5	19.2	18.8	16.7	
Total Plant TSS Removal Efficiency (%)	---	92%	94%	93%	92%	92%	92%	94%	
Wet Weather Treatment Facility									
BOD TO Wet Weather Facility (pounds/year)	---	2,290,000	1,638,460	2,361,933	2,414,044	3,651,168	4,321,434	2,150,975	
BOD FROM Wet Weather Facility (pounds/year)	---	1,510,000	726,541	874,387	962,545	1,258,955	1,448,060	707,575	
Wet Weather BOD Removal Efficiency (%)	50%	34%	56%	63%	60%	66%	66%	67%	
TSS TO Wet Weather Facility (pounds/year)	---	4,030,000	2,257,182	3,048,027	3,130,925	5,649,463	8,300,487	3,491,268	
TSS FROM Wet Weather Facility (pounds/year)	---	1,480,000	520,375	520,252	560,013	1,134,753	1,339,022	526,597	
Wet Weather TSS Removal Efficiency (%)	70%	63%	77%	83%	82%	80%	84%	85%	

[3] The permit average for "Rate to DW/Secondary During EWWPT (MGD)" rose to 110 MGD in 2014 (applicable for FY 2015 and onwards).

2.3.2.2 CBWTP Max-Month and Peak-Week Treatment Performance

Table 6 provides maximum 30-day treatment results for BOD and TSS. While the permit requires reporting of maximums on a calendar month basis, this evaluation uses a more stringent moving 30-day window analysis. Maximum 30-day concentrations and loadings for both BOD and TSS at the outfalls for the maximum 30-day period of the year (ending April 19, 2018 for BOD and March 23, 2018 for TSS) were below the permit's monthly limits.

Table 6 FY 2018 Wet Weather Max-Month (30-days maximum solids loading) Treatment Performance[4]

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	77	45,000	17,634	23-Mar-18	3.1/6.1 inches of rain in 30d
TSS	30	22	103	45,000	18,962	19-Apr-18	
Secondary Biological Treatment - 100 MGD Minimum Instantaneous							
BOD5	30	25	80	22,500	16,395	23-Mar-18	3.1 inches of rain in 30d
TSS	30	25	90	22,500	16,532	24-Mar-18	
Wet Weather / CEPT System - Intermittent Discharges							
BOD5	45	17	41	22,500	5,719	25-Jan-18	7.0 inches of rain in 30 d
TSS	45	14	41	22,500	4,682	25-Jan-18	

4 As stated in the Discharge Monitoring Reports (DMRs), Portland applies the System-Based Performance Requirements for Secondary and WWTF as in-plant guidelines. Permit compliance is required only for the combined OF001 and OF003 effluent.

Table 7 provides peak 7-day treatment results for BOD and TSS. As in the previous discussion for the 30-day analysis, the permit requires reporting of peaks on a calendar week (Sunday to Saturday) basis. However, this analysis uses a more stringent moving 7-day window. Treatment performance for both 7-day BOD and TSS concentrations for the maximum period (ending March 1, 2018) was above permitted weekly values due to a short plant upset. The February 2018 monitoring report for the plant described a filamentous bloom in the secondaries and restoration using RAS chlorination to return to permitted levels. This report was delivered to DEQ on March 14, 2018.

Table 7 FY 2018 Wet Weather Peak-Week (7-days maximum solids loading) Treatment Performance[4]

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	**62**	85	118,800	43,776	1-Mar-18	0.6 inches of rain in 7d
TSS	45	**48**	85	118,800	33,797	1-Mar-18	
Secondary Biological Treatment - 100 MGD Minimum Instantaneous							
BOD5	45	**57**	90	37,500	**42,464**	1-Mar-18	0.6 inches of rain in 7d
TSS	45	44	90	37,500	33,197	1-Mar-18	
Wet Weather / CEPT System - Intermittent Discharges							
BOD5	65	29	58	81,300	14,033	21-Nov-17	3.4/3.3 inches or rain in 7d
TSS	65	27	55	81,300	12,200	11-Apr-18	

2.4 Wet Weather Treatment Performance for Enhanced Wet Weather Primary Treatment (EWWPT) Events

Wet weather treatment performance is best evaluated by examining the events in which the WWTF discharged treated effluent. These events are called Enhanced Wet Weather Primary Treatment (EWWPT) events to underscore that the wet weather flow diverted from the secondary system receives CEPT.

An EWWPT event begins when the WWTF starts discharging effluent, and ends after either of the following:

- WWTF discharge has ended AND the plant inflow remains below 80 MGD for 6 hours OR
- WWTF discharge has ended and no subsequent WWTF discharge occurs for 48 hours. This condition may occur when low level rainfall keeps plant inflows up, but Operations is able to send all inflows through secondary treatment.

Table 8 summarizes the WWTF events for FY 2018. The full, detailed list of the events is in Table 9.

Table 8 FY 2018 Enhanced Wet Weather Primary Treatment Events Summary

		CBWTP Flows		WWTF Flows				WWTF Effluent			
	Events	Avg Influent During EWWPT (MGD)	Avg Secondary Flow During EWWPT (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	**36**				**1,885**	**601**	**64**	**707,575**	**526,597**		
Average/Event		**210**	**117**	**76**	**52**	**16.7**	**1.8**	**19,655**	**14,628**	**51**	**33**

Key aspects for this year's WWTF performance include:

- Volume of EWWPT events was 1.9 billion gallons. This is only about 7% of the total volume received at the CBWTP for the year (26.8 billion gallons; see Table 5).
- An EWWPT event was in progress during the year for about 600 hours (7% of the year) and 64 calendar days (a little less than 2 days per week). Treatment throughout the WWTF continues to be highly intermittent.
- The average mean concentrations (EMC) for BOD of 51 mg/L and 33 mg/L for TSS is a decrease in performance over FY 2017 but is comparable to other drier years and with expected values for the CEPT system.
- Operators maintained an average of 117 MGD of flow through secondary treatment during EWWPT events, compared to the permit requirement of 110 MGD. This rate is 56% of the average flow rate reaching the plant during an EWWPT event (210 MGD).
- EWWPT events lasted just under 17 hours on average and typically occurred across 1.8 days. This is representative of the much drier year experienced than FY 2017.

Table 9 Enhanced Wet Weather Treatment Events - Detailed Information

		CBWTP Flows		WWTF Flows				WWTF Effluent			
Date & Time Bypass Event Started	Event #	Avg Influent During EWWPT (MGD)	Avg Secondary Flow During EWWPT (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)
9/20/17 2:45	1	284	121	76	70	22.0	2	45,659	30,118	78	52
10/12/17 21:45	2	168	118	37	3	1.8	1	1,019	694	45	31
10/19/17 11:00	3	291	126	136	88	15.5	2	28,176	15,736	38	21
10/21/17 13:15	4	312	122	153	218	34.3	2	60,600	50,186	33	28
11/5/17 4:30	5	207	130	60	8	3.3	1	4,011	2,380	59	35
11/8/17 23:45	6	214	119	82	13	3.8	2	3,678	2,858	34	27
11/10/17 4:30	7	269	120	135	37	6.5	1	6,988	5,773	23	19
11/13/17 4:30	8	221	125	79	10	3.0	1	2,779	2,105	34	25
11/15/17 9:00	9	322	122	160	107	16.0	2	55,572	43,820	63	49
11/16/17 22:45	10	144	120	18	3	3.5	2	1,045	810	48	37
11/20/17 3:00	11	167	115	43	151	83.5	4	48,308	40,226	38	32
11/26/17 13:45	12	266	124	125	48	9.3	1	12,117	6,866	30	17
11/28/17 13:15	13	272	123	135	38	6.8	1	18,671	9,335	59	29
12/2/17 15:00	14	202	119	70	14	4.8	1	6,309	3,388	55	29
12/19/17 12:45	15	295	120	126	47	9.0	1	27,624	27,624	70	70
12/22/17 22:15	16	222	119	94	36	9.3	2	14,163	6,725	47	22
12/28/17 18:15	17	230	113	103	131	30.5	3	56,959	59,602	52	55
1/9/18 4:30	18	246	125	100	41	9.8	1	11,053	11,388	33	34
1/11/18 8:30	19	196	118	66	67	24.3	2	28,028	18,509	50	33
1/17/18 20:15	20	171	109	50	47	22.5	2	16,219	8,790	42	23
1/23/18 12:30	21	162	113	38	175	110.0	6	69,992	51,852	48	36
1/29/18 19:00	22	258	120	125	39	7.5	2	14,574	9,926	45	30
2/18/18 16:15	23	195	119	68	18	6.3	1	7,965	3,413	54	23
2/24/18 12:30	24	142	110	24	2	1.5	1	362	338	29	27
2/25/18 17:45	25	156	110	38	1	0.8	1	450	326	45	33
2/28/18 17:15	26	140	110	23	9	9.8	2	7,057	2,933	90	38
3/8/18 16:30	27	157	110	33	3	2.0	1	1,837	880	80	39
3/13/18 14:15	28	172	116	45	7	3.5	1	3,706	1,516	67	28
3/16/18 2:30	29	152	121	24	1	0.8	1	169	175	27	28
3/22/18 8:15	30	159	115	38	73	45.8	3	27,725	13,377	46	22
4/5/18 18:15	31	195	112	72	10	3.5	1	6,384	2,799	73	32
4/7/18 4:45	32	269	120	140	284	48.5	3	84,809	75,851	36	32
4/11/18 22:45	33	129	112	13	4	6.5	2	2,079	1,438	68	47
4/15/18 5:00	34	169	109	54	69	30.5	2	17,761	7,825	31	14
4/28/18 22:00	35	221	109	98	14	3.5	2	11,662	5,739	98	48
6/9/18 21:00	36	173	110	52	3	1.5	1	2,065	1,276	77	47
Total	**36**				**1,885**	**601**	**64**	**707,575**	**526,597**		
Avg/Event		**210**	**117**	**76**	**52**	**17**	**1.8**	**19,655**	**14,628**	**51**	**33**

BOD and TSS removal efficiencies compared to event volume are shown in Figure 3 (BOD) and Figure 4 (TSS). Small events tend to have higher BOD and TSS concentrations, and larger volume events have lower concentrations. The CEPT system achieves better than 50% BOD and 70% TSS removal efficiencies on an overall basis. All wet weather events this fiscal year continue to place above the target efficiencies, as seen on the charts.

