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

August 30, 2019

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 2019**
Columbia Boulevard Wastewater Treatment Plant NPDES Permit #101505

Dear Mr. Pinney:

Enclosed, please find two copies of the *Annual CSO and CMOM Report, FY 2019*, 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 2019 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 2019)

CITY OF PORTLAND | BUREAU OF ENVIRONMENTAL SERVICES

Annual CSO and CMOM Report FY 2019

REQUIRED BY NPDES PERMIT #101505

ENVIRONMENTAL SERVICES
CITY OF PORTLAND
working for clean rivers

Nick Fish, Commissioner

Michael Jordan, Director

ENVIRONMENTAL SERVICES
CITY OF PORTLAND

working for clean rivers

Annual CSO and CMOM Report - FY 2019

September 2019

Report prepared for the
Oregon Department of Environmental Quality
Portland, Oregon

Acknowledgments

Asset Systems Management, CSO Technical Team
Arnel Mandilag
Nick McCullar
Mike Szwaya

CBWTP Operations
Mike Ciolli

Maintenance Engineering
Randy Hess
Gary Irwin

FOG Program
Ali Dirks
John Holtrop

Support
Adrienne Aiona
Dan Ashney
Diane Dulken
Sam Gould
Michael Hauser
Tim Kurtz
Jason Law
Nishant Parulekar
Kevin Ramey
Josh Robben
Kevin Tran
Grant Wright

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

For More Information

Arnel Mandilag
503-823-7256
arnel.mandilag@portlandoregon.gov
1120 SW 5th Ave, Room 1000
Portland, OR 97204-1912

Contents

Tables

Figures

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 2019 is July 1, 2018, through June 30, 2019)

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 2019 (FY 2019: July 1, 2018, through June 30, 2019) provides a comprehensive review of Portland's integrated combined sewer overflow (CSO) system and the Capacity, Management, Operation, and Maintenance (CMOM) Program during FY 2019. This report provides updates to the previous report submitted for FY 2018.

1.1 Changes from FY 2018 Report

No structural changes from last year's report were introduced this year.

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 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 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 (1,006 miles of sanitary sewer including force mains, 913 miles of combined sewer, and 721 miles of sewer laterals) and 41,255 sewer manholes.

The system also includes two wastewater treatment plants and 99 pump stations. There are 84 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 2019 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 2019 was a year with below average total rainfall depth, with very few intense periods of rainfall. An average of 30.5 inches fell over the combined service area. Normally, 36-43 inches falls over the city in any given year. Only one CSO was recorded, which met the permit's requirements for storm return periods during CSO events.

There was no exceedance for either of the maximum 7-day effluent limits for the plant for the CBWTP. For FY 2019, maximum 7-day concentrations were 21 mg/L for BOD and 24 mg/L for TSS; 45 mg/L is the permitted effluent limitation. There was also no exceedance for either of the maximum 30-day limits: 21 mg/L for BOD and 25 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 64% BOD removal and 81% 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 85% for BOD and 90% for TSS. Combined removal for all plant flows at all times was 95% for both BOD and TSS.

Low rainfall led to the lowest volume of flow captured by the Willamette and Columbia Slough storage facilities since the facilities became fully operable: 3.7 billion gallons. Operators managed the integrated collection system to treat 57% of this volume through the secondary system, with 43% treated through the WWTF. There were 35 events in which flows were sent through the WWTF. The average WWTF event lasted 11 hours and discharged 45 million gallons from the WWTF. During the events, the average flow rate treated by the dry weather/secondary system was 118 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 2019 include:

- Inspection of 0.78 million feet (147 miles) of sewer pipe, or about 8% 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 11,958 feet of pipe; 40% of the repairs were in response to collection system problems
- Repair of 694 service laterals totaling about 8,815 feet of pipe; 37% of those repairs were in response to discovered problems
- Treatment of nearly 370,000 feet (69 miles) of sewer pipe for roots using chemical root foaming
- Completion of 316 inspections of manholes considered to be at greatest risk of failure (Tier 2—see Section 3.1.5).
- Completion of 21 Capital Improvement Program (CIP) projects repairing and rehabilitating portions of the sanitary and combined collection system during the 2018 calendar year, resulting in an estimated risk reduction of $43.7

million. Maintenance activity on mainlines and service laterals also resulted in an estimated risk reduction of $5.8 million.[1]

The number of sewer releases from the City-maintained sanitary and combined sewers increased slightly in FY 2019. The number of sewer releases per 100 miles of sewer was 7.1 in FY 2019, which 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 95% of the time during FY 2019.

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

Section 2 Integrated CSO System Performance for FY 2019

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 2019.

2.1 Rainfall Patterns for the Past Fiscal Year

The area weighted average rainfall for FY 2019 for the Willamette CSO area measured 30.5 inches over the year, 82% of the average annual rainfall of 37 inches for Portland.

During this period, one summer storm generated CSO discharges after exceeding the 3-year summer design storm.

- October 25-29, 2018 – Summer CSO event

No winter storms generated a CSO discharge. Six winter storms were large enough to have caused a valid CSO, although no CSO occurred. CSOs were avoided for the following events.

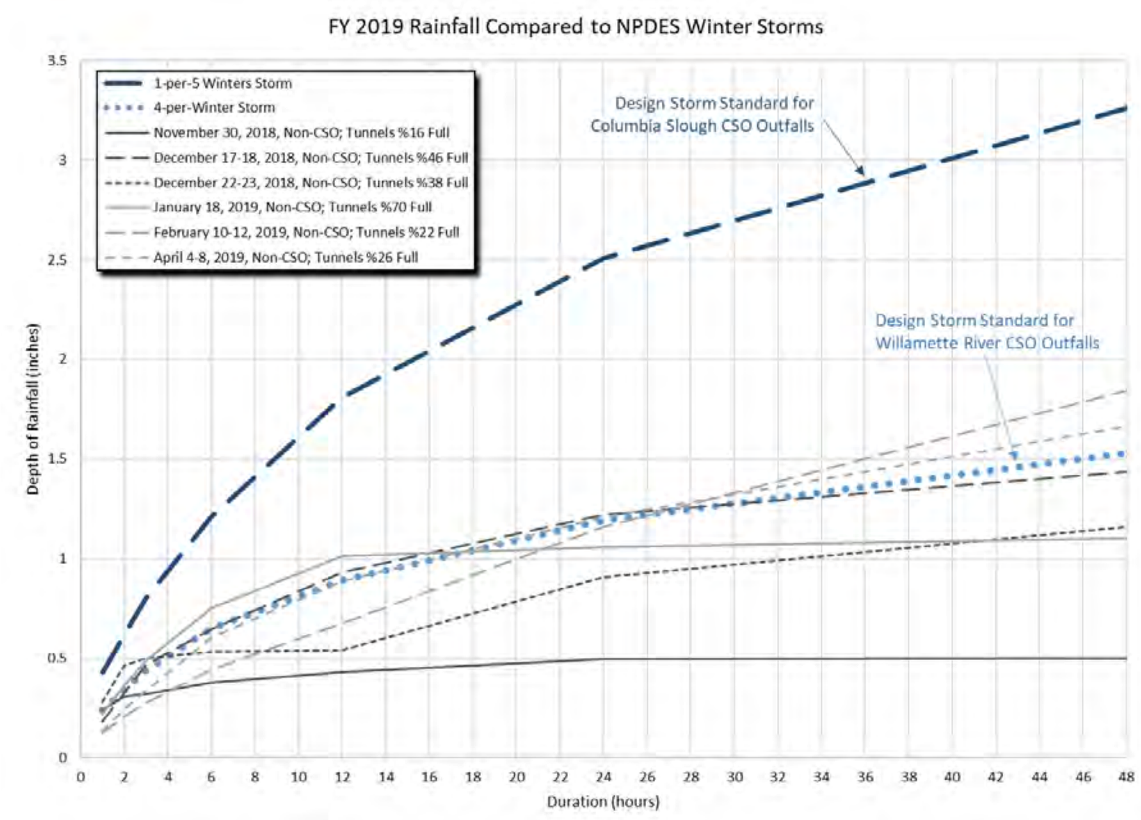
- November 30, 2018 – Winter storm event
- December 17-18, 2018 – Winter storm event
- December 22-23, 2018 – Winter storm event
- January 18, 2019 – Winter storm event
- February 10-12, 2019 – Winter storm event
- April 4-8, 2019 – Winter storm event

The summer storm of October 25-29, 2018 consisted of light, sporadic showers before a moist trough of low pressure began to pass through the city, bringing steadily increasing rain to the region. The rainfall intensity peaked before midnight and resulted in a CSO discharge only from OF52. Rainfall at the nearby Water Pollution Control Lab Rain Gauge #160 exceeded the 10-year design storm for all durations between 15 minutes and 24 hours. Across the city rainfall exceeded the 3-year summer design storm for durations between 15 minutes and 48 hours.

2.1.1 Winter Storm Review

The six storms that exceeded the 4-per-winter NPDES Permit design depths are 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 observed rainfall events are compared to the two NPDES Winter Design Storms (4-per-winter and 5-year winter) shown with blue-tinted dashed lines. The six storms that exceeded the 4-per-winter design storm but did not result in CSOs are shown in grey.

Figure 1 CSO winter storms compared to NPDES winter storms



Details for the winter rainfall events are provided in Table 1 below.

Table 1 Winter storm comparisons

Storm	Duration (hours)						Notes
	1	3	6	12	24	48	
Willamette River Winter Design Storm (inches)							
4-per-Winter Design Storm	0.24	0.44	0.65	0.89	1.19	1.53	
Columbia Slough Winter Design Storm (inches)							
5 Year Winter Design Storm	0.43	0.80	1.21	1.81	2.51	3.26	
FY 2019 Winter Storms - Average Rainfall over Willamette CSO Basin (inches)							
November 30, 2018	0.24	0.32	0.38	0.43	0.49	0.50	Exceeds 4-per-winter design storm for 1 hour duration. No CSO event.
December 17-18, 2018	0.18	0.47	0.65	0.93	1.22	1.43	Exceeds 4-per-winter design storm for durations between 3 and 24 hours. No CSO event.
December 22-23, 2018	0.28	0.50	0.53	0.54	0.91	1.16	Exceeds 4-per-winter design storm for 1 and 3 hour durations. No CSO event.
January 18, 2019	0.22	0.49	0.75	1.01	1.06	1.10	Exceeds 4-per-winter design storm for durations between 3 and 12 hours. No CSO event.
February 10-12, 2019	0.12	0.28	0.44	0.68	1.16	1.84	Exceeds 4-per-winter design storm for 48 hour duration. No CSO event.
April 4-8, 2019	0.13	0.34	0.61	0.89	1.21	1.66	Exceeds 4-per-winter design storm for durations between 12 and 48 hours. No CSO event.

2.1.2 Summer Storms Review

One storm exceeded the NPDES Permit 3-year Summer Storm design depth and resulted in a CSO discharge. The storm is 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 rainfall event is shown as a solid red line. The two comparison Summer Design Storms (3-year summer and 10-year summer) are shown with blue-tinted dashed lines. Table 2 provides rainfall details for this event. The October 25-27 storm was more intense locally but also exceeded the design storm over the entire Willamette CSO area.

