Thea Foss and Wheeler-Osgood Waterways 2022 Source Control and Water Year 2022 Stormwater Monitoring Report

March 2023

Prepared for
Washington State Department of Ecology and
U.S. Environmental Protection Agency

Prepared by
City of Tacoma

This page is intentionally left blank

ACKNOWLEDGEMENT

Main Report prepared by Environmental Services, Science and Engineering:

- Mary Henley, Laura Nokes and Dana de Leon, Environmental Programs, Watershed Planning Group
- Arielle Flesher and Katie Foster, Administration Services

Source Control Activities Report (Appendix A) prepared by Environmental Services:

- Mary Henley and Laura Nokes, Science and Engineering, Environmental Programs, Watershed Planning Group
- Tony Miller and Cassie Petty, Business Operations, Environmental Compliance

Data Validation Report (Appendix B) prepared by Environmental Services:

- Laura Nokes, Chris Burke and Dana de Leon, Science and Engineering, Environmental Programs, Watershed Planning Group:

Special consideration to the following support staff:

- Data Management and Analysis Application Development and Support from Karen Bartlett, Bonnie McLeod, and Kali Legg, Asset Management, Analytics & Engineering and Bob Saucier, Peter Van Pelt and Michael Sparkman, Asset Management, Technology & Business Operations, Application Development, GIS
- Rainfall, Stormwater and Stormwater Sediment Sampling and Data Management from Steve Shortencarrier, Ryan Gore, Chad Atkinson, and Steve George with support from Haley Abbruscato and Michael Blanchette, Laboratory Services, Quality Assurance and Laboratory Data Management: Environmental Services Laboratory Services with special consideration to support from Monica Herbert, Tiffany Ryan, and Eric Bitten, Environmental Services Laboratory.

Special thanks to all others in Environmental Services whose hard work has resulted in the statistically significant improvements in stormwater quality and the success of this Superfund cleanup and source control program.

- Business Operations Environmental Compliance, business inspections and spill response
- Science and Engineering, Environmental Programs, NPDES with Stormwater Municipal NPDES Permit Compliance
- Operations Maintenance, Transmission Maintenance, sweeping, line cleaning and other stormwater system cleaning and maintenance.

This page is intentionally left blank

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

Attachments, Tables and Figures in Appendices

Appendix A Drain-by-Drain Analysis of Source Control Activities

Appendix B Data Validation Report Water Year 2022

List of Tables - Appendix B

List of Figures - Appendix B

Appendix C Supporting Field and Hydrologic Data

Appendix E Statistical Summary of Stormwater and Baseflow Data

Appendix F Drain-by-Drain Box Plots of Stormwater and Storm Sediment Data

Drain-by-Drain Comparison in Stormwater – October 2001-September 2022

Drain-by-Drain Comparison in Stormwater [Log Scale} – October 2001-September 2022

Basin-by-Basin Comparison in Storm Sediment – Water Years 2002-2022

Basin-by-Basin Comparison in Storm Sediment [Log Scale] – Water Years 2002-2022

Appendix G Year-by-Year Box Plots of Stormwater Data

Year-by-Year Comparison in Stormwater – October 2001-September 2022

Year-by-Year Comparison in Stormwater [Log Scale] – October 2001-September 2022

Appendix H Seasonal Box Plots of Stormwater Data

Seasonal Variation in Stormwater – October 2001-September 2022

Seasonal Variation in Stormwater [Log Scale] – October 2001-September 2022

LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
BEL	Biological Effects Level
BMPs	Best Management Practices
BNSF	Burlington Northern Santa Fe
CD	Consent Decree
CDF	Controlled Density Fill
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CHB	Community for a Healthy Bay
City	City of Tacoma
CIPP	Cured-In-Place Pipe
COCs	Contaminants of Concern
CRM	Certified Reference Material
DEHP	Di(2-ethylhexyl) phthalate or Bis(2-ethylhexyl) phthalate
DMMP	Dredged Material Management Program
Ecology	Washington State Department of Ecology
EC	Environmental Compliance
EPA	Environmental Protection Agency
ER	Exceedance Ratio
Foss Waterway	Thea Foss and Wheeler-Osgood Waterways
FWDA	Foss Waterway Development Authority
GOF	Goodness-of-fit
HPAHs	High Molecular Weight PAHs
IDDE	Illicit Discharge Detection and Elimination
ISWGP	Industrial General Stormwater Permit issued by Ecology
LCS	Laboratory Control Sample
LID	Low Impact Development
LPAHs	Low Molecular Weight PAHs
LTMP	Long Term Monitoring Plan
LUST	Leaking Underground Storage Tank
MLLW	Mean Lower Low Water
MS4	Municipal Separate Storm Sewer System
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPDES Phase I Permit	NPDES Phase I Municipal Stormwater Permit dated August 1, 2012
NWDC	Northwest Detention Center
OF	Outfall
OMMP	Operations, Maintenance, and Monitoring Plan
PAHs	Polycyclic Aromatic Hydrocarbons

LIST OF ABBREVIATIONS - CONTINUED

PCBs	Polychlorinated biphenyls
Permit	State Waste Discharge General Permit for Discharges from Large and Medium Municipal Separate Storm Sewer Systems
PIC	Pierce County Code Enforcement Officers Group
PSD	Particulate Size Distribution
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
ROW	Right-of-way
SSPM	Stormwater Suspended Particulate Matter
SAP	Sampling and Analysis Plan
SQOs	Sediment Quality Objectives
SR	State Route
STRAP	Stormwater Rapid Assessment Program
SWMP	Stormwater Management Program
SWPPP	Stormwater Pollution Prevention Plan
TNT	The News Tribune
TPCHD	Tacoma Pierce County Health Department
TSS	Total Suspended Solids
Twin 96ers	Outfall 237A and 237B
UCL	Upper Control Limit
USGS	United States Geological Survey
LUST	Leaking Underground Storage Tank
UST	Underground Storage Tank
Utilities	Group of Private Utilities who performed cleanup in the Head of the Thea Foss Waterway
WASP	Water Quality Analysis Simulation Program
WRDA	Water Resources Development Act
WSDOT	Washington State Department of Transportation
WY	Water Year

EXECUTIVE SUMMARY

Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), also referred to as Superfund, contaminated bottom sediments were remediated in the Thea Foss and Wheeler-Osgood Waterways in Tacoma, Washington, under the oversight of the Environmental Protection Agency (EPA) at a cost of $105 million. In 2022, EPA initiated the process of deleting the waterway from the National Priorities List as part of the Commencement Bay Superfund site. It is unknown at this time when this process is expected to be completed.

The waterways are located in a highly urbanized basin with residential, commercial, and industrial land uses and transportation corridors. Sources of Contaminants of Concern (COC) continue to exist in the drainage basins and are conveyed to the waterway via stormwater (municipal and private), aerial deposition, marinas, and groundwater discharges. The contaminants identified as having the greatest potential to affect sediment quality following the cleanup action include polycyclic aromatic hydrocarbons (PAHs) and phthalates.

Since stormwater is one of the potential sources, the City of Tacoma (City) has been implementing a comprehensive monitoring and source control strategy in the Foss Waterway Watershed since 2001. Stormwater monitoring is required to be conducted under a Stormwater Work Plan Addendum to the Thea Foss Waterway Consent Decree (CD) with EPA and currently by Section S8.C of the National Pollutant Discharge Elimination System (NPDES) and State Waste Discharge General Permit for Discharges from Large and Medium Municipal Separate Storm Sewer Systems (Permit), which supersedes previous NPDES requirements.

The Thea Foss Post-Remediation Source Control Strategy implemented under the CD used a multifaceted approach consisting of aggressive source control efforts, continuation of the comprehensive monitoring program, a computer model (used during the first ten years) to predict impacts, and a decision matrix to identify the need for additional source controls. This monitoring information was used to guide control of contaminant sources in the drainage basins. The intent of this program is to help provide long-term protection of sediment quality in the waterways and to fulfill NPDES requirements. Implementation of the requirements of the CD remain in effect until performance standards in the waterway are met.

Under the comprehensive monitoring program, annual baseflow[1], stormwater, and stormwater suspended particulate matter (SSPM) monitoring of the stormwater discharges from seven outfalls to the Thea Foss Waterway are used to evaluate effectiveness of the City's source control efforts, and to provide early warning of any new problems which arise in the drainages. The requirements of the monitoring program and the approach to the evaluation of results were originally outlined in the 2001 Sampling and Analysis Plan (SAP) for the Thea Foss and Wheeler-Osgood Waterways dated September 2001 (Tacoma 2001) and approved by EPA on September 13, 2001. A revised Thea Foss and Wheeler-Osgood Waterways Stormwater Monitoring Quality Assurance Project Plan (2020 QAPP) for monitoring was completed and

[1] After 10 years of baseflow monitoring were completed at the end of WY2011, baseflow monitoring was discontinued (approval granted by EPA and Ecology on February 7 and February 9, 2012, respectively). Baseflow quantity and quality were determined to be well characterized by the 10-year monitoring record. Some additional baseflow monitoring was performed in WY2016 and in WY2019 to determine whether there had been changes in recent years.

approved in August 2020 and went into effect starting with Water Year 2021 (WY2021) monitoring.

This annual report outlines the City's existing programs completed in WY2022 and includes a status update on ongoing source control investigations, as well as an evaluation of the need for any new stormwater management actions. Annual source control evaluations are completed for the seven major outfalls discharging to the waterways: Outfalls (OF) 230, 235, 237A, 237B, 243, 245, and 254. The evaluations include a drain-by-drain assessment incorporating the review of ongoing studies, source control investigations, water quality data, and SSPM data for that outfall/basin. A summary of this evaluation is included in Section 5 of this report.

As part of the WY2022 evaluation, this report reviews results from 21 years of outfall monitoring conducted under the Foss Monitoring Program and source control actions completed in the Thea Foss drainage basins. The City completed additional sediment monitoring in the portion of the waterway north of the SR509 Bridge in 2018, and an analysis of this data relative to stormwater concentrations was included in the WY2018 report to evaluate the impact of known ongoing urban and marine sources to the waterway. At this time the waterway appears to have equilibrated with known sources generally at concentrations below levels of concern. The City and others will be monitoring waterway sediments next in 2023 and the WY2023 report will include a qualitative analysis of this data. Based on results of the WY2018 monitoring and subsequent reporting, EPA determined that the requirements of the Record of Decision have been met, and the remedial action in the waterway is complete. Based on this determination, they have initiated the process of deletion of the Thea Foss Waterway from the National Priorities List as part of the Commencement Bay/Nearshore Tideflats Superfund site.

WY2022 STORMWATER QUALITY STATISTICAL ANALYSIS

Over the 21-year period (August 2001-September 2022), stormwater and stormwater sediments have been sampled at the seven major outfalls that discharge into the Thea Foss and Wheeler-Osgood Waterways. In addition, baseflow was sampled at the same seven outfalls for the first ten years of the program and confirmed with additional sampling in 2016 and 2019. Over the last 21 years, 2,325 samples have been collected with 366 baseflow, and 1,463 stormwater samples collected at the outfalls, and 128 outfall and 368 upline SSPM samples collected in pipeline sediment traps deployed throughout the watershed. This depth of data provides the basis for meaningful statistical evaluation of the trends over the program period.

Stormwater Time Trend Analysis[2] Forty-eight statistically significant time trends (48 out of 49 tests or approximately 98 percent of the tests) were shown in Year 21 using simple linear regression. All trends were in the direction of decreasing concentrations. This is the same number of trends and constituents with trends as were observed in WY2021. In Years 19 through 21, 48 trends have been observed, but the constituents were different in Year 19. Between Years 15 and 18, 47 significant trends were observed; in Years 13 and 14, 46 significant trends were observed; in Year 12, 44 significant trends were detected; in Year 11, 41 significant trends were detected; in Year 10, 37 significant trends were detected; in Year 9, 26

[2] It should be noted that some new statistical approaches were implemented beginning in WY2012 and for this reason, the results since then are not fully comparable to results from previous years. However, these changes have improved the statistical approach to the trend analysis, and the City's ability to discern trends.

significant trends were observed; in Year 8, 10 significant trends were observed; and in Year 7, only 4 significant trends were observed.

In addition to the 49 time trend tests that have been evaluated in past years, the 2014 QAPP requires the City to analyze and evaluate total copper. For three outfalls, OF235, OF237B, and OF245, the data collected since WY2015 has been added to data previously collected under the NPDES program between WY2010 and WY2012. With more data available, an evaluation of time trends has been performed for these outfalls for the last several years. As of WY2019, sufficient data is available for all seven outfalls to perform an evaluation of time trends, although with less data available, the statistical results will not be fully comparable to data for the remaining constituents. With these seven tests added, there are 51 statistically significant time trends (51 out of 56 tests, or approximately 91 percent of the tests) shown in Year 21, with all trends in the direction of decreasing concentrations. As additional data becomes available, time trends for copper will become more comparable to remaining tests.

The time trends were modeled with best-fit regression equations to estimate percent reductions over the 21-year monitoring period for these constituents and outfalls:

- **Total Suspended Solids (TSS)**: Approximately 40-78 percent reduction all seven outfalls
- **Copper:** Approximately 34-50 percent reduction in OF235, OF237B, and OF245
- **Lead**: Approximately 71-83 percent reduction in all seven outfalls
- **Zinc**: Approximately 51-71 percent reduction in all seven outfalls
- **PAHs**: Approximately 64-90 percent in all seven outfalls with the exception of indeno(1,2,3-c,d)pyrene at OF237A
- **Bis(2-ethylhexyl)phthalate (DEHP)**: Approximately 48-82 percent reduction in all seven outfalls

ONGOING EFFORTS TO EFFECT CHANGE

The cumulative effect of municipal, state, and federal source control efforts has likely caused the observed improvements in stormwater quality. The City has directed numerous source control efforts in this watershed focused on these COCs. Refer to Sections 2.0 and 5.0 for more detail regarding specific efforts.

The City implements aggressive source control activities that comply with or exceed the requirements of the NPDES permit requirements. Many of these activities have been developed specifically to respond to sources of contaminants found during various investigations.

Stormwater Management Program The 2019 NPDES Phase I Municipal Stormwater Permit, effective August 1, 2019, through July 31, 2024, requires the City to implement a Stormwater Management Program (SWMP) which is divided into 11 components, including stormwater outfall sampling, stormwater planning, source control, maintenance, inspections, capital projects, and program development and implementation for the municipal separate storm sewer system (MS4). The City integrates these NPDES program elements with the ongoing Thea Foss Program.

The City's stormwater ordinance, through the 2021 Stormwater Management Manual, requires stormwater treatment and control systems on new and redeveloped sites when certain thresholds are met, and provides a mechanism for enforcement of the stormwater management regulations. Through new development and redevelopment, stormwater runoff from industrial and commercial sites throughout the Thea Foss Basin is being converted over time from untreated to treated runoff (i.e., removal of solids from stormwater runoff).

In 2022, City staff performed numerous field activities within the Foss Waterway Watershed, including the following:

- Responded to 233 spills/complaints including conducting investigations
- Provided technical assistance on source control and best management practices (BMPs)
- Conducted 154 business inspections and follow-ups

All the business inspections, complaints and spills, and various source control field activities are documented and tracked using a web-based database. The web-based database is an effective tool for retrieving historical information and examining trends.

Enhanced Maintenance The City has conducted several special studies over time to better understand the distribution of DEHP and PAHs in the urban environment and how those and other COCs might best be controlled with enhanced maintenance. The following enhanced maintenance elements are currently being implemented in the City:

- Basin-wide sewer line cleaning program to remove residual sediments in the storm drains and sediment-bound contaminants. Contaminants in sediments present in the system may not solely be from new sources but may in part be from legacy contamination in the pipe that could be continuing to impact stormwater or baseflow quality through resuspension and/or dissolution. Based on the effectiveness seen in this program since it was implemented in the Foss Waterway in 2006, the City has expanded this program to include the drainage system throughout the City. Currently, the City is anticipating a 20-year cycle for cleaning of the storm system throughout the City as a part of routine maintenance. The City is continuing to evaluate the need to increase the frequency in this sensitive area.
- An enhanced street sweeping program has been implemented in an attempt to reduce sediment buildup in the storm sewer system. Under the enhanced program, the sweeping frequency was increased, air regenerative sweepers replaced mechanical sweepers, and the City has also increased communications with residents, which helped raise awareness of the importance of the street sweeping program.
- Finally, in industrial areas, the City is currently conducting a pilot program to evaluate the effectiveness of further increasing the frequency of street sweeping in the industrial areas around the Thea Foss Waterway in reducing the levels of metals in stormwater.

Results of statistical analyses using WY2022 data are included in Section 2 of this report.

THEA FOSS WATERWAY SEDIMENT QUALITY

When the waterway sediment remediation projects were completed, the majority of the sediment surface had no, or very low, concentrations of contaminants present since the surface was either dredged to clean sediments or covered with new, clean capping materials. It was anticipated that ongoing source contributions to the waterway would cause concentrations of contaminants to increase gradually. Over time, the goal is to have the contaminant concentrations equilibrate at a level below the sediment cleanup standards set by the EPA.

The sediments in the waterway are the true barometer of whether additional source controls are needed for compliance with regulatory requirements. Sediment monitoring was last performed by the City in 2018 in the portion of the waterway generally north of the SR509 Bridge. An analysis of the results shows that the data were generally consistent with, or better than, previous monitoring results indicating that the risk of wide-scale recontamination in the waterway remains low. At this time, it appears that waterway sediment concentrations have largely equilibrated with modern sources since the completion of the remedial action in 2006. As a result, the risk of recontamination is not expected to be substantially higher in the future unless there is a change in the nature, strength, or distribution of waterway sources. The next scheduled sediment monitoring event will occur in 2023.

STATUS OF SOURCE CONTROL EFFORTS

In December 2020, EPA determined that the City had fully performed the sediment remedial action in the Thea Foss and Wheeler-Osgood Waterways. As such, and because the waterway sediments have reached equilibrium with modern sources at levels generally below EPA's required cleanup levels for the Superfund site, there is not currently a need for new source control actions. Several source control investigations and actions are underway at this time and will be carried out to completion. The status of these activities is described in Sections 2 and 5 and Appendix A. In addition, if future monitoring identifies the potential of a new source that may be affecting sediment quality in the waterway, additional source control actions will be undertaken.

In addition, the City believes some minor additional improvements in stormwater quality may be realized in the future with ongoing NPDES Permit programs and continuing improvements in source control implementation. Sediment trap results are valuable in that they provide an early warning of potential stormwater sources to the waterway sediments that can be investigated and addressed before Sediment Quality Objective (SQO) exceedances requiring action are identified in the waterways.

2023 Source Control Work Plan A considerable amount of source control work has taken place in the Foss Waterway Watershed over the last 21 years. With the significant improvements realized, fewer source control issues remain and as described above, no new investigations are needed at this time. The Source Control Work Plan for 2023 is included in Section 6 of this report that identifies specific activities for the watershed and for each basin that are currently underway.

CONCLUSION

Through the City's implementation of its SWMP, as well as through the control of other sources, reduction of contaminant loads to the Thea Foss and Wheeler-Osgood Waterways over the years has been substantial. The improvement in stormwater quality since the mid-1990s indicates that source control efforts by the City and others in the Foss Waterway Watershed have been effective in reducing chemical concentrations in stormwater. Tests performed over the entire project period show 98 percent statistically significant time trends, all in the direction of decreasing concentrations. This result is significant and a testament to the City's ongoing comprehensive source control program[3].