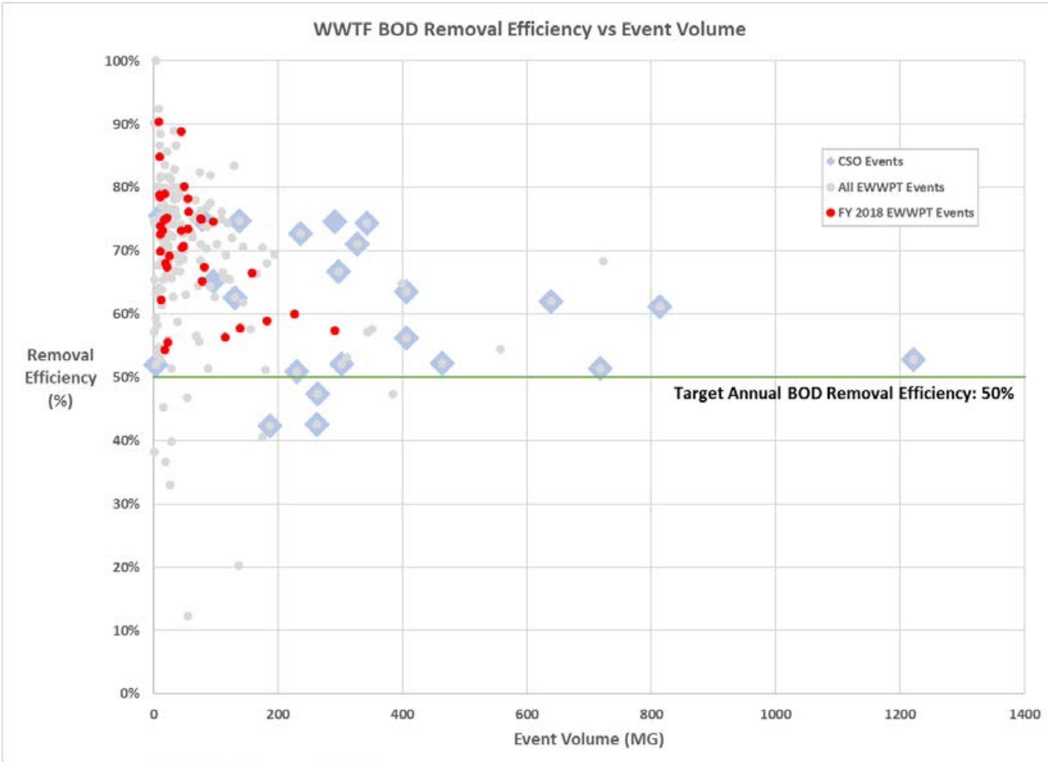


Figure 3 WWTF BOD Removal Efficiency vs. Event Volume

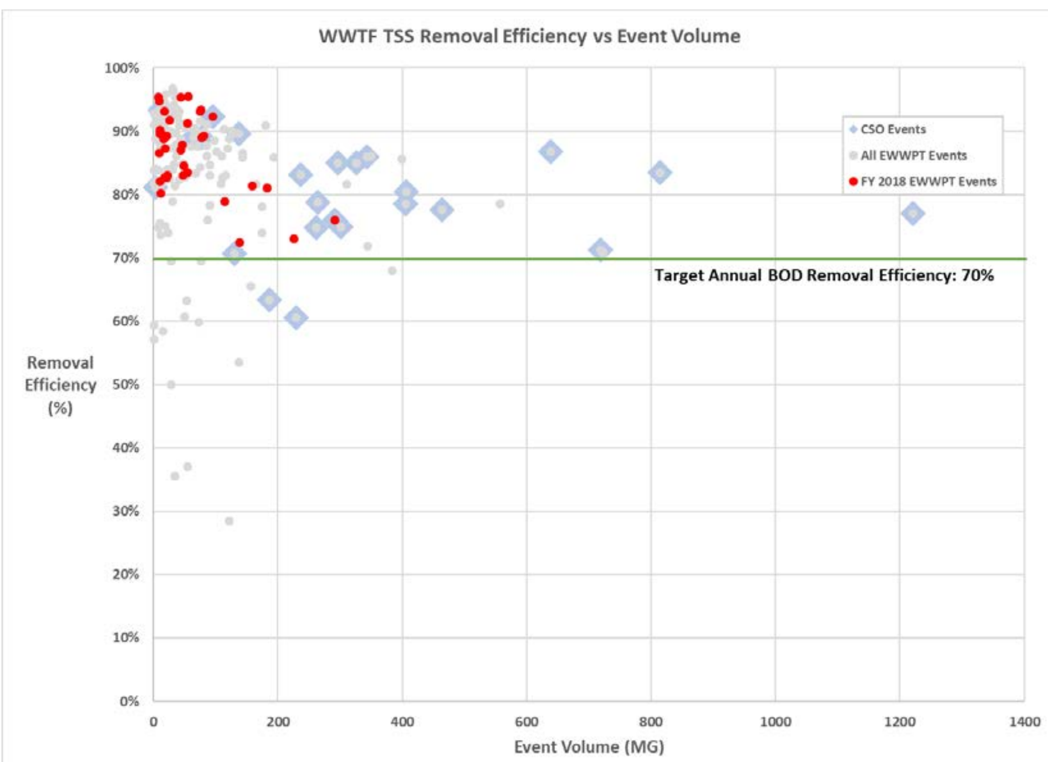


Figure 4 WWTF TSS Removal Efficiency vs. Event Volume

2.5 CSO System and Water Quality Monitoring

2.5.1 CSO Discharge Sampling

Portland completed the permit requirements of obtaining 5 event samples for the current permit cycle (8 total were retrieved: 2 near Outfall 46, and the remaining near Outfall 36). Portland has elected to continue to retrieve one sample per year as part of its Post-Construction Monitoring Program. Figure 5 shows the laboratory analysis report for the October 19-22, 2017, event. This grab sample, like the previous ones, was collected near Outfall 36 (Alder). For details about this sampling program, please see Section 8.2 of the *FY 2015 Annual CSO and CMOM Program Report*.

City of Portland
Water Pollution Control Laboratory
6543 N. Burlington Ave. / Portland OR 97203 (503) 823-5600 fax (503) 823-5656
ORELAP Certification ID 4023

LABORATORY ANALYSIS REPORT

Project:	**CSO Permit**	Client:	Asset Management
Work Order:	**W17J167**	Project Mgr:	Arnel Mandilag
Received:	10/22/17 3:14		
Submitted By:	Field Operations		

Sample	Laboratory ID	Matrix	Type	Sample Collection Date Start	Sample Collection Date End	Qualifier
CSO36	W17J167-01	Stormwater	Grab	10/22/17 02:45	10/22/17 02:45	

Analyte	Result	Units	MRL	Dil.	Batch	Prepared	Analyzed	Method	Qualifier
CSO36 : W17J167-01									
Microbiology									
E. coli	**36000**	MPN/100 mL	100	1	B17J335	10/22/17 07:45	10/23/17	Colilert QT	
General Chemistry									
Total suspended solids	**51**	mg/L	3		B17J383	10/25/17	10/25/17	SM 2540D	
Total Metals									
Total Metals by ICPMS									
Copper	**6.65**	ug/L	0.200	1	B17J334	10/23/17	10/24/17	EPA 200.8	
Lead	**6.90**	ug/L	0.100	1	B17J334	10/23/17	10/24/17	EPA 200.8	

Figure 5 October 22, 2017, CSO Discharge Water Quality Sample Result - OF 36

2.5.2 Willamette River Instream Water Quality Sampling

Figure 6 through Figure 10 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 sampling results indicate continued similar performance as FY 2017.