Figure 2 Rainfall compared to NPDES summer storms

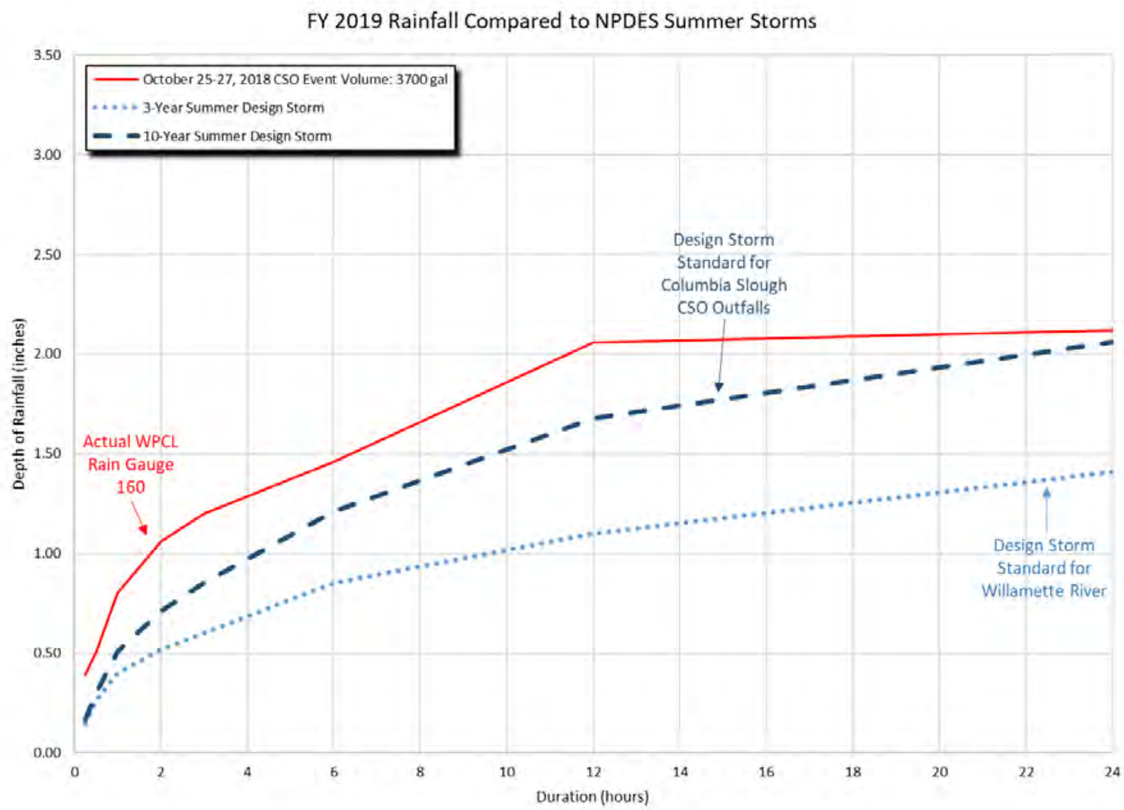


Table 2 Summer storm comparisons

Storm	Duration (min)		Duration (hours)						Notes
	15	30	1	3	6	12	24	48	
Willamette River Summer Design Storm (inches)									
3-Year Summer Design Storm	0.15	0.26	0.40	0.60	0.85	1.10	1.41	2.12	
Columbia Slough Summer Design Storm (inches)									
10-Year Summer Design Storm	0.17	0.30	0.48	0.85	1.25	1.68	2.06	3.15	
FY 2019 Summer Storms - Average Rainfall over Willamette CSO Basin (inches)									
October 25-29, 2018	0.15	0.29	0.41	0.74	0.92	1.25	1.56	1.83	Exceeds 3-year summer design storm for durations between 15 minutes to 24 hours.
FY 2019 Summer Storms - Average Rainfall at Water Pollution Control Lab Rain Gauge #160 (inches)									
October 25-29, 2018	0.39	0.51	0.80	1.20	1.46	2.06	2.12	2.61	Exceeds 10-year summer design storm for durations between 15 minutes to 24 hours, and 3-year summer design storm for 48 hour duration.

2.2 CSO Discharges into the Willamette River and Columbia Slough

2.2.1 Discharge Events

In FY 2019, there was one summer CSO discharge event to the Willamette River and none to the Columbia Slough. Please consult the compliance letter submitted to DEQ for details on the circumstances and validation of this event as allowed by the NPDES permit for CBWTP.

- **October 25-29, 2018.** 0.0037 MG (3,700 gallons) discharged over a total of 10 minutes from the St. Johns B OF52 outfall. The storm that led to the overflow was caused primarily by heavy rainfall as a low-pressure system passed through the area during the day on October 27, 2018. Rainfall at the nearest gauge just reached 25-year design storm levels for durations 10 minutes to 2 hours.

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 below average during the reporting period. The system only experienced one summer overflow out of a total 48 distinct storm events. Approximately 1,300 MG were stored in the CSO tunnels during these events.

Total CSO discharge for the year was only 0.0037 MG from the Willamette CSO system, which was less than 0.00002% of the wet weather volume handled by the combined and sanitary collection systems. This equates to more than 99.9% volume control, exceeding the 94% level of control expected from the Willamette CSO system.

2.2.1.2 Were Wet Weather Flows Maximized to the Plant?

There was only one very small overflow from a single outfall. The rest of the wet weather flow captured by the collection system was delivered to the treatment plant.

2.2.1.3 Was System Storage Maximized?

All flows leading to the CSO storage tunnels were captured and delivered to the plant during FY 2019. The only overflow that occurred was due to rainfall that overwhelmed a local system. Tunnel storage levels peaked at 76% of their capacity during all events. For non-CSO sized storms, tunnel storage levels did not exceed more than 28% of their capacity.

2.2.2 Dry Weather Overflow Events

No dry weather overflow events from the combined system outfalls were recorded in FY 2019.

2.2.3 Control of Floatables and Debris

City maintenance crews inspect and clean the bar screens for certain overflow structures, including those in the St. Johns area that drain to the Willamette River. Other bar screens are cleaned when CSOs are discharged through them, but no such discharges occurred in FY 2019.

Table 3 Floatables control system event maintenance summary

CSO Event Date(s)	Maint. Date	Location	Description of Maintenance
October 25-29, 2019	10/31/2019	St. Johns B OF52	Very light debris consisting of paper, < 1 gal.

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 2019. The system experienced a below average year in terms of total rainfall, having received about 30.5 inches. Influent volumes to CBWTP were reduced by 11% from FY 2018, and the percentage treated by the secondary system remained at 93%. The percentage of captured CSO treated via secondary decreased from 64% in FY 2018 to 57% in FY 2019. While this appears to be a drop in performance, review of last year's data against this year's data reveal that the 64% is less the norm; issues with the flowmeters at the headworks and towards the WWTF appear to have resulted in underestimates of flow to the WWTF. These issues were improved on earlier this year. For FY 2019, Overall BOD and TSS removal efficiencies continue to exceed 90% at the plant's two outfalls, OF001 and OF003. Both BOD and TSS removal efficiencies reached a high of 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, Swan Island CSO pump station (SICSO), which drains the Willamette River system, and the Influent Pump Station (IPS), which drains the Columbia Slough system. About 3,700 MG of captured CSO reached the plant (see Table 5). About 6,400 MG of tunnel flow was pumped, representing 173% 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 and other sewer lines.

Table 4 Volume pumped from CSO tunnels

CSO Tunnel Pumping	Total Pumped Volume (MG)
Swan Island CSO Pump Station	
Force main 1 (Peninsular Dry Weather)	4,285
Force main 2 (Peninsular Wet Weather)	286
Force main 3 (Portsmouth Wet Weather)	1,108
Swan Island CSO Pump Station Subtotal	5,679
Influent Pump Station Total	738
Total Volume Pumped to CBWTP from Tunnels	6,417

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]. Annual percent removal efficiencies for the wet weather system 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 table provides a comparison of the performance against the average year model and permit values. Key parameters are in blue text. For FY 2019:

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

- Secondary treatment achieved 118 MGD, 7% 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 (58% compared to 54%).
- BOD and TSS removal efficiencies for the wet weather system exceeded the permit's annual requirements: BOD removal was 64% compared to the permit's requirement of 50%, and TSS removal was 81% 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.
- **Were effluent limits achieved at OF001 and OF003?** Yes. The numbers indicate that the system is producing the proper annual treatment results.

Examination of the annual results indicates 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**	*With CEPT* **FY 2019**	**Trend**
Annual Rainfall Depth (inches/year)	37	46.8	40.2	40.0	33.9	53.4	59.5	37.6	30.5	
Flows to CBWTP										
Influent Volume (MG/Year)	28,300	28,800	26,625	26,549	25,760	30,665	33,544	26,844	23,763	
Dry Weather Sanitary Volume (MG/Year)	22,100	20,200	19,496	19,471	19,609	20,179	22,358	21,635	20,037	
Captured CSO Flow - Volume (MG/Year)	6,200	8,600	7,129	7,078	6,151	10,485	11,187	5,209	3,726	
Total Volume Treated Thru Secondary (MG)	25,443	25,662	24,197	24,002	23,221	26,301	28,765	24,947	22,173	
% of Plant Flow Treated Through Secondary System	90%	89%	91%	90%	90%	86%	86%	93%	93%	
WWTF (EWWPT) Events										
Rate to DW / Secondary During EWWPT (MGD)	100	120	126	112	112	117	119	117	118	
Number of Events / Year	32	29	22	27	27	39	41	37	35	
WWTF Volume / Year	2,857	3,138	2,429	2,546	2,540	4,363	4,779	1,897	1,590	
Amount of Captured CSO Treated via Secondary (%)	54%	64%	66%	64%	59%	58%	57%	64%	57%	
Duration of WWTF Events (hours)	919	706	668	904	591	1241	1333	602	387	
Calendar Days of WWTF Discharges (days)	---	66	50	65	51	92	99	65	52	
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	2,786,772	
BOD Average Concentration (mg/l)	27	16.6	13.3	15.7	19.4	15.1	16.3	13.6	14.1	
Total Plant BOD Removal Efficiency (%)	---	93%	95%	94%	93%	93%	92%	95%	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	3,237,714	
TSS Average Concentration (mg/l)	27	21.0	16.1	18.3	20.5	19.2	18.8	16.7	16.3	
Total Plant TSS Removal Efficiency (%)	---	92%	94%	93%	92%	92%	92%	94%	95%	
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	1,552,975	
BOD FROM Wet Weather Facility (pounds/year)	---	1,510,000	726,541	874,387	962,545	1,258,955	1,448,060	707,575	559,554	
Wet Weather BOD Removal Efficiency (%)	50%	34%	56%	63%	60%	66%	66%	67%	64%	
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	2,417,045	
TSS FROM Wet Weather Facility (pounds/year)	---	1,480,000	520,375	520,252	560,013	1,134,753	1,339,022	526,597	454,989	
Wet Weather TSS Removal Efficiency (%)	70%	63%	77%	83%	82%	80%	84%	85%	81%	

[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 March 12, 2019, for BOD and March 9, 2019, for TSS) were below the permit's monthly limits.

Table 6 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	21	90	45,000	15,716	12-Mar-19	5.2 inches of rain in 30d
TSS	30	25	89	45,000	18,530	9-Mar-19	
Secondary Biological Treatment - 100 MGD Minimum Instantaneous							
BOD5	30	21	75	22,500	13,090	16-Mar-19	3.5 inches of rain in 30d
TSS	30	24	78	22,500	16,032	14-Mar-19	
Wet Weather / CEPT System - Intermittent Discharges							
BOD5	45	23	29	22,500	5,617	20-Dec-18	6.4 inches of rain in 30 d
TSS	45	19	29	22,500	4,559	20-Dec-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. Concentrations for both 7-day BOD and TSS for the maximum period (ending February 15, 2019) were below the permit's weekly limits.

Table 7 Wet weather peak (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	21	137	118,800	23,709	15-Feb-19	2.8 inches of rain in 7d
TSS	45	24	137	118,800	27,662	15-Feb-19	
Secondary Biological Treatment - 100 MGD Minimum Instantaneous							
BOD5	45	33	78	37,500	21,514	14-Mar-19	2.9 inches of rain in 7d
TSS	45	32	78	37,500	21,093	14-Mar-19	
Wet Weather / CEPT System - Intermittent Discharges							
BOD5	65	32	51	81,300	13,913	14-Feb-19	2.9 inches or rain in 7d
TSS	65	28	51	81,300	11,821	14-Feb-19	

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 2019. The full, detailed list of the events is in Table 9.

Table 8 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	**35**				**1,590**	**387**	**52**	**559,554**	**454,989**		
Average/Event		**213**	**118**	**85**	**45**	**11.1**	**1.5**	**15,987**	**13,000**	**53**	**43**

Key aspects for this year's WWTF performance include:

- Volume of EWWPT events was 1.6 billion gallons. This is only about 7% of the total volume received at the CBWTP for the year (23.8 billion gallons; see Table 5).
- An EWWPT event was in progress during the year for about 387 hours (4% of the year) and 52 calendar days (about 1 day per week). Treatment through the WWTF continues to be highly intermittent.
- The average mean concentrations (EMC) for BOD of 53 mg/L and 43 mg/L for TSS is a decrease in performance over FY 2018 but is comparable to other dry years and with expected values for the CEPT system.
- Operators maintained an average of 118 MGD of flow through secondary treatment during EWWPT events, compared to the permit requirement of 110 MGD. This rate is 55% of the average flow rate reaching the plant during an EWWPT event (213 MGD).
- EWWPT events lasted just over 11 hours on average and typically occurred across 1.5 days. This is representative of the even drier year experienced than FY 2018.