Source control activities currently being implemented by the City include business inspections, response to spills and illicit discharges, mapping/maintenance/cleaning of the stormwater system, source tracing pollutants of concern, and implementation of the City's Surface Water Management Manual through the stormwater ordinance. The City will continue with ongoing source tracing investigations. Ongoing control of sources that are outside the City's jurisdiction must also continue to be coordinated by other federal, state, and local authorities.

It should be noted that while considerable improvements to stormwater quality have been made, the largest changes were realized in the earlier years of the program when major sources were identified and eliminated. Because the source control program has been so effective through the years, fewer major sources or maintenance actions are needed and the program has attained equilibrium or maintenance mode. In other words, the concentrations of contaminants of concern in the stormwater in the Foss Waterway Watershed have generally reached a level where the opportunities for large reductions are more limited. This may over time lead to the appearance of fewer additional decreasing trends in contaminant concentrations, lower percentages of reduction, and potentially even a few minor increasing trends, particularly if looking only at results from more recent years. However, data shows that the City's stormwater source control and monitoring program have been very effective in reducing contaminant levels in stormwater and SSPM and that the risk of recontamination of sediments over biological effects thresholds in the Thea Foss Waterway from stormwater is low.

[3] Copper was added as an analyte in WY2015. As of WY2019, it was determined that sufficient data was available for all seven outfalls to perform an evaluation of time trends, although with less data available, the statistical results will not be fully comparable to data for the remaining constituents. With these seven tests added, there are 51 statistically significant time trends (51 out of 56 tests, or approximately 91 percent of the tests) shown in Year 21. As additional data becomes available, time trends for copper will become more comparable to remaining tests.

1.0 INTRODUCTION

Stormwater monitoring is required under the Thea Foss Waterway Consent Decree (CD) with the Environmental Protection Agency (EPA) and elected by the City to perform under Section S8.B of the National Pollutant Discharge Elimination System (NPDES) and State Waste Discharge General Permit for Discharges from Large and Medium Municipal Separate Storm Sewer Systems (Permit). To address these monitoring requirements, stormwater monitoring is conducted at seven outfalls in the Thea Foss Waterway and includes collection of event-based composite and grab samples for chemical analysis as well as annual sediment samples for chemical analysis.

1.1 THEA FOSS CONSENT DECREE OVERVIEW AND MONITORING REQUIREMENTS

Under the Foss CD with EPA dated May 9, 2003, the City completed remediation of marine sediments in the majority of the Thea Foss and Wheeler-Osgood Waterways in Tacoma, Washington in March 2006. Remediation of the southernmost 1,000 feet of the Thea Foss Waterway was completed in 2004 by a group of private utilities (Utilities) under a separate CD with EPA. The waterways are narrow estuarine water bodies on the southeastern margin of Commencement Bay, with 13 municipal outfalls that discharge stormwater to the waterways as well as numerous private outfalls. Based on the success of the cleanup, EPA has initiated the process of delisting the Thea Foss and Wheeler-Osgood Waterways from the National Priorities List as part of the Commencement Bay Superfund Site. It is unknown at this time when the delisting will be completed.

With the completion of the cleanup action in the Thea Foss and Wheeler-Osgood Waterways and pending delisting of the site, it remains necessary to continue monitoring and source control activities as required by the CD to ensure sediment quality is protected in dredged, capped, and natural recovery areas. Included as part of the CD Statement of Work, a letter addendum dated November 1, 2001 (identified as Attachment 1 to the CD), provides a detailed schedule and work plan for the City's stormwater source control efforts for the Thea Foss and Wheeler-Osgood Waterways. This addendum, herein referred to as the Stormwater Work Plan Addendum, includes a description of stormwater monitoring efforts, studies, source control efforts, and BMP assessments for municipal stormwater sources.

1.2 PHASE I PERMIT OVERVIEW AND MONITORING REQUIREMENTS

Monitoring is also performed to meet the requirements of the NPDES Phase I Permit (Permit). The Washington State Department of Ecology (Ecology) issued the most recent Permit on July 1, 2019, with an effective date of August 1, 2019, and an expiration date of July 31, 2024. This Permit required the City to develop an updated QAPP and submit the final plan before August 2020. The 2020 QAPP (Tacoma 2020b) was approved in August 2020 and went into effect beginning October 1, 2021, and remained in effect for WY2022 monitoring.

The Permit applies to all entities in Washington State that are required to have stormwater permit coverage under current (Phase I) EPA stormwater regulations. Section S8 – Monitoring and Assessment of the Phase I Permit includes two separate components with multiple compliance options for municipalities. The City has chosen the following activities to meet the obligations outlined in this section:

- **S8.A Regional Status and Trends Monitoring** –The City has elected to make the annual payments into a collective fund for Section S8.A to implement regional receiving water status and trends monitoring of small streams and marine nearshore areas in Puget Sound.
- **S8.B Stormwater Management Program Effectiveness Monitoring and Source Identification Studies** – The City has selected Option #2 to meet the requirements under S8.B. Section S8.C.2.a encourages the City to continue monitoring the same five locations that were monitored under Section S8.C of the Phase I Municipal Stormwater Permit August 1, 2013 – July 31, 2018.

The 2020 QAPP, developed in accordance with Section S8.C and Appendix 9 of the 2019-2024 permit, provides details on the stormwater discharge monitoring component in place for stormwater monitoring beginning in WY2021.

1.3 Goals and Objectives

The goal of the stormwater characterization monitoring study is to meet the requirements of the Foss CD and Section S8.B of the Permit. The goals of both programs generally involve:

- Measuring the effectiveness of stormwater source control actions, confirming that reductions in concentrations of target analytes have been realized, and confirming that recontamination from stormwater sources is not occurring. This is achieved by gathering data to identify trends in the quality of the water.
- Providing an early indication of any new water or sediment quality problems associated with the storm drains.
- Informing decision-making regarding additional source controls.
- Tracing sources of contamination to outfalls using sediment traps.

The objectives are accomplished through performance of the following:

- Provide Ecology and EPA with data characterizing the quality of the water and sediments discharging into the Thea Foss and Wheeler-Osgood Waterways
- Collect and submit for analysis representative composite and grab stormwater samples during stormflow events from all seven outfalls
- Collect and submit for analysis representative annual sediment samples at specified manholes;
- Produce an annual report documenting activities associated with the sampling and analysis effort, a quality assurance review of field and laboratory data, and an evaluation of the data relative to continuing source control efforts and deliver the report to Ecology and EPA

1.4 Background

1.4.1 Remedial Action Description

In 2006, the City completed remediation of marine sediments in the Thea Foss and Wheeler-Osgood Waterways. The remedy for the waterway included a combination of natural recovery, dredging, and capping. The dredged material was disposed of in a nearshore confined disposal facility in the nearby St. Paul Waterway.

In general, the remedy included the following elements:

- No action at the mouth of the waterway, an area of clean sediments.
- Natural recovery north of East 11th Street, an area where low-level contamination was expected to recover to below the SQOs within the first 10 years following remediation, and which is currently below required navigational depths.
- Some combination of dredging (complete or partial) followed by capping over any residual contaminated sediment in the area from the East 11th Street Bridge to just north of the State Route (SR) 509 Bridge. Note that the authorized channel depth requirements are generally maintained in this area.
- Capping (by others, referred to herein as the Utilities) from just north of the SR509 Bridge to the head of the waterway to maintain a depth of 10 feet Mean Lower Low Water (MLLW). Deauthorization of the federal navigation channel in this area was required to eliminate the need to maintain authorized channel depths and was approved as part of the Water Resources Development Act (WRDA) Bill of 2007.

Other remedy features included:

- Construction of intertidal habitat as mitigation for construction impacts
- Dredging to maintain authorized depths in the active navigation channel
- Capping of about 20 acres of sediments in channel and harbor areas
- New slopes and erosion protection on about 10,000 feet of shoreline

In December 2019, EPA determined that the remedial action work that the City was required to perform under the Consent Decree with EPA had been officially completed and they have initiated the process to delist the waterway from the Commencement Bay Superfund Site. Long-term monitoring and maintenance work for containment and mitigation areas will continue under the Long-Term Monitoring Plan, along with stormwater monitoring under the Stormwater Work Plan Addendum as the only remaining work under the Consent Decree.

1.4.2 Drainage Basin Description

The Thea Foss and Wheeler-Osgood Waterways are estuarine waterways on the southeastern margin of Commencement Bay. In Commencement Bay and the waterways, average tidal fluctuations vary from 0 feet MLLW to 11 feet MLLW. Extreme tides, which generally occur in June and December, range from approximately –4.0 feet MLLW to 14.5 feet MLLW. The Thea Foss Waterway lies generally north-south along the City’s downtown corridor. The Wheeler-Osgood Waterway lies west-east and connects to the east side of the Thea Foss Waterway just south of the Murray Morgan (11th Street) Bridge. The Thea Foss and Wheeler-Osgood Waterways are commonly referred to as the Thea Foss or Foss Waterway and are referred to herein as the Foss Waterway. The drainage area tributary to the Foss Waterway is referred to herein as the Foss Waterway Watershed.

The Foss Waterway Watershed is one of nine watersheds in the City (see Figure 1-2). This watershed covers approximately 5,864 acres and is comprised of drainage basins located in the south-central portion of Tacoma. The area borders the North Tacoma Watershed on the north, Lawrence Street on the west, and East "F" to East "K" Streets on the east. The area extends as far south as South 86th Street and includes portions of the Tideflats on the east side of the Foss Waterway.

The primary municipal outfalls to the Foss Waterway are OF237A and OF237B (twin 96ers), OF230, OF235, OF243, OF245, and OF254. These outfalls cover 5,744 acres (98 percent) of the watershed. There are also several other smaller outfalls that discharge to the waterway. Primary land uses within the basins draining to each of the major outfall are as follows:

Outfall	Area (Ac)	Land Use
230	557	Commercial and Residential
235*	156	Residential and Commercial
237A	2,823	Residential, Commercial, and Industrial
237B	1,991	Residential and Commercial
243	59	Industrial and Commercial
245	39	Industrial and Commercial
254	119	Industrial and Commercial

A new outfall, OF230A, was under construction throughout WY2022. Transition of flow from the drainage area to the new outfall did not begin until the end of the water year, so all stormwater data from WY2022 will be evaluated consistent with data from the entire reporting period. This new outfall will carry approximately 98 percent of the stormwater previously discharging to OF230 and approximately 26 percent of the stormwater previously discharging to OF235. The City will be proposing a modification to the monitoring program in 2023.

Overall, land use in the watershed is predominately residential, although most of the City's commercial businesses are also located in this watershed (see Figure 1-3). There are some industrial uses, which are concentrated mainly in the eastern Tideflats areas and Nalley Valley portions of the watershed.

Several of the outfalls discharging to Foss Waterway are tidally influenced, and portions of the pipe are inundated with marine water twice a day depending on the pipe elevations and the tide height. Continuous or tidal baseflow is also present in some of the outfalls. Baseflow in OF230, OF235, OF237A, and OF237B is continuous. In OF237A and OF237B, this baseflow is derived from old creeks and seeps that were piped and/or infiltrating groundwater. In OF230 and OF235, this baseflow consists of groundwater and/or noncontact cooling water. Baseflow in eastside outfalls OF243, OF245, and OF254 is seasonal (i.e., higher in the winter and lower in the summer) and is believed to be due to groundwater infiltration due to the high water tables in the Tideflats area.

Since 2001, the City has performed a significant amount of sampling and analysis of the storm drains entering the Foss Waterway. Over the last 21 years, 2,325 samples have been collected, including baseflow (366), stormwater (1,463), and SSPM samples (128 outfall and 368 upline). The purpose of the sampling efforts is to evaluate the quality of stormwater discharges to the Foss Waterway and the effect of those discharges on sediment quality. Early in the program, the results of these efforts were used in an overall evaluation of source loadings to the waterway to predict whether municipal stormwater discharges would be protective of sediment quality following remediation. Prior to beginning remedial action projects, EPA determined that sufficient source control was in place to complete the work. Now the results of stormwater monitoring are used to evaluate the effectiveness of source control efforts, and to provide early warning of any new problems which may arise in the drainages. In addition, the results are used to track changes in stormwater quality and to document the improvements that have been realized over time due to source control and other efforts.

1.4.3 Contaminants of Concern

COCs are those contaminants that were identified through sediment monitoring and model predictions to have the greatest potential to compromise sediment quality in the waterways following remediation. They were, therefore, the primary target for source control activities for the municipal storm drains as well as for other potential sources that are largely not in the City's control. DEHP and various PAHs are the primary COCs for the Foss Waterway and have therefore been the primary focus of source control activities to date. In addition, residual concentrations of other legacy COCs for which sources have largely been controlled through regulatory bans or restrictions are continuing to be monitored. These legacy COCs include mercury and polychlorinated biphenyls (PCBs). Source control activities have also been conducted for these COCs.

1.5 THEA FOSS POST-REMEDIATION SOURCE CONTROL STRATEGY

For ongoing evaluation of the municipal stormwater discharges and their relation to future sediment conditions in the waterway, the City established a source control strategy. This strategy is set forth in Figure 1-1.

The City is continuing to implement a comprehensive stormwater monitoring program in the Foss Waterway Watershed. The results of these efforts have been used over time to focus source control efforts and to assess the source control program's effectiveness. The various components of the post-remediation source control strategy are described in more detail throughout this report.

The City is committed to an ongoing program of stormwater source control to maintain and enhance stormwater quality in the Foss Waterway Watershed. The City will implement all "reasonable and practicable" controls necessary to improve stormwater quality and comply with regulatory standards. "Reasonable and practicable" shall take into consideration maintenance requirements, flood control, and cost in comparison to the effectiveness achieved or expected in reducing contaminant loads to the Foss Waterway.

The remainder of this report is as follows:

- Section 2.0 provides a summary of the source control activities performed during 2022 in the Foss Waterway Watershed.
- Section 3.0 presents the results of the Water Year 2001-2022 stormwater and storm sediment monitoring.
- Section 4.0 presents the results of the Foss Waterway sediment monitoring, when new data are available.
- Section 5.0 provides an update on the evaluation of program effectiveness for the Thea Foss Source Control Strategy.
- Section 6.0 presents a summary of the conclusions, pollutant loading analysis, and recommendations.

This page is intentionally left blank

2.0 SUMMARY OF SOURCE CONTROL ACTIVITIES

The NDPES Phase I Permit, effective August 1, 2019, through July 31, 2024, requires a SWMP, which is divided into 11 components. One of these components is source control. The City integrates this NPDES program element with the ongoing Thea Foss Program to protect the sediment remedy in place in the waterway.

The source control activities performed in 2022 are summarized in Section 2.1, including those associated with the 2022 Source Control Work Plan and those associated with the City's Permit as part of the City's SWMP. Section 2.2 discusses overall requirements of the NPDES Phase 2 Permit, and finally, Section 2.3 presents a summary of the special studies that have been conducted under the Thea Foss Program relevant to source control within the Foss Waterway Watershed.

2.1 SOURCE CONTROL ACTIVITIES COMPLETED IN WY2022

This section provides a summary of source control activities performed in 2022 in the Foss Waterway Watershed. These activities are further detailed in Appendix A, and where relevant, in the specific outfall work plan sections.

Results from WY2022 sediment trap monitoring used in source control investigations is described below in Section 2.1.1 and a status update on source control activities performed under the 2022 Source Control Work Plan is provided in Section 2.2.2.

2.1.1 Stormwater Suspended Particulate Matter (SSPM) Monitoring

SSPM monitoring has been used over time in identifying potential problem areas in sub-drainage systems. Multi-year sampling is used to confirm an ongoing problem area or to confirm control/resolution of an issue. Between WY2002 and WY2022, upstream monitoring has been performed in most of the Foss drainage basins. Table 2-1 lists the upstream monitoring locations as well as the end of pipe sediment trap locations for each of these years.

The drainage basins and SSPM data are shown graphically in Figures 2-1.1 through 2-1.4 for four of the key COCs (i.e., mercury, total PAHs, total phthalates, and total PCBs). These figures show each outfall and upline sediment trap location and the relative level of concentration for that location for that year. The levels of concentrations are color-coded as low, medium, and high concentration ranges with each additional year stacked on the previous year. These levels are set without regulatory basis, but rather were set at the beginning of the sampling program at concentrations based on the data collected to allow for meaningful comparison between monitoring locations and identify areas that were different from others, requiring follow up action.

Low concentration ranges (green) represent concentrations that are similar to other locations with no need for additional source control efforts currently. Medium concentration ranges (yellow) represent concentration levels that are slightly higher than other locations. For locations with medium levels, additional source control actions were initiated in some areas but were at a lower priority in comparison to other locations with higher levels that were determined to be of greater impact. High concentration ranges (red) represent concentration levels above and beyond other locations in the Foss Waterway Watershed, and the need for additional source control was greater in comparison to other locations.

In WY2022, SSPM data for the most part remained the same. However, a few locations increased and a few decreased in concentration as summarized below:

- **Mercury**: Consistent with the past several years, no locations were measured in the high-level range during this monitoring year. Two locations, MH390 (OF245) and FD23 (OF243), were in the moderate range in WY2022 (see Figure 2-1.1). No sample was obtained from FD3A in WY2022 due to ongoing construction activities. These locations are described further below:
    - At MH390 (OF245), concentrations have been in the low range since the beginning of the monitoring period in WY2002. The WY2022 concentration of 0.211 mg/kg was just above the 0.20 mg/kg level established to evaluate relative concentrations on Figure 2-1.1. WY2023 sediment trap results will be reviewed to determine whether this result was an anomaly.
    - At location FD23 (OF243), levels have consistently been in the moderate range since WY2007, and this continued in WY2022. Concentrations during this period ranged from 0.206 mg/kg to 0.661 mg/kg with the highest concentration observed in WY2018 and the lowest concentration in this range observed in WY2021. The WY2022 concentration was 0.2140 mg/kg, remaining in the low end of the range. Considerable source control activities have been performed and follow up work is continuing at this time. A new potential source was identified in 2019 and source control is ongoing. Resampling of the catch basin source occurred in 2022, and the concentration remained elevated although lower than previously detected. In 2023 the catch basin will be recleaned and sampled when sufficient sediment has accumulated.
    - At FD3A (OF230), concentrations have been in the low range since WY2015. The WY2021 concentration was 0.232 mg/kg, just above the 0.20 mg/kg level that was established to evaluate relative concentrations on Figure 2-1.1. No sample was obtained in WY2022 due to ongoing construction activities in the area. This location will continue to be monitored to determine whether the WY2021 moderate level detection was an isolated occurrence or whether any follow up is needed.
- **PAHs**: In WY2022, there were no locations with PAH concentration above the level established for medium or high-level relative concentrations as shown on Figure 2-1.2. PAH concentrations in sediment trap FD13B New (OF237A), which was placed just upstream of FD13B in WY2013 due to water level increases caused by the media filtration treatment system, had fluctuated between the medium and the high range since it was installed. The WY2021 concentration of total PAHs detected at this location dropped to the low range with a concentration of 159,944 µg/kg, down from a concentration of 282,110 µg/kg detected in WY2020. Levels remained in the low range in WY2022 with a measured concentration of 142,919 µg/kg. A source control investigation was initiated in this area in WY2014, resulting in a point source control action in 2016. WY2017 concentrations, however, remained high (316,529 µg/kg) leading to additional work at the site. Additional sources were identified, and the City is continuing to work with these property owners to eliminate sources as they are identified. Additional discussion of this work is included in Section 5.3.
- **Total Phthalates**: All sediment trap concentrations have been in the low range since WY2014 (see Figure 2-1.3).