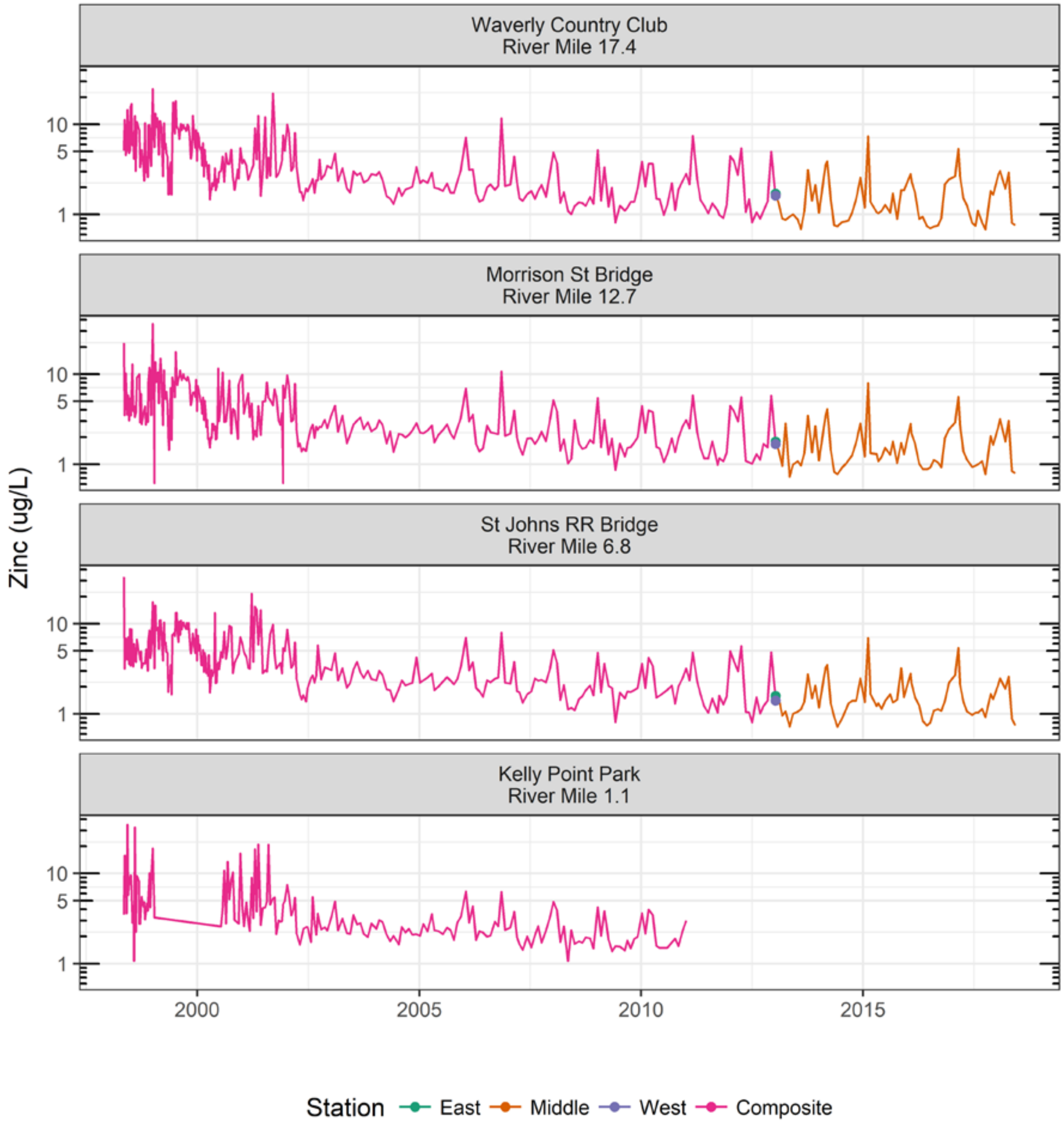


Figure 6 Willamette River Monitoring Results for Zinc

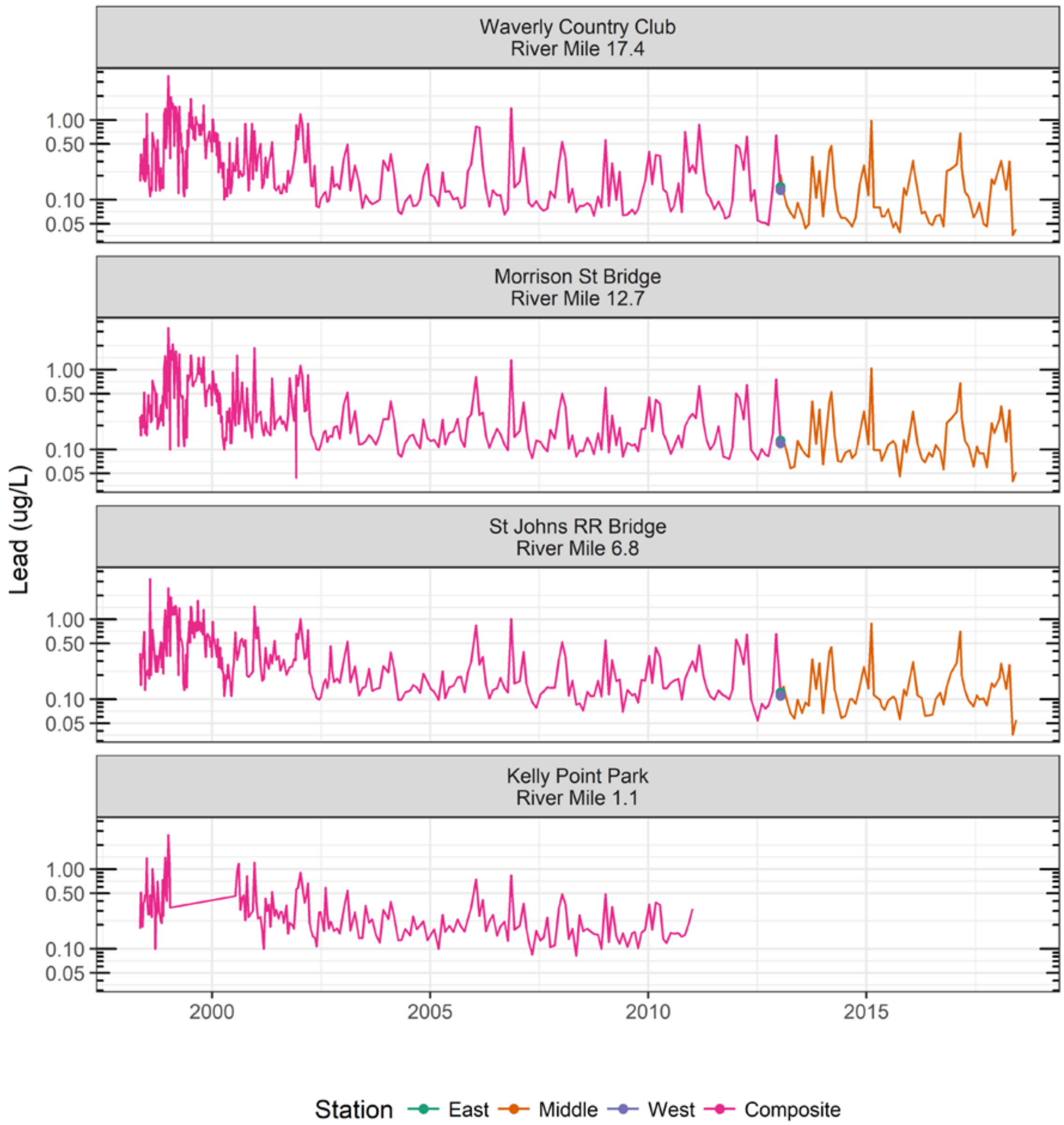


Figure 7 Willamette River Monitoring Results for Lead

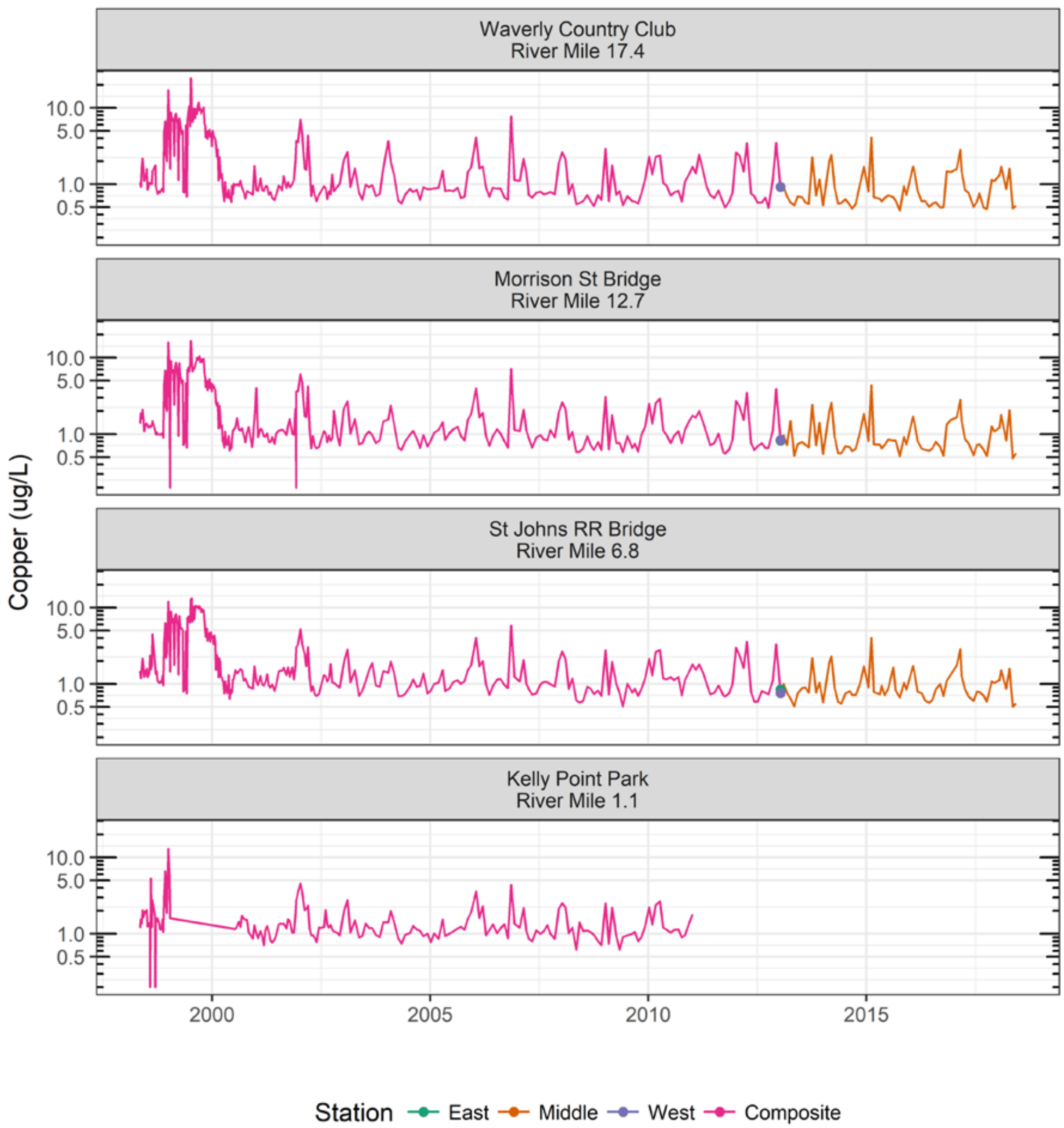


Figure 8 Willamette River Monitoring Results for Copper

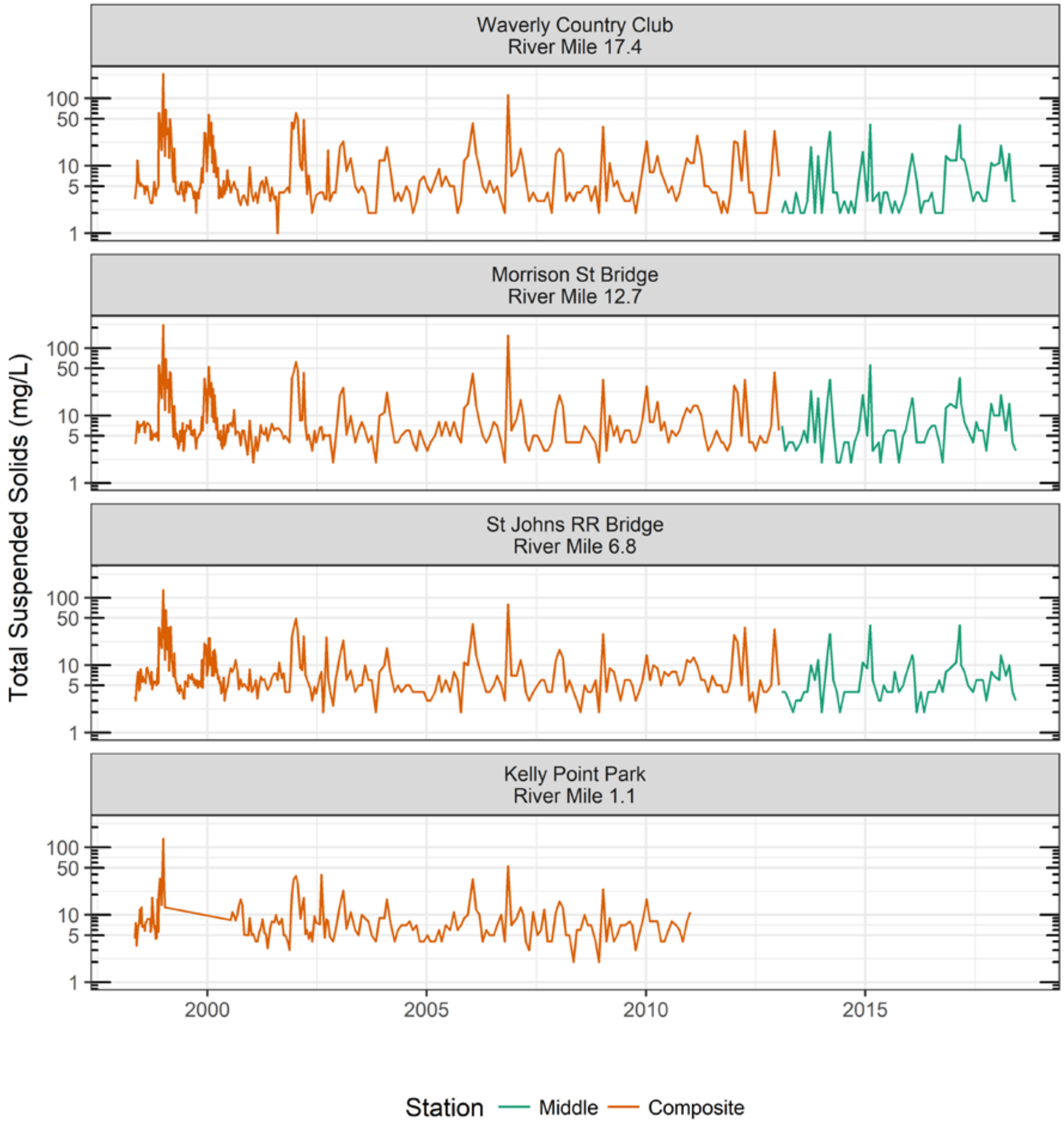


Figure 9 Willamette River Monitoring Results for TSS

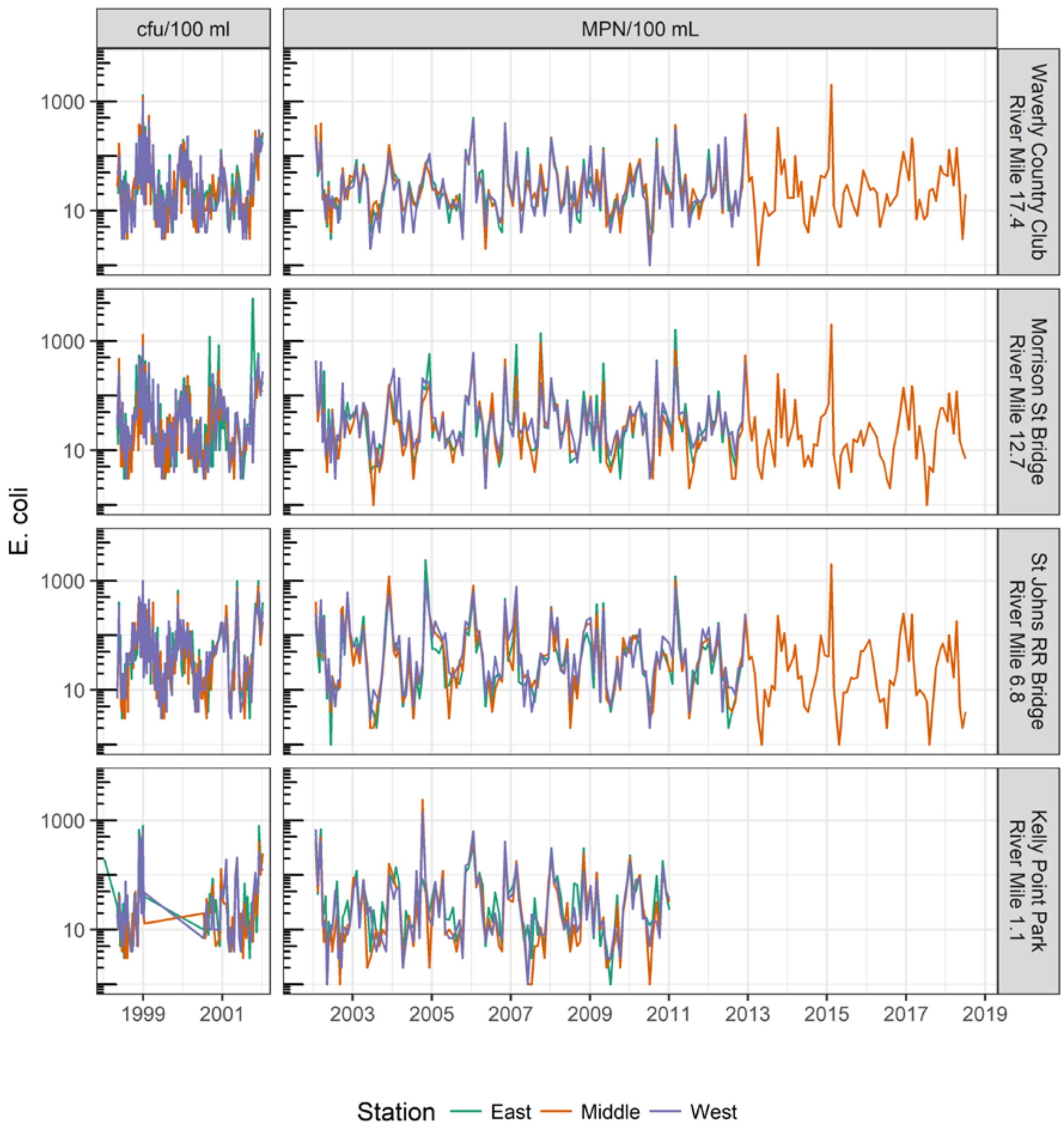


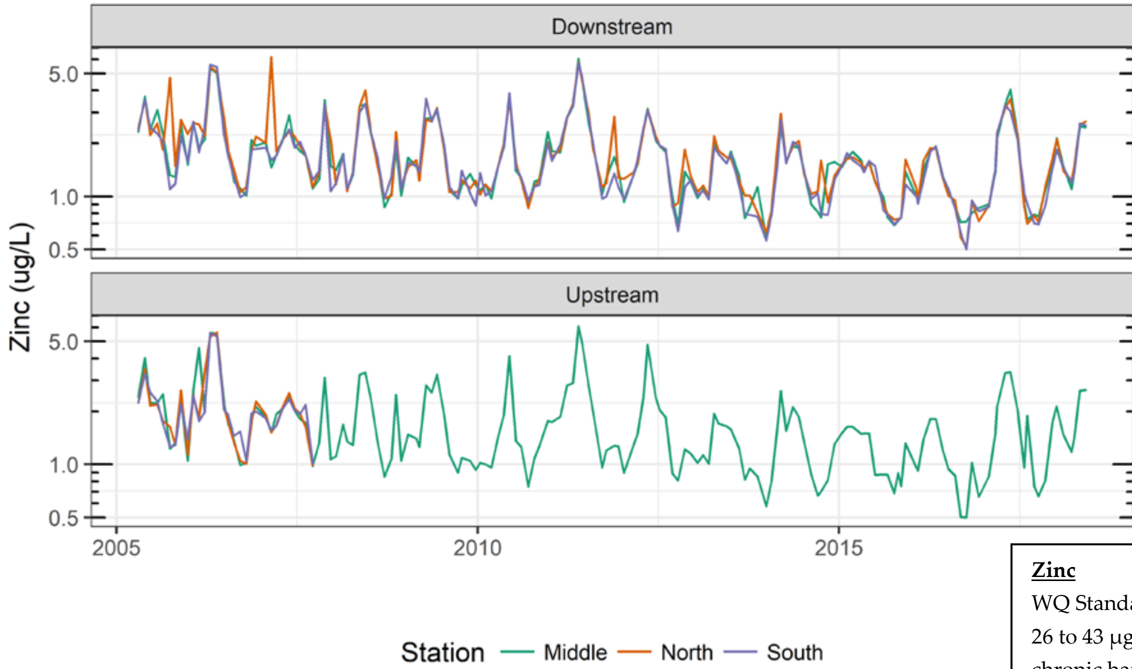
Figure 10 Willamette River Monitoring Results for E. coli