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)
9/12/18 20:00	1	163	110	45	14	7.5	2	19,150	14,111	162	119
10/6/18 2:00	2	236	121	104	14	3.3	1	9,925	4,210	85	36
10/27/18 19:00	3	233	112	114	170	36.0	3	40,355	43,576	28	31
11/22/18 15:00	4	297	126	162	43	1.0	1	23,749	13,824	67	39
11/23/18 12:45	5	204	120	75	27	8.8	1	14,241	10,216	62	45
11/27/18 3:00	6	263	121	134	59	10.5	1	19,772	20,337	40	42
11/28/18 13:15	7	165	120	36	12	8.0	1	1,896	3,292	19	33
11/30/18 18:00	8	199	121	66	32	11.5	2	14,420	14,387	55	55
12/9/18 15:15	9	246	120	118	43	8.8	1	22,196	13,740	62	38
12/11/18 18:45	10	284	122	154	64	10.0	2	21,286	21,666	40	40
12/16/18 16:15	11	224	119	91	15	4.0	1	2,517	2,517	20	20
12/17/18 21:15	12	265	122	134	139	24.8	2	47,866	36,187	41	31
12/20/18 13:45	13	163	118	39	1	0.8	1	577	600	56	59
12/22/18 21:00	14	204	115	82	117	34.5	3	19,387	17,193	20	18
12/29/18 21:15	15	265	121	137	54	9.5	2	12,426	9,941	28	22
1/6/19 15:00	16	191	118	63	9	3.3	1	4,516	2,868	64	40
1/8/19 9:00	17	152	120	20	2	2.8	1	714	286	38	15
1/18/19 18:00	18	265	118	130	118	21.8	2	37,211	32,833	38	33
1/20/19 10:30	19	253	120	125	44	8.5	1	13,210	10,275	36	28
1/22/19 14:45	20	247	119	119	24	4.8	1	13,556	4,126	69	21
2/9/19 4:15	21	231	119	101	13	3.0	1	8,254	12,537	79	120
2/11/19 1:45	22	237	120	108	218	48.3	3	76,388	62,385	42	34
2/14/19 13:00	23	228	120	100	27	6.5	1	12,747	7,827	56	35
2/20/19 0:15	24	170	120	33	5	3.8	1	1,904	2,046	44	47
2/22/19 20:15	25	217	119	87	14	3.8	1	10,097	6,501	89	57
2/23/19 21:00	26	207	116	86	51	14.3	2	11,765	8,200	28	19
3/8/19 20:00	27	170	120	41	6	3.8	1	3,126	4,793	58	89
3/12/19 3:45	28	182	111	62	32	12.3	1	10,369	6,381	39	24
3/25/19 21:15	29	133	109	12	0	0.5	1	39	65	18	31
4/5/19 13:30	30	222	119	94	14	3.5	1	7,158	4,921	63	43
4/6/19 10:15	31	196	117	73	157	51.8	3	51,917	40,955	40	31
5/19/19 2:15	32	238	120	109	39	8.5	1	15,193	15,510	47	48
5/25/19 20:30	33	158	119	31	3	2.0	1	1,635	1,411	77	67
6/26/19 23:30	34	142	109	22	1	1.3	2	366	269	38	28
6/27/19 21:15	35	199	110	61	10	4.0	2	9,626	5,003	113	59
Total	**35**				**1,590**	**387**	**52**	**559,554**	**454,989**		
Avg/Event		**213**	**118**	**85**	**45**	**11**	**1.5**	**15,987**	**13,000**	**53**	**43**

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. Most wet weather events this fiscal year placed above the target efficiencies, as seen on the charts. These sporadic events with lower efficiencies tend to happen during drier years.

Figure 3 WWTF BOD removal efficiency vs. event volume

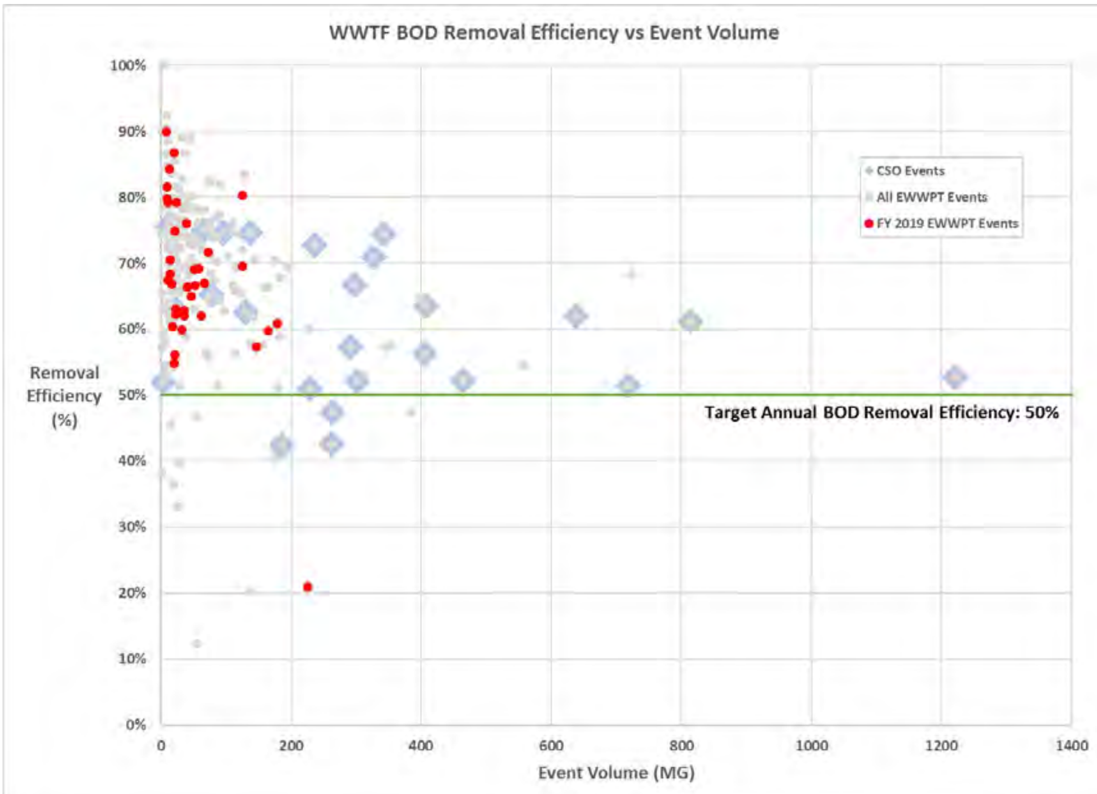
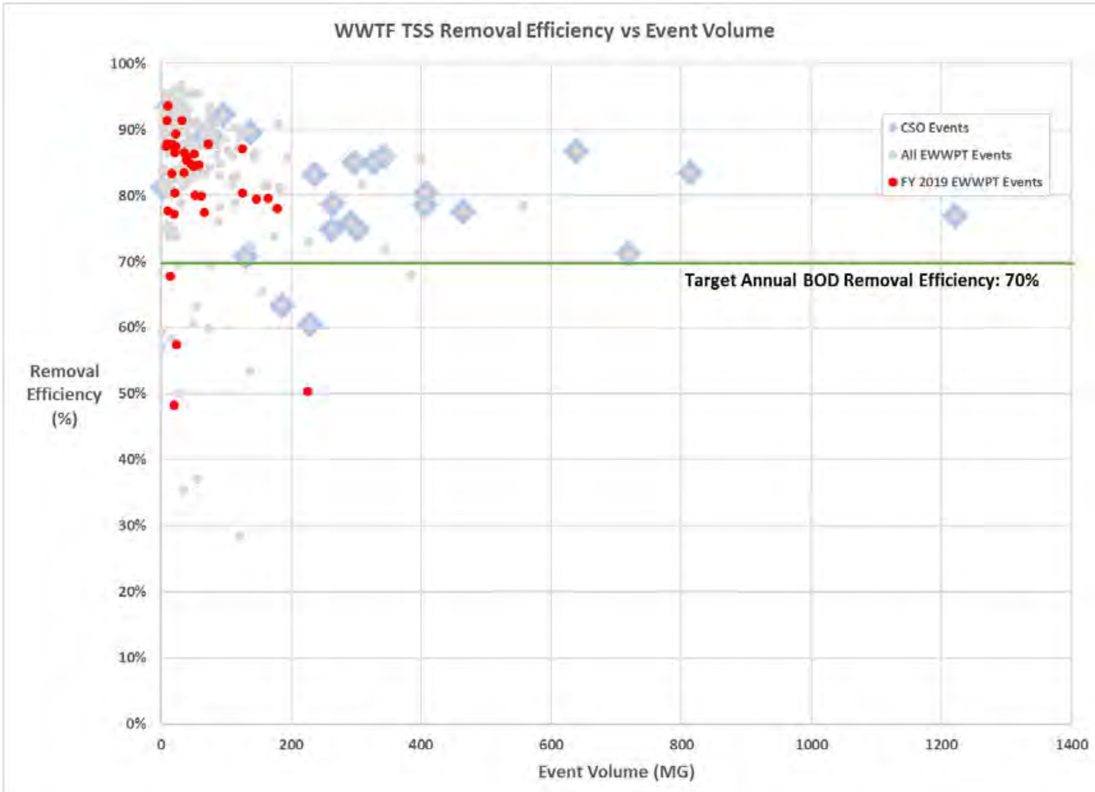


Figure 4 WWTF TSS removal efficiency vs. event volume



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. For FY 2019, however, there were no large-scale Willamette River CSO system overflows, and therefore no event samples were obtained. For details about this sampling program, please see Section 8.2 of the *FY 2015 Annual CSO and CMOM Program Report*.

2.5.2 Willamette River Instream Water Quality Sampling

Figure 5 through Figure 9 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 2018.