- **Total PCBs**: One location was in the high-level range and two locations were in the medium range during WY2022 sampling. No sample was obtained from FD3A in WY2022 due to ongoing construction activities. The location with concentrations in the high range was FD16 (OF230), and locations in the medium range were FD10-C (FD237A) and FD18 (OF230) (see Figure 2-1.4). Each of these locations is described in more detail below, along with others that were previously elevated[4]:
  - Concentrations at FD3A (OF230) have been in the high-level range since WY2013. Detected concentrations between WY2017 and WY2020 ranged from 590 µg/kg to 3,600 µg/kg, the concentration detected in WY2021 was 550 µg/kg. No sample was obtained from FD3A in WY2022 due to ongoing construction activities. A source control investigation has been underway in this area for the last several years. Several sources have been identified and some are in the process of being removed. The City is continuing to work with the property owners and regulatory agencies to complete source control actions at these properties (see Section 5.1).
  - Concentrations in FD16 (OF230) fluctuated between low and medium levels from WY2007 to WY2021. The WY2022 concentration of 663 µg/kg was more than double the WY2021 concentration of 170 µg/kg. A source control investigation was conducted in this area between 2017 and 2019, leading to the cleaning of public and private storm systems in the vicinity. With the increasing concentrations in WY2022, additional source control actions will be initiated in 2023. See Section 5.1.
  - FD10C (OF237A) has fluctuated between medium and high levels from WY2013 to WY2022. Concentrations during this time period have ranged from 130 µg/Kg to 1300 µg/kg. The WY2022 concentration of 165 µg/kg is the third year of a decreasing trend at this location following source control efforts. The source control investigation is continuing in this area and additional information can be found in Section 5.3.
  - FD18 (OF230) has varied between moderate and high concentrations since WY2011. The lines in this area were cleaned in 2015, and subsequently concentrations climbed to 790 µg/kg in WY2018, 2,200 µg/kg in WY2019, and 5,300 µg/kg in WY2020. A source control investigation was conducted and identified a source which was removed in WY2020. The WY2021 concentration dropped to 780 µg/kg, a significant drop, but still in the high range. WY2022 results dropped further to a moderate level concentration of 225 µg/kg. Line cleaning is planned for WY2023 after a construction project in this area is complete and follow up sampling will be performed when sufficient sediment has accumulated (see Section 5.1).

[4] During WY2020 SSPM results showed consistently higher levels of PCBs wherever they were detected. Because these higher concentrations were present across several locations and drainage basins, it did not appear to be caused by a specific event or source. While a cause for these elevated concentrations was not identified during the investigation, based on the lower results exhibited during WY2021and WY2022, it was determined that WY2020 results were not accurate and will not be used to determine steps forward in source tracing investigations. See Section 3.5.2.

- WY2020 concentrations in FD2 (OF237A) were measured in the medium range (390 µg/kg) for the first time since WY2015. In WY2021, results decreased to 180 µg/Kg, still in the medium range. There is no known source for these intermittent increases in concentration. PCBs were not detected in FD2 in WY2022.
- Concentrations at FD3-New (OF230) were at medium levels between WY2015 and WY2017 but were not detected at this location in WY2018. In WY2019, concentrations returned to medium levels (350 µg/kg) and in WY2020, more than doubled to an elevated level of 910 µg/kg. In WY2021, concentrations returned once again to medium levels at 300 µg/kg and in WY2022 were at the low level concentration of 64 µg/kg. FD3-New previously had relatively high levels measured between WY2004 and WY2007, but those decreased to low levels between WY2008 and WY2013 following cleaning of the lines in the drainage basin. The lines were cleaned again in early 2015. Additional source control activities for PCBs are currently underway in this basin.
- Concentrations at FD6 were low throughout the monitoring period until measuring at a medium level (280 µg/kg) in WY2019 and increasing to a high level (420 µg/kg) in WY2020. In WY2021 and WY2022, PCBs were not detected at this location. A significant development project is underway at a previously identified cleanup site (Jefferson Avenue site) in this area, and following completion of the construction project, sediment trap results will be reviewed to determine whether development activities at that site have resolved this issue of intermittent elevated concentrations.
- Concentrations at FD2A (OF237A) measured in the medium range (ranging from 210 µg/kg to 280 µg/kg) from WY2018 to WY2020. This represented a slight increase since WY2017 when concentrations were in the low range (99 µg/kg). Concentrations had previously been at the medium level of 170 µg/kg at this location in WY2016. In WY2021, concentrations decreased again into the low range with a concentration of 100 µg/Kg, and were undetected in WY2022. Source control investigations for PCBs are ongoing in the upper portion of this drainage basin near FD10C, as discussed above and in greater detail in Section 5.3. Following completion of that work, the need for additional investigation in this drainage basin will be determined.
- Concentrations at FD35 (OF237B) varied between the high and medium ranges between WY2012 and WY2017 with concentrations ranging from 130 to 850 µg/kg. A source control investigation was completed in this area, followed by removal of the expected source in 2015-2016. The WY2018 sediment trap sample was the first representing a full year of the area in its remediated condition. Concentrations were at low levels in WY2018 (92 µg/kg) where they remained in WY2019 (94 µg/kg). While the concentration increased back to the medium range at 250 µg/kg in WY2020, PCBs were not detected in WY2021 or WY2022. The WY2020 concentration appears to be an anomaly, and source control efforts in this area appear to have been successful in removing this source. Therefore, samples from FD35 will no longer be analyzed.

Over the 21-year monitoring period, the number of sites with concentrations at the medium and high levels has decreased significantly. This is a good indicator of the effectiveness of the source control program. However, as indicated above, several sites remain at medium and high levels or fluctuate to the medium and high levels as compared to the other sites in the Foss Waterway Watershed and are therefore the focus of ongoing source control work.

The data results by basin are discussed in Section 5.0 of this report. The City will continue to conduct SSPM monitoring using sediment traps at the outfalls and at selected upstream locations in several drainage basins where needed for ongoing source control investigations.

2.1.2 2022 Source Control Work Plan Status

Tacoma submitted the 2021 Stormwater Source Control Report and Water Year 2021 Stormwater Monitoring Report on March 31, 2022 (Tacoma 2022). In this report, the City recommended several source control activities in the 2022 Source Control Work Plan (referred to herein as the 2022 Work Plan). A summary of the status or outcome of each of these source control activities is provided below.

A majority of the recommended tasks from the 2022 Work Plan were completed or are ongoing at this time. Activities from the 2022 Work Plan and their status are as follows:

- **OF230:** Continue follow-up on private property cleanups performed, and complete ongoing system cleaning and monitoring for PCBs and PAHs as appropriate in the areas draining to FD3A, FD3A New, and FD18.

  Status: Significant work has been underway in this area since 2012, and several Mercury, PCB, phthalate, and PAH sources have been identified and controlled. Several areas of concern have been the subject of ongoing work, and 2022 activities in each of these areas are summarized below:

  - South 12th Street and Pacific Avenue (PCBs): Due to construction in the area, there are no WY2022 sediment trap results for FD3A. WY2021 sediment trap results for
    FD3A had continued to show elevated PCB concentrations (550 µg/kg), although they were significantly lower than measured in WY2020 (3,600 µg/kg) (see footnote 4 in
    Section 2.1.1). Source control actions are continuing in this area and additional catch basin sampling performed in the area indicated either a continued source, or insufficient cleaning performed post source control actions previously performed. Some catch basins were inaccessible for sampling during this previous event. In 2021, the City recleaned these basins and in 2022 they were resampled. Results from one of the basins showed continued elevated results, so the City met with the owners of adjacent properties to discuss the results. It was agreed that the catch basins would be recleaned as needed and all would be resampled when sediments have accumulated to ensure that levels detected in 2022 were not an anomaly. A plan for next steps will be developed when these results are available.
  - South 9th Street and Fawcett Avenue (PCBs): Following completion of building remediation in 2020, the storm system was cleaned. In September 2021, sediment samples were taken from adjacent catch basins, and elevated PCB concentrations were detected. At the City's request, the property owner pressure washed the sidewalks to remove residual materials. In 2022, a construction project began at this location, which involved the removal and replacement of all of the curb/gutter and sidewalk at this intersection. The project also removed one

of the catch basins sampled during this investigation. After this project is complete, the catch basins will be cleaned and once adequate sediment has accumulated, the catch basins will be resampled to ensure the sources of PCBs have been removed from this site.

  - South 13th Street and Commerce Street (PCBs): Catch basins were cleaned in May 2021. It is anticipated that resampling will occur in summer 2023 when sufficient sediment has accumulated.
  - South 10th Street and Pacific Avenue (PCBs): The City is continuing to work with the EPA to develop a remediation plan for the Park Plaza North parking structure. The City presented sampling results and a summary report to EPA in early 2022 and anticipates initiation of remediation in 2023.
  - South 14th Street and "A" Street (PAHs): Throughout 2022, the City continued to work with the property owner to fix a damaged drainage pipe that was allowing sediments to enter the system. The property owner obtained a permit from Ecology in 2022 and the repair was completed in October 2022. Both the municipal and private systems were cleaned in November 2022. Public catch basins will be resampled in 2023 when sufficient sediment has accumulated.

Reports describing the investigations performed to date in this area and the status of each are included in Appendix A.

- **OF230/OF235:** Continue to monitor spring/summer outliers for copper to stormwater. If they persist, evaluate potential sources.

  Status: No copper outliers were observed during WY2020 sampling; however, one moderate outlier was detected in OF230 and two extreme outliers in OF235 in WY2021 sampling. All the WY2021 outliers were detected in the spring. No outliers were detected in WY2022. The City will continue to watch for these outliers and is investigating potential sources. One potential source was identified as discussed in Appendix A. The City is working with the property manager at the Union Station to clean their onsite drainage system and will resample when this work has been completed. In addition, the City has requested information regarding any ongoing maintenance procedures used on their site, including the large copper roof.

- **OF235:** Evaluate the need for additional source control work for lead, copper, and DEHP in stormwater following completion of construction activities in this area. These construction activities are expected to have a positive impact on controlling the flow of potentially contaminated groundwater into the storm drainage system.

  Status: During 2022, the City continued to monitor the sites in this area with active construction to ensure proper BMPs were maintained. Upon completion, it will be determined whether construction in this area will eliminate runoff from possible contaminated groundwater in this drainage basin. This project is on hold until the new Foss Waterway outfall construction is completed. The construction for the new outfall and the rerouting of the stormwater system was completed in December 2022 and it is anticipated that construction for the Tacoma Town Center Jefferson Street Project will continue in 2023. In December 2022, a stormwater collection pond at the construction site was connected to the City's stormwater system and will be in place through the end of the project.

- **OF237A:** Continue to work in the area at and around The News Tribune to eliminate source(s) of PAHs to the municipal drainage system. Monitor upcoming SSPM results and catch basin sample results near FD13B-New to evaluate whether source control work done to date in this area has been successful in eliminating this source.

  Status: This investigation has been ongoing for several years, with medium range PAH concentrations present in FD13B-New through WY2020, before dropping to the low range in WY2021 where they remained in WY2022. In 2021, staff discovered an additional property that has stormwater discharge to this system. Catch basins from that property showed high concentrations of PAHs, and the property owner was asked to clean their entire system. This system cleaning was performed in September 2021, and basins were resampled in 2022. Results continued to be elevated so the City is continuing to work with the property owner to complete additional work on resurfacing the parking lot. Once this work is complete, the system will be cleaned and resampled when sufficient sediment has accumulated.

  A report on the status of this investigation is included in Appendix A.

- **OF237A:** Continue evaluation of possible sources of PCBs to FD10C.

  Status: During 2021, additional sampling showed no apparent sources of PCBs. In 2022, additional investigation was performed to confirm that there were no errors in the mapping that might lead to identification of a potential source. With that mapping information confirmed, the City is continuing the investigation with installation of short-term sediment traps at two new location in attempt to isolate the source. Data is expected in early 2023, and next steps will be determined based on results.

  A report describing the investigation completed to date is included in Appendix A.

- **OF237A:** Evaluate potential sources of occasional outliers of indeno(1,2,3-cd)pyrene and other PAHs in stormwater.

  Status: Periodic high outlier concentrations of indeno(1,2,3-cd)pyrene have been detected in this basin over time, including some higher concentrations in WY2021 and an extreme outlier in WY2022 (see Figure G-6). Overall concentrations are significantly reduced over concentrations identified early in the 21-year monitoring record. However, because of these occasional elevated concentrations, the City will initiate review of potential unidentified sources of indeno(1,2,3-c,d)pyrene and other PAHs in this drainage basin.

- **OF243:** Perform follow-up work with the business owner and system cleaning work in the area where elevated mercury concentrations were identified in catch basins in the FD23 drainage area.

  Status: During 2022 staff resampled the identified catch basin to determine if there is an ongoing mercury issue at that location. The catch basin was sampled on June 21, 2022, and the results were 1.38 mg/kg. Catch basin concentrations continue to trend downward and there are no other probable sources to investigate at this location. During 2023, EC staff will request to have the catch basin recleaned and sampled after sediment accumulates to determine if there is a continued source or residual contamination from the previously remediated source.

- **OF243/OF245/OF254:** Continue evaluation of the effectiveness of the street sweeping pilot project on lead and zinc concentrations in the industrial area as additional data becomes available.

  Status: The City initiated a pilot program in WY2014 that continued through WY2022 to determine whether an increased frequency of street sweeping in this area would influence elevated lead and zinc concentrations in stormwater and baseflow in this area. Starting on October 1, 2013, the City began sweeping the right-of-way (ROW) within the OF243 and OF245 drainage basins at a frequency of once every two weeks rather than the usual frequency of once per month for industrial areas. An evaluation of the effectiveness of this increased sweeping frequency on metals reductions has been performed since WY2017 and is discussed in more detail in Section 2.3.2. Note that while initial results appear promising, the statistical analysis will be more robust in future monitoring years as more data becomes available. The pilot project is continuing in WY2023.

- **OF254:** Continue to work toward expansion of the area of increased street sweeping frequency to the remainder of basin as resources become available.

  Status: This drainage basin did receive extra sweeping during WY2022, and results will be included in statistical analyses when sufficient data is available.

Other tasks conducted under the Source Control Program are:

- Continue Foss Stormwater Monitoring for WY2023.

  Status: WY2022 stormwater monitoring was completed on September 30, 2022, and WY2023 stormwater monitoring is currently underway.

- Review WY2022 SSPM data in all areas when available to evaluate the effectiveness of treatment systems installed and confirm the effectiveness of source control actions that have been taken over time.

  Status: Data review completed. An evaluation of these results is included in Sections 3.0 and 5.0 and summarized above. Generally, stormwater facilities are inspected once per year and maintenance performed as indicated by inspection results. The City has a twenty-year cleaning cycle for drainage systems throughout the City. Determination of whether a more frequent maintenance schedule is needed in the Foss Basins will continue to be statistically evaluated as additional data become available.

- Monitor the major construction activities throughout the watershed including the Washington State Department of Transportation (WSDOT) Nalley Valley Viaduct/SR-16 rebuild.

  Status: Ongoing. Major construction projects occurring in each basin are discussed in Section 5.0 as applicable.

- Monitor and conduct inspections at new developments as completed to review appropriate BMPs for each site.

Status: Inspections at new developments continue, including the inspection/approval of new BMP treatment devices.

- Implement the City's Stormwater Management Manual, 2021 Edition.

  Status: The 2021 Stormwater Management Manual is currently being implemented for projects with applications submitted on or after July 1, 2021.

- Continue NPDES business inspections program and document the inspections using the business inspections database. Respond and track all complaints/spills in the complaints database.

  Status: Business inspections and spill/complaint response is continuing, and activities are tracked in the database. A summary is provided in Appendix A.

- Monitor Tacoma-Pierce County Health Department (TPCHD) and Ecology underground storage tank/leaking underground storage tank (UST/LUST) removal projects along with any other remediation projects in the watershed.

  Status: Ongoing. A summary of UST/LUST work performed under TPCHD oversight in 2022 is included in Appendix A.

2.2 City of Tacoma Phase I Municipal Stormwater Permit

The City of Tacoma Phase I Municipal Stormwater Permit regulates the discharge of stormwater to surface waters and groundwaters of the state from the City's MS4. The permit is designed to protect and improve the water quality of receiving waters by implementing stormwater management activities. Tacoma's SWMP describes the City of Tacoma's plan for meeting Permit goals and managing stormwater in compliance with the NPDES Phase I Municipal Stormwater Permit.

The 2019-2024 NPDES permit included a requirement that a new Stormwater QAPP be developed. Sampling reported in this monitoring report was performed in compliance with the 2020 QAPP developed under the 2019-2024 permit.

The City's program and its progress under the NPDES permit each year are summarized in an NPDES Annual Report. The NPDES Annual Report is used as a tool to assess the City's progress and to determine whether any changes to the SWMP procedures or priorities are needed to fulfill the permit obligations. The SWMP is evaluated annually, and updated when necessary, based on the annual report and program assessment.

2.2.1 City of Tacoma Stormwater Management Program

The SWMP describes Tacoma's plan for meeting Permit goals and managing stormwater in compliance with the NPDES Phase I Municipal Stormwater Permit. The City is considered a leader in responding to water quality issues related to urban runoff. The City's activities have included pioneering efforts in water quality testing to identify pollutants in stormwater runoff as early as 1980. Other efforts have included investigating source control and treatment of stormwater pollutants like phthalates. The Tacoma City Council and Tacoma's Surface Water Utility ratepayers have supported substantial rate increases in recognition of the importance of protecting and enhancing the water quality in Commencement Bay and our freshwater lakes, wetlands, and streams in the face of increasing stormwater runoff and pollutant loads from urban development, increased traffic, and population pressure.

The City's established goals further emphasize its commitment to meeting the water quality goals under this permit. These priorities include the following:

- Manage stormwater to minimize flooding, erosion, and contamination
- Mitigate the impacts of increased runoff from urbanization
- Manage runoff from developed properties and those under development
- Protect the health, safety, and welfare of the public
- Correct or mitigate existing water quality problems
- Restore and maintain the chemical, physical, and biological integrity of waters in the City for the protection of beneficial uses
- Develop and put into place a cost-effective, affordable SWMP
- Educate the public about what they can do to help keep our waters clean

The Science and Engineering Division, Operations and Maintenance Division, and Environmental Compliance Section of the Environmental Services Department administer Tacoma's SWMP. Staffing and budget are designed to meet the program goals and challenges described above. Current work includes:

- Inspecting business activities and educating businesses about BMPs to reduce stormwater impacts
- Collecting and evaluating stormwater and sediment quality monitoring data
- Implementing a source control and illicit discharge screening program throughout the City's nine watersheds
- Mapping, maintaining, and cleaning the City's stormwater system that includes approximately 500 miles of storm pipe, 10,000 manholes, 19,000 catch basins, 450 outfalls, four pump stations, and over 130 stormwater ponds and other treatment and flow control facilities
- Managing the City's tree canopy cover and open spaces to maximize stormwater benefits
- Rehabilitating and replacing aging infrastructure and improving the storm system with capital projects to address identified flow control and water quantity issues; infrastructure assessment of areas in need of attention is done using crawler cameras
- Providing public education about the impacts of polluted runoff and practices to reduce those impacts to create behavior change in target audiences ranging from school-age children and homeowners to property managers and builders
- Coordinating our activities regionally through watershed councils, NPDES permit-holder committees, and others
- Permitting and inspecting new and redevelopment construction projects to help them comply with stormwater requirements including erosion control, maximizing onsite

management, use of Local Improvement Districts (LID), stormwater treatment, flow control, wetlands protection, and ongoing maintenance

- Provide staff training to ensure the City activities and operations minimize impacts to stormwater and receiving waters

City-wide activities are expected to benefit the quantity and quality of stormwater discharges to the Foss Waterway as well as discharges to other receiving waters throughout the City. As indicated above, the SWMP is evaluated annually and updated, when necessary, based on the annual report and program assessment that will continue to supplement and enhance the City's existing program activities.