2.5.3 Columbia River Instream Water Quality Sampling

Figure 11 through Figure 15 show measurements of the main parameters of interest related to wet weather treatment and the Columbia River: Zinc, Lead, Copper, TSS, and *E. coli*. These charts compare the measurements upstream and downstream of the combined mixing zone. The charts also include the relevant numeric water quality standard for each parameter except for TSS, which is not a toxic. For the metals, the range of chronic water quality standard values is based on the measured total hardness of the river, which varies from a low of 45 to a high of

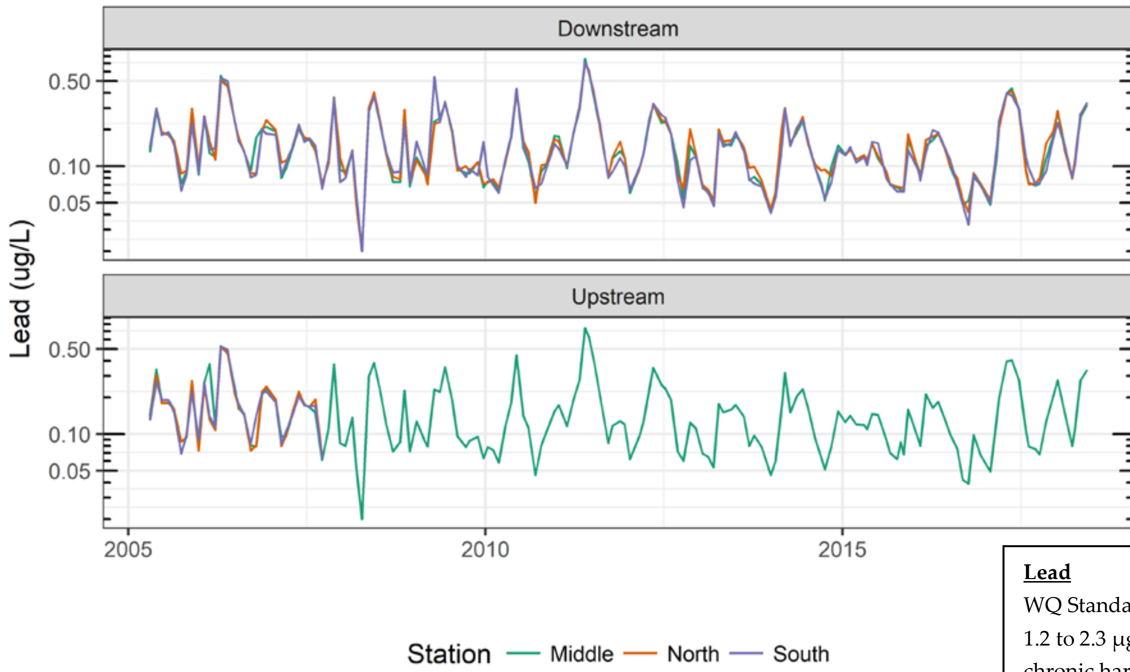
78. The charts show the reasonable range of chronic standards based on the hardness values measured in the river during the sampling period.

All parameters are well below the numeric water quality standards. There is little difference between the upstream and downstream measurements.



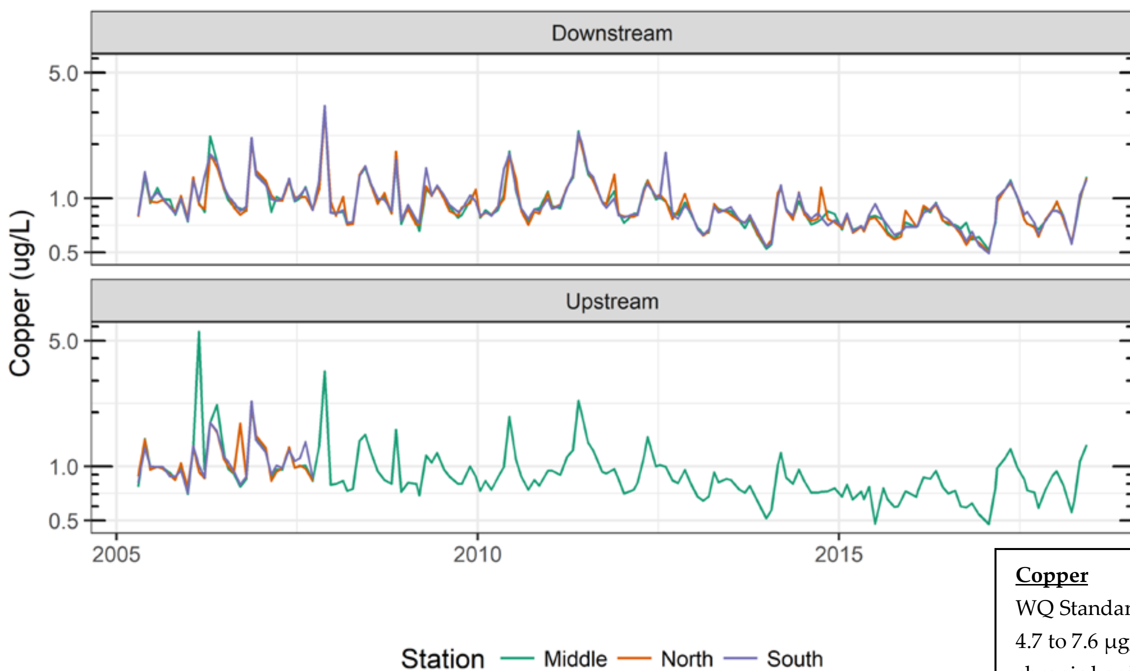
Zinc
WQ Standard:
26 to 43 µg/L
chronic hardness range

Figure 11 Columbia River Mixing Zone Sampling for Zinc



Lead
WQ Standard:
1.2 to 2.3 µg/L
chronic hardness
range

Figure 12 Columbia River Mixing Zone Sampling for Lead



Copper
WQ Standard:
4.7 to 7.6 µg/L
chronic hardness
range

Figure 13 Columbia River Mixing Zone Sampling for Copper

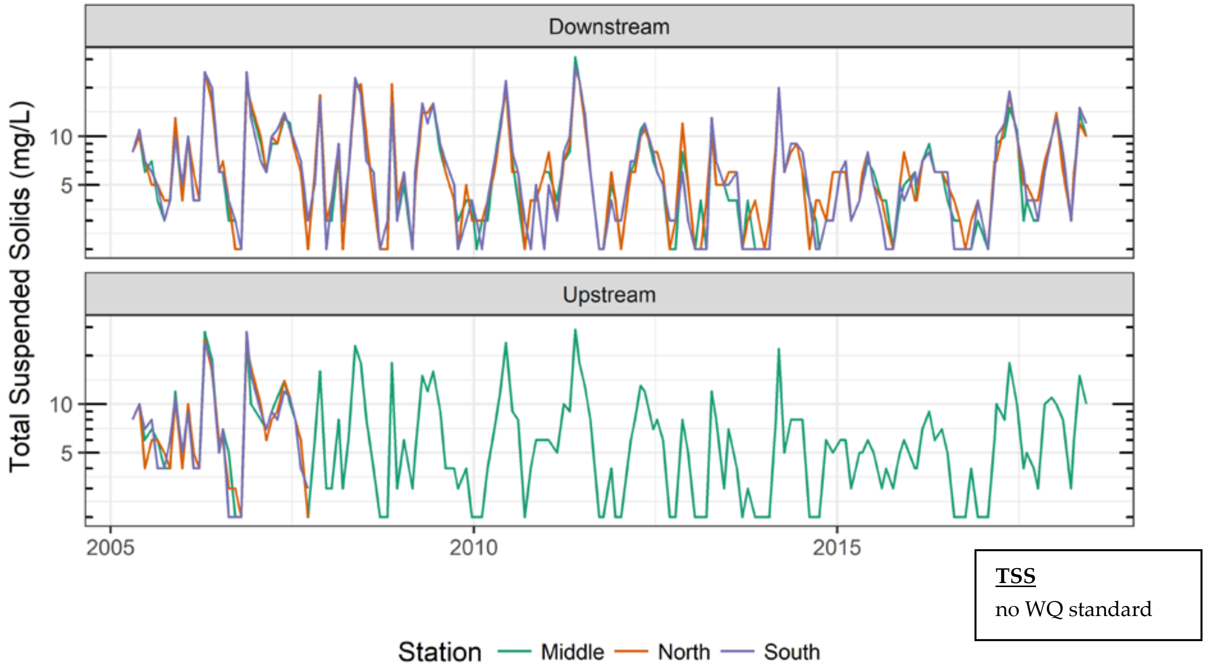


Figure 14 Columbia River Mixing Zone Sampling for TSS

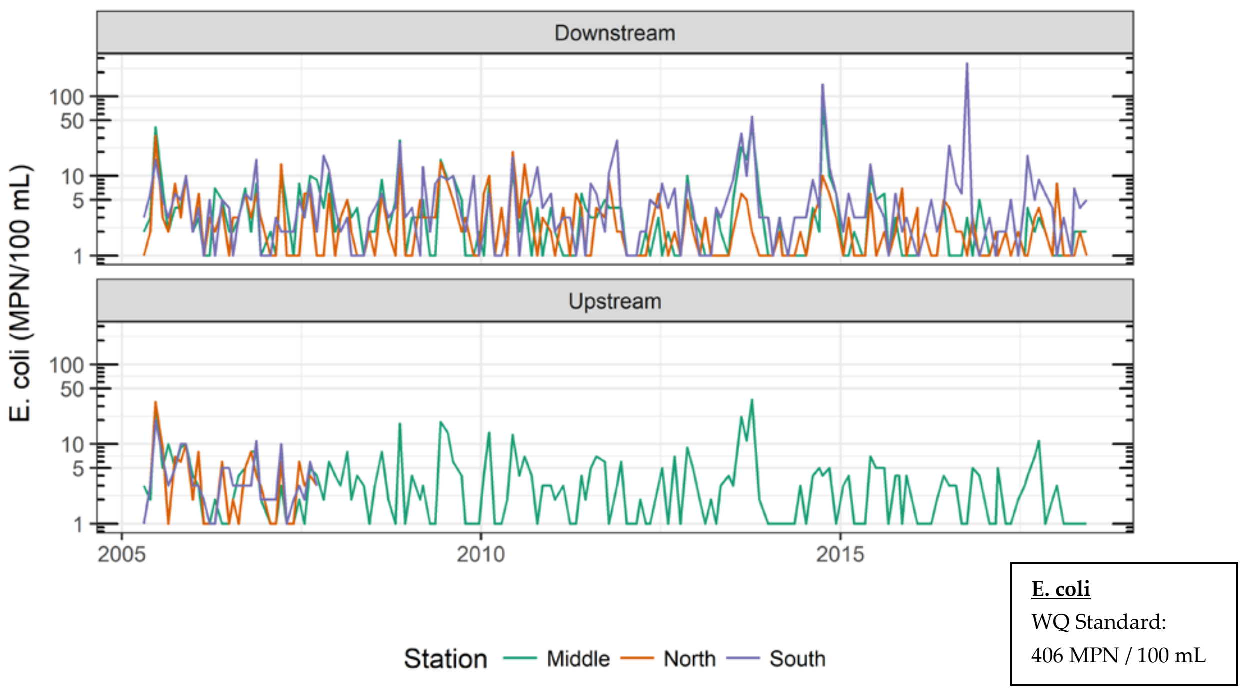


Figure 15 Columbia River Mixing Zone Sampling for E. coli

Section 3 CMOM Program Implementation

The City of Portland's CMOM program is 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 2018 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, can extend an asset's useful life, 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 2018, the sewer inspection program inspected 615,932 lineal feet (117 miles) of mainline sewer pipe, which corresponds to approximately 6% 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, in response to sewer problems, and to support asset reinvestment projects through the CIP. In FY 2018, approximately 93% of the work orders in the mainline inspection program were considered planned work, including general preventive maintenance and support of the City's CIP Sewer Rehabilitation Program. The CCTV inspection program provides the pipeline condition assessment information that is instrumental to the risk prioritization process used to drive the CIP Rehabilitation Program work. In addition to mainline sewer inspections, the City completed 514 service lateral inspections in FY 2018.