Figure 5 Willamette River monitoring results for zinc

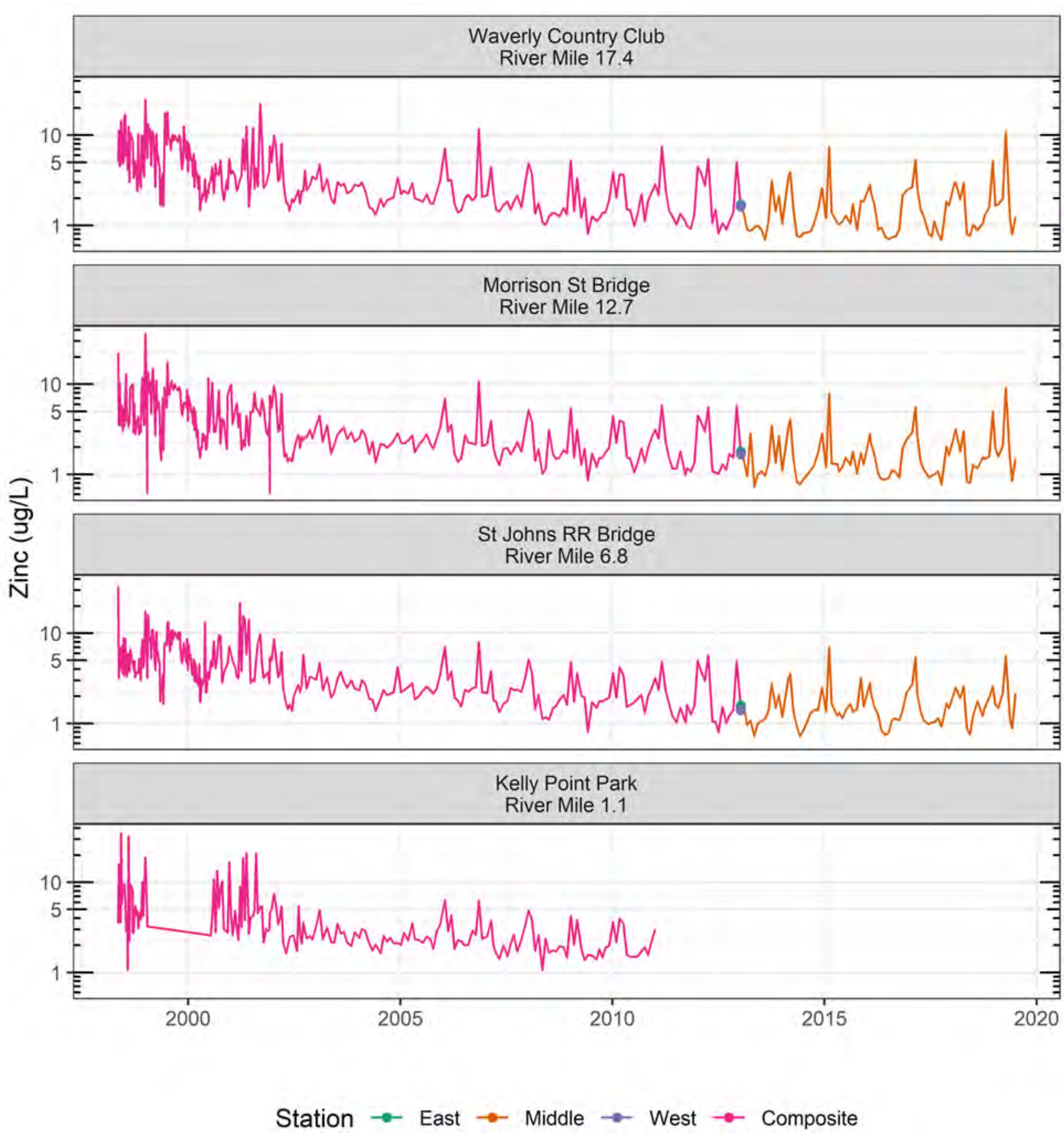


Figure 6 Willamette River monitoring results for lead

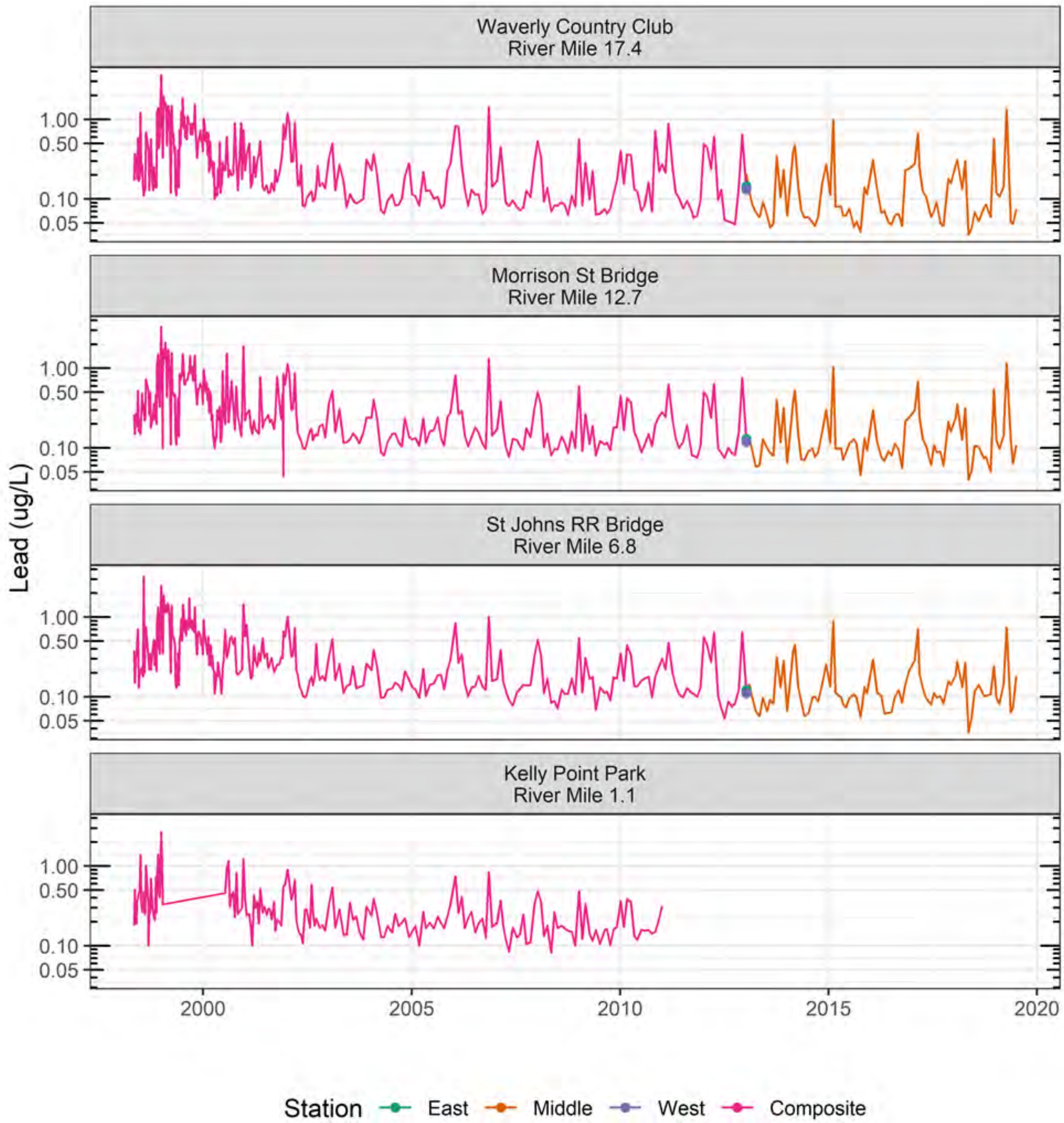


Figure 7 Willamette River monitoring results for copper

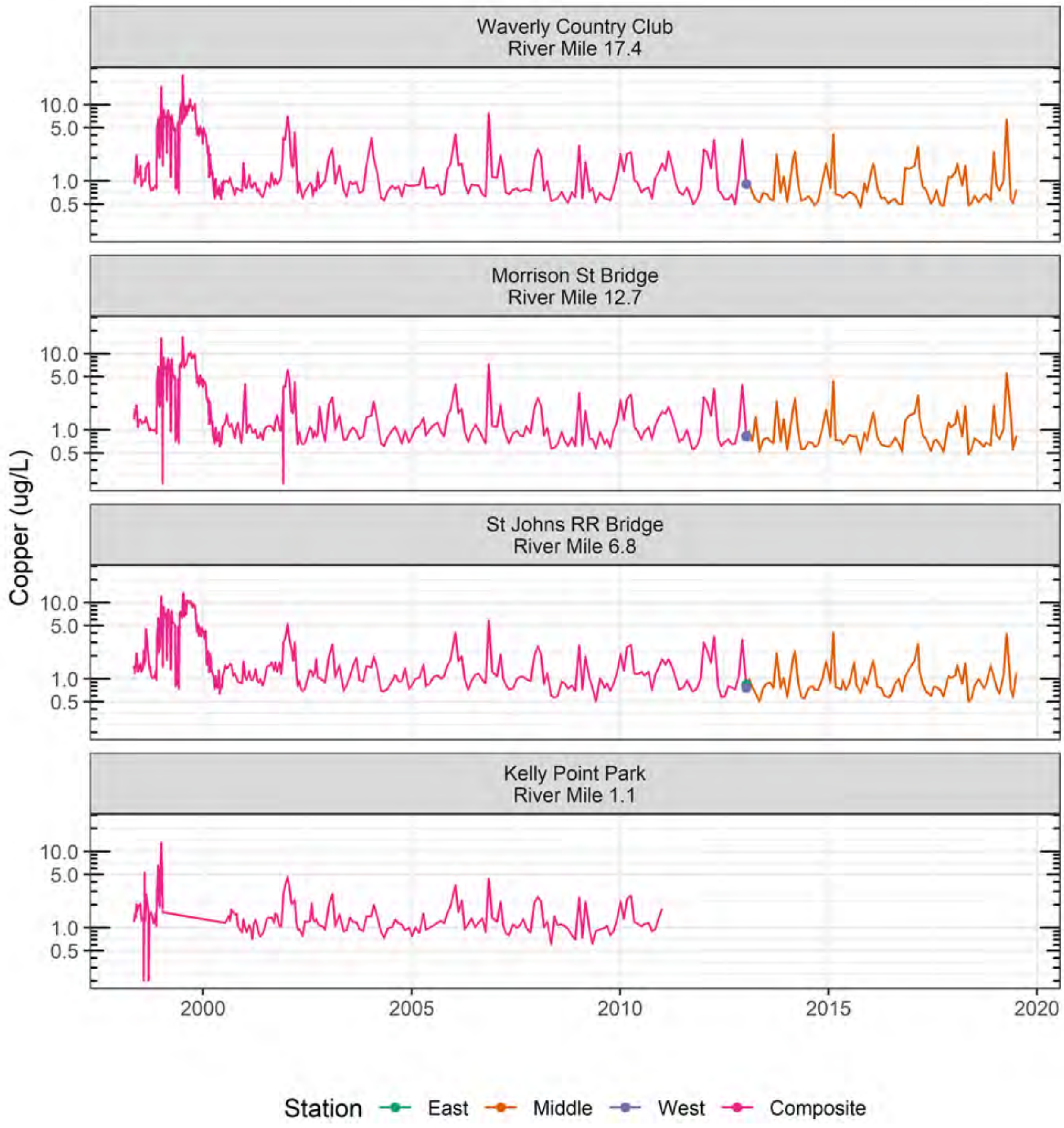


Figure 8 Willamette River monitoring results for TSS

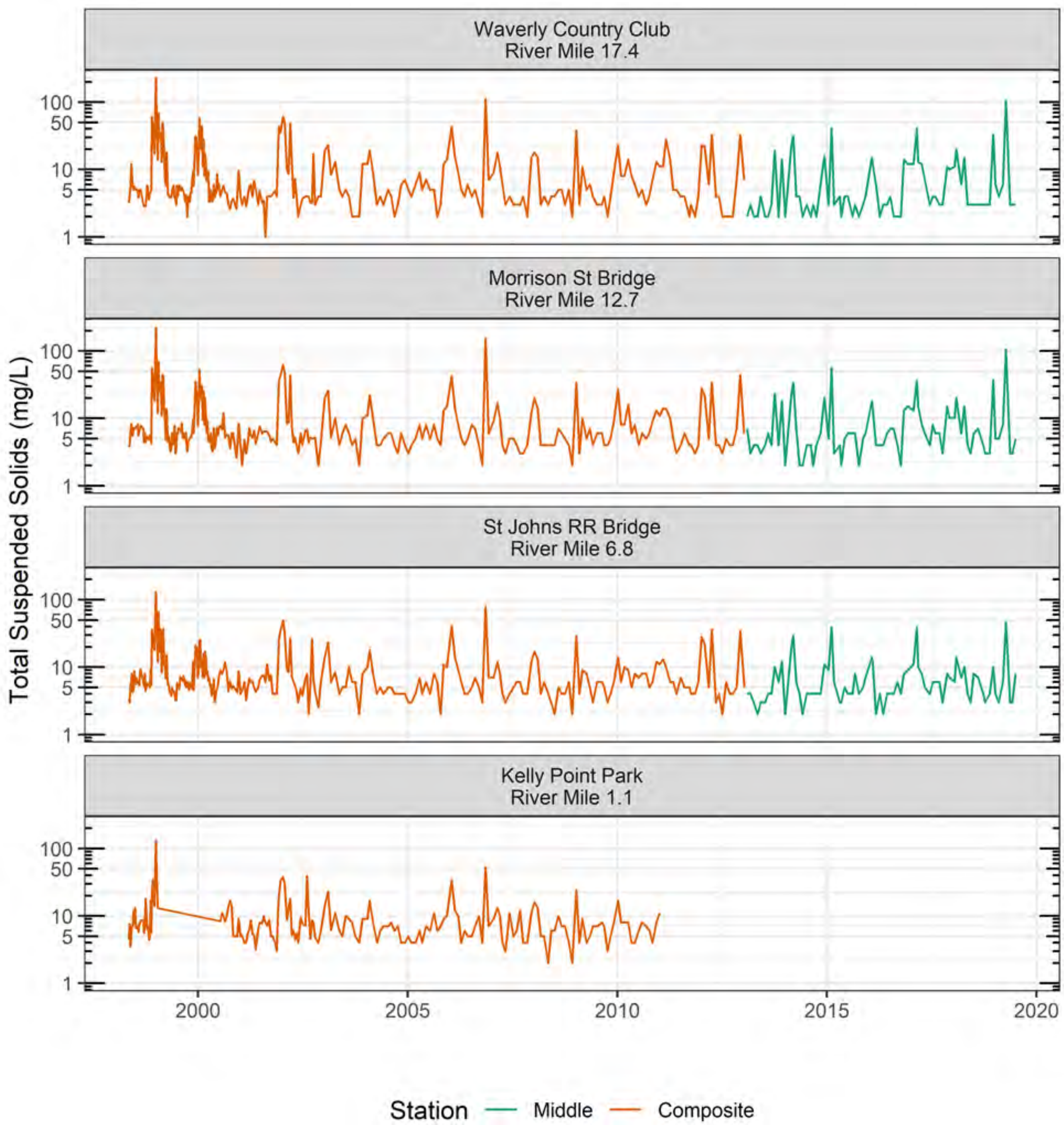
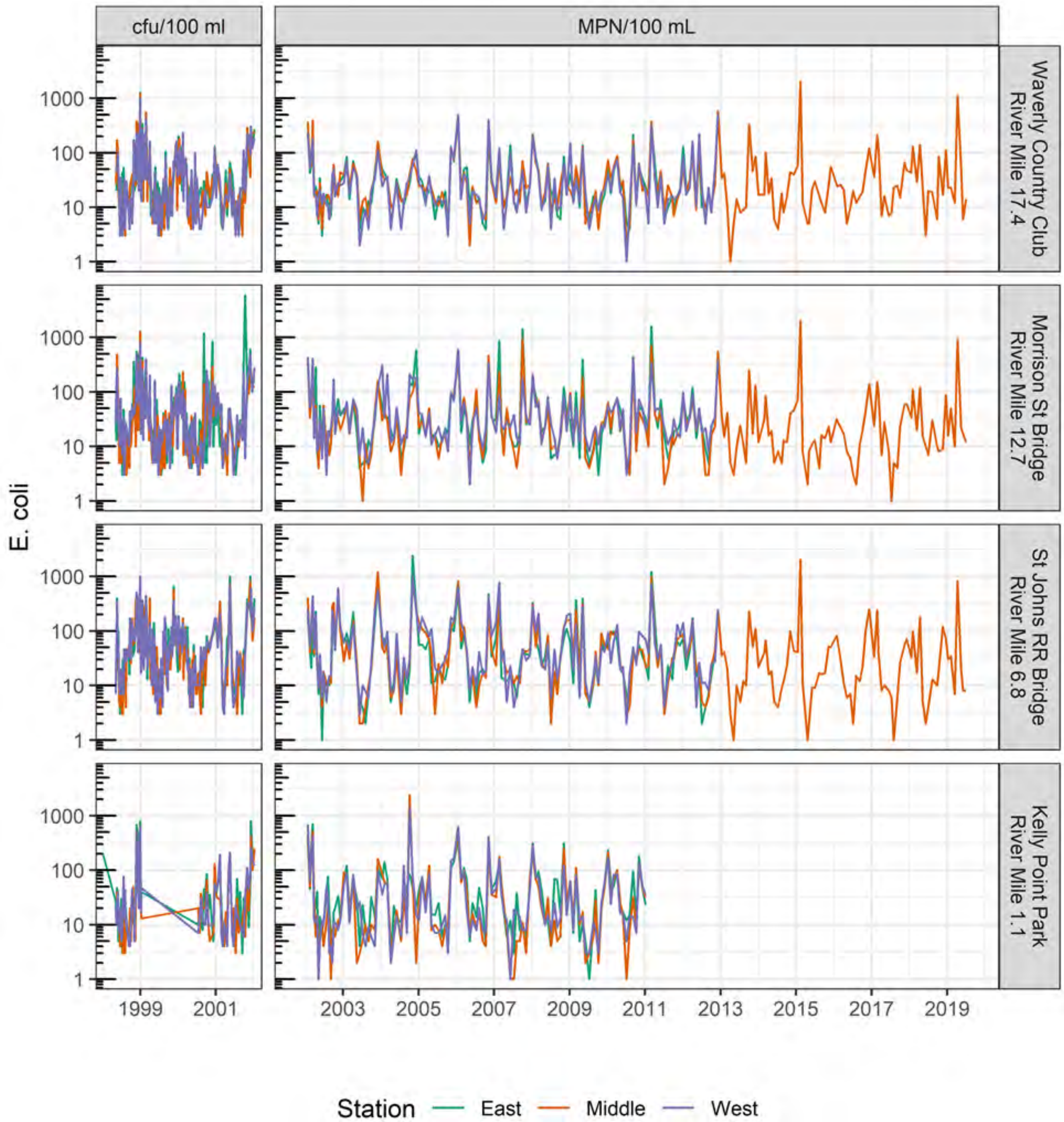


Figure 9 Willamette river monitoring results for *E. coli*