2.2.2 2022 Business Inspections/Spills/Complaints

The City began conducting stormwater business inspections prior to 1984 as part of its delegated responsibility to implement Ecology's NPDES sanitary sewer pretreatment program. Subsequently, the inspection program was intensified in the Foss Waterway Watershed in response to EPA's identification of municipal outfalls as a potential source of contaminants to the Foss Waterway, which had been identified as a problem area within the Commencement Bay Superfund Site. In 2002, under the CD with the EPA for the Foss Waterway Superfund Cleanup, the City further expanded its comprehensive source control program in the Foss Waterway Watershed. The City's Source Control Program was later expanded City-wide to fulfill the 2007 NPDES permit requirements.

The current program is managed by the Environmental Services Department and includes the following:

- Inspecting multi-family units (i.e., those that include four or more residential units) in addition to businesses and industries. Inspections address both stormwater and sanitary compliance.
- Providing information on BMPs and program literature directly to businesses during site visits (which are available in the City's Stormwater Management Manual).
- Educating the general public and businesses on BMPs and City environmental programs.
- Inspecting and signing off on commercial drainage facilities. This inspection also provides an educational opportunity for Environmental Compliance (EC) inspectors to review operation and maintenance requirements with the builder or owner.
- Continuing to implement the City's Illicit Discharge Detection and Elimination (IDDE) Program that includes investigation and termination of illicit connections. The IDDE Program uses the City's database to track the complete process of screening, investigation, referral to responsible agencies (if other than the City), and enforcement.
- Use of a SQL database, the Environmental Services Spills and Complaints Database, to track spills, complaints, business inspections and flooding claims since 2003. Regular updates and refinements have been made to facilitate advanced data management for tracking inspections.
- Investigating potential illicit or historic contamination discharges based on complaints, business inspection reports and stormwater monitoring information and responding to potential and confirmed illicit discharges using the same procedures applied to potential illicit connections.

Out of all the 2022 business inspections/spill and complaints responses (479 business inspections, 851 spill/complaint responses, and 1,090 treatment device inspections), only 16 formal enforcement action letters (ten Warning letters, one Illicit Connection letter, three Surfacing Effluent letters, and two Notices of Violation) were sent City-wide. Three of these were in the Foss Waterway Watershed. City-wide, only a small percentage of all inspections led to formal warnings or enforcement which shows that the City's education-based source control program continues to be very successful and that the business community and City's residents are very supportive and engaged in protecting stormwater quality.

Thus far, since the first NPDES Permit was issued in 2007, Tacoma has canvassed/inspected 100 percent of the City, inspecting both sanitary and stormwater compliance. The vast majority of the inspections originally found catch basins that had never been cleaned. These inspection efforts have resulted in tons of catch basin sediment removal, drainage repair, sewer protection, and customer education.

2.3 BMP Effectiveness Studies

The primary COCs in waterway sediments are DEHP and PAHs. Since their presence is fairly ubiquitous in urban runoff, many of the City's source control efforts over the years have been aimed at reducing concentrations of these constituents. Phthalates, in particular, are widespread in the urban environment. Because of challenges faced by the City and others in addressing phthalate contamination, a Phthalate Work Group comprised of the City, EPA, Ecology, King County/Metro, and Seattle Public Utilities was formed in 2006 to research the sources, pathways, and treatment options for phthalates and other ubiquitous compounds in stormwater. The group developed a Summary of Findings and Recommendations document[5] which is currently in the process of being implemented by the regulatory agencies. Ecology is currently working with the Washington State Department of Health, along with industry and environmental stakeholders including the City, to develop a Phthalate Action Plan that identifies sources of phthalates, and recommends actions to reduce the use, release, and exposure to phthalates in Washington.

In addition, the City is continuing to employ enhanced maintenance in the municipal stormwater conveyance system as described further below. Maintenance area sub-basins are shown on Figure 2-2.

2.3.1 Storm Line Cleaning

The City evaluated the effectiveness of a thorough and systematic maintenance practice for aging pipe systems. Between 2006 and 2008, the City completed basin-wide sewer line cleaning of three entire drainage basins (OF254, OF235, and OF230) and part of a fourth basin (OF237A). In 2010 to 2011, a fifth basin (OF237B) was cleaned and in 2021 a first cleaning occurred in OF243 and OF245. The objective of the sewer line cleaning program was to remove residual sediments in the storm drains, some of which may contain legacy contamination from past years that may continue to contaminate stormwater or baseflow through resuspension and/or dissolution. Second cleanings have been performed in portions of OF237A andOF254.

---

[5] Document is available on the Washington State Department of Ecology's website. To view the document copy and paste this link into your web browser: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.592.1779&rep=rep1&type=pdf

This effectiveness evaluation was included in past annual reports and results are updated here with the WY2022 data. Results of the analysis are presented in Table 2-2 and shown graphically on Figures 2-3.1 through 2-3.7. A summary of significant reductions observed for each outfall is discussed in Section 5.0. This effectiveness evaluation will continue to be updated as more post-cleaning data become available. While the City's Asset Management group has established a City-wide schedule of line cleaning approximately every twenty years, the Foss data will be evaluated statistically to determine whether more frequent cleaning is needed due to the sensitivity of the receiving water body. As additional wide-scale cleaning in the Foss Basin is performed, the statistical approach will be reviewed and modified, if applicable, to provide the most meaningful analysis of effectiveness of this enhanced maintenance practice over time.

2.3.2 Enhanced Street Sweeping

In January 2007, the City's street sweeping program was transferred from the Streets and Grounds division to the Sewer Transmission Maintenance section for continued implementation. The program was enhanced at that time in an attempt to reduce sediment buildup in the storm sewer system. The schedule was set to sweep all areas of the City twice per year, with more frequent sweeping in the business districts and on major arterials. The 12 primary business districts in the City are swept at night two to three times per week and major arterials are swept on a 3-week rotation. The City also increased communications with residents and business owners, which helped raise awareness of the importance of the street sweeping program.

In 2007, when the work was transferred over, sweeping was done with a combination of mechanical and vacuum sweepers. In 2008, the City started the transition from mechanical sweepers to regenerative air machines. In mid-2018, due to the end of usable life of one of the City's regenerative air sweepers and a staff retirement, Tacoma temporarily reduced its street sweeping program. This resulted in Tacoma reducing the frequency of arterial sweeping to quarterly and residential streets to annually. The City received a grant from Ecology in 2021 to purchase an additional street sweeper that will allow staff to increase back to the higher sweeping frequency. The proposed schedule will increase the frequency of sweeping at arterials from every 12 weeks to every six weeks and increase residential sweeping to twice per year. The sweeper was purchased during 2021, however there are currently delivery delays. The expected delivery date is October 2022 – early January 2023. GPS is used to track the number of miles swept and the amount of material removed is recorded.

Similar to line cleaning, the effectiveness of the program was evaluated, and results are presented in Table 2-3.1. The results are discussed in more detail in Section 5.0 and Appendix A. This effectiveness evaluation will continue to be updated as more post-enhanced sweeping data becomes available.

In addition, in response to relatively elevated concentrations of lead and zinc in both stormwater and baseflow in the industrial basins OF243 and OF245, the City initiated a pilot program in WY2014 to determine whether an increased frequency of street sweeping in this area would have an effect on these results. Starting on October 1, 2013, the City began sweeping the ROW within these drainage basins at a frequency of once every two weeks rather than the usual frequency of once per month for industrial areas. The pilot project continued in WY2022 and is ongoing at this time.

With several years of data available, statistical analysis of the effectiveness of this enhanced sweeping schedule was done, although results will be more statistically robust as additional data becomes available. Evaluation of the change in concentrations before and after implementation of the pilot project in these basins is presented in Table 2-3.2. The results are discussed in more detail in Section 5.0. This effectiveness evaluation will continue to be updated as more data becomes available.

With the promising results shown from the pilot project in the basins for OF243 and OF245, a portion of the OF254 drainage basin was added to the pilot project starting in January 2019. As staff and equipment capacity becomes available the City hopes to increase street sweeping in the entire OF254 drainage basin. It is expected this will occur in 2023.

2.3.3 CIPP Lining

Approximately 41,921 linear feet of existing storm sewer has been rehabilitated in the Foss Waterway Watershed using CIPP construction technologies. This approach fixes pipe defects (e.g., cracks, holes) that could have allowed potentially contaminated groundwater and soil from historic “hot spots” to enter the storm sewer system. Similar to line cleaning and street sweeping, the effectiveness of this approach was evaluated through WY2020, and results showing the effectiveness of this maintenance activity are presented in past reports. Since this is not a maintenance activity that will recur in these pipes over time, the statistical comparison of pre- and post-lining was discontinued in WY2020.

3.0 STORMWATER AND STORM SEDIMENT MONITORING RESULTS

A major component of the Thea Foss Post-Remediation Source Control Strategy is the stormwater monitoring program. As described above, conducting stormwater monitoring is required under the Thea Foss Waterway Consent Decree (CD) with EPA and by Section S8.C of the National NPDES and State Waste Discharge General Permit for Discharges from Large and Medium Municipal Separate Storm Sewer Systems (Permit). To address these monitoring requirements, stormwater monitoring is conducted at seven outfalls in the Foss Waterway and includes collection of event-based composite and grab stormwater samples as well as annual sediment trap samples for chemical analysis.

The goal of the stormwater characterization monitoring study is to meet the requirements of the Foss CD and Section S8.C of the Permit. The goals of both programs generally involve:

- Measuring the effectiveness of stormwater source control actions, confirming that reductions in concentrations of target analytes have been realized, and confirming that recontamination from stormwater sources is not occurring; this is achieved by gathering data to identify trends in the quality of the water
- Providing an early indication of any new water or sediment quality problems associated with the storm drains
- Informing decision-making regarding additional source controls
- Tracing sources of contamination in outfalls as needed using sediment traps

The objectives will be accomplished through performance of the following:

- Provide Ecology and EPA with data characterizing the quality of the water and sediments discharging into the Thea Foss and Wheeler-Osgood Waterways
- Collect and submit for analysis representative composite and grab stormwater samples during stormflow events from all seven outfalls
- Collect and submit for analysis representative annual sediment samples at specified manholes
- Produce an annual report documenting activities associated with the sampling and analysis effort, a quality assurance review of field and laboratory data, and an evaluation of the data relative to continuing source control efforts and deliver the report to Ecology and EPA

Over a 21-year period (August 2001–September 2022), stormwater and SSPM have been sampled at the seven major outfalls that discharge into the Thea Foss and Wheeler-Osgood Waterways. In addition, baseflow was sampled at the same seven outfalls for the first ten years of the program[6]. Over the last 21 years, 2,325 samples have been collected, with

[6] After ten years of baseflow monitoring were completed at the end of WY2011, baseflow monitoring was discontinued (approval granted by EPA and Ecology on September 7th and September 9, 2012, respectively). Baseflow quantity and quality were determined to be well characterized by the 10-year monitoring record. Some additional baseflow monitoring was performed in WY2016 and in WY2019 to determine whether there had been changes in recent years. In general, both the 2016 and 2019 baseflow concentrations were similar to or less than the 2001-2011 baseflow concentrations.

366 baseflow and 1,463stormwater samples collected at the outfalls, and 128 outfall and 368 upline SSPM samples collected in pipeline sediment traps deployed throughout the watershed. The whole-water and SSPM concentrations discharged to the waterway are affected by a number of factors. Some of these factors include:

- Weather conditions and rainfall amounts and distributions which cannot be controlled by the City
- Inherent variability of chemical concentrations in stormwater runoff which are addressed using statistically based sampling designs
- Source activities and land use within the basin
- Illicit discharges

Section 3.1, Sample Representativeness, is a summary of the Data Validation Report that is presented in Appendix B. WY2022 analytical data for stormwater and SSPM are presented in Appendix D.

3.1 SAMPLE REPRESENTATIVENESS

Representativeness evaluates field sampling approximation of actual (true) stormwater and SSPM water quality and quantity of the Foss Waterway Watershed. Representative sampling results are used to identify trends in stormwater quality, provide an early indication of new contaminant sources, and trace sources of contamination within the municipal outfalls (Tacoma 2020b).

3.1.1 Monitoring Design

Stormwater comprises the majority of freshwater discharge from municipal outfalls and is a direct result of precipitation that produces stormwater runoff and is not a direct result of tidal fluctuations. Baseflow represents the continuous daily discharge from the municipal outfalls that is not a direct result of precipitation and is not a direct result of tidal fluctuations. Sources of baseflow may originate from seeps, creeks, groundwater infiltration, and illicit connections (see Appendix B).

Baseflow monitoring was discontinued after WY2011 because after ten years of monitoring it was determined that the baseflow component was well characterized. Some additional baseflow monitoring was performed in WY2016 and again in WY2019 to determine whether there were any changes in baseflow conditions since WY2011. In general, baseflow concentrations in both WY2016 and WY2019 were similar to or less than the 2001-2011 baseflow concentrations.

Annual sampling goals for WY2022 include (from each monitoring outfall):[7]

- To meet NPDES Permit Section S8.C requirements:
    - A total of 55 composite stormwater samples combined from the seven outfalls.

---

[7] Prior to WY2013, the annual sampling goal was to collect ten samples from each of the seven monitored outfalls. In October 2012, EPA and Ecology approved a reduction in sampling frequency beginning in WY2013.

  - Sediment trap sampling at six of the outfalls (all but OF254). Five of these locations are collected using in-line sediment traps placed to collect SSPM from stormwater only. The other SSPM location, MH390 (OF245), is a sump manhole and the sediment it collects represents a combination of stormwater and baseflow.

- To meet the Foss CD:
  - A minimum of eight stormwater samples from OF230, OF235, OF237A, and OF237B
  - A minimum of three stormwater samples from OF243, OF245[8], and OF254
  - One SSPM sample from each outfall, except for OF254, as described above

Stormwater monitoring is conducted at seven of the 13 City outfalls discharging to the Foss Waterway. These seven outfalls comprise approximately 5,744 acres, or 98 percent of the total Foss Waterway Watershed drainage (5,864 acres, see Section 1.2.2). Monitored outfalls include OF230, OF235, OF237A, OF237B, OF243, OF245, and OF254. Primary land uses within the Foss Waterway Watershed include residential, commercial, and industrial.

Contaminant source tracing is further executed through sampling of SSPM (see Section 2.1.1). One station is located within the stormwater distribution system, near each outfall that represents the entire basin. It was not possible to locate an SSPM station within OF254 because of tidal influence. Additional upstream stations have been established throughout the Foss Waterway Watershed to evaluate and isolate contaminant sources. Over the years of the program, up to 34 SSPM locations have been sampled annually strictly for source tracing purposes. Sites are removed when it is determined that further source tracing in that area are not needed. In WY2022, nine upline sediment traps were sampled for source tracing purposes in addition to the six outfall sites.

3.1.2 Rainfall Summary for WY2022

For each Water Year, 2002 through 2022, monthly and annual rainfall totals are presented in Table 3-1. The total rainfall for WY2022 was 44.92 inches, almost six inches more than the recent historic average of 38.95 inches (Tacoma No. 1 National Oceanic and Atmospheric Administration (NOAA) site).

The rainfall during WY2022 was generally similar to typical rainfall patterns with a few more extreme monthly averages as illustrated Table 3-1. Rainfall for most months during the wet season was variable with two months having significantly more rainfall than normal and a few months having slightly less rainfall than normal. The remainder of the water year from May through August exhibited the same variable conditions with some months exhibiting somewhat more rainfall than normal and some months with less than average rainfall conditions, including September with no rainfall.

With 21 years of monitoring, the average monthly and annual average rainfall depths for the monitoring period are close to the historical record and are believed to be representative of the

[8] Note that to achieve the target of 55 samples per year required under the NPDES permit, OF245 is included in the list of outfalls with a target of eight samples per year.

average historical record. Table 3-1 shows that the average monthly rainfall for each month during the monitoring period is relatively consistent with historic averages except for November which had nearly 4.5 inches more rainfall than average.

3.1.3 Baseflow

In OF230, OF235, OF237A, and OF237B, baseflow is continuous, derived from old creeks that were piped, seeps or groundwater infiltration, and tides that have a minimal effect. Baseflow in all these systems also includes some amount of non-contact cooling water. A summary of baseflow sources to these outfalls is provided in Appendix B.

OF243, OF245, and OF254 do not have any creeks or other sources that provide constant baseflow. These drains do, however, have tidal backflushing year-round and during the wet season there is evidence of groundwater infiltration due to the high water table in the Tideflats area. The groundwater table is comprised of a bottom layer, which is influenced by tides, and an upper fresher water lens. In the wet season, the upper lens is freshened by rain recharge and salinity effects (e.g., conductivity) are less.

As indicated above, baseflow sampling was conducted during the first ten years of the monitoring program but was discontinued after WY2011 when it was determined that the baseflow had been well characterized. Additional baseflow monitoring was performed in WY2016 and WY2019 to determine whether there had been changes in recent years. Based on the results of the samples taken, it can be concluded that baseflow concentrations have remained fairly consistent or have improved over time.

3.1.4 Stormwater

The intent of stormwater sampling is to identify trends in stormwater quality, to measure the effectiveness of source control actions, and to provide early warning of any new problems that arise in the watershed. Stormwater representativeness is a function of seasonal and individual storm characteristics.

Individual storms, historic averages, and seasonal effects Storm events are variable in nature by runoff volume, flow rate, antecedent rainfall, and season. Each year, this variability is evaluated by comparing the magnitude and intensity of the runoff hydrographs (see Figures 3-2.1 and 3-2.2), where samples were collected on the hydrographs, time between storm events, and time of year the samples were collected, to determine whether a representative range of storm types were included in the monitoring program.

Sampled storms during WY2022 were generally similar but with somewhat storms in the approximately 0.5-0.59 inches in depth range as well as those greater than 0.9 inch range when compared to historic storm magnitudes (see Figure 3-3). Approximately 10.5 percent of both 1948-2009 storms and WY2002-WY2022 storms deposited approximately 0.5-0.59 inch of rainfall compared to 17.6 percent for WY2022. For storms greater than 0.9 inch, approximately 9 percent of 1948-2009 storms and 15 percent of WY2002-WY2022 storms were of this magnitude, while 23.5 percent of storms were greater than 0.9 inch in WY2022. Despite these differences, the growing overall monitoring record completed under this program generally continues to reflect a closer approximation of the historical record (Figure 3-1) except for an ongoing trend toward larger storms during the monitoring period when compared to the historic record.

Based on the historical record (1982-2009), 84 percent of annual precipitation occurs during the wet season and 16 percent during the dry season (see Figure 3-4). Stormwater sampling under the overall monitoring program remains slightly biased toward the dry season, with 23 percent (WY2002-WY2022) of sampled storms occurring during the dry season and 77 percent during the wet season. This is likely due to the fact that antecedent periods are easier to meet in the dry season as compared to the wet season, which provides more opportunities for sampling. WY2022 was closer to the historical record with 18 percent of sampled storms occurring during the dry season and 82 percent during the wet season.