In FY 2018, the sewer cleaning program cleaned 1,247,626 feet (236 miles) of sewer pipe, which corresponds to approximately 12% of the mainline sewer system. The sewer cleaning program includes preventive maintenance, accelerated cleaning in grease management areas, support for the root treatment program, special investigations related to collection system problems, and support of CIP projects.

In FY 2018, 96% 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.

In support of BES's integrated approach towards overall watershed health, Maintenance Engineering and Watershed Services staff conducted stream walks and data analysis to assess external factors that might affect sewer pipes near streams. The Ruby Creek walk, conducted in April 2018 (FY 2018), started at 7827 SW Ruby Terrace and terminated at the confluence of Ruby Creek and Stephenson Creek. The walks followed approximately 700 lineal feet of 8-inch sanitary sewer mainline and four manholes. The Marquam Gulch walk, conducted in April and May 2018 (FY2018), were performed in the northern half of the 205-acre Marquam Nature Park, bounded approximately to the north SW Broadway Drive, to the west by SW Sherwood Drive/Place, to the south by SW Marquam Hill Road, and to the east by SW Sam Jackson Road. The walks followed approximately 7,300 lineal feet of 8, 14, 21, 24, 30, and 40-inch combined sewer mainline and 16 manholes. BES is continuing to evaluate all the streamwalk data collected to assess the usefulness of external visual inspection and observations of site conditions in conjunction with other preventive maintenance activities and to develop a standardized, repeatable condition assessment approach for this type of inspection moving forward.

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[5] are assigned when work orders are created. The priority codes are used when

[5] *Hansen* refers to Infor Public Sector, © 2018 Infor. All rights reserved. www. infor.com

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 Sanitary Sewer Overflow (SSO) and hazard-related repairs). The *CMOM Program Report* includes descriptions of sewer repair maintenance activities and equipment.

During FY 2018, 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 Maintenance Capital Contract Program or emergency CIP projects.

City maintenance crews completed mainline sewer repairs totaling 8,429 lineal feet. Approximately 58% of these repairs were considered 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 either from 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 typically localized spot repairs where pipe sections are excavated and replaced or renewed using cured-in-place pipe (CIPP) liners.

City crews completed over 536 service lateral repairs totaling approximately 7,095 lineal feet. Approximately 57% of these repairs were unplanned. Unplanned service lateral repairs are typically in response to a sewer system problem such as a sewer backup or a positive dye test from a sewer investigation. Planned service lateral repairs generally occur in conjunction with adjacent repairs on mainline sewers. Service lateral repairs typically involve the complete replacement or renewal 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 2018, BES Maintenance Engineering continued to manage the chemical root control program using third-party service providers who apply 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 2018, nearly 150,000 lineal feet (28 miles) 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

In FY 2018, six sewer releases from the City-maintained sewer system were attributable to grease. This low number emphasizes the effectiveness of the Portland's program to control fats, oils, and grease (FOG), which was described in the *City of Portland Grease Management and Control Program* document that was included in the *CMOM Program Report*. The program was enhanced during FY 2018 by the addition of a new full-time FOG inspector position, bringing the total to three.

The *Cut Through the FOG Program* significantly updated its outreach and educational materials to more equitably inform food service customers impacted by our program. The *Cut Through the FOG* web page (https://www.portlandoregon.gov/bes/54538, Figure 16) and fact sheets were updated with versions in seven additional languages. The program completed production on three multilingual videos and published them to the web page. The videos are intended to educate food service employees on the proper way to clean a grease trap, kitchen best management practices, and how to manage their sewer costs. They also contain information on how FOG can negatively impact the sewer system and what food service establishments need to do to prevent its discharge and stay in compliance.

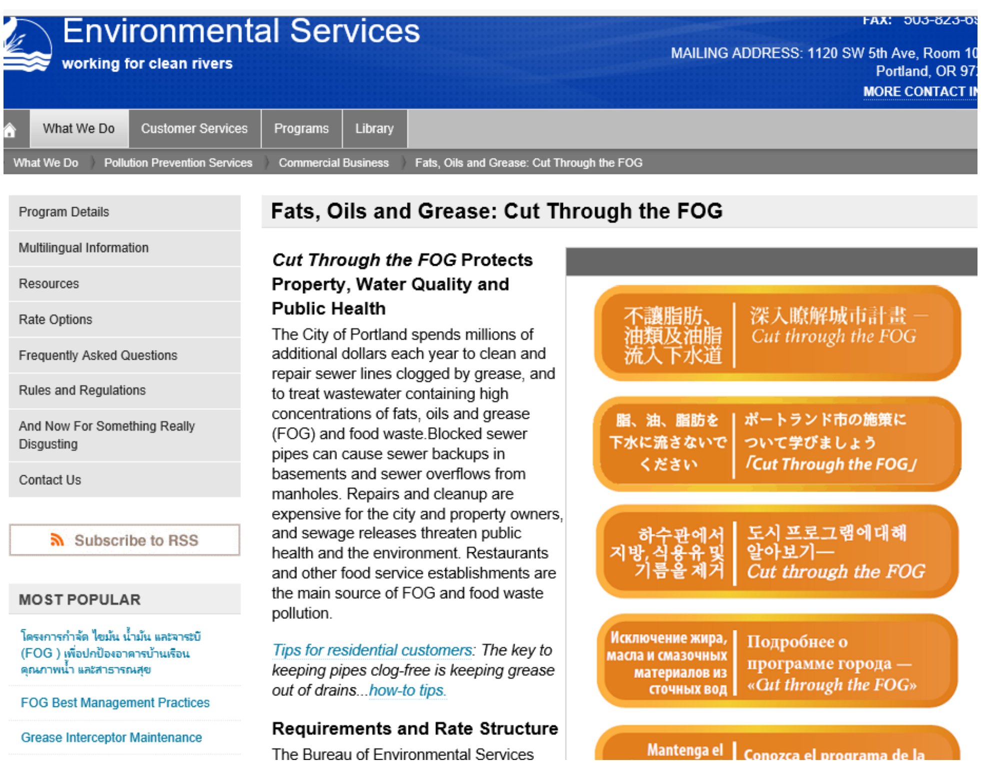


Figure 16 Cut Through the FOG Website

Areas of the collection system vulnerable to FOG buildup and blockages are managed on a more frequent preventive maintenance and cleaning cycle. In FY 2018, 71,860 lineal feet (14 miles) of FOG-related sewer cleaning was conducted, including 46,715 lineal feet (8 miles) of cleaning in designated Accelerated Grease Cleaning Areas. A total of 26,900 lineal feet (5 miles) of mainline sewer received FOG-related CCTV inspections during FY 2018.

The FOG management program has continued to proactively inspect food service establishments to ensure that grease interceptors are installed correctly, in a proper state of repair, and are cleaned at the proper frequency. FOG enforcement actions in FY 2018 are summarized in Table 10.

Table 10 FOG Enforcement Activities in FY 2018

Description	Number	Requirement
Warning Notice	271	Increase grease removal device cleaning frequency
	61	Repair or replace grease removal devices
Notice of Violation with Civil Penalties/ Cost Recovery	6	Plumb all fixtures to a grease interceptor
	16	Service grease interceptor at prescribed cleaning frequency
	2	Make required grease interceptor repairs
	3	Escalated enforcement for failing to meet compliance dates for original NOV

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. Based on CCTV inspection results and similar information, the FOG Coordination Team determines areas that are cleaned at an accelerated frequency.

The Pollution Prevention Plan Review Section is an important component of BES's control of FOG. In FY 2018 the Pollution Prevention Plan Review Section required 265 food service establishments to plumb all kitchen fixtures to grease interceptors per current Oregon Plumbing Specialty Code due to new development, redevelopment, or enforcement requirements.

3.1.5 Manhole Inspection

BES continued the second tier of the risk-based manhole inspection in FY 2018. As described in the *Collection System Inspection and Cleaning Plan* submitted to DEQ in December 2012, Tier 2 manhole inspections are more detailed in nature than the routine Tier 1 manhole inspections performed during inspection of associated mainline sewers. The Tier 2 manhole inspections focus on the manholes considered to be at the greatest risk of failure, prioritized by age and material. The Tier 2 manholes are primarily those constructed of brick and monolithic concrete.

In FY 2018, 546 manhole inspections were completed. Inspections identified the need for some minor repairs but in general the manhole inspections have shown that the manholes are predominantly in good condition. The majority of the defects found have been manhole cover/frame damage and light to medium deterioration of the bench/channel. One manhole was found to have missing bricks, and another deteriorated to the point of needing a complete replacement. Of the Tier 2 manholes inspected in FY 2018, 19 were identified for repair and one for replacement. Work orders have been written. All of the repair work orders will be completed by City maintenance crews.

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 reporting releases 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.

BES maintains sewer release data within the Hansen computerized maintenance management system (CMMS), allowing service call information to be connected with follow-up actions and 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 11. BES further categorizes weather-related sewer releases, as shown in Table 12, to more directly associate these releases with the City's levels of service established through the BES Asset Management Improvement Program.

Table 11 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 12)
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

*The Water Bureau Break cause was changed to "Surcharge" effective July 1, 2018 to more clearly indicate these sewer releases result from collection system surcharge conditions, rather than damage resulting from Water Bureau activities

Table 12 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, 6-hour 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.

As of the end of FY 2018, BES owned and maintained approximately 1,917 miles of main line sanitary and combined sewers, and 712 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. During FY 2018, the City experienced 168 sewer releases over the 2,629 miles of collection system, which is approximately 6.4 releases per 100 miles of sewer.

Sewer release data is updated by BES SPCR as more complete information becomes available and investigations are conducted, and thus totals in this report reflect current records and may not match previous years' reports and/or monthly discharge monitoring report submittals. A comparison with previous fiscal years is shown in Figure 17.

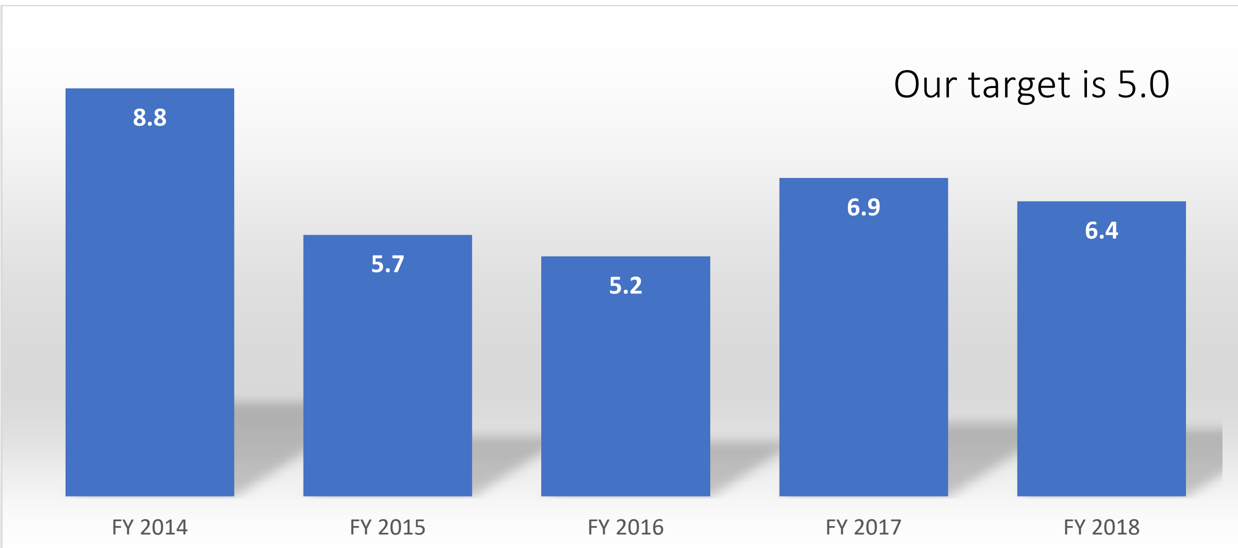


Figure 17 SSOs per 100 Miles of Sewer

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 2 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 2-hour on-site response goal does not apply.