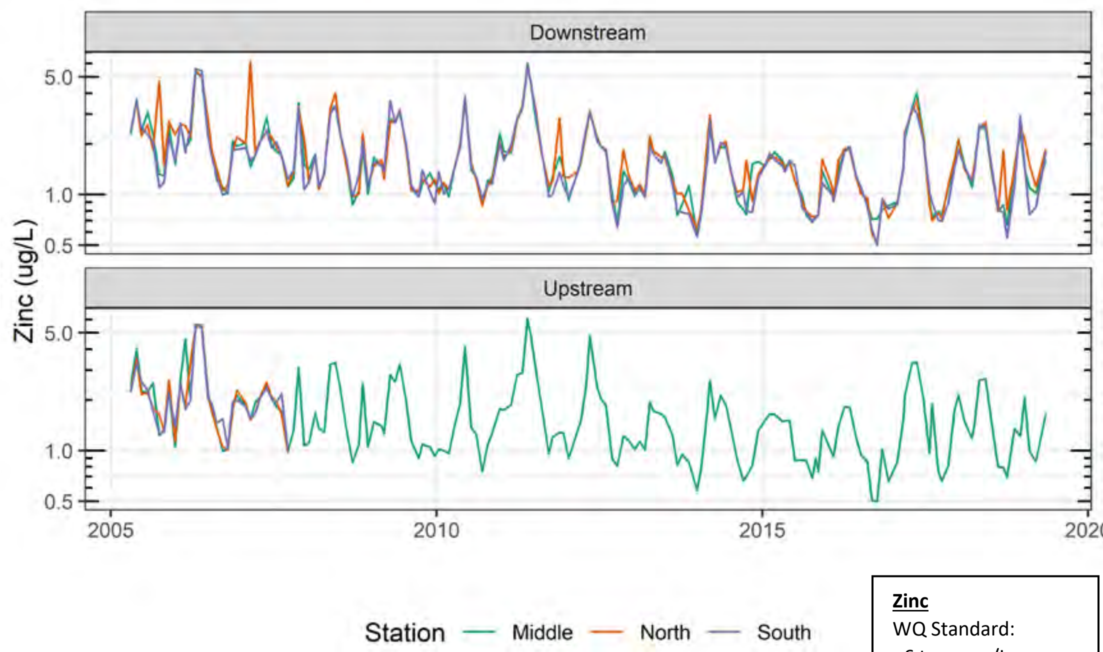


2.5.3 Columbia River Instream Water Quality Sampling

Figure 10 through Figure 14 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.

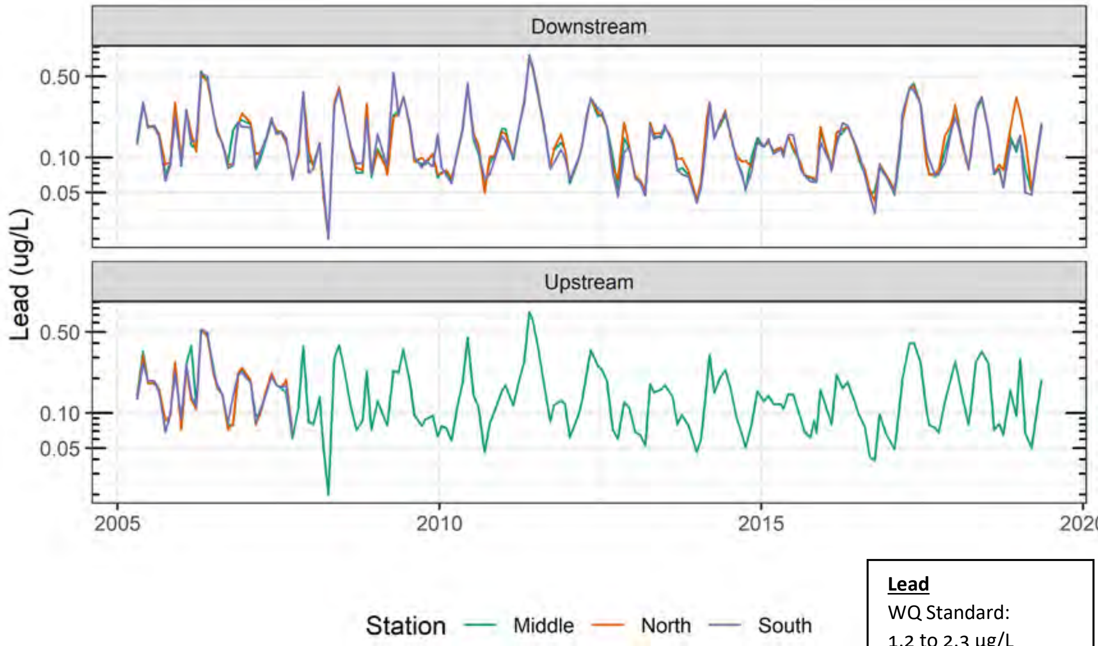
All parameters are well below the numeric water quality standards. There is little difference between the upstream and downstream measurements.

Figure 10 Columbia River mixing zone sampling for zinc



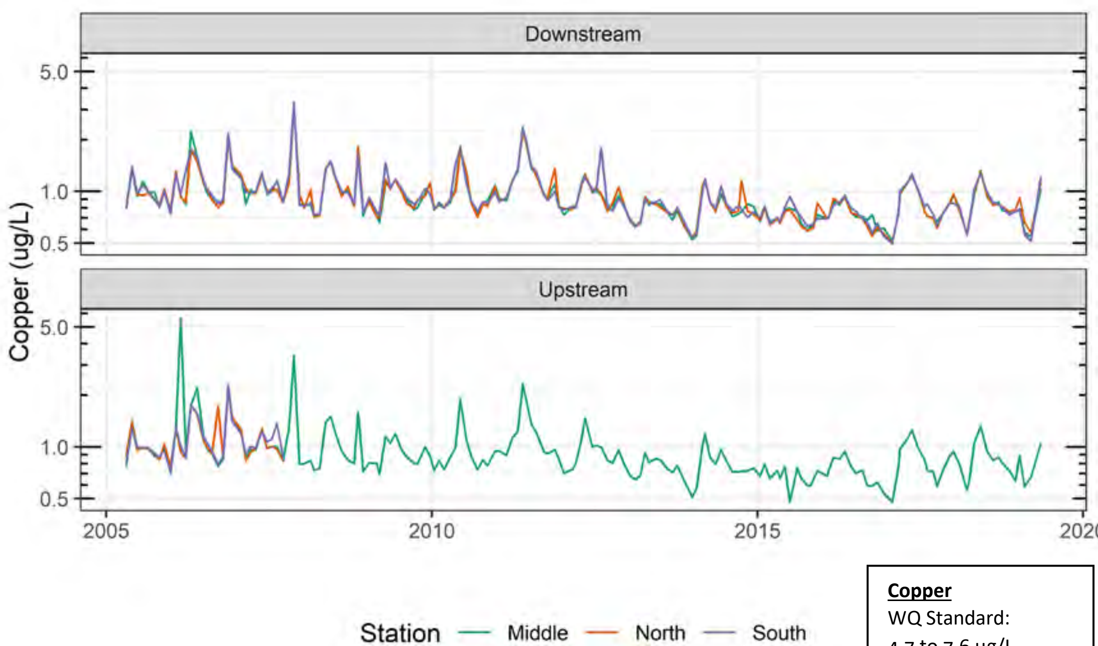
Zinc
WQ Standard:
26 to 43 µg/L
chronic hardness
range