Numeric goals Stormwater sampling representativeness criteria is summarized as follows:

- To meet the requirements of the NPDES Permit, a total of 55 composite samples were taken from the seven outfalls monitored:
- To meet the requirements of the Foss CD:
    - Eight samples collected annually at four sites (OF230, OF235, OF237A, and OF237B)
    - Three samples collected annually from three sites (OF243, OF245[9], and OF254);
- Precipitation:
    - Proportional to storm seasonality
    - During storm flow conditions, defined as:
        - Total precipitation of at least 0.2 inches and,
        - Antecedent periods of less than or equal to 0.05 inch of precipitation in the previous 24 hours during the wet season and less than or equal to 0.02 inch of precipitation in the previous 48 hours during the dry season.
- Storm, sampling, and tidal influence including:
    - Flow composite samples representing 75 percent of the total storm volume (OF237A[10] and OF237B) or,
    - Conductivity (tidal influence) of ≤ 2,000 µS/cm (≤ 5,000 µS/cm at OF243 and OF254), and
    - A minimum of 10 aliquots composited at all sites.

A dry period of six hours provides delineation between individual storms.

In WY2022, samplers were deployed during 24 different events at the various outfalls, resulting in 132 individual sample deployments (see Appendix B, Table B4-2). Seventy-one samples were submitted for analysis during WY2022, of which 70 were accepted. All seven outfalls met the annual sampling goal of eight storms per year for OF230, OF235, OF237A, OF237B, and OF245, and three storms per year for OF243 and OF254.

---

[9] As indicated above, to achieve the target of 55 samples per year under the NPDES permit, OF245 is included in the list of outfalls with a target of eight samples per year.
[10] OF237A, which is now monitored at the 237A New manhole, has some tidal influence so this criterion does not strictly apply.

For each sampling event during WY2022, the City reviewed the flow hydrograph, the discrete sampling times relative to tidal stage, rainfall, and the conductivity (salinity) of the discrete samples to determine which of these samples should be composited to best represent the runoff event. The level, velocity, and flow data for every storm event was evaluated and determined to be representative of stormwater runoff conditions. Most of the stormwater criteria were met for conductivity, tidal window, rainfall, and required number of aliquots, and if not, were evaluated and the samples determined to be representative. Field and analytical data for all the samples collected and analyzed are included in Appendices C and D of the WY2022 Report. Rejected data were not included in any of the statistical analyses. Additional details regarding data validation and sample representativeness are included in Appendix B, Section 4.0.

Stormwater Representativeness Over the course of the City's 21-year monitoring record, a representative range of storm events has been characterized considering the following hydrological variables (see Figures 3-2.1 and 3-2.2):

- Total rainfall
- Runoff hydrograph
- Intensity
- Antecedent period
- Season

3.1.5 Stormwater Suspended Particulate Matter Monitoring – Sediment Traps and MH390 Sump

SSPM monitoring is considered successful if samples obtained from each monitoring outfall have laboratory results that are verifiable. Sample volumes available at each site vary with weather and insufficient volumes may be available to perform all analyses. In WY2022, six samples from the six outfalls[11] locations (FD1, FD2, FD3 New, FD6, FD23, and MH390) were submitted to the City laboratory for analysis. Nine additional upline sediment traps were also placed for source tracing purposes. In all, samples were collected from a total of 15 SSPM locations in WY2022, including the outfall and upline locations.

3.1.6 Representativeness of WY2022 Laboratory Analyses

The WY2022 laboratory quality assurance/quality control (QA/QC) review included 71 stormwater samples and 15 SSPM samples; detection limit performance samples; laboratory and field blanks; laboratory, matrix, and field duplicates; spiked surrogates; laboratory control and matrix samples; and certified reference materials (CRM). Overall, 10,327 sample and QA/QC results were analyzed in WY2022. Data was reviewed, verified, and validated using a Tier II data review level or higher.

This type of analysis is helpful in identifying issues to be addressed when the majority of data quality is acceptable yet may still be improved. In WY2021, 96 percent of stormwater and 88 percent of SSPM data met measurement quality objectives. Only 0.4 percent of the data was

[11] OF254 does not have a sediment trap because of tidal influences.

classified as censored or rejected. Stormwater and SSPM samples are therefore considered representative. This review is provided in Appendix B.

3.2 MONITORING RESULTS: WY2002-WY2022 (YEARS 1 THROUGH 21)

This section presents a qualitative and quantitative description of spatial and temporal patterns in stormwater and storm sediment quality in Monitoring Years 1 through 21 which occurred in WY2002 through WY2022. The qualitative analysis is derived from visual inspection of summary tables and box plots appended to this report (see Appendices E through H). The quantitative analysis includes statistical test procedures described in Section 14.3 of the Thea Foss Stormwater QAPP.

The objective of the statistical evaluation is to test the magnitude and significance of spatial and temporal trends in the monitoring data. Spatial trend analysis includes identification of particular municipal storm drains that may be significantly higher or lower in concentration compared to other storm drains in the Foss Waterway Watershed. Temporal trend analysis includes identification of increases or decreases in stormwater concentrations over time that may be caused by source control actions, construction activities, changes in source strength, land use, or other characteristics of the drainage basins over time.

In the past, temporal trend analysis has also included an evaluation of seasonality and whether significantly higher stormwater concentrations were observed during certain parts of the year. Conventional wisdom suggests higher concentrations might be expected during dry season conditions because there is more time for contaminants to accumulate on drainage basin surfaces between runoff events. There are two seasons in a water year, as defined in the NPDES Phase I Permit; the wet season runs from October 1 through April 30, and the dry season runs from May 1 through September 30.

3.2.1 Summary Statistics

For each detected chemical at each outfall, the following summary statistics are calculated for baseflow, stormwater, and sediment trap data sets (see Appendix E):

- Number of samples analyzed
- Number and percentage of samples with detected chemical concentrations
- Arithmetic mean concentration
- Median concentration (50th percentile)
- Minimum and maximum concentrations
- 10th and 90th percentile concentrations
- Standard deviation of the arithmetic mean concentration
- Coefficient of variation
- Standard error of the arithmetic mean concentration
- 95th percentile upper and lower confidence limits on the arithmetic mean and median concentrations

Global summary statistics averaged over all municipal outfalls in the Foss Waterway drainage basin and all available monitoring years (WY2002-WY2022: Years 1 through 21) are provided in Tables 3-2.1, 3-2.2, 3-3.1, and 3-3.2 for baseflow[12], stormwater and sediment trap data, respectively. The global summary statistics include:

- Total number of samples
- Percentage of samples with detected concentrations
- Minimum and maximum detected concentrations for each outfall
- Mean and median concentrations for each outfall
- Global weighted-mean concentrations for the entire Thea Foss basin (weighted by number of samples per outfall)
- Overall maximum concentration for all outfalls, and sampling date of maximum concentration

Summary statistics are generated using Microsoft® Office Excel 2010. For non-detected concentrations, 1/2 reporting limit values were used as specified in the 2020 QAPP (Tacoma 2020b.)

3.2.2 Contaminants of Concern

COCs are those contaminants that were identified through sediment monitoring and model predictions to have the greatest potential to compromise sediment quality in the waterways following remediation. They are, therefore, the primary target for source control activities for the municipal storm drains as well as for other potential sources that are largely not in the City's control. DEHP and various PAHs are the primary COCs for the Foss Waterway and have therefore been the primary focus of source control activities to date. In addition, residual concentrations of other legacy COCs for which sources have largely been controlled through regulatory bans or restrictions are continuing to be monitored. These legacy COCs include mercury and PCBs. Source control activities have also been conducted for these COCs.

The NPDES permit identifies stormwater quality analytes as parameters of concern based on the analytes that have a history of association with stormwater discharges and are expected to be found in urban environments. These analytes include conventional parameters, nutrients, metals, selected organics (including PAHs and DEHP), fecal coliforms, and total petroleum hydrocarbons.

Tables B2-7 and B2-9 contain lists of all parameters that have been analyzed under either the Thea Foss CD or the Permit. If either the Permit or the Foss CD requirements are discontinued for any of the monitoring activities at some point in the future, these tables will be used to determine which analyses are required under the remaining regulations.

---

[12] Baseflow results for WY2002 to WY2011 are presented in Table 3-2.1. Some additional baseflow monitoring was performed in WY2016 and WY2019 to determine whether there have been changes in recent years. WY2016 and WY2019 baseflow results are included in Table 3-2.2. Additional discussion about baseflow monitoring and a comparison of results is included in Appendix B.

The Table 3-2.1 and 3-2.2 summary charts for baseflow were prepared and statistical tests performed on the following parameters:

- Total Suspended Solids (TSS) (initial baseflow and WY2016/WY2019)
- Conventionals (MBAS, BOD and Turbidity) (WY2016/WY2019)
- Nutrients (Nitrate+Nitrite as N, Orthophosphate, Total Phosphorus, and Total Nitrogen) (WY2016/WY2019)
- Total and Dissolved Metals (lead, mercury, and zinc) (initial baseflow and WY2016/WY2019)
- Total and Dissolved Metals (cadmium and copper) (WY2016/WY2019)
- Chlorpyrifos (WY2016/WY2019)
- PAHs (initial baseflow and WY2016/WY2019)
- Phthalates (initial baseflow and WY2016/WY2019)
- Herbicides (2,4-D and Dichlobenil) (WY2016/WY2019)
- TPH (NWTPH-Diesel, NWTPH-Gasoline and NWTPH-Heavy Oil) (WY2016/WY2019)
- Fecal Coliform (WY2016/WY2019)
- BTEX (WY2016/WY2019)

The Table 3-3.1 summary chart for stormwater was prepared and statistical tests performed on the following indicator parameters:

- TSS
- Conventional parameters (MBAs, BOD, Chloride, Conductivity, Hardness, pH, and Turbidity)
- Fecal Coliform, E.Coli, and Enterococci
- Nutrients (Nitrate+Nitrite as N, Orthophosphate, Total Phosphorus, and Total Nitrogen)
- Insecticides (2,4-D, Carbaryl, Chlorpyrifos and Bifenthrin)
- Herbicides (Dichlorobenil)
- Total and Dissolved Metals (copper[13], cadmium, lead, mercury, and zinc)
- PAHs
- Phthalates
- Total Petroleum Hydrocarbons (TPH-Oil, TPH-Gasoline, and TPH-Diesel)
- BTEX

---

[13] Copper was added as a key constituent for stormwater and SSPM in the 2014 QAPP. Analysis for copper in stormwater began for OF235, OF237B, and OF245 in WY2010 under the NPDES program, and continued through WY2012. Under the 2014 QAPP, copper was added as a key constituent for stormwater and SSPM and therefore analysis for copper began for all of the outfalls in WY2015. Statistical analyses for this constituent are being performed, although results will become more robust over time as additional data becomes available.

The Table 3-3.2 summary chart for SSPM was prepared and statistical tests performed on the following indicator parameters:

- Conventional parameters (Grain Size, TOC, Total Solids, and Total Volatile Solids)
- Nutrients (Total Phosphorus)
- Metals (cadmium, copper, lead, mercury, and zinc)
- Total Petroleum Hydrocarbons (TPH-Oil and TPH-Diesel)
- PAHs
- Phthalates
- Bifenthrin
- PCBs
- Phenolics
- Dichlobenil

Graphical presentations and trending statistics are performed for key constituents of interest. For whole-water, key constituents include the following analytes:

- TSS
- Metals (total copper, total lead, and total zinc)
- Phenanthrene (a low-molecular weight PAH)
- Pyrene and Indeno(1,2,3-c,d)pyrene (high-molecular weight PAHs)
- Bis(2-ethylhexyl)phthalate DEHP

For sediment, key constituents include the following analytes:

- Metals (total copper, total lead, total mercury, and total zinc)
- TPH-Oil
- Bifenthrin
- Phenanthrene (a low-molecular weight PAH)
- Pyrene and Indeno(1,2,3-c,d)pyrene (high-molecular weight PAHs)
- Total PCBs
- Butylbenzylphthalate, DEHP, and total phthalates

3.2.3 Statistical Test Methods

The stormwater monitoring data were subjected to the following statistical tests as further discussed in the 2020 QAPP:

- Qualitative Assessment of Spatial and Temporal Trends
- Statistical Distribution Testing

- Analysis of Variance (ANOVA) and Post-Hoc Comparison Tests:
    - Parametric ANOVA and Tukey Test (Stormwater Data) (Table 3-4)
    - Nonparametric ANOVA (Kruskal-Wallis Test) and Dunn Test (Baseflow and SSPM Data); and (Table 3-5)
- Time Trend Analysis (Lognormal Linear Regression) (Table 3-6)

The ANOVA, Kruskal-Wallis, Tukey, and t-tests analyses are performed using SYSTAT Version 13 or equivalent. The lognormal regressions and nonparametric post-hoc tests (Dunn Test) are performed in Microsoft Excel using the equations in Zar (1999).

Graphical data presentations were prepared for key constituents. Box and whisker plots provide a graphical representation of spatial and temporal trends in stormwater quality and include:

- Outfall-to-outfall comparison – stormwater (land use differences, Appendix F of the WY2022 Report)
- Year-by-year comparisons within a given outfall (long-term trends, Appendix G of the WY2022 Report)
- Wet season versus dry season comparison (seasonal differences, Appendix H of the WY2022 Report)

Box and whisker plots are generated using SYSTAT® Version 13, IDL by Exelis, or a suitable substitute. These plots display the following characteristics of the data distributions:

- Interquartile range, or IQR (data between the 25th and 75th percentile)
- Median and arithmetic mean
- Moderate outliers (more than 1.5 x IQR above the 75th percentile, or below the 25th percentile)
- Extreme outliers (more than 3 x IQR above the 75th percentile, or below the 25th percentile)

In addition, time-series scatter plots of the key constituents (Figures 3-5.1 through 3-5.8) in stormwater are prepared with annotation to delineate the different monitoring years. Time-series plots, as well as box plots, include comparable data collected back to August 2001.

3.3 SPATIAL ANALYSIS

This section presents a qualitative and quantitative spatial analysis of differences in stormwater and SSPM quality between municipal storm drains. It should be noted that there are similarities as well as differences in the spatial patterns of exceedances observed in stormwater and SSPM, as discussed in the following sections and as shown on Tables 3-4 and 3-5.

Qualitative analysis includes inspection of drain-by-drain summary statistics and box plots. Quantitative analysis includes lognormal parametric ANOVA and post-hoc comparison (Tukey Test) for stormwater data, and nonparametric ANOVA (Kruskal-Wallis test) and post-hoc comparison (Dunn Test) for SSPM data. Note that this information is used to guide stormwater source control activities that are discussed further in Section 5.0.

3.3.1 Baseflow Quality

Baseflow sampling was discontinued at the end of Year 10 since baseflow quality was well characterized. Refer to the WY2012 report (Tacoma 2013) for a detailed description of the baseflow characteristics in each of the outfalls.

Since 2011, detection limits for some analytes have changed and are lower than those in the 2001 SAP. The WY2011 baseflow concentrations, many of which were not detected, biased the baseflow pollutant loadings and overestimated the resulting loads. To more accurately estimate the baseflow loadings, baseflow samples were collected in WY2016 and WY2019 and analyzed for the stormwater analytes listed in the QAPP.

Most of the WY2016/WY2019 data results are similar or less than the 2001-2011 data results. In a few instances the WY2016/2019 arithmetic mean or median results were slightly higher than the 2001-2011 data results; however, in the majority of cases, the maximum WY2016/2019 results for that analyte were within the 2001-2011 data range for that analyte. The WY2016/2019 results further support the conclusion that baseflow concentrations in the Foss outfalls have remained fairly consistent or are improving over time.

3.3.2 Stormwater Quality

Qualitative Outfall Comparisons Inspection of summary tables and box plots of stormwater quality among the various Foss Waterway storm drains suggests the following generalized conclusions (see Table 3-3.1 and Appendices D, E, F, and G):

- **TSS** Overall, comparatively higher TSS concentrations are observed in OF254 (see Figures F-1 and F-11). OF235 and OF237A had elevated maximum concentrations (441 and 668 mg/L), while OF254 had the highest mean (91.0 mg/L) and median (69.0 mg/L) concentrations, with OF243 next highest with a mean concentration of 64.2 mg/L. OF230, OF237B, and OF237A had the lowest means (49.0, 49.0, and 49.1 mg/L, respectively) and median (30.8, 35.0, and 33.9 mg/L, respectively) TSS concentrations.

- **Metals** Comparatively higher mean and median lead concentrations were observed in OF235 (54.19 µg /L and 41.15 µg /L, respectively); while OF243 also showed some evidence of elevated lead concentrations, including the highest overall lead concentration (379 µg/L) in September 2009, as well as the second highest mean and median lead concentrations (33.67 µg/L and 16.20 µg/L). The highest mean mercury concentrations were observed at OF254 (0.0265 µg/L), while the maximum mercury concentration (0.8700 µg/L) was observed in OF245 in 2008. The highest mean (133.2 µg/L) and median (106.0 µg/L) zinc concentrations were found at OF245 while the maximum zinc concentration (1,170 µg/L) was observed in OF243, with the maximum concentration detected in 2004.[14] The highest mean, median, and maximum copper concentrations to date were observed at OF235 (28.05 µg /L, 22.50 µg/L, and 162 µg /L, respectively) with the maximum concentration occurring in 2015.

[14] While elevated zinc values of 4570 ug/l total and 4430 ug/l dissolved were measured on February 1, 2018, these values were nearly 4 times higher than the previously identified extreme outliers with no apparent cause, so these values were not included in the summary statistics

- **Phthalates** DEHP is the phthalate compound with most frequent detections (87 percent detection) and the highest mean and median concentrations. The highest mean and maximum concentrations of DEHP were observed in OF235 (4.03 µg/L and 97 µg/L, respectively), while the highest median concentrations were observed in OF230 (2.00 µg/L). The second highest mean and maximum concentrations were observed in OF230 (3.23 µg/Land 44.1 µg/L). Unusually elevated DEHP concentrations were also found in OF245 in Year 2 (October 2002 through April 2003), and in OF230 and OF243 in Year 7, but these appear to be isolated occurrences (see Appendices F and G). Certain other phthalates, though less frequently detected, peaked at higher concentrations. Elevated diethylphthalate concentrations were measured in 2002 in OF237A (230 µg/L), OF235 (590 µg/L), OF245 (430 µg/L), and OF254 (120 µg/L). The peak butylbenzylphthalate concentration was measured in OF245 (290 µg/L) in 2003. However, diethylphthalate and butylbenzylphthalate have been detected in less than half the samples (29 percent and 36 percent detections, respectively). Peak concentrations of dimethyl phthalate, di-n-butyl phthalate, and di-n-octyl phthalate occurred at OF230, OF237A, and OF254, respectively, although these concentrations were one to two orders of magnitude lower than the peak concentrations of the other phthalates. The fact that the peak concentrations of various phthalates occur in different outfalls indicates that the phthalate composition is somewhat variable across the Foss Waterway drainage basins. All peak concentrations occurred in 2005 or earlier, indicating improvement over time.