Response time performance for FY 2018 is shown in Table 13. A comparison with previous fiscal years is shown in Figure 18. Sewer emergency response crews arrived on site within the City's 2-hour response time target 96% of the time during FY 2018, which is the best response time performance since annual CMOM program reporting began in FY 2014.

Table 13 SSO Response Time and Counts for FY 2018

FY 2018 Total Urgent Calls Sewer Release Calls	Number of Calls	Percent of Total
Urgent Calls with Response Time Less Than 2 Hours	372	96
Urgent Calls with Response Time 2 Hours or More	15	4
Total	387	100

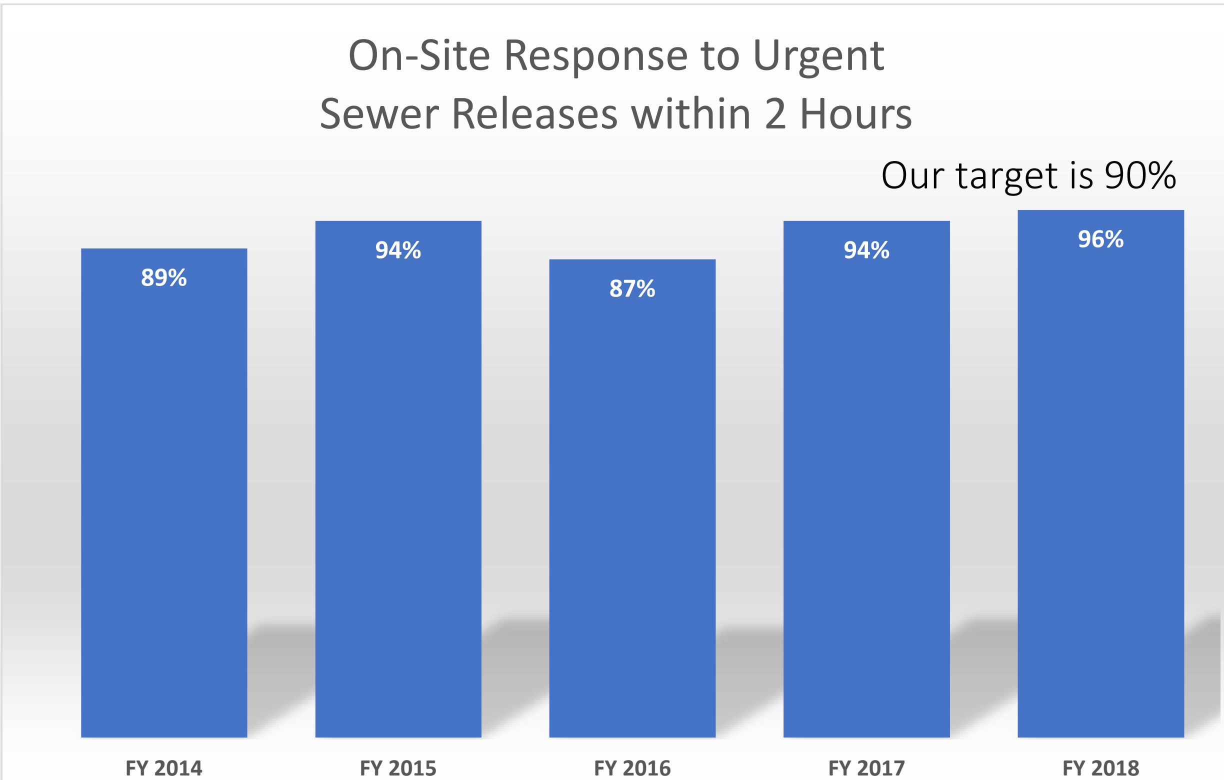


Figure 18 SSO Response Time Comparison

4.3 Analysis of Causes and Locations of Sewer Releases

During FY 2018, the City experienced 168 releases from the sanitary and combined sewer systems. There were no weather-related release events in FY 2018 that exceeded the design capacity of the collection system (referred to as *force majeure*).

A chart comparing the causes of releases in FY 2014 through FY 2018 is shown in Figure 19. 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 2018 are shown on the map in Figure 20.

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. There were 51 releases caused by structural defects in FY 2018. There were 40 releases from structurally defective laterals, 10 from mainline sewers, and one from a pump station. As part of the City's CIP sewer rehabilitation program, poor condition mainline sewers are identified for repair. The laterals connecting to those pipes are inspected during the design process and included for replacement or rehabilitation if structurally and/or operationally deficient. The risk of releases associated with structural defects should decrease as the large number of sewer repair, rehabilitation, and replacement CIP projects currently in design or under construction are completed.

Roots. During FY 2018, of the 52 releases caused by roots, 8 were in sewer mainlines and 44 were in service laterals. To reduce the risk of future root intrusion, City crews installed CIPP liners or excavated and replaced the majority of laterals where releases occurred in FY 2018.

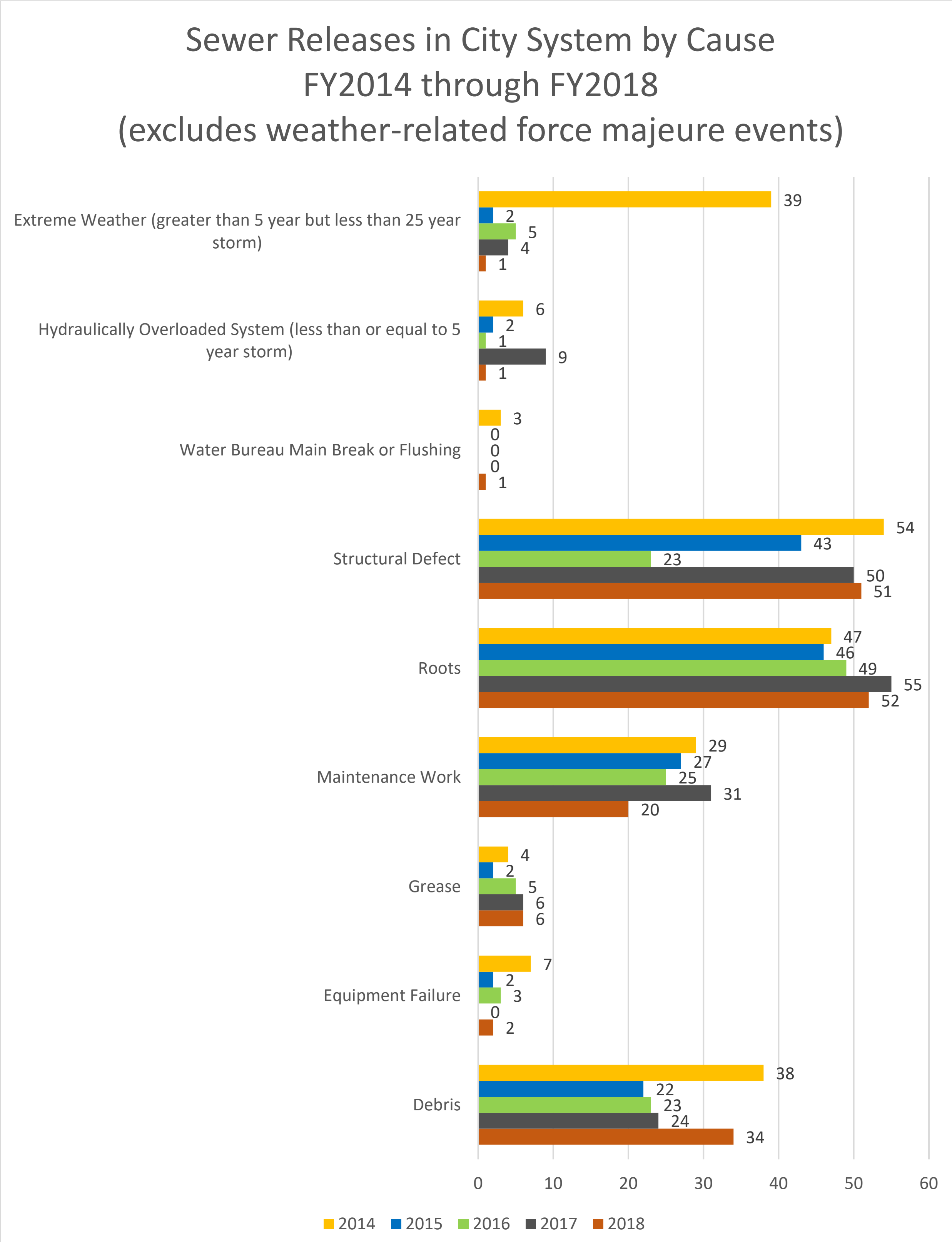


Figure 19 Comparison of Causes of Sewer Releases in FY 2014 through FY 2018

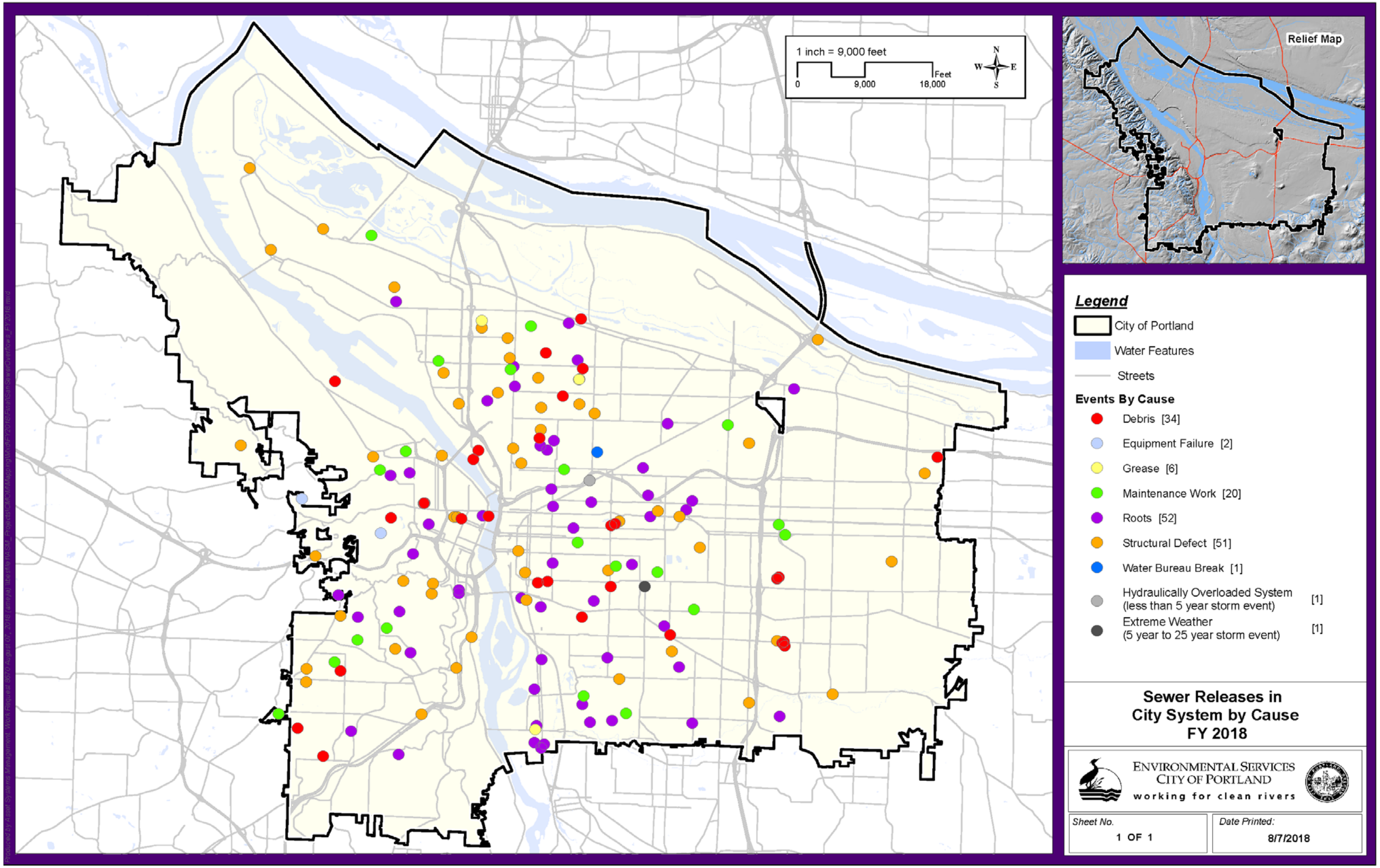


Figure 20 Sewer Releases in City System by Cause, FY 2018

Maintenance. In FY 2018, there were 20 releases associated with maintenance activities, compared to 29 in FY 2014, 27 in FY 2015, 25 in FY 2016, and 31 in FY 2017. Fourteen releases were associated with sewer cleaning operations; most of these releases were "bowl water" from toilets and the volume was less than 10 gallons (four of these releases were attributed to BES contractors). While precautions are taken to prevent these "blow back" 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. Special precautions, such as using cleaning nozzles with steeper jet angles and running lower pressures, are taken in areas prone to blow back.