Figure 11 Columbia River mixing zone sampling for lead



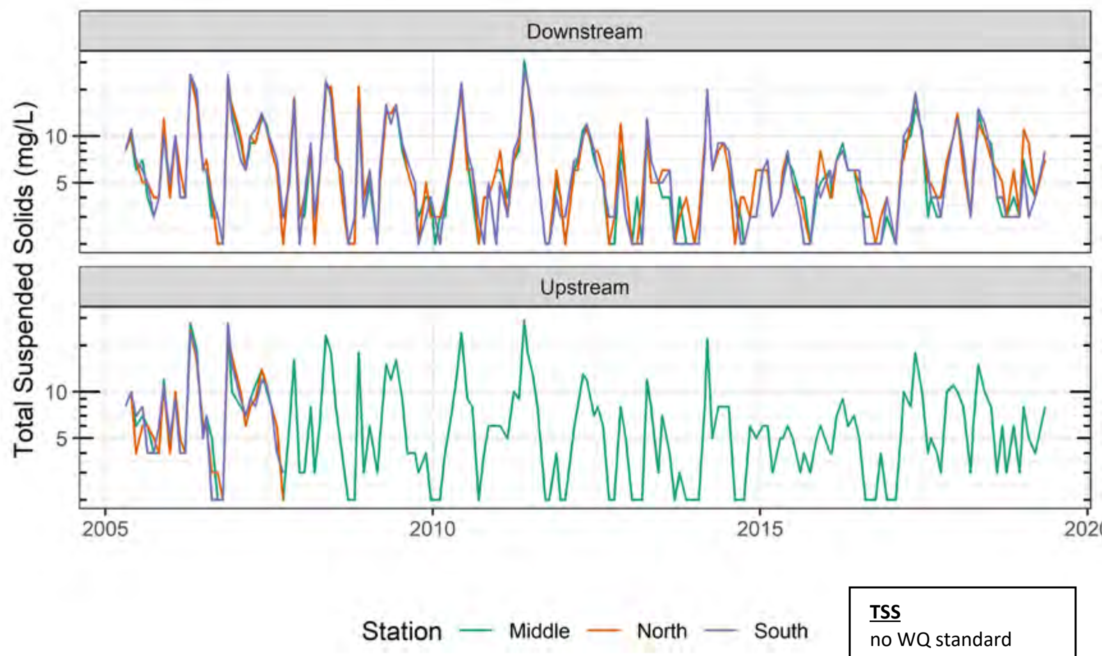
Lead
WQ Standard:
1.2 to 2.3 µg/L
chronic hardness
range

Figure 12 Columbia River mixing zone sampling for copper



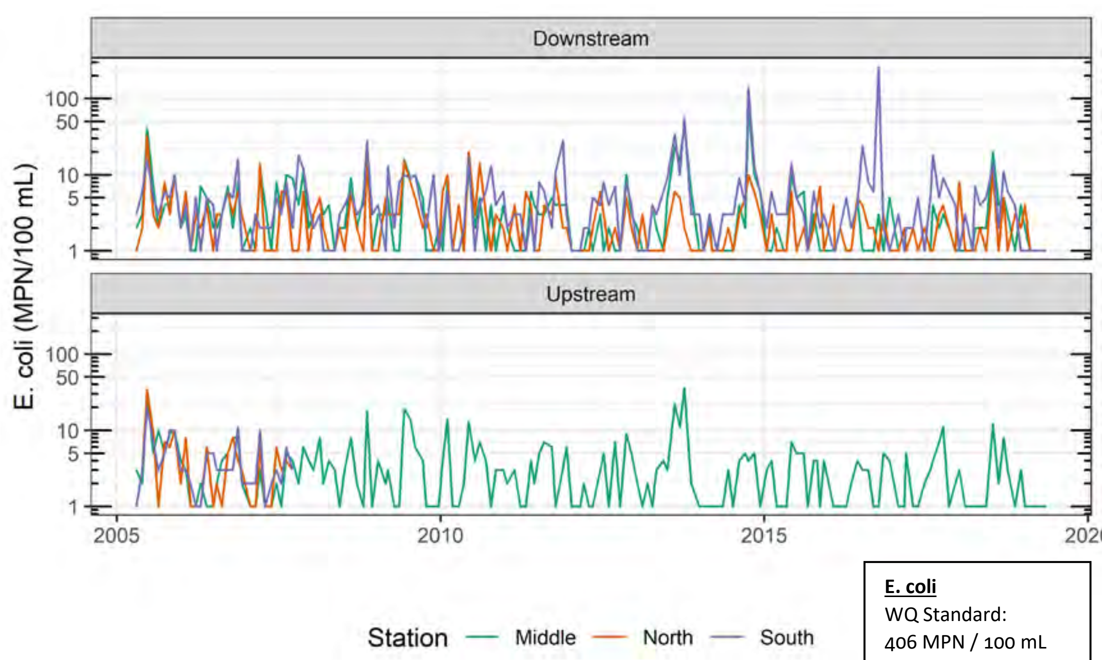
Copper
WQ Standard:
4.7 to 7.6 µg/L
chronic hardness
range

Figure 13 Columbia River mixing zone sampling for TSS



TSS
no WQ standard

Figure 14 Columbia River mixing zone sampling for *E. coli*



E. coli
WQ Standard:
406 MPN / 100 mL

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 2019 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 2019, the sewer inspection program inspected 777,529 lineal feet (147 miles) of mainline sewer pipe, which corresponds to approximately 8% 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 Capital Improvement Program (CIP). In FY 2019, 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 692 service lateral inspections in FY 2019.

In FY 2019, the sewer cleaning program cleaned 1,253,557 feet (237 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 2019, 91% 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 upper Marquam Nature Park walks, conducted in May 2019 (FY 2019), were between SW Fairmont Boulevard and SW Sherwood Drive parallel to SW Gale Avenue. The walks followed approximately 1180 lineal feet of 8, 12 and 15-inch sanitary sewer mainline and eight manholes. The Sam Jackson Road walk, conducted in May 2019 (FY2019), was between SW Wood Street and SW Sam Jackson Road just below the OHSU campus. The walk followed approximately 580 lineal feet of 8-inch sanitary sewer mainline and three 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 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 2019, 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 11,958 lineal feet. Approximately 40% 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 694 service lateral repairs totaling approximately 8,815 lineal feet. Approximately 37% 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 2019, BES Maintenance Engineering continued to manage the chemical root control program using third-party service

[5] *Hansen* refers to Infor Public Sector, © 2017 Infor. All rights reserved. www. infor.com

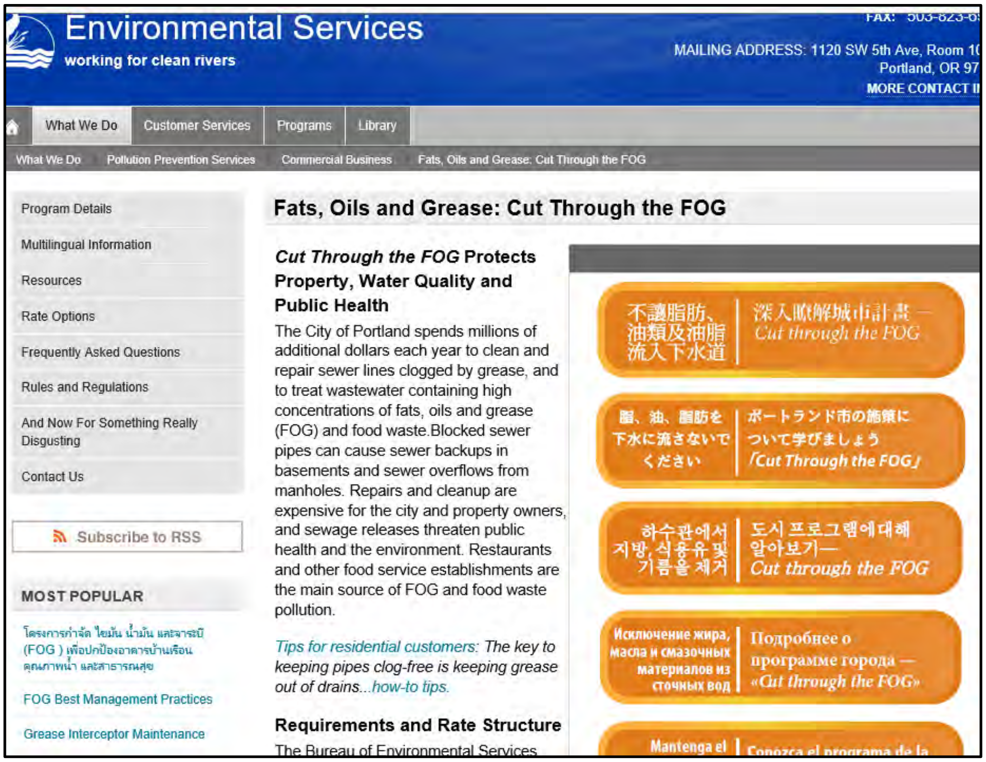
providers who apply dense herbicidal foam that kills roots on contact without harming trees or surface vegetation. The City's Root Control Program uses a priority ranking system so that sewers with the greatest need for chemical root treatment are addressed first. During FY 2019, 367,000 lineal feet (69 miles) of mainline sewer were chemically treated for roots. In addition to chemical root foaming, City crews cleaned approximately 21,000 lineal feet of sewer to locally remove roots using root saws and conventional cleaning in support of sewer inspection activities as well as in response to sewer system problems.

3.1.4 Grease Management and Control Actions

In FY 2019, five 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 *Cut Through the FOG Program* has developed and maintains outreach and educational materials to more equitably and effectively inform food service customers impacted by our program. The *Cut Through the FOG* web page (https://www.portlandoregon.gov/bes/54538, Figure 15) has program fact sheets and three multilingual educational videos in seven languages in addition to English. 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 customers need to do to prevent its discharge and stay in compliance.

Figure 15 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 2019, 51,071 lineal feet (9.7 miles) of FOG-related sewer cleaning was conducted, including 29,854 lineal feet (5.7 miles) of cleaning in designated Accelerated Grease Cleaning Areas. A total of 28,058 lineal feet (5.3 miles) of mainline sewer received FOG-related CCTV inspections during FY 2019, of which 15,952 lineal feet (3.0 miles) were in the Accelerated Grease Cleaning Areas.

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 2019 are summarized in Table 10

Table 10 FOG Enforcement Activities in FY 2019

Description	Number	Requirement
Warning Notice	259	Increase grease removal device cleaning frequency
	78	Repair or replace grease removal devices
Notice of Violation with Civil Penalties/ Cost Recovery	4	Plumb all fixtures to a grease interceptor
	13	Service grease interceptor at prescribed cleaning frequency
	4	Make required grease interceptor repairs
	2	Escalated enforcement for failing to meet compliance dates for original NOV

The FOG Coordination Team meets three times a year 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.

Plan review is an important component of BES's control of FOG. In FY 2019, plan reviews resulted in requiring 52 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 2019. 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 2019, 316 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 defects found have been manhole cover/frame damage and light to medium deterioration of the bench/channel. Two manholes were found to have missing bricks and needed total replacement. Of the Tier 2 manholes inspected in FY 2019, 14 were identified for repair and two for replacement; work orders have been written. All 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
Surcharge	BES collection system surcharging but not weather event related
Cause Unknown	A release where the investigation does not identify a specific cause

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.

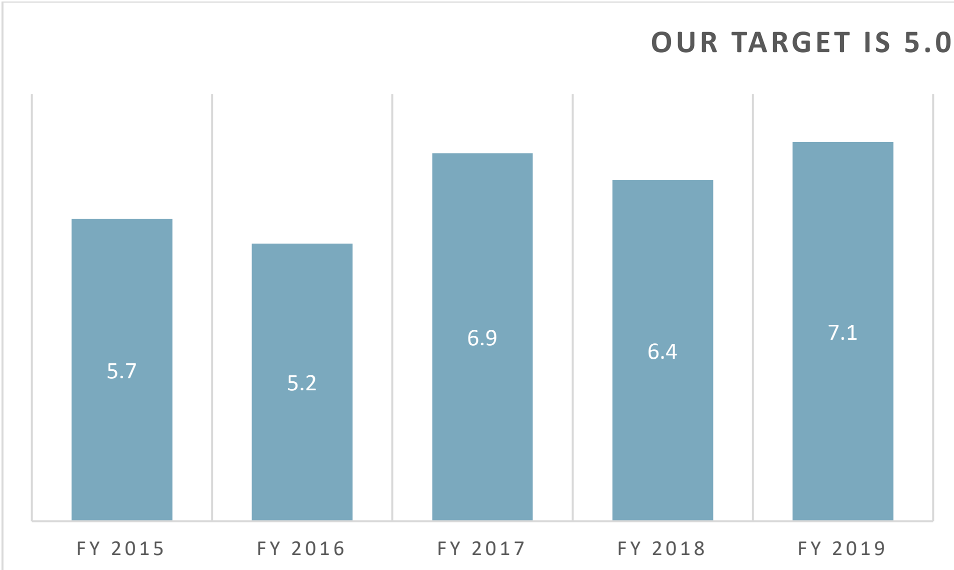
4.2.1 SSOs per Hundred Miles of Pipe

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 2019, BES owned and maintained approximately 1,919 miles of main line sanitary and combined sewers, and 721 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 2019, the City experienced 188 sewer releases over the 2,640 miles of collection system, which is approximately 7 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 16.