- **PAHs** OF245 contains the highest maximum concentrations of several of the lighter-weight PAH compounds including acenaphthene, acenaphthylene, fluorene, and phenanthrene, while OF235 contained the highest maximum concentrations of several other the lighter-weight PAH compounds including naphthalene, 2-methylnaphthalene, and total Low Molecular Weight PAHs (LPAHs). Comparatively higher mean and median concentrations of a number of LPAHs and the maximum concentration of anthracene were observed in OF254. The maximum concentrations observed in OF245 occurred in 2004, while the maximum concentrations observed in OF235 were in 2002. Comparatively higher mean, median, and maximum concentrations of HPAHs were generally observed in OF237A and OF254. The only exception is that the maximum concentration for dibenz(a,h)anthracene of 0.684 µg/L occurred in OF243 in 2016. The elevated concentrations in OF237A occurred in 2007, while the elevated concentrations in OF254 occurred in 2002. In general, PAH concentrations over the last fourteen years (Years 8 through 21) were relatively low compared to previous monitoring years.

Parametric ANOVA Results ANOVA was performed to determine whether there are statistically significant differences between outfalls. The ANOVA test helps to determine whether stormwater quality in the Foss Waterway Watershed is relatively uniform across drainages (i.e., all outfalls are drawn from a single statistical population), or whether there is reason to believe that certain drainages are unique (i.e., characterized by unusually high or low concentrations).

Goodness of fit tests show that practically all stormwater analytes in all outfalls may be characterized by lognormal or nearly lognormal statistical distributions (Tacoma 2009a, Tacoma 2012). Therefore, lognormal parametric ANOVA tests were conducted. The ANOVA test statistic is the F statistic with 6 (n-1) degrees of freedom (n = 7 outfalls in the monitoring program).

ANOVA and post-hoc comparison tests were performed using: (1) all 21 years of monitoring data, and (2) only the last two years of monitoring data[15]. ANOVA tests using the entire 21-year monitoring record have significantly more power to discriminate between drains due to a much larger sample size. ANOVA tests using only the most recent monitoring data have lower statistical power but provide information on the most current conditions in the storm drains, to better determine whether the City's source control actions have resulted in recent improvements in stormwater quality and to guide future source control activity prioritization.

Following are the results of the parametric ANOVA test using all 21 years of stormwater[16] monitoring data:

Parameter	F Statistic	Probability	Significant?
TSS	18.695	<0.001	Yes
Total Copper	77.863	<0.001	Yes
Total Lead	134.280	<0.001	Yes
Total Zinc	40.590	<0.001	Yes
Phenanthrene	7.977	<0.001	Yes
Pyrene	12.239	<0.001	Yes
Indeno(1,2,3-c,d)pyrene	17.891	<0.001	Yes
DEHP	18.512	<0.001	Yes

Following are the results of the parametric ANOVA test using only the last two years of monitoring data:

Parameter	F Statistic	Probability	Significant?
TSS	5.071	<0.001	Yes
Total Copper	19.139	<0.001	Yes
Total Lead	32.038	<0.001	Yes
Total Zinc	8.283	<0.001	Yes
Phenanthrene	8.713	<0.001	Yes
Pyrene	10.992	<0.001	Yes
Indeno(1,2,3-c,d)pyrene	13.629	<0.001	Yes
DEHP	12.474	<0.001	Yes

The parametric ANOVA test results indicate there is greater than or equal to 99.9% probability ($p \leq 0.001$) that one or more outfalls are significantly different from the norm, either higher or lower, for every one of the index constituents. The ANOVA test results indicate it is possible in all cases to differentiate stormwater quality between outfalls in the Foss Waterway Watershed for the index constituents using the entire data set, or only the last two years of data. As a

[15] Earlier annual reports presented only the last year of monitoring data. However, due to the reduction in sampling numbers starting with WY2013, the ANOVA analysis was changed to include the last two years of data. Without this change, very few statistically significant differences would be observed.

[16] Stormwater analysis for copper found in OF235, OF237B, and OF245 was performed between WY2010 and WY2012, discontinued, and then began for all outfalls in WY2015. Therefore, with less data available, statistics performed for copper are not fully comparable to those performed for other parameters.

result, post-hoc tests were performed to identify which specific outfalls contain unusually high or low stormwater concentrations.

Parametric Post-Hoc Comparison (Tukey Test) Because the ANOVA test showed statistically significant differences ($p < 0.05$) between stormwater quality in the various municipal drainages, post-hoc tests were performed to determine which specific drains are higher or lower than normal. The Tukey Test is an appropriate post-hoc test for parametric ANOVA. The results of the parametric post-hoc tests are summarized in Table 3-4. On this table, the top portion provides the results for the evaluation of the 21-year data set, while the bottom portion provides the results when looking at only the last two years of data. Since this data set is smaller, there is somewhat less confidence in the results, however, it does provide some indication of the current source control status and priorities.

Drainages and constituents exhibiting significant differences in stormwater quality, based on the entire 21-year monitoring record, include the following (see Table 3-4):

- **TSS** When looking at the 21-year monitoring data, TSS concentrations are moderately lower in OF230 (-3) and significantly higher in OF254 (+6). Other outfalls are relatively similar. When looking at the last two years of data, TSS concentrations are moderately higher in OF254, and generally neutral to slightly lower in the other outfalls.
- **Total Copper**[17] When looking at all of the monitoring data, copper concentrations are significantly higher in OF235 (+6) and moderately higher in OF243 (+3). Concentrations are moderately lower in OF230 (-3) and OF237A (-4), and significantly lower in OF237B (-5). When looking at only the last two years of data for copper, concentrations are moderately higher at OF235, OF243, and OF254 (all at +4), while the concentration at OF237B is significantly lower (-6).
- **Total Lead** OF237A (-3), OF237B (-4), and OF245 (-4) contain lead concentrations that are moderately below average when looking at the entire monitoring period while OF243 (+4) and OF235 (+6) are moderately to significantly elevated compared to other outfalls during this same time period. When looking at only the last two years of data, concentrations are generally more neutral, with the exception of OF235, which remains significantly elevated relative to other outfalls (+6). Concentrations at OF243 went from moderately higher (+4) when looking at the overall dataset, to just slightly higher (+1) when looking at data from only the last two years.
- **Total Zinc** Zinc concentrations in OF237B are significantly lower (-6) and concentrations in OF243 are moderately lower (-3) than all other outfalls during the full monitoring period. OF254 (+3) and OF245 (+4) are moderately elevated in zinc when looking at the 21-year monitoring period. When looking at only the last two years of data, zinc concentrations are generally more neutral but remain significantly lower than other outfalls (-6) in OF237B.
- **DEHP** When looking at data from the entire monitoring period, OF230 and OF235 (both at +5) contain significantly elevated DEHP concentrations relative to other outfalls while OF243 has significantly lower concentrations (-5). DEHP concentrations in the remaining

[17] Outfalls OF235, OF237B, and OF245 have more data available for evaluation with a total of ten years of monitoring completed. OF230, OF237A, OF243, and OF254 have seven years of data available. In general, the statistical evaluation for copper is not fully comparable to outfalls with different amounts of data available.

outfalls are relatively low and largely indistinguishable from one another. The significantly higher concentrations are less apparent at OF230 (+3) when looking at only the last two years of data while concentrations at OF235 are only slightly elevated (+2) compared other outfalls. DEHP concentrations are significantly lower (-6) at OF243 based on the last two years of data.

- **PAHs** OF237B has moderately lower concentrations of pyrene (-4) and significantly lower levels of phenanthrene (-5) while OF245 has moderately lower concentrations of pyrene (-3) and significantly lower indeno(1,2,3-c,d)pyrene (-6) when looking at the 21-year monitoring period. Conversely, OF254 has moderately higher concentrations of pyrene (+4) and phenanthrene (+3) and OF237A has moderately higher concentrations of pyrene (+3) and significantly higher concentrations of indeno(1,2,3-c,d)pyrene (+5) during this same 21-year period. When looking at only the last two years of data, OF237A contains significantly higher indeno(1,2,3-c,d)pyrene (+6) and pyrene (+5) as well as moderately higher phenanthrene (+4) relative to other outfalls. OF237B contains moderately lower phenanthrene (-4) and pyrene (-4), and OF245 contains moderately lower indeno(1,2,3-c,d)pyrene (-3). All other PAHs are relatively neutral and largely indistinguishable from one another over the last two years.

In summary, when looking at the entire monitoring period, results indicate that OF235 (copper, lead, DEHP), OF230 (DEHP), OF237A (indeno(1,2,3-c,d)pyrene and pyrene), OF243 (copper and lead), OF245 (zinc), and OF254 (TSS, zinc, phenanthrene, and pyrene), have the highest number or most extreme positive pair comparisons; therefore, source control activities, as needed, are best focused for these constituents in these drainages. OF237B, and to a lesser extent OF245, OF230, OF237A, and OF243 have the highest number of negative pair comparisons relative to other drains, and therefore exhibit the best overall stormwater quality. With 21 years of monitoring data, very good statistical power has been achieved (with exception for copper), and the spatial patterns in Foss stormwater are relatively stable and generally consistent from one monitoring year to the next.

When looking at only the last two years of monitoring data, results generally show more neutral conditions in all the outfalls, although the statistical power of this analysis is lower. The only exceptions are PAHs in OF237A, which become more elevated when looking at only the last two years, and lead in OF235, which remains significantly elevated. A few samples with relatively higher concentrations of indeno(1,2,3-c,d)pyrene detected in WY2021 and WY2022 in OF237A are likely causing the higher relative level shown in Table 3-4 (see also Figure G-6).

3.3.3 Baseflow Versus Stormwater Quality

Summary statistics for baseflow[18] for WY2002-2011 and WY2016/2019 are provided in Table 3-2.1 and Table 3-2.2, respectively. Summary statistics for stormwater quality are provided in Table 3-3.1. These tables include mean concentrations averaged across all seven outfalls in the Foss Waterway Watershed. The arithmetic mean concentrations in baseflow and stormwater are summarized below for the Thea Foss index chemicals.

---

[18] Baseflow results are presented for WY2002 to WY2011 since baseflow monitoring was discontinued after WY2011. Some additional baseflow monitoring was performed in WY2016 and WY2019 to determine whether significant differences had been realized since initial comprehensive baseflow monitoring was discontinued.

Constituent	Units	**Mean Baseflow** WY01-11/WY16 &19	**Mean Stormwater**	**Ratio** WY01-11/WY16 &19 to WY2022
TSS	mg/L	12 / 4.8	59.8	20% / 8%
Lead	µg/L	5.5 / 1.7	21.8	25% / 8 %
Zinc	µg/L	47 / 11	102.7	46% / 11%
Phenanthrene	µg/L	0.013 / 0.009	0.066	20% / 14%
Pyrene	µg/L	0.026 / 0.008	0.140	19% / 6%
Indeno(1,2,3-c,d)pyrene	µg/L	0.006 / 0.005	0.037	16% / 14%
DEHP	µg/L	1.1 / 0.536	2.5	44% / 21%

Inspection of these summary statistics indicates the following:

- Baseflow concentrations are consistently lower than stormwater concentrations. WY2001-11 average baseflow concentrations range from approximately 1/5 to 2/5 (16 - 46%) of stormwater concentrations. WY2016 & 2019 average baseflow concentrations range from approximately 1/20 to 1/5 (6 - 21%) of stormwater concentrations.
- In addition to lower mean concentrations, baseflow samples are generally characterized by lower maximum values and less frequent detections.
- Because the TSS content is approximately five (2001-11) to 12 (2016 & 19) times higher in stormwater, the increased chemical concentrations that are observed during storm events is likely caused in part by suspended sediments entrained in the runoff.

3.3.4 Storm Sediment Quality

SSPM samples were collected in pipeline sediment traps and in the MH390 sump (representing OF245). These samples include suspended particulate matter in transport through the storm drains. OF254 does not have a sediment trap because of tidal influences. SSPM data helps to provide information on hydrophobic constituents such as mercury, HPAHs, DDT, and PCBs, which have a strong affinity for sediments but are poorly soluble and often undetected in whole-water samples. In conjunction with baseflow and stormwater data, SSPM data is used to help the City, EPA, and Ecology identify and trace unusually elevated sources of contaminants in the municipal drainages.

Summary statistics for SSPM for WY2002-WY2022 are provided in Table 3-3.2. This table includes weighted mean concentrations averaged across the six outfall sediment traps in the Foss Waterway Watershed (weighted by sample size for each location). The weighted mean concentrations are summarized below for the Thea Foss index chemicals.

Due to the limited dataset available for review (only one sample per year), the assumption was made in early reports that the SSPM data would follow a lognormal distribution similar to the stormwater data. This assumption was tested in WY2011 and it was determined that the sediment traps were generally not well described by a lognormal distribution. Therefore, nonparametric statistical tests were used.

ANOVA was performed to identify storm drains with significantly higher or lower sediment concentrations compared to other drains in the Foss Waterway Watershed. A nonparametric ANOVA (Kruskal-Wallis Test) was performed, with 5 (n-1) degrees of freedom (n = 6 outfalls in the sediment trap monitoring program).

Following are the results of the nonparametric ANOVA test using all 21 years of storm sediment data:

Parameter[1]	F Statistic	Probability	Significant?
Copper	41.953	<0.001	Yes
Lead	96.482	<0.001	Yes
Zinc	72.325	<0.001	Yes
Mercury	63.558	<0.001	Yes
TPH-Heavy Oil	42.372	<0.001	Yes
Phenanthrene	58.533	<0.001	Yes
Pyrene	50.447	<0.001	Yes
Indeno(1,2,3-c,d)pyrene	71.972	<0.001	Yes
Bifenthrin	23.923	<0.001	Yes
Total PCBs	26.226	<0.001	Yes
DEHP	33.665	<0.001	Yes
BBP	78.986	<0.001	Yes
Total Phthalates	34.940	<0.001	Yes

[1] Note that analysis for DDT was discontinued in WY2013 and analysis for Bifenthrin and copper began in WY2015

The nonparametric ANOVA test results indicate there is a high probability (equal or greater than 99 percent confidence; $p \leq 0.01$) that storm sediment concentrations in one or more outfalls are significantly different from the norm, either higher or lower, for all analytes.

Following are the results of the nonparametric ANOVA test using only the last five years of monitoring data:

Parameter[1]	F Statistic	Probability	Significant?
Copper	22.840	<0.001	Yes
Lead	25.551	<0.001	Yes
Zinc	18.006	0.003	Yes
Mercury	18.775	0.002	Yes
TPH-Heavy Oil	12.944	0.024	Yes
Phenanthrene	18.156	0.003	Yes
Pyrene	19.957	0.001	Yes
Indeno(1,2,3-c,d)pyrene	21.630	0.001	Yes
Bifenthrin	12.712	0.026	Yes
Total PCBs	9.561	0.089	Yes
DEHP	15.771	0.008	Yes
BBP	19.937	0.001	Yes
Total Phthalates	11.875	0.037	Yes

[1] Note that analysis for DDT was discontinued in WY2013. Analysis for Bifenthrin and copper began in WY2015.

The nonparametric ANOVA test results indicate it is possible to differentiate SSPM quality for most of these analytes between outfalls in the Foss Waterway Watershed using only the last five years of data. Only Total PCBs show no significant differences between the outfalls as shown on Table 3-5.

Pair-comparison tests were performed using the Dunn method, as summarized in Table 3-5. Each outfall is compared to a maximum of five other outfalls in the storm sediment monitoring program (six outfalls total). Outfalls and constituents that exhibit a higher number of significant pair comparisons help to identify drainages that are increasingly unique (either higher or lower concentrations) compared to the other drains in the Foss Waterway Watershed. On Table 3-5, the top portion provides the results for the evaluation of the 21-year data set, while the bottom portion provides the results when looking at only the last five years of data. Since this data set is smaller, there is somewhat less confidence in the results, however, it does provide some indication of the current source control status and priorities.

Following is a summary of observations regarding spatial patterns in SSPM quality based on the 21-year monitoring record. The spatial patterns observed in the SSPM data are sometimes but not always consistent with the patterns observed in stormwater data (compare Table 3-5 and Table 3-4). Discrepancies between these two data sets are included below and may be caused by differential transport of pollutants in dissolved and particulate phases.

- **Metals** SSPM in OF243 is moderately elevated in copper (+3), lead (+3), mercury (+4), and zinc (+4). OF230 and OF235 are slightly elevated in some metals, but to a lesser degree than OF243. OF237B has moderately lower copper, lead, and mercury concentrations (all at -3), and significantly lower zinc (-5) relative to other outfalls, while OF245 contains moderately lower lead concentrations (-3).

  Some of these patterns found in SSPM are contrary to those observed in stormwater. For example, lead and copper concentrations in OF235 are significantly elevated in stormwater (both at +6), but at most only slightly elevated in SSPM (+2 and +1, respectively); zinc concentrations in OF243 are moderately elevated in SSPM (+4) but not in stormwater (-3). Conversely, zinc concentrations in OF245 are moderately elevated in stormwater (+4) but are neutral (0) in SSPM.

- **Total Petroleum Hydrocarbons (TPH-Oil)** SSPM in OF237B is significantly lower in TPH-Oil (-5) relative to the other outfalls while levels at other outfalls are generally similar throughout the drainage basin.

- **Pesticides** No significant differences in DDT concentrations were observed among the six outfalls during the time it was monitored. It is no longer analyzed under the 2014 QAPP. Bifenthrin was added as a constituent in the 2014 QAPP, and in general all outfalls appear to be generally similar throughout the basin based on available data, although it is slightly elevated in OF237A.

- **PAHs** Storm sediment in OF245 contains moderately to significantly lower concentrations of PAHs (-4 to -5) relative to all other outfalls. SSPM in OF230 and OF237A are slightly to moderately enriched in all three PAHs (+2 to +4). The remaining outfalls are generally neutral for PAHs (+1 to -2). These patterns are generally consistent with those observed in stormwater except for OF230 where, as indicated above, the SSPM is slightly to moderately enriched (+2 to +3) in all three indicator PAHs while the stormwater is generally more neutral (0 to +2).

- **Total PCBs** SSPM concentrations at all six locations are relatively neutral (-1 to +1).

- **Phthalates** DEHP is fairly consistent in concentrations in storm sediment throughout the various drainages; only OF237B (-3) shows a moderately lower concentration in DEHP. This pattern is not altogether consistent with that observed in stormwater. DEHP in OF230 and OF235 was significantly elevated in stormwater (both at +5), but not in SSPM (both at +1). OF243 and OF245 continue to exhibit notably different phthalate compositions that are dominated by butylbenzylphthalate (+2 and +4, respectively). In particular, OF243 and OF245 have the majority of the highest butylbenzylphthalate concentrations in the monitoring program (see Figure F-30).

When looking at only the last five years of monitoring data, fewer spatial patterns are observed, and the patterns are generally consistent with the 21-year monitoring record results (Table 3-5). This suggests that there has not been a significant change in spatial distribution over the 21-year monitoring record, although the differences between outfalls are less pronounced when looking at only the more recent data.

3.4 Seasonal Analysis

This section presents a qualitative evaluation of seasonality in baseflow and stormwater quality by inspection of seasonal box plots (see Appendix H). As per the City's NPDES Phase I Permit, the wet season is defined as October 1st through April 30th, and the dry season is defined as May 1st through September 30th.

It might be expected that dry season conditions would generate higher contaminant concentrations in both baseflow and stormwater. This might be caused by more isolated storms and longer antecedent dry periods between storms, resulting in longer periods of contaminant accumulation on the surfaces of the drainage basin. The seasonal effect on runoff quality found through the City's monitoring program is evaluated below.