Six maintenance-related releases were associated with sewer repairs. Three releases involved installation of CIPP liners, one by a City crew and two by BES contractors. One release occurred after a sewer lateral being excavated by a City repair crew was blocked by rocks and soil during a rainstorm. One release occurred when a sewer lateral was damaged during maintenance activities conducted by the City's Water Bureau. One release to surface water (described below) occurred when a pump station maintenance crew inadvertently left a force main drain valve open during pressure testing.

Debris. There were 34 releases caused by debris in FY 2018, compared to 38 in FY 2014, 22 in FY 2015, 23 in FY 2016, and 24 in FY 2017. In addition to accumulation of debris during normal system operation, introduction of foreign objects and debris into the system by third parties resulted in several clusters of sewer releases in FY 2018. While the source of debris and vandalism is difficult to trace, enforcement action is being pursued in response to utility contractors who bored through public sewers at several locations. Disposable wipes were a significant factor in debris-related sewer releases in FY 2018. BES continues to conduct "what not to flush" public outreach.

4.3.1 Sewer Releases to Surface Water in FY 2018

Sewer releases to surface water occurred at five locations in FY 2018. The circumstances of these release events are described below. Although volume estimates are not always available, they are included in each event below when possible.

6900 SW Railroad Street (release to Woods Creek): On July 13, 2017, a sewage release occurred from a manhole at SW 69th and Railroad within the City of Beaverton. This manhole is part of the Clean Water Services collection system and receives flow from the Fanno Basin pumping system, which is operated by the City of Portland. The discharge flowed north along a series of ditches, eventually reaching Woods Creek near SW Oleson Road. The sewage release was due to the drain valve at SW 69th and Railroad being left in an open position by City of Portland pump station maintenance personnel during force main pressure testing by a BES construction contractor. Based on engineering analysis of available flow and pump station data, the volume of the release was estimated at 85,000 to 175,000 gallons. The wide variation is because it is unknown how much water was still in the line at the time of startup. To ensure that future sewer releases like this one will not occur, BES developed the *Fanno Basin Pumping System Operations Plan* in collaboration with Clean Water Services, and is in the process of developing and implementing a training plan for BES staff. Additionally, BES has installed a lock mechanism on the drain valves and created a procedure in the operations plan wherein the locks must be removed by both jurisdictions and BES personnel must stay on site during any discharge, and then locks are to be reinstalled by both jurisdictions once the valve is closed.

12567 N Lombard Street (release to Columbia Slough): On October 17, 2017, investigation was conducted and confirmed that sewage coming out of the ground underneath the N Lombard Street overpass near N Burgard Road was coming from an underground force main. The released material ran underneath some nearby railroad tracks, down a heavily vegetated hill and into the Columbia Slough. The volume of the sewage release is estimated to be approximately 25,000-40,000 gallons based on the duration of the release and the performance characteristics of the Lombard Pump Station pumps. The sewage release infiltrated into the ground around the railroad tracks prior to reaching surface water, and it is believed that the impact to surface water was minimal. As soon as the source of the release was identified as the force main, the pump station was shut down. To maintain service to the system, as well as to drain the pressure main, sewage was pumped from the Lombard Pump Station wet well into trucks where it was transported to the nearby Rivergate Pump Station for reintroduction to the sewer system. An immediate repair of the pressure main was initiated. A damaged section of the force main removed and repaired using concrete and metal patch. A pressure test was conducted to ensure that the repair was sufficient, and the excavation was backfilled. The repair was completed on Friday, November 20, 2017

4740 SW Lowell Court (release to Ivy Creek): On October 31, 2017, the City responded to an odor complaint at the Bridlewood Bridge near the address of 4909 SW Lowell Court. Responding crews investigated and found a sewage release occurring near the address of 4740 SW Lowell Court. Crews observed that the concrete main sewer line in Ivy Creek had become damaged and was releasing sewage into the creek. Crews immediately set about repairing the damaged sewer line, and the release was stopped at 11:43 p.m. that evening. On December 13, 2017, the PVC pipe that had been installed as a temporary repair was replaced with HDPE pipe, and the closure collars were encased in concrete.

5001 N Columbia Boulevard (release to Columbia Slough): On December 5, 2017, maintenance crews were draining a 20-inch force main near the CBWTP to conduct a CCTV of the interior to check for corrosion. The line was isolated using a blind flange. The force main at the top of the pedestrian bridge (a high point) was still under pressure. A gate valve at the pedestrian bridge was opened to release gases and approximately six gallons of sewage was released. Of that amount several drops fell into the Columbia Slough below. Crews closed the isolation valve and were able to drain the force main to primary treatment at the nearby treatment plant. A construction project that includes installation of an air relief valve on the force main is scheduled to begin in June 2019.

9405 SW Lancaster Road (release to Falling Creek): On April 8, 2018, a resident near SW Lancaster Road reported an overflowing manhole on that street. City emergency crews responded and immediately initiated sewage release response procedures. Flow was observed coming from manhole ADD058 and was proceeding down SW Lancaster Road until it left the road and reached nearby Falling Creek, a tributary of Tryon Creek. The crew determined that a downstream blockage was occurring in the main sewer causing the overflow. The blockage was removed and the release stopped at 2:00 p.m. on April 8, 2018. The volume was estimated to be 24,000 gallons. A subsequent CCTV survey determined that the cause of the release was a root blockage in the main sewer. Sewer cleaning was performed on April 9, 2018 to remove roots from the sewer. Additionally, a cured-in-place liner was installed on May 25, 2018 to reduce the chance of this occurring again.

4.4 Conclusions and Follow-Up 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 2018 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. Typically, 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.

The majority of structurally-defective laterals where releases occurred in FY 2018 have been repaired by City crews using CIPP liners or were excavated and replaced. To proactively prevent sewer releases from laterals, CIP projects for replacement, repair, and rehabilitation of sewer mainlines also include inspection and repair/replacement of service laterals based on the risk of structural or operational failure. 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 gradually decrease as significant capital reinvestment in the sewer system is accomplished and 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.

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 Maximization of Storage in the Collection Systems

One of the Nine Minimum Controls, *Maximization of Storage in the Collection Systems,* ensures that combined sewage is kept within the sewer system using existing in-system storage. This optimizes the volume sent to enhanced wet weather treatment, increasing the volume treated by the biological secondary processes and reducing the number and volume of CSO events. While this control originally focused on keeping sewers free of blockages, removing relatively clean stormwater from the collection system also contributes to maximizing available storage and conveyance capacity. The programs documented here also have the added benefits of increased visibility of these efforts and public education opportunities.

5.1 Private Development and Redevelopment

BES's Stormwater Management Manual (SWMM) applies to all development and redevelopment proposals that create or redevelop over 500 square feet of impervious area.

In FY 2018, implementation of the SWMM in combined sewer basins led to construction of stormwater facilities at 857 properties, managing 74 acres of private impervious area onsite, thereby reducing stormwater volume into the combined system.

City staff are implementing a newly revised SWMM that went into effect August 2016.

5.2 Private Property Retrofit Program

Installation of stormwater facilities on private property continues in the Private Property Retrofit Program. Guided by BES's 2012 Combined Sewer System Plan and its Capital Improvement Program, this program researches opportunities with private property owners to voluntarily retrofit or install on-site stormwater facilities to keep runoff out of the combined sewers. The reduced runoff helps reduce local sewer capacity problems and reduce CSO volumes. For more information, see previous Annual CSO and CMOM reports (FY 2014 and FY 2015).

For FY 2018, 2.4 acres of impervious surfaces were managed by 64 private property stormwater retrofit projects. An area of focus is shown in Figure 21. Three examples of this year's retrofits are shown in Figure 22, Figure 23, and Figure 24 below.

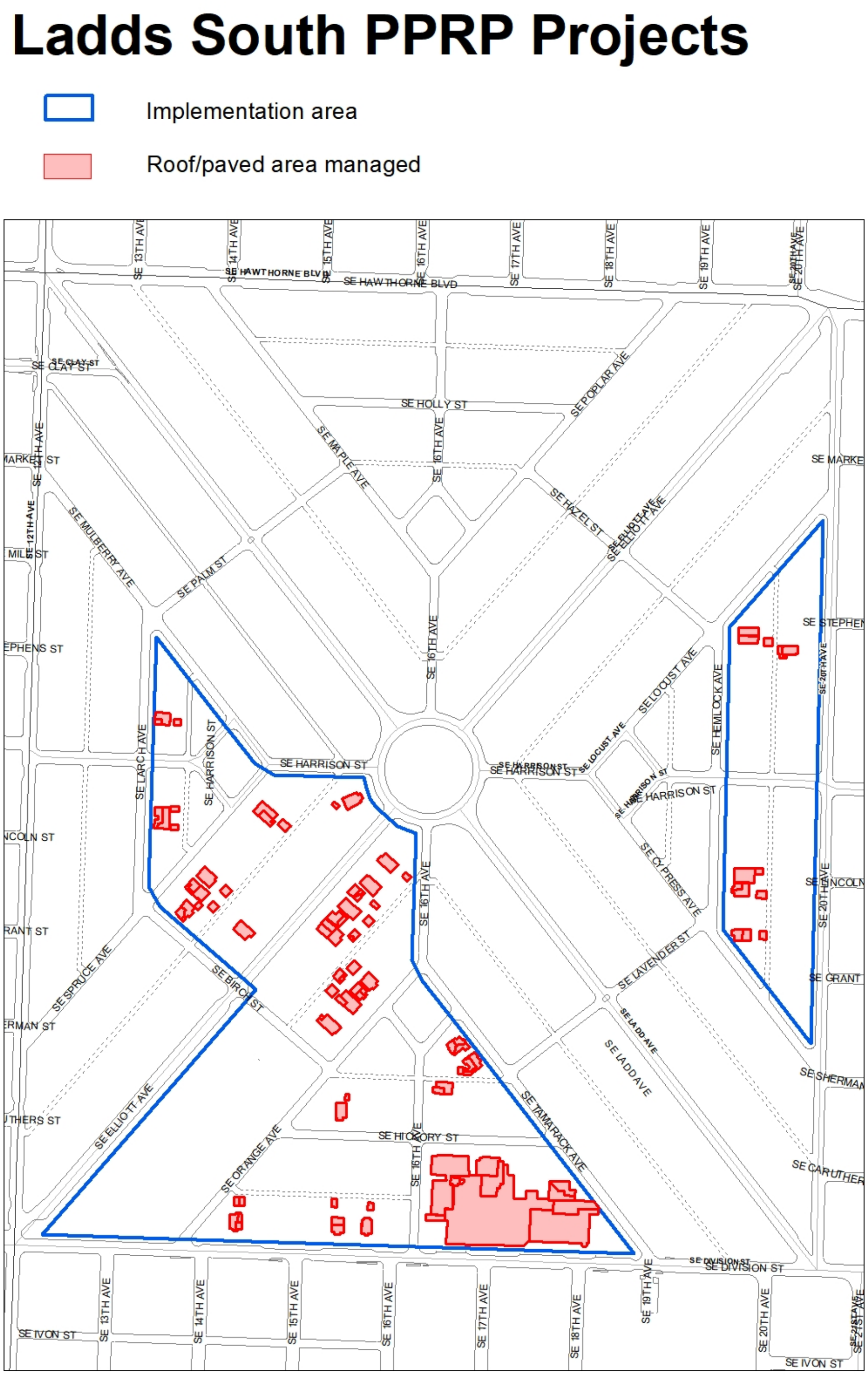


Figure 21 Map of An Example Project Area

Figure 22 Example Retrofit #1

Figure 23 Example Retrofit #2

Figure 24 Example Retrofit #3

5.3 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, SWMM, and developer floor area ratio bonuses in specific portions of the city.

As of June 2018, Portland has over 492 ecoroofs installed throughout the city, managing almost 32 acres of roof. Approximately 387 of those ecoroofs are in the combined sewer area. During FY 2018, 18 new ecoroofs were installed in the combined sewer area, managing approximately 3.2 acres of roof. This roof area represents 3.2 million gallons of rainfall to the combined system annually, and Portland's monitoring data indicate that approximately 1.7 million gallons are retained by the roofs and returned to the atmosphere through evapotranspiration.