Figure 16 SSOs per 100 miles of sewer



4.2.2 Response to Urgent Health and Safety-Related Service Requests

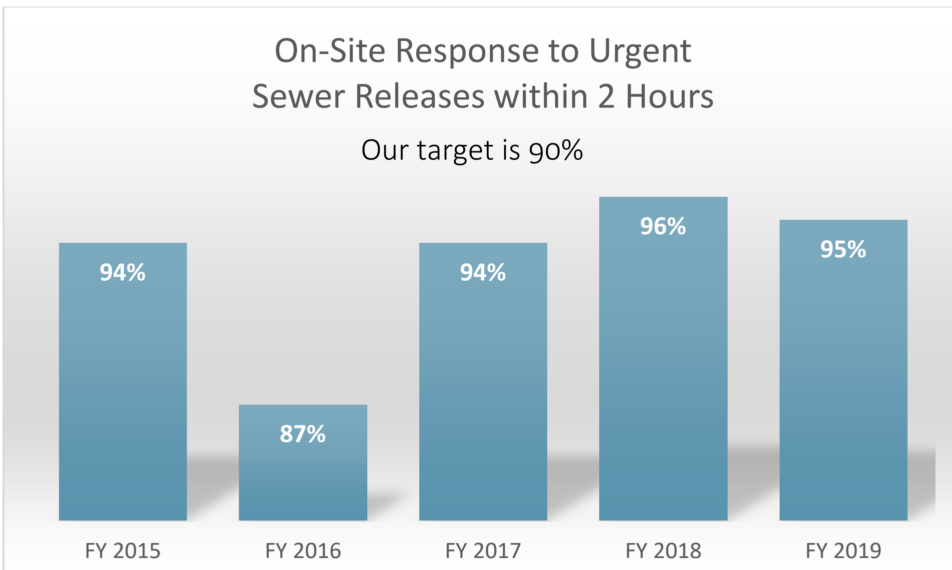
The City's goal is for a sewer emergency crew to be on site within 2 hours of receiving the initial call reporting an urgent sewer release. BES SPCR is responsible for maintaining electronic records of sewer releases, and their records are used to assess the response time of the on-site emergency crew. 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 2019 is shown in Table 13. A comparison with previous fiscal years is shown in Figure 17. Sewer emergency response crews arrived on site within the City's 2-hour response time target 95% of the time during FY 2019.

Table 13 SSO Response Time and Counts for FY 2019

FY 2019 Total Urgent Calls Sewer Release Calls	Number of Calls	Percent of Total
Urgent Calls with Response Time Less Than 2 Hours	409	95%
Urgent Calls with Response Time 2 Hours or More	22	5%
Total	431	100%

Figure 17 SSO response time comparison



4.3 Analysis of Causes and Locations of Sewer Releases

During FY 2019, the City experienced 188 releases from the sanitary and combined sewer systems. There were no weather-related release events in FY 2019 that exceeded the design capacity of the collection system (referred to as *force majeure*).

A chart comparing the causes of releases in FY 2015 through FY 2019 is shown in Figure 18. 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 2019 are shown on the map in Figure 19.

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 34 releases caused by structural defects in FY 2019. There were 21 releases from structurally defective laterals, 10 from mainline sewers, and three from manholes. 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 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 2019, of the 68 releases caused by roots, 25 were in sewer mainlines and 42 were in service laterals, and one from a manhole. 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 2019.

Figure 18 Comparison of causes of sewer releases in FY 2015 through FY 2019

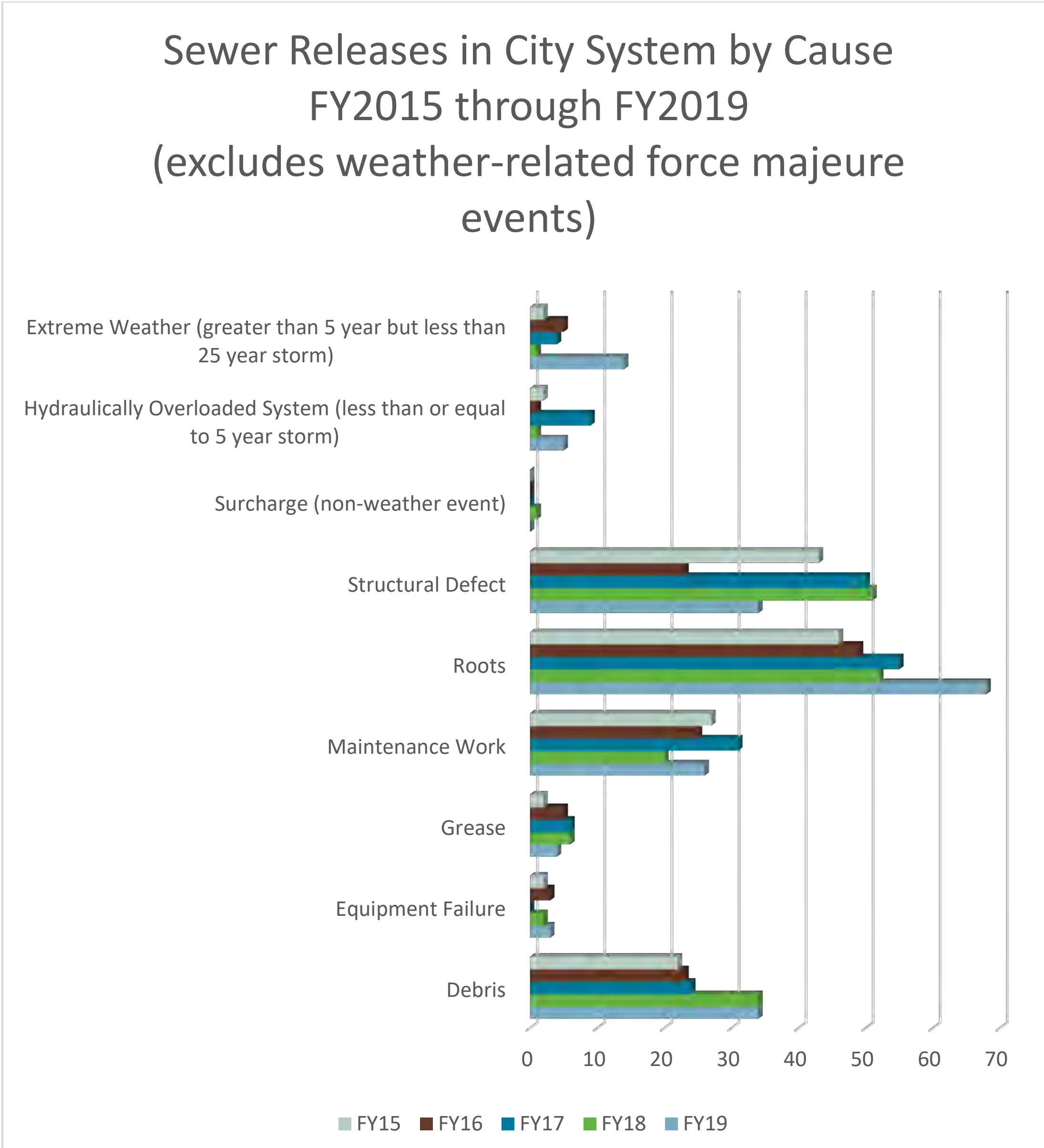
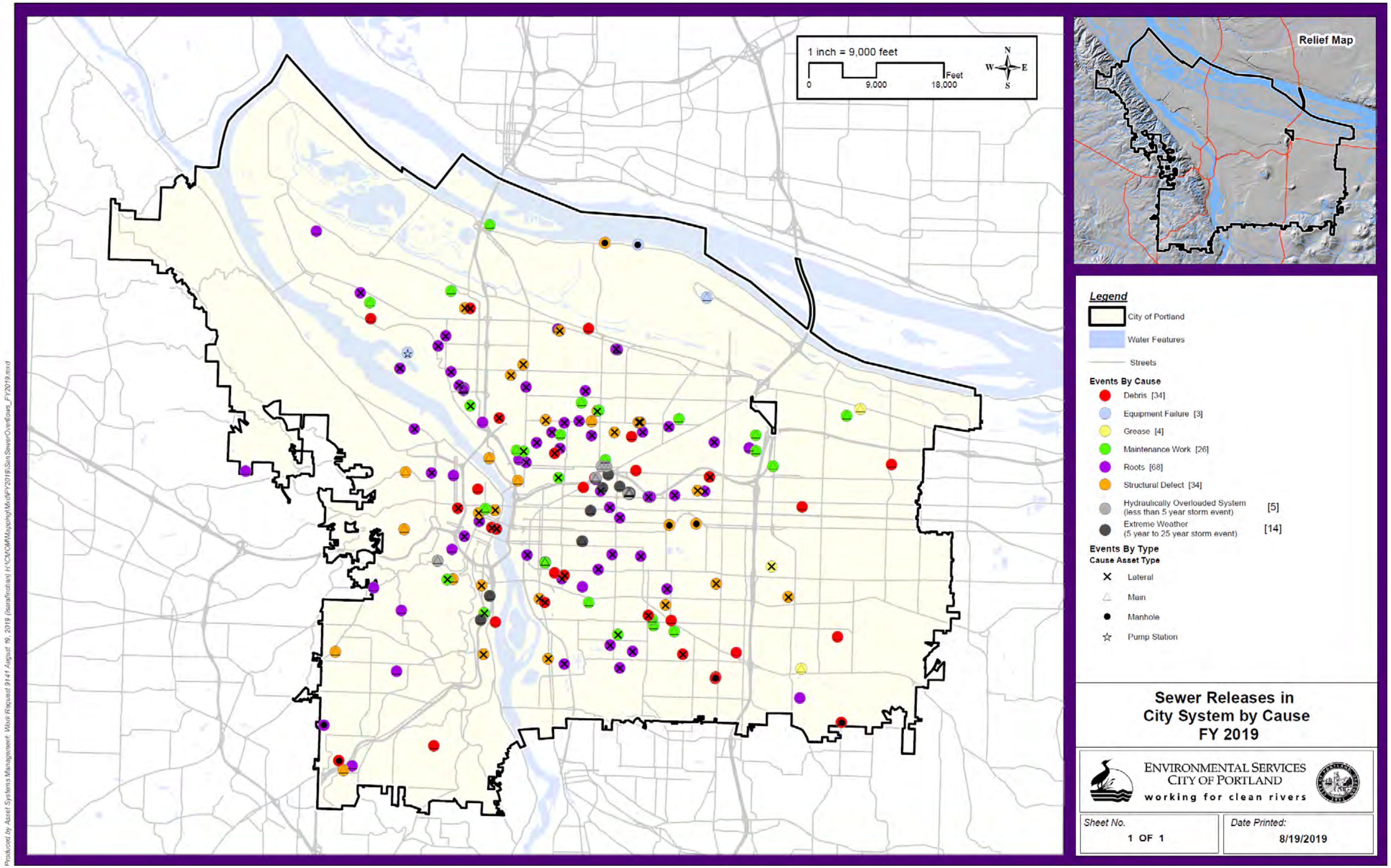


Figure 19 FY 2019 sewer release map



Maintenance. In FY 2019, there were 26 releases associated with maintenance activities. Eighteen releases were associated with sewer cleaning operations; many of these releases were "bowl water" from toilets and the volume was less than 10 gallons (three 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.

Eight maintenance-related releases were associated with either sewer repairs or sewer construction projects. Four releases involved installation of CIPP liners, two by City crews and two by BES contractors. Two releases occurred during BES construction projects when contractors either abandoned or failed to reconnect BES assets that still had active sewer connections. The other two releases occurred during construction projects related to private development. The causes were debris in the system for one and a poor flow diversion plan for the other.

Debris. There were 34 releases caused by debris in FY 2019, 18 of which were associated with sewer mains. In addition to accumulation of debris during normal system operation, introduction of foreign objects and debris into the system by third parties can be associated with at least six of the main line sewer releases in FY 2019. 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. BES continues to conduct "what not to flush" public outreach, disposable wipes were a significant contributor to the increase in debris-related sewer releases in FY 2019.