3.4.1 Seasonal Analysis of Stormwater Quality

Inspection of box plots comparing stormwater quality between the wet and dry seasons for the 21-year monitoring record suggests the following (see Appendix H):

- Evidence of seasonal effects in TSS concentrations is weak in all outfalls.
- Metals (lead and zinc) in stormwater showed occasional evidence of seasonality (i.e., higher median, mean, and/or peak concentrations during dry season months).
- Evidence of seasonal effects was generally not observed in organics data.
- Similar patterns were observed in baseflow data (i.e., inorganic constituents exhibit stronger evidence of seasonality), whereas evidence of seasonality for organic constituents is weak or absent. This analysis was performed based on the first 10 years of baseflow monitoring performed from WY2002-WY2011 and presented in the WY2011 report (Tacoma 2012).

3.5 Time Trend Analysis

This section presents a qualitative and quantitative analysis of time trends in stormwater quality. The objective of time trend analysis is to identify specific drains and constituents that show evidence of significant improvement or degradation in stormwater quality over time. The changes can be a result of source control actions in the drainage basins that help to curtail pollutant concentrations, or alternatively, changes or disturbances in the watersheds that may cause concentrations to increase, (e.g., temporary construction activities or increased urban density and traffic).

3.5.1 Stormwater Time Trends

Qualitative Analysis of Time Trends Inspection of box plots comparing stormwater quality from one monitoring year to the next suggests the following (see Appendix G):

- Time trends can be difficult to discern by visual inspection of the year-to-year box plots due to the generally high degree of variability in stormwater data. Time trends are evaluated using more quantitative statistical tests later in this section.
- Despite the inherent variability of the data, there nevertheless appears to be across-the-board reductions in most metals, PAH compounds, and DEHP in most drains since about Year 10 of the monitoring program. Having generally stabilized at low levels for several consecutive years, these trends may be indicative of the effectiveness of the City's source control and enhanced maintenance programs, and additional reductions will be difficult to achieve. Note that apparent higher organics concentrations are present in the last eight years, however, because this increase in concentrations was seen consistently in all the outfalls, additional investigation was performed to evaluate this issue. A summary of the investigation is provided below in Section 3.5.2.
- Unusually dry (Year 2 and Year 4) and unusually wet (Year 6, Year 12, Year 15, and Year 16) monitoring years are summarized in Table 3-1. WY2017 was the wettest year in the monitoring record, while WY2005 was the driest year of the 21-year monitoring record. WY2022 was slightly above average in comparison to other monitoring years. Despite the variability over time, there has been no discernible relationship between these unusual water years and stormwater quality. Reliable correlations between stormwater quality and other hydrologic parameters (i.e., rain depth, rainfall intensity, and antecedent period; see Figures 3-2.1 and 3-2.2) are not discernible either.

Simple Linear Regression Analysis of Time Trends The simple linear regression is performed using the logarithms (base 10) of the stormwater concentrations. This is equivalent to an exponential decay model, which is a typical decay profile for environmental data. No seasonal effects were modeled with the regression given that such effects are not consistently observed and are especially weak for organic compounds.

The relevant regression statistics are summarized in Table 3-6. Scatterplots of the time-series data and best-fit lognormal regression models are presented on Figures 3-5.1 (TSS), 3-5.2 (copper), 3-5.3 (lead), 3-5.4 (zinc), 3-5.5 (phenanthrene), 3-5.6 (pyrene), 3-5.7 (indeno(1,2,3-c,d)pyrene), and 3-5.8 (DEHP). These plots show all significant cases of the simple linear regression test.

The regression analysis confirms that reducing trends are statistically significant in 48 of 49 cases at or greater than 95 percent confidence for the seven original key constituents (i.e., all but copper). This is the same number of trends that was observed in WY2021. A decreasing trend for TSS in OF254 was observed for the first time in WY2021. While a significant decreasing trend for indeno(1,2,3-c,d)pyrene in OF237A has been present for many years, it was not observed in WY2021 or WY2022. All other trends were for the same locations and constituents previously observed.

In addition to the 49 time trend tests that have been evaluated in past years, the 2014 QAPP required the City to analyze and evaluate total copper. For three outfalls, OF235, OF237B, and OF245, the data collected since WY2015 has been added to data previously collected under the NPDES program between WY2010 and WY2012. With more data available, an evaluation of time trends has been performed for these outfalls for the last several years. In WY2019, it was determined that sufficient data was available for all seven outfalls to perform an evaluation of time trends, although with less data available, the statistical results will not be fully comparable to data for the remaining constituents. With these seven tests added, there are 51 statistically significant time trends (51 out of 56 tests, or approximately 91 percent of the tests) shown in Year 21, with all trends in the direction of decreasing concentrations. As additional data becomes available, time trends for copper will become more comparable to remaining tests.

The best fit regression equations are used to estimate percent reductions over the 21-year monitoring period for these constituents and outfalls:

- TSS: Approximately 40-78 percent reduction in all seven outfalls
- Copper: Approximately 34-50 percent reduction in OF235, OF237B, and OF245
- Lead: Approximately 71-83 percent reduction in all seven outfalls
- Zinc: Approximately 51-71 percent reduction in all seven outfalls
- PAHs: Approximately 68-90 percent reduction in phenanthrene and pyrene in all seven outfalls, and approximately 64-84 percent reduction in indeno(1,2,3-c,d)pyrene in all outfalls except OF237A
- DEHP: Approximately 48-82 percent reduction in all seven outfalls

3.5.2 Analytical Results Follow Up

In review of the analytical results and trends over time, two anomalies were identified which the City evaluated on a comprehensive basis. The first is the organics uptick that was identified in WY2014 and has been discussed in past reports. The second is the frequent and dispersed higher levels of PCBs in sediment traps that were identified during WY2020. A discussion of each of these issues and a summary of the completed evaluations is provided below.

Organics Uptick Review of the scatterplots (Figures 3-5.1 through 3-5.8) showed that while results for TSS and metals generally appear to fall within the range of expected concentrations, there has been an apparent slight uptick in concentrations of organics realized at all outfalls in recent years, coinciding with the start of sampling under the 2014 QAPP. This was first reported in the WY2016 report (Tacoma 2017). While it was expected that there will be a leveling off result over time as the effects of source control actions reach an equilibrium, the across-the-board uptick at all outfalls appeared unusual and led to significant investigation of potential causes for this apparent uptick.

A number of different lines of inquiry were pursued focused on laboratory reporting and performance (see Tacoma 2021 for a complete summary of these efforts). At this time, organics data appears to be leveling out at the recently observed concentrations, leading to the conclusion that these concentrations are representative of the stormwater quality. It appears that rather than these concentrations being higher, past concentrations may have been biased low. While this observed slight increase in organic concentrations is present, concentrations remain substantially lower than the concentrations present early in the monitoring program (see boxplots in Appendix G).

Investigations are completed at this time; however, the City will continue to monitor this as additional data becomes available to identify any ongoing anomalies.

Increased PCB levels in Sediment Traps Review of WY2020 SSPM results showed consistently higher levels of PCBs wherever they were detected. Because these higher concentrations were dispersed across several locations and drainage basins, it did not appear to be caused by a specific event or source. Sampling methods remained the same as prior years. Based on this observation of elevated levels, significant investigation into potential causes was initiated as described in the WY2020 report (Tacoma 2021). Following a thorough analysis, no cause for the increased PCB levels was identified. WY2021 and WY2022 SSPM concentrations returned to expected levels. Therefore, it was determined that WY2020 results were not accurate and will not be used to determine steps forward in source tracing investigations.

3.6 CONCLUSIONS

The City has been performing outfall monitoring in the Thea Foss Basin for 21 years. Most of the COCs have undergone significant reductions in concentrations and loads compared to past monitoring efforts in the late 1980s through mid-1990s. The cumulative effect of federal, state, and municipal source control efforts has likely caused the observed improvements in stormwater quality. The City has directed numerous source control efforts in this watershed, including control of potential TSS, metals, PAH, and DEHP sources. In particular, PAH and DEHP concentrations in the last 13 years have decreased significantly in all the outfalls. Having generally stabilized now for several consecutive monitoring years, the observed concentration reductions are likely an indication of source control effectiveness. The City will continue to evaluate remaining known source(s) of the COCs in the Foss Waterway Watershed. The COCs for each basin and source control priorities are discussed in Section 5.0.

Many significant reductions have been observed in the City's 21-year monitoring record. Forty-eight time trends were shown to be statistically significant in Year 21 (48 out of 49 tests, or approximately 98 percent of the tests) using simple linear regression. All trends were in the direction of decreasing concentrations. As shown below, this is the same number of trends observed in WY2021. While the overall number of trends was the same, it should be noted that a new statistically significant decreasing trend for TSS in OF254 was identified for the first time in WY2021, while the ongoing decreasing trend for indeno(1,2,3-c,d)pyrene in OF237A fell below the level of significance in WY2021 where it remained in WY2022.

Year	No. of Significant time trends	Percent of 49 tests
21	48	98%
20	48	98%
19	48	98%
18	47	96%
17	47	96%
16	47	96%
15	47	96%
14	46	94%
13	46	94%
12	44	90%
11	41	84%
10	37	76%
9	26	53%

8	10	20%
7	4	8%

With sufficient copper data available, an overall evaluation of the source control program including trends for copper for three of the outfalls (OF235, OF237B, and OF245) began in WY2015, and for the other four outfalls (OF230, OF237A, OF243, and OF254) began in WY2019. It should be noted that the results are not as statistically robust, so are not directly comparable to analyses performed for the other constituents. Based on this analysis, the number of statistically significant trends becomes 51 of 56, or 91 percent of tests, showing statistically significant improvement. The three trends are for the three outfalls with the most data, OF235, OF237B, and OF245. As more data becomes available, the data is expected to become more comparable to other constituents.

Year	No. of Significant time trends	Percent of tests
21	51	91%
20	50	89%
19	51	91%
18[19]	50	89%
17[20]	49	94%
16	49	94%
15	48	92%
14	47	90%
1-13	Not applicable	

With a comprehensive monitoring record – including a 21-year record of sampling of storm events along with ten full years of sampling baseflow events[21] – the drainages in the Foss Waterway Watershed have been well characterized. Significant reducing trends have been observed in a majority of cases, including statistically significant reductions in PAHs, TSS, lead, zinc, copper, and DEHP concentrations in all or a majority of the drains where sufficient data is available, attesting to the effectiveness of the City's stormwater management program.

[19] Beginning of trend analysis for all seven outfalls for a total of 56 tests going forward.

[20] Includes trend analysis for three outfalls (OF235, OF237B, and OF245) for a total of 52 tests.

[21] Comprehensive baseflow sampling was discontinued at the end of WY2011, so there is a ten-year record for baseflow. Stormwater sampling has continued and currently has 20 years of monitoring data. Some additional baseflow monitoring was completed in WY2016 and WY2019.

4.0 THEA FOSS WATERWAY SEDIMENT MONITORING

The purpose of this section is to evaluate trends in sediment quality in the Thea Foss Waterway over the post-remediation monitoring period. When new sediment analytical results are available, they are compared to cleanup standards to determine if sediment quality in the waterway is being protected from ongoing sources.

4.1 BACKGROUND

When the waterway sediment remediation projects were completed, the majority of the sediment surface had no, or very low concentrations of contaminants present since the surface was either dredged to clean sediments or covered with new, clean capping materials. It was anticipated that ongoing source contributions to the waterway would cause concentrations of contaminants to increase gradually. Over time, the goal is to have the contaminant concentrations equilibrate at a level below the sediment cleanup standards set by the EPA. The City developed a predictive model so that actual sediment monitoring results could be compared to model predictions during the first ten years post-cleanup to determine areas where additional source controls may be needed to remain in compliance. When comparisons were made at Year 10 (2016), the waterway sediments were found to be generally in equilibrium with the current sources, so it was determined that further comparisons to computer model predictions were no longer needed.

4.2 SEDIMENT MONITORING UNDER LONG-TERM MONITORING PLANS

The City remains responsible for collecting post-construction sediment quality data in the middle and outer portions of the Thea Foss Waterway and in the Wheeler-Osgood Waterway. In addition, beginning in 2023, the City will also be collecting surface sediment samples for long-term monitoring in the Head of Thea Foss Waterway. During WY2022, there was no monitoring done in either the Utilities' work area or the City's work area. In 2018, the Utilities collected their Year 14 sediment monitoring data in the Head of the Thea Foss Waterway, and the City collected Year 12 sediment monitoring data in other parts of the waterway. These results were presented in the WY2018 report. While there were a few isolated, low level exceedances of zinc, DEHP, and PAHs observed at some locations in both the City's and Utilities' work areas within the waterway during 2018 monitoring, there were no recontamination issues identified that required follow up. Since no monitoring was required in 2022 in any portions of the water, there are no new results available to present in this report. The next available data will be collected in summer 2023, and a summary of results will be presented in the WY2023 report.

Based on the City's Year 12 report, EPA has determined that the remedial action goals have been achieved and has initiated a partial delisting process for the waterway. There is no update on the status of this process at this time.

This page is intentionally left blank

5.0 THEA FOSS PROGRAM EFFECTIVENESS: WATER YEARS 2001 TO 2022

In this section, program effectiveness of the Thea Foss Source Control Strategy is evaluated by linking source control activities, long-term outfall monitoring results, and post-construction sediment monitoring, as applicable (see Figure 1-1).

Long-term outfall monitoring is used to measure the effectiveness of Tacoma's SWMP and on-the-ground source control activities. Monitoring also provides information for evaluation of the need for any new source control activities. Monitoring tools used to achieve this are temporal trend analysis and spatial trend analysis. Temporal trend analysis provides a measure of changes in the characteristics of the drainage basins over time by identifying increases or decreases of contaminant concentrations. These changes can be the result of source control activities, construction activities, or other impacts in the basin that alter land use. Spatial trend analysis identifies particular municipal storm drains that may be significantly higher or lower in contaminant concentrations compared to other storm drains in the Foss Waterway Watershed and guides source control prioritization. Table 3-4 summarizes this analysis for stormwater, while Table 3-5 summarizes the analysis for SSPM. On each of these tables, the top portion provides the results for the evaluation of the 21-year data set, while the bottom portion provides the results when looking at only the more recent data. For stormwater the last two years of data are evaluated, while for SSPM the last five years are evaluated since there is only one data point for each year. Since the two- or five-year data sets are smaller, there is somewhat less confidence in the results, however, it does provide some indication of the current source control status and priorities.

Each subsection below includes a presentation of stormwater and SSPM data. SSPM data helps to provide information on extremely hydrophobic constituents such as mercury, HPAHs, pesticides, and PCBs, which have a strong affinity for sediments but are poorly soluble and often not detectable in whole-water samples. In conjunction with baseflow and stormwater data, SSPM data is used to help the City, EPA, and Ecology identify areas of unusually elevated contaminants in the municipal drainages and to determine the need for focused source control work.

It should be noted that the spatial patterns observed in stormwater are not always consistent with those observed in SSPM. Discrepancies between these data sets may be caused by differential transport of pollutants in dissolved and particulate phases or how the source is introduced into the system (e.g., below ground leak, illicit connection, contact with stormwater).

Post-construction surface sediment data from the waterway is used as another tool to evaluate the effectiveness of existing source controls in the Foss Waterway Watershed, whether additional source controls and BMPs for municipal stormwater discharges or other sources are necessary and appropriate, and if so, where and how they might best be implemented. As discussed in Section 4.0, there were no recontamination issues requiring follow-up identified the most recent in-waterway monitoring performed in 2018. The next sediment monitoring event will be performed in summer 2023 and a summary of results will be presented in the WY2023 report.

Although the recommendations presented in this section are intended specifically for municipal outfalls and activities within their respective drainage basins, stormwater discharges must also be evaluated in the context of other source loads to the waterway. It is anticipated that chemical loads from other sources will be appropriately monitored and managed under other federal, state, and local regulatory programs.

5.1 OUTFALL 230

Many activities have occurred in the OF230 drainage basin, some of which have contributed to improvements in the quality of baseflow, stormwater, and SSPM. Statistically significant improvements in all index COCs (TSS, lead, zinc, PAHs, and DEHP) have been observed in stormwater in OF235 (Table 3-6). Figure 5-1.1 shows the annual average concentrations for stormwater, baseflow, and SSPM.

This section provides a summary of water/sediment quality results within the OF230 drainage basin and compares the water/sediment data results with the major source control and other activities that have occurred within the basin. A more comprehensive description of source control activities performed to date is provided in Appendix A.

As indicated in Section 3, a new outfall, OF230A, was under construction throughout 2022. Upon completion, this new outfall is designed to carry approximately 98 percent of the stormwater previously discharging to OF230 and approximately 26 percent of the stormwater previously discharging to OF235. The City will be proposing a modification to the monitoring program in 2023.

Transition of flow from the drainage area to the new outfall did not begin until after the end of the water year, so all stormwater data from WY2022 will be evaluated consistent with data from the entire reporting period. Because the transition of flow took place from October through December of 2022, WY2023 data will represent only a portion of the year and will be discussed in further detail in the WY2023 report. Also due to construction of the new outfall (OF230A), FD3A was removed in December 2021 and was not reinstalled until January 2023 after construction was complete. Therefore, there are no results for this sediment trap in WY2022. Since the sediment trap was not reinstalled until after the start of WY2023, the results that will be reported in next year's report will reflect deployment for a partial year.

5.1.1 Water and SSPM Quality

Annual and seasonal data for stormwater and SSPM for the COCs and other parameters is used to identify ongoing areas of concern. The following paragraphs summarize the WY2001-WY2022 monitoring results for OF230, where COCs in this outfall are different from other Foss drainage basins, and where source control activities may be focused.

5.1.1.a TSS and Metals

Stormwater TSS concentrations in OF230 stormwater remain among the lowest mean and median observed in all the drainages (see Table 3-3.1 and Figures F-1 and F-11). Stormwater TSS concentrations in OF230 are moderately below average (-3) during the 21-year monitoring period but slightly better than average (-1) when looking at only the last two years (see Table 3-4). As shown in Figure 3-5.1 and Table 3-6, TSS has shown a statistically significant improvement in stormwater quality from 2001 to present. The best-fit regression equations result in an estimated 47 percent reduction in TSS concentrations in OF230 in the 21-year monitoring period.

As shown in Figure G-2, G-3, G-12, and G-13, lead and zinc concentrations in stormwater have remained fairly consistent over the last 21 years, although decreasing somewhat in the last eleven to twelve years. Stormwater quality in OF230 for both the 21-year data set and the last two years is slightly elevated in lead and zinc (each at +1) as compared to the other outfalls (see Table 3-4).

Analysis for copper at this outfall began in WY2015 so more limited data is currently available for complete and comparable statistical analysis. When looking at the eight years of data available, OF230 is moderately lower in copper as compared to other outfalls (-3), while it is only slightly lower (-2) when looking at the last two years of data. While the regression analysis showed a statistically significant increase in WY2020, in WY2021 and WY2022 this increasing trend was not apparent. Copper levels are generally relatively low compared to other outfalls, and this apparent increasing trend may have been a result of several outliers measured in the spring or summer of WY2017, WY2018, and WY2019 (see Figures G-5 and G-15). These outliers have more influence in the smaller data set. No outliers were identified in WY2022. An overall outlier analysis is planned for 2023.

SSPM Storm sediment in OF230 is slightly elevated in lead, mercury, and zinc (+2, +1, and +1, respectively) as compared to most other outfalls when looking at the 21-year monitoring record (see Table 3-5 and Figures F-21 through F-23 and F-33 through F-35). When looking at only the last five years of data, SSPM quality in OF230 is generally similar to the other basins for lead, mercury, and zinc (all at 0). Copper also appears to be slightly lower (-1) based on all available data, and neutral (0) over the last five years compared to other outfalls.