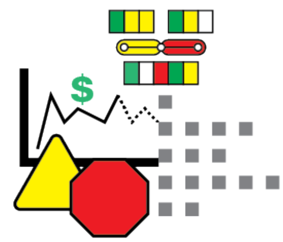
5.4 Public Right-of-Way Development and Redevelopment

As of June 2018, Portland has implemented over 2,100 green streets in the right-of-way, with approximately 970 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 2018, 28 new green street facilities were installed in the combined sewer area. The projects were implemented by BES CIP projects and PBOT street projects that required stormwater management. Collectively, these facilities manage approximately 2.8 acres of impervious area that generate 2.8 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 2.0 million gallons of runoff annually from the combined sewer system through infiltration and evapotranspiration.

Section 6 System Reinvestment and Risk Reduction

The City of Portland, Bureau of Environmental Services' asset management program is founded on strategically reducing risk through cost effective investments. The City has improved its methods for calculating risk and making cost effective decisions to reduce risk through investment activities. This section discusses how the City is valuing existing risk in the collection system and how its investments reduce risk to meet levels of service.



6.1 FY 2018 Reporting Methodology, Changes and Improvements

Risk in mainline pipes is generally determined by inspections and hydraulic modeling.

Pipe inspections provide the condition data used to determine the risk of structural failure. The inspections include routine maintenance inspections to determine the structural condition of the pipes, and post-repair acceptance inspections to ensure that repairs meet designated standards and/or contract specifications. Structural risk of laterals is assumed based on quantity of lateral repaired.

Hydraulic modeling is done to determine the risk of capacity failure, specifically to determine the likelihood of basement and surface flooding with respect to the Bureau's adopted levels of service.

System risks change over time as a result of the following:

1. **Capital Improvement Program:** Capital projects repair or rehabilitate existing assets or introduce new ones reduce capacity (level of service) risk and structural (mortality) risk in the system.
2. **Maintenance:** Maintenance work orders seek to reduce structural risk in the system by applying targeted repairs or emergency replacements and rehabilitation on high-risk assets.
3. **Change in pipe condition due to aging:** Inspections provide more accurate information about pipe condition than simple age-based assumptions. Changes in risk can be due to actual aging as indicated by consecutive inspections, or due to the inspection-based

condition of pipes varying from the age-based assumed condition. Since actual pipe condition can be better than the age-based assumed condition, risks can decrease for a particular pipe when it is first inspected.

4. **Unexpected changes to hydrologic conditions:** In general, future development conditions are modeled to allow BES to provide sufficient capacity to meet anticipated hydrologic conditions in the future. Future conditions are largely defined by the City's currently adopted Comprehensive Plan. In some instances, development may occur that is different than was set in the Comprehensive Plan. These changes may have a positive or negative effect on capacity risk.

Items 1 and 2, above, are the focus of this section.

The City of Portland has been working diligently over the past fiscal year on developing a risk reporting methodology for pipe rehabilitation. The methodology relies on existing internally-developed asset management and project tracking systems. These systems underwent significant changes and upgrades over the past year, but they need to be further adjusted to enhance risk reduction reporting.

The City is in the process of improving risk calculations for large diameter (36-inch or larger vertical and/or horizontal dimension) pipe assets. The risks for large diameter assets assume different failure scenarios and rehabilitation methods, compared to smaller diameter pipes. Results presented in this report apply to smaller diameter pipes (less than 36-inch diameter).

6.2 FY 2018 Activity for Risk Reduction

Risk reduction is the present value of the cost of repairing or replacing infrastructure, thereby deferring failure, and its related consequences, to the expected life of the repair or replacement.

Risk reduction for capital work is now reported on a calendar year basis as fiscal year reporting is delayed due to construction during the summer and end of the fiscal year. Risk is not reported for investments in correcting non-conforming sewers (e.g., sewers not constructed to current standards).

6.2.1 Risk Change Due to Capital Improvements and Inspections

Capital improvement projects are designed and installed to resolve capacity and mainline structural risk. Resolution of both types of risk are included in the risk reduction calculations. The changes in capacity and structural risk due to rehabilitation is summarized in Table 14. This data is currently incomplete, and the actual risk reduction may be higher. BES is continuing to work on improving the data systems required to develop these risk reductions more accurately.

Table 14 Risk Change Due to Capital Improvement Projects with Available Data

Type	Value
Total Risk Reduction Due to CIP Investment in Repaired/Replaced Pipe	$14,680,000

The Capital Improvement Program completed four projects in the sanitary and combined collection system during the 2017 calendar year. These projects repaired and rehabilitated 161 sanitary and combined sewer gravity mains.

6.2.2 Risk Change Due to Maintenance Activity

Maintenance repairs reduce risk in the collection system and involve localized repairs on sewers and the replacement of service laterals. The Hansen system for calendar year 2017 showed that planned maintenance activities included approximately 17,300 lineal feet of repair and lining work on sewer main assets and 273 laterals which were replaced or lined.

A corrected value for the calendar year 2016 risk reduction for maintenance activity is provided here also for comparison. Risk numbers last year underwent several revisions, and the current method for calendar year 2017 was applied for 2016.

Table 15 Risk Change Due to Maintenance Activity with Available Data

Type	Value
Total risk reduction due to maintenance activity (CY 2016, corrected)	$4,990,000
Total risk reduction due to maintenance activity (CY 2017)	$2,890,000

Appendix A CSO Event History

When reporting on *how the Portland CSO system has performed*, the City of Portland usually refers to the number of events and the size of overflows that have occurred since the system became fully operational in December 2011. From that standpoint, BES has validated and reported 24 permitted events from the Willamette River and Columbia Slough facilities.

Prior to December 2011, the Amended Stipulation and Final Order from DEQ required the City of Portland to eliminate most overflows to the Columbia Slough by December 1, 2000. Another 16 outfalls (represented by a mix of outfalls from the West Side and East Side of the Willamette River) were controlled by December 1, 2006.

Columbia Slough CSO Events since October 2000

This table presents the CSO events to the Columbia Slough since the Columbia Slough CSO system became fully operational in October 2000. There were no CSO events to the Columbia Slough in FY 2018. Winter events are shaded in blue, and summer events are shaded in yellow. All events were valid under the NPDES permit at the time.

Table 16 Columbia Slough CSO Events since October 2000

CSO Discharge Events			Storm Characteristics			System Totals		West 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)
1	May 26, 2012	> 100-year, 30-minute storm	-	-	-	0.022	0.20	0.022	0.20
2	December 5-13, 2015	25-year, 3-6 hour storm	2.04	2.61	3.19	0.01	0.15	0.01	0.15

Willamette River CSO Events from December 2006 to December 2011

Table 17 presents the CSO events to the Willamette River since the West Side Willamette River CSO Tunnel became fully operational in December 2006 until the full Willamette system became operational in December 2011. Winter events are shaded in blue, and summer events are shaded in yellow. All events were in compliance with the requirements of the NPDES permit and the 1994 Amended Stipulation and Final Order in effect at the time.

Table 17 Willamette River CSO Events, December 2006-December 2011

CSO Discharge Events*			Storm Characteristics			System Totals		West 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)
1	Dec 14, 2006	4-per-Winter Storm	0.82	1.17	1.60	66.85	18.37	66.85	18.37
2	Jan 3, 2007	4-per-Winter Storm	0.69	1.04	1.54	5.15	4.35	5.15	4.35
3	Dec 2-3, 2007	> 5-year 24-hour Winter Storm	0.97	1.76	3.09	154.5	26.85	154.5	26.85
4	Nov 12, 2008	4-per-Winter Storm	0.76	1.02	1.38	8.1	4.1	8.1	4.1
5	Jan 1-2, 2009	5-year Winter Storm	1.12	1.52	2.73	122.60	21.58	122.60	21.58
6	May 4, 2009	3-year Summer Storm (3-6 hr duration)	0.94	1.02	1.18	5.26	1.05	5.26	1.05
7	Nov 7, 2009	2-per-Winter Storm	0.93	1.22	1.51	9.60	2.92	9.60	2.92
8	June 6, 2010	3-year Summer Storm	1.07	1.25	1.43	26.02	3.08	26.02	3.08
9	Nov 17, 2010	1-per-Winter Storm	1.03	1.56	1.77	11.48	5.58	11.48	5.58
10	Dec 8-12, 2010	5-year Winter Storm	1.43	1.52	2.34	41.82	8.92	41.82	8.92
11	Dec 28, 2010	2-per-Winter Storm	0.57	0.89	1.58	6.85	5.50	6.85	5.50
12	Jan 15-16, 2011	1-per-Winter Storm	0.94	1.21	2.13	26.27	8.92	26.27	8.92
13	Feb 27-Mar 4, 2011	1-per-Winter Storm	1.15	1.70	2.41	75.98	28.25	75.98	28.25

CSO Discharge Events*			Storm Characteristics			System Totals		West 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)
14	Nov 21-23, 2011	5-year Winter Storm	1.44	1.66	2.24	115.96	6.25	115.96	6.25

Willamette River CSO Events since December 2011

This table presents the CSO events to the Willamette River since the Willamette River CSO Tunnel system became fully operational in December 2011. FY 2018's events are listed in the bold box below. Winter events are shaded in blue, and summer events are shaded in yellow. All events were valid under the NPDES permit at the time.

Table 18 Willamette River CSO Events, December 2011 to June 2018

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	304.90	10.30	86.40	10.30	218.50	10.30
2	May 26, 2012	> 100-year, 30-minute Storm	-	-	-	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	176.40	9.50	44.00	9.50	132.40	9.30
4	November 24, 2012	3-per Winter, 24-hour Storm	0.61	1.09	1.49	0.50	0.80	0.50	0.80	-	-
5	May 23, 2013	3-year, 12-hour Summer Storm	0.90	1.22	1.50	26.30	2.30	11.90	2.30	14.40	1.80
6	September 27-30, 2013	10-year, 24-hour Summer Storm	1.20	1.41	2.08	88.50	7.00	27.00	7.00	61.50	5.40

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)
7	March 25-30, 2014	2-per Winter, 12-hour Storm	0.89	1.26	1.53	43.10	3.00	14.30	3.00	28.70	3.00
8	June 15-16, 2014	3-year, 30-minute Summer Storm	-	-	-	0.03	0.20	-	-	0.03	0.20
9	October 22-23, 2014	10-year, 24-hour Summer Storm	1.42	1.68	2.11	69.4	3.92	13.41	3.50	56.00	3.92
10	December 4-6, 2014	5-year, 3-hour Winter Storm	0.95	1.37	1.56	1.6	1.57	0.05	0.27	1.52	1.57
11	January 17-18, 2015	1-per Winter, 24-hour Storm	0.97	1.50	2.04	91.6	7.98	15.15	6.75	76.43	7.98
12	March 14-15, 2015	1-per Winter, 48-hour Storm	1.05	1.80	2.41	78.9	6.48	16.61	5.92	62.31	6.48
13	October 30-November 2, 2015	50-year, 2-hour storm	1.94	1.98	2.55	190.5	6.35	30.24	4.88	160.05	6.35
14	November 16-17, 2015	1-per Winter, 1-hour storm	0.80	0.85	1.37	0.03	0.17	-	-	0.03	0.17
15	December 5-13, 2015	25-year, 3-6 hour storm	2.04	2.61	3.19	638.7	15.60	134.86	13.33	503.83	15.60
16	December 16-19, 2015	1-per Winter, 3-48 hour storm	1.11	1.56	2.37	145.8	11.00	26.79	9.70	118.99	10.30
17	May 19, 2016	3-year, 30-minute Summer Storm	-	-	-	0.02	0.18	-	-	0.02	0.18
18	October 13-17, 2016	> 100-year, 1-2 hour storm	1.56	1.81	2.09	0.92	0.63	0.89	0.63	0.03	0.33
19	November 22-25, 2016	5-year winter, 3-hour storm	1.20	1.81	2.47	210.5	17.00	49.36	16.10	161.15	16.60
20	January 17-18, 2017	2-per-winter, 1-day storm	0.61	1.03	1.78	93.5	8.90	20.82	7.50	72.70	8.90

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)
21	February 3-6, 2017	5-year winter, 1-day storm	0.81	1.48	2.53	206.0	12.10	53.07	11.5	152.95	12.1
22	February 7-10, 2017	4-per-winter, 1-day storm	0.51	0.82	1.36	0.0035	0.17	0.0035	0.17	-	-
23	February 15-16, 2017	1-per-winter, 1-2 day storm	0.80	1.25	1.98	89.6	6.4	25.61	5.8	63.98	5.8
24	May 12-14, 2017	>10-year summer, 15 minute storm	0.43	0.68	0.75	0.0051	0.20	0.0051	0.20	-	-
25	September 17-20, 2017	10-year summer, 15-minute – 2-hour storm	0.76	1.18	1.58	0.097	0.63	-	-	0.097	0.063
26	October 19-22, 2017	10-year summer, 24-hour storm	0.96	1.64	2.29	70.5	6.17	19.82	4.92	50.68	6.00
27	April 6-8, 2018	1-per-winter, 12-48 hour storm	0.74	1.29	1.94	24.7	2.55	4.71	2.32	19.95	2.52