4.3.1 Sewer Releases to Surface Water in FY 2019

Sewer releases to surface water occurred at five locations in FY 2019. 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.

9784 NW Caxton Lane (release to a tributary of Mill Creek): On July 26, 2018, a sewage release was observed from manhole ABF003 in NW Portland. The sewage went onto the ground in the backyard of a residence, ran down a steeply sloped hill, and then reached an unnamed tributary of Mill Creek. The volume of the release was estimated at 340 gallons. PBOT/MO crews responded and cleared a root blockage from the manhole. The BES public information officer issued a press release to alert the public. SPCR collected two rounds of *E.coli* samples from the creek (both upstream and downstream of the release) to document the impact and the return to baseline conditions.

9426 SW 62nd Drive (release to a tributary of Ash Creek): On December 14, 2018, a sewage release occurred from a public manhole in an easement on private property due to a downstream root blockage in the main sewer. Sewage flowed across private property to a small stream (an unnamed tributary of Ash Creek). No solids were discharged, and no surface cleanup was necessary. The root blockage was cleared on that same day. After this work was completed, *E. coli* samples were collected from stream from above and below the point of impact. Results showed a return to baseline conditions.

4640 SW Macadam Avenue (release to the Willamette River): On December 27, 2018, a sewage release occurred from a cleanout on private property to the parking lot at this location. The sewage entered an on-site catch basin. From there, flow went to Outfall 4 and then into the Willamette River. The volume of the release was estimated at 1,000 gallons. The cause of the release was a debris blockage in the downstream sanitary sewer. The blockage was removed, and flow was restored on 12/27/2018. *E.coli* samples were collected from the Willamette River the day after the release from above and below the site of the release and were determined to be at baseline levels.

10815 SW 57th Avenue (release to a tributary of Fanno Creek): On January 10th, 2019, a City Parks Bureau employee observed an overflowing manhole in Dickinson Park near 10815 SW 57th Avenue. Flow was observed coming from manhole ADF404 and across the ground surface and into a nearby stream.

City emergency crews responded and immediately initiated sewage release response procedures. The crew determined that debris in the main sewer line was causing a blockage that resulted in a sewer overflow. The blockage was cleared, and the release was stopped that same day.

A CCTV inspection of the sewer main revealed root intrusions and solid material, including wood, that may have been dumped in an act of vandalism. The manhole has been placed on an increased inspection schedule to ensure that further blockages do not occur. The volume of the released material was estimated at 3,600 gallons.

A press release was issued, and sewage release signs were placed in the area. E. coli samples were collected from the unnamed creek (both upstream and downstream of the release) on January 10th and then again on January 14 to assess the impact to the surface water. The initial samples reported elevated E. coli levels in the creek and then the subsequent samples taken reported a return to baseline conditions.

11130 SW Barbur Blvd. (release to a tributary of Ash Creek): On April 26, 2019, a BES field operations crew was visiting a flow monitoring location on an unnamed tributary of Ash Creek in southwest Portland near the address of 10908 SW SW 64th Avenue. The crew observed that the creek appeared gray and cloudy and appeared visually similar to that of wastewater. The crew immediately called the BES Duty Officer who responded to investigate. The Duty Officer tracked the stream to storm node ADJ602 at 11130 SW Barbur Boulevard and observed a lateral discharging what appeared to be sanitary flow into that storm sewer node. PBOT maintenance crews were dispatched to the site to further investigate and determine the source of flow. At this point, the discharge was thought to be a private-to-storm sewer cross-connection.

A dye test was conducted in the nearby BES sanitary sewer line. Dye was inserted into sanitary sewer manholes ADJ358 and ADJ360. That dye then appeared downstream in storm node ADJ602. The maintenance crew immediately conducted a CCTV inspection of sewer line ADJ358-ADJ349 and identified the presence of a defect in the sanitary sewer line about 40-feet upstream from manhole ADJ349. At this time, it was determined that an active sewage release was occurring.

The conclusion from the investigation was that sewage was being released from sanitary sewer line segment ADJ358-ADJ349 and had found a preferential subsurface pathway to the private property storm sewer lateral at 11130 SW Barbur Blvd, which then discharged to the storm system at ADJ602.

The crew immediately set about repairing the sanitary sewer line, and the sewage release was stopped at 3:00am, April 27, 2019. A press release was issued by the BES public information officer on that same morning of April 27, 2019.

Using a flow rate/duration method calculated from the discovery at the creek to the time that the release was stopped, the total estimated volume of the sewage release was 70,566 gallons. This estimate is very imprecise since the start time of the sewage release is unknown and it is unclear what percentage of flow left the sanitary sewer line and entered the storm system. E. coli samples were collected from three locations downstream from the release to confirm the impact to the stream and to document a return to baseline conditions.

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. BES's CMOM program effectively incorporates the essential elements and best management practices for proper operation and maintenance of the collection system.

BES is currently evaluating ways to improve the overall effectiveness of the sewer main line cleaning program, focusing on ways to reduce sewer releases related to operational problems such as roots and debris. As part of this work BES will reassess the thresholds for placing pipes into the chemical root treatment program and/or the mid cycle cleaning program.

The City continues to install cleanouts whenever our maintenance crews replace a sewer lateral The addition of the cleanout, routinely installed at the curb, provides crews with an ability to perform future maintenance activities such as cleaning and chemical root treatment.

Additionally, 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 2019, implementation of the SWMM in combined sewer basins led to construction of stormwater facilities at 489 properties, managing 49 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

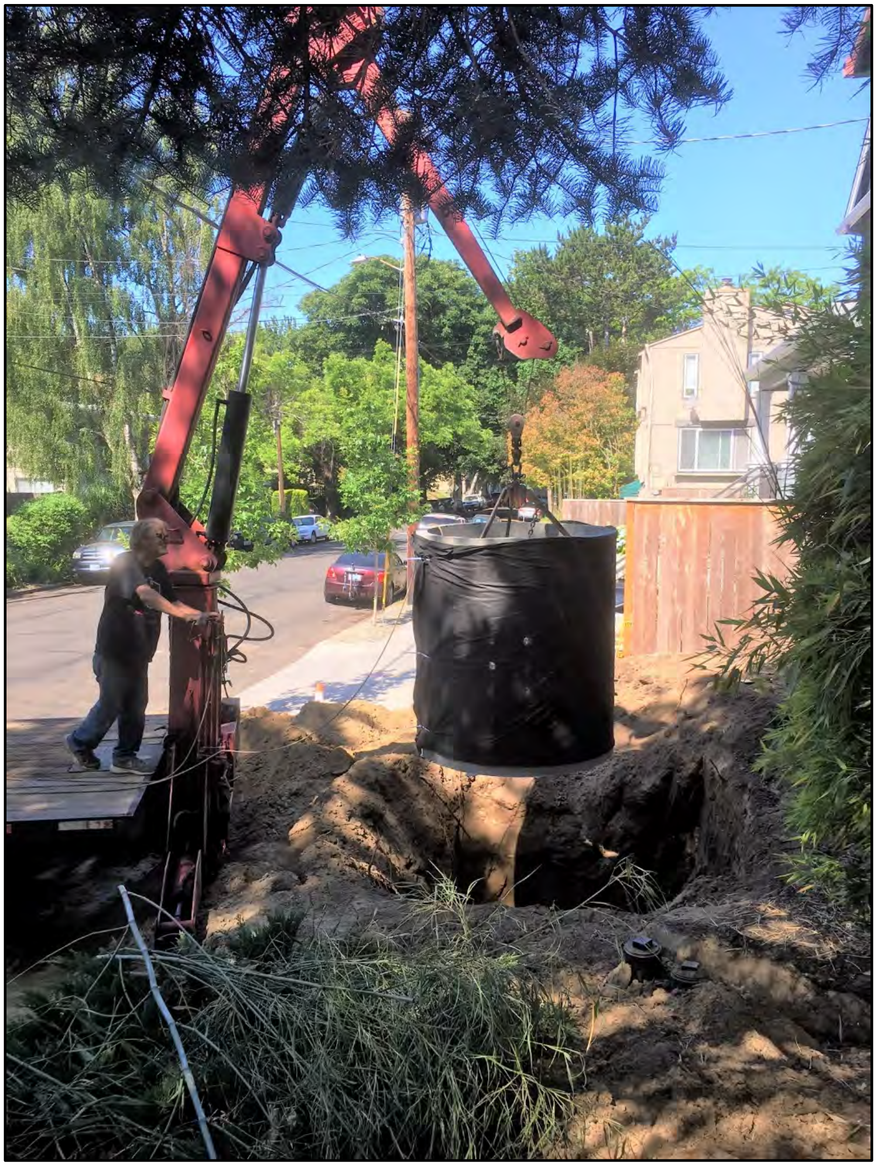
Installation of stormwater facilities on private property continues in the Private Property Retrofit Program. Guided by BES's 2012 *System Plan—Executive Report: Combined and Sanitary Sewer Elements* and its Capital Improvement Program, this program researches opportunities with private property owners 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 (FYs 2014 and 2015).

For FY 2019, 3.2 acres of impervious surfaces were managed by 105 private property stormwater retrofit projects. Three examples of this year’s retrofits are shown in Figure 20, Figure 21, and Figure 22 below.

Figure 20 Example retrofit #1, Buckman area rain garden

Figure 21 Example retrofit #2, NE Davis rain garden

Figure 22 Example retrofit #3, drywell installation



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 Central City requirements, the City's Green Building Policy, SWMM, and developer floor area ratio bonuses in specific portions of the city.

As of June 2019, Portland has over 500 ecoroofs installed throughout the city, managing over 34 acres of roof. Approximately 402 of those ecoroofs are in the combined sewer area. During FY 2019, 24 new ecoroofs were installed in the combined sewer area, managing approximately 5.5 acres of roof. This roof area represents 5.5 million gallons of rainfall to the combined system annually, and Portland's monitoring data indicate that approximately 2.8 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 2019, Portland has implemented over 2,300 green streets in the right-of-way, with approximately 1,000 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 2019, 15 new green street facilities were installed in the combined sewer area (there is an overall increase of 30 green streets over FY 2018, with the remainder due to tracking corrections). The facilities were implemented by BES CIP, PBOT interagency, and private development projects. Collectively, these facilities manage approximately 2.7 acres of impervious area that generate 2.7 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 1.9 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 2019 Reporting Methodology, Changes, and Improvements

Risk in mainline pipes and pump stations are 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.

Likewise, pump station inspections also provide condition data used to determine the risk associated with operational failure of the critical assets within a pump station. Hydraulic modeling is done to determine the risk of capacity failure, specifically to determine the likelihood of overflows.

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 to 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).

The City will also complete its *Pump Station System Plan* in 2019. The plan developed a process to implement a data-driven risk analysis process for determining necessary pump station investment. To promote consistency in decision making, the asset management approach developed for the collection system was tailored for use in evaluating pump station assets. Characterization to identify condition, capacity, and level of service deficiencies among pump station assets is used to quantify risk with the goal of identifying corrective actions. These actions meet the BES core mission by protecting public health, water quality, and the environment in a manner that optimizes the return on investment for the rate paying customer.

6.2 FY 2019 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 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 is likely much 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	$53,900,000

The Capital Improvement Program completed 21 projects in the sanitary and combined collection system during the 2018 calendar year. These projects repaired and rehabilitated 496 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 showed that planned maintenance activities included approximately 6,770 lineal feet of repair and lining work on sewer main assets and 395 laterals which were replaced or lined.

Table 15 Risk change due to maintenance activity with available data

Type	Value
Total risk reduction due to maintenance activity	$6,350,000

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 2019. Winter events are shaded in green, 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

This table 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 green, and summer events are shaded in yellow. All events complied 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

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)
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
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 2019's events are listed in the bold box below. Winter events are shaded in green, 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 2019

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
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

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)
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
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

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)
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
28	October 25-29, 2018	25-year, 10-minute - 2-hour storm	1.46	2.06	2.12	0.0037	0.17	-	-	0.0037	0.17

The City of Portland complies with all non-discrimination laws including Title VI (Civil Rights) and Title II (ADA). To request a translation, accommodation or additional information, please call 503-823-7740, or use City TTY 503-823-6868, or Oregon Relay Service: 711.

Printed on recycled paper. WT 1614