In WY2015, mercury concentrations at FD3A increased from low levels back to medium levels, and then returned to low levels in WY2016, where they remained through WY2020 (see Figure 2-1.1). In WY2021, mercury concentrations increased back to medium levels at 0.232 mg/kg, just above the threshold used on the figure to define medium level concentrations. There was no sample available for FD3A in WY2022 due to construction of the new outfall in this area.

As shown in Figures 2-1.1 and 5-2.1, mercury concentrations at all these locations generally decreased somewhat from WY2004 to WY2009, which is believed to be a result of the storm line cleaning project and removal of a point source (see Section 5.1.2 below). Due to increasing or variable contamination levels in sediment traps in recent years (after point source removal and storm line cleaning), source(s) of mercury were determined to still be present, and this led to additional investigation and removal of additional sources. The general stabilization of concentrations at lower levels indicates that sources have likely been controlled at this time. In WY2020, FD18B was removed, and based on results from WY2021, mercury was removed from the analyte list for FD18.

5.1.1.b PAHs

Stormwater OF230 had similar to slightly higher levels of phenanthrene, pyrene, and indeno(1,2,3-c,d)pyrene in stormwater as compared to other outfalls (+1, 0, and +2) when looking at the 21-year monitoring record (see Table 3-4 and figures in Appendix F). When looking at only the most recent two-year monitoring record, OF230 is neutral relative to other outfalls for indeno(1,2,3-c,d)pyrene and pyrene (0), and slightly elevated in phenanthrene (+1).

Most PAH concentrations in stormwater appear to have decreased following line cleaning (see Section 5.1.2) and stayed fairly constant from WY2009 (Year 8) to WY2014 (see Figure 5-1.1 and figures in Appendix G). The apparent uptick in organics concentrations observed in recent years of monitoring was further evaluated and, as discussed in Section 3.5.2, it was concluded that the earlier data was likely biased low. As shown in Table 3-6 and Figures 3-5.5, 3-5.6, and 3-5.7, PAHs (phenanthrene, pyrene and indeno(1,2,3-c,d)pyrene) show a statistically significant improvement in stormwater quality from 2001 to present. The best-fit regression equations result in an estimated 81 to 85 percent reduction in PAHs in OF230 in the 21-year monitoring period.

SSPM Compared to the other outfalls, SSPM quality in OF230 is slightly enriched in phenanthrene and pyrene (both at +2) and moderately enriched in indeno(1,2,3-c,d)pyrene (+3) when looking at the 21-year monitoring period (see Table 3-5 and figures in Appendix F). When looking at just the last five years, all three indicator PAHs are neutral to slightly enriched relative to other outfalls, with phenanthrene and pyrene at 0 and indeno(1,2,3-c,d)pyrene at +1. As shown in Figure 5-1.1, SSPM PAH concentrations increased slightly between WY2005 to WY2009. SSPM PAH concentrations remained fairly consistent with a slight increase in 2014 but generally decreasing concentrations since that time, with an increase observed in WY2020 and a decrease in concentrations in WY2021. Earlier data had indicated a possible ongoing source(s) of PAHs in the FD3A area that was present in the stormwater sediments but wasn't seen in stormwater concentrations. Source control investigations identified a potential source in this area and cleanup was completed and post-cleanup monitoring is underway. Additional investigation identified another possible source in this area, and it is currently being addressed by the property owner. There was no sample from FD3A available in WY2022 due to construction in the areas, but ongoing monitoring will confirm whether control of the identified sources has been successful (see Section 5.1.2 below).

As shown in Figure 5-2.1, all the OF230 sub-basins appear to have also remained relatively consistent over the last 21 years. Overall, PAH concentrations throughout this basin are considered to be relatively low level (see Figure 2-1.2); however, because PAHs have been an ongoing priority for sediment recontamination throughout the waterway, they have been a priority for source control in this basin and others since the beginning of the monitoring program.

5.1.1.c Phthalates

Stormwater The second highest mean and maximum as well as the highest median concentrations of DEHP in stormwater were observed in OF230 (3.23, 44.1, and 2.00 µg/L, respectively) (see Table 3.3.1 and Figures F-8 and F-18). An unusually high peak concentration of DEHP was observed in Year 7 (WY2008) in OF230, but this appears to be an isolated occurrence (see Figures G-8 and G-18). OF230 contains significantly elevated DEHP concentrations (+5) in stormwater when reviewing the 21-year monitoring record (see Table 3-4). Concentrations of DEHP in OF230 are moderately elevated (+3) when only the last two years of monitoring data are evaluated.

As shown in Table 3-6 and on Figure 3-5.8, DEHP shows a statistically significant improvement in stormwater quality from 2001 to present. The best-fit regression equations result in an estimated 67 percent reduction in DEHP in OF230 in the 21-year period. In particular, there was a consistent decrease in total phthalate concentrations from WY2008 to WY2014 (see Figures 5-1.1, G-8, and G-18) that occurred following cleaning of the storm lines (see Section 5.1.2). The apparent uptick in organics concentrations observed in the last eight years of monitoring was evaluated by the City and, as discussed in Section 3.5.2, recent results were determined to be representative while earlier results were likely biased low. While this slight increase in organic concentrations is observed, concentrations remain substantially lower than the concentrations present early in the monitoring program (see boxplots in Appendix G).

SSPM OF230 SSPM quality is slightly enriched in DEHP and total phthalates (both at +1), and slightly lower in butylbenzylphthalate (-1) relative to other outfalls when looking at the entire 21-year monitoring record (see Table 3-5 and figures in Appendix F). Concentrations of DEHP, butylbenzylphthalate, and total phthalates are all neutral (0) relative to other outfalls when looking at the last five years of data.

Within the OF230 basin, some of the higher concentrations of total phthalates were found early in the monitoring program in FD3A (max of 161,500 µg/kg in WY2004), in FD3B (max of 130,590 µg/kg in WY2005), in FD16 (max of 161,860 µg/kg in WY2010), and in FD18 (max of 100,520 µg/kg in WY2004) (see Figures 2-1.3 and 5-2.1). Concentrations have generally been much lower since cleaning of the storm drainage system, although intermittent medium level concentrations were noted in FD18 and FD18B in WY2010 and WY2012. Concentrations have been in the low range since WY2012 throughout this basin.

5.1.1.d Pesticides

Stormwater Analysis for bifenthrin in stormwater began in WY2021 under the 2020 QAPP. Statistical analysis will be performed when sufficient data is available.

SSPM Analysis for bifenthrin in SSPM began in WY2015 under the 2014 QAPP. Although there are fewer data points available for statistical analysis, the results are significant ($p<0.05$) and there are only slight discernible differences between outfalls. OF230 is neutral (0) relative to other outfalls based on available data. The highest maximum concentration of bifenthrin was found in OF230 (142 µg/kg) with the maximum concentration detected in 2015 (Table 3-3.2).

5.1.1.e PCBs

Stormwater PCBs are not a COC tested for in stormwater under the 2020 QAPP.

SSPM Many of the highest concentrations in SSPM PCBs during the monitoring period have been found in the OF230 drainage basin (see Figures F-31 and F-43). WY2017 concentrations at FD3A were less than half the concentration measured in WY2016, however they increased each year between WY2018 and WY2020. Following a thorough analysis, no cause for the across-the-board elevated PCB levels in WY2020 was identified. Therefore, as discussed in Section 3.5.2, it was determined that the WY2020 results were not accurate and they will not be used to determine steps forward in source tracing investigations. The WY2021 concentration at FD3A was the lowest observed since 2005, however it remained in the high range relative to other outfalls (Figure 2-1.4). There is no data available for WY2022 due to the construction project in the area. Concentrations at FD3-New have fluctuated between low and high levels since WY2014, with WY2022 concentrations returning to the low range relative to other outfalls (Figure 2-1.4).

Concentrations at FD18 decreased from high levels to moderate levels in WY2014, where they remained through WY2017. In WY2018, concentrations increased back to the high range, nearly double the WY2017 concentration, where they remained through WY2021 (Figure 2-1.4). Source control activities have taken place in this area as further described in Section 5.1.2 below. The WY2022 concentration at FD18 returned to the medium range. As final work on the source control project as well as an adjacent project in this area is completed, additional sampling will be performed to confirm that this source has been controlled.

PCB concentrations at FD16 fluctuated between low and medium levels relative to other outfalls since WY2013. The WY2022 concentration was in the high range. Total PCBs in SSPM in OF230 were slightly elevated (+1) relative to other outfalls when looking at the entire 21-year monitoring record, but there are no significant differences between outfalls when looking at the last five years of data (see Table 3-5).

As shown on Figure 2-1.4, PCBs concentrations at FD3A, FD3 New, FD18, and FD16 were intermittently at high levels before the 2007 cleaning project and were at low levels immediately following the cleaning (also see Figure 5-2.1 and Section 5.1.2). However, PCB concentrations at all these locations have been fluctuating between low, medium, and high levels since pipe cleaning, with moderate to high levels detected since WY2012. Over the last several years, additional sources of PCBs in the OF230 drainage basin have been identified and are in various stages of source control actions. The status of this work is further described below.

5.1.2 Source Control Program Activities

Mercury Source Tracing Investigation Several source control investigations for mercury have been performed, and actions taken to eliminate identified sources. Additional information can be found in Appendix A.

Due to the likely presence of a remaining source or sources in this drainage basin, specifically the FD18 and FD3A areas, a source tracing investigation was launched to further investigate potential sources of mercury in this area.

Results from the mercury investigation and business inspections of the surrounding area indicated that sources of mercury were likely present in two primary areas: one in the sidewalk roof drains draining to a catch basin at the corner of South 12th and Court A, and one found at a lower concentration level at South 11th and Broadway. The South 12th and Court A area was subsequently resolved as described in the WY2020 report. At the South 11th and Broadway location, mercury concentrations continued to trend downward but remained higher than normal catch basin concentrations. The basins were cleaned in November 2018 and resampled in June 2020. While mercury concentrations continue to trend downward at this location, higher than normal basin concentrations remain present.

There are no sediment trap results for WY2022 at FD3A due to construction activities in the area. Due to construction of the new outfall (OF230A) this sediment trap was removed in December 2021 and was not reinstalled until January 2023, after construction was complete. WY2021 sediment trap sampling results had increased slightly to medium levels, however the measured concentration of 0.023 mg/kg was just over the 0.20 mg/kg used in Figure 2-1.1 to differentiate low and medium levels. If no additional sources in the South 11th and Broadway area are identified, and following review of sediment trap results in WY2023, the City will determine whether there is a need for continuation of this investigation in the future.

More detailed information regarding this investigation can be found in Appendix A.

PCBs Source Tracing Investigation Since the inception of the sediment trap monitoring program, intermittently high levels of PCBs have been identified in some of the OF230 sediment traps (see Figure 2-1.4). After the lines were cleaned in 2007, concentrations decreased, but over time increased back to moderate to high levels. Because of the likely presence of a remaining intermittent source or sources, a source tracing investigation was launched in 2012 in conjunction with the mercury source tracing work described above, to further investigate potential sources of PCBs in this drainage basin.

In 2013, the investigation indicated that elevated levels of PCBs were present in the caulking materials from two properties: the Wells Fargo and Sound Physicians (now known as 1123 Pacific Partners) properties located in the vicinity of South 12th and South 13th Streets, between Pacific Avenue and Court "A" in downtown Tacoma. It was determined likely that these materials were the source of PCB contamination found in the nearby catch basins in the targeted drainage areas. To ensure that the contamination did not reach the waterway, the system was cleaned in early 2015.

Significant remediation work has been performed at both properties. The catch basins in the area were cleaned and during 2022, the City resampled the catch basins adjacent to the Wells Fargo building and found that there appears to be a continuing source of contamination at the southeast corner of the property. The catch basin in the southeast corner of the site showed a concentration of 0.9 mg/Kg in 2016 and 1.8 mg/Kg in 2017, and as a result the system was cleaned in 2017. Following this cleaning, this same catch basin had a concentration of 12 mg/Kg in 2022. During discussions with the property owners/managers of this site, it was agreed that the City would clean and resample in 2023 to ensure that the concentration detected in 2022 was not an anomaly. Once the results are received, the City will meet with the property owners to discuss any required remediation moving forward. All of the catch basins surrounding this complex were cleaned in October 2022.

At the 1123 Pacific Partners site during 2022, the City attempted to resample three adjacent catch basins. One of the locations did not have enough sediment to sample and the two other catch basin samples exhibited concentrations that were reduced from 2020 levels but were still considered elevated concentrations. It was discovered that the property was purchased by new owners in 2022 and they were unaware of the PCB remediation at this location. The City met with the new owners to provide the history and status of the work. Based on the lack of sediment at one of the three catch basins targeted for sampling in 2022 and the reduction in concentration at the others, it was agreed that the City would clean all of the targeted catch basins (completed during 2022) and resample in 2023.

During the spring of 2023, the City plans on retargeting these catch basins for resampling to determine if historic contamination is still an issue at this location.

WY2021 sediment trap results for FD3A continued to show an elevated PCB concentration (550 µg/kg); however, this concentration is among the lowest detected at this location during the 21-year monitoring period. As indicated above, WY2022 SSPM results are not available for FD3A due to construction activities. The sediment trap at this location was replaced in January 2023, so WY2023 results will represent only a partial year. These partial year results, and future SSPM monitoring results, will be reviewed in conjunction with source control catch basin results to identify next steps at these properties.

While this area was identified as the highest priority, several other areas with lower levels of PCB contamination were also identified through the initial investigation. These areas were initially assigned lower priority ratings since contaminant levels were lower. Storm drains throughout this area were cleaned in February 2015, and the area resampled in March/April 2016. Results indicated ongoing lower-level sources of PCBs in several areas, leading to additional investigation. Updates on each of these PCB investigations are provided below, and more information can be found in Appendix A.

- One of these areas is located at South 9th and Fawcett St. in the FD18 area. Investigation led to the identification of the CenturyLink building as the likely source of PCB contamination found in the nearby catch basins. The City worked with the business and regulatory agencies to stop the source of PCBs discharging from this site. The property owner completed the encapsulation project for the building in 2020. Catch basins were cleaned following activities at the site. Samples from 2021 and 2022 both indicated the potential for residual issues caused by the construction activities. Following correction of these issues the plan was to clean and then resample. However, before this could occur, a construction project began at this location, which involved the removal and replacement of all of the curb/gutter and sidewalk at this intersection. The project also removed one of the catch basins sampled during this investigation. Due to the duration of this project, no further investigation or cleaning of the system was completed in this drainage area during 2022. After completion of the sidewalk replacement project, the City will clean the catch basins and then, once adequate sediment has accumulated, the catch basins will be resampled to ensure the sources of PCBs have been removed from this site. PCB concentrations at FD18 have continued to decrease since remediation work was completed in 2020 with WY2022 concentrations dropping to medium levels (230 µg/kg) in this basin for the first time since 2017.

- Another area of concern is located at South 13th and Commerce. Initial source tracing efforts did not turn up a likely source. Cleaning of the system was performed in this area in 2021 and basins will be resampled when sufficient sediment has accumulated to determine if an issue is persisting at this site. Staff attempted to resample the catch basins during 2022 but were unable to collect samples due to insufficient sediment. It is anticipated that these catch basins will be resampled in summer 2023.

- Finally, the Park Plaza parking garage located at South 10th and Pacific Avenue was identified in 2016 as having exposed caulking, sealant, and sediment materials that are likely the source of PCBs in the storm system. The City, as property owner, is continuing to work with EPA to assess the extent of contamination and develop a remediation plan. It is expected that remediation will be initiated during 2023.

The City is continuing to coordinate efforts to keep contaminants out of the municipal stormwater collection system. Sediment trap results for WY2023 will be assessed to monitor the ongoing conditions in this basin as additional sources are controlled. More detailed information regarding these investigations can be found in Appendix A.

PAH Source Tracing Investigation Based on sediment monitoring in OF230, the FD3A drainage area was identified as having ongoing issues with PAH sediment contamination. A source control investigation identified elevated levels of PAHs in a specific segment of the FD3A drainage area leading to identification of a parking area at the corner of Court A and South 14th Street as having the presence of elevated PAH concentrations.

Since the source was identified, the City has been working cooperatively with the property owner as they clean and repair their private onsite storm system. The City will continue to work with the property owner to see if this issue has resolved. Repair of the private system was completed in October 2022, and the municipal catch basins that the private systems connect to were cleaned in November 2022. The City will resample this location when sufficient sediment has accumulated to ensure this PAH source has been removed.

PAH concentrations in FD3A decreased over time from 111,295 µg/kg in WY2016 to 10,009 µg/kg in WY2019. In WY2020, there was a slight increase in concentrations to 33,202 µg/kg, but they decreased again to 8,666 µg/kg in WY2021. This overall decrease in concentrations indicates that efforts to date have been successful. There were no PAH results for the FD3A drainage area during 2022. Due to construction of the new outfall (OF230A) this sediment trap was removed in December 2021 and was not reinstalled until January 2023 after construction was complete. The results that will be reported next year in the WY2023 report will reflect deployment for a partial year.

More detailed information regarding this investigation can be found in Appendix A.

FD16 PCB Source Tracing Investigation Composite catch basin samples were taken in the FD16 drainage basin during 2017 to investigate the ongoing presence of PCBs is this area. Through this sampling, the City discovered elevated PCBs in catch basin sediments from three segments in the FD16 drainage basin. Following continued investigation in 2018, five discrete catch basin locations were cleaned, and resampling suggested that the relatively low-level concentrations of PCBs were emanating from building materials located at 1301 and 1331 Tacoma Avenue South. PCBs were not detected in FD16 in WY2019 or WY2020. The plan was to remove the sediment trap at this location if PCBs remained undetected in WY2021. However, PCB concentrations at this site increased back up to medium levels with a concentration of 170 µg/kg. In WY2022, concentrations increased to the relatively high level of 430 µg/kg, indicating the likely presence of an ongoing source. With the increasing concentrations in WY2022, additional source control actions will be initiated in 2023. The City will resample catch basin sediment in areas with previously elevated PCB concentrations to determine if there is a continued source in this drainage area. The City will continue to monitor sediment trap results during 2023.

More detailed information regarding this investigation can be found in Appendix A.

Storm System Cleaning In 2007, the municipal storm system in OF230 was cleaned and video inspected. The objective of this project was to remove residual sediments in the storm drains that may contain legacy contaminants. As discussed in detail in the WY2011 report, storm system cleaning contributed to significant reductions in stormwater concentrations. Sewer line cleaning is an important component of the City's source control program, and the City is currently on a schedule of cleaning each storm system area on a 20-year cycle. Additional cleaning is performed on an as-needed basis to address specific maintenance needs. In combination with other source control activities, storm system cleaning appears to have been effective at removing all seven of the compounds tested. The City is statistically evaluating the results to determine whether a maintenance schedule different from the City-wide schedule for pipe cleaning projects is needed within this sensitive basin.

Statistically significant reductions were evident for TSS, lead, zinc, PAHs, and DEHP (see Table 2-2). Line cleaning, along with other source control activities, resulted in reductions of TSS at 27 percent, lead at 50 percent, zinc at 28 percent, DEHP at 57 percent, and PAHs (phenanthrene, pyrene, and indeno(1,2,3-c,d)pyrene) at 77-82 percent.

Enhanced Street Sweeping Program In January 2007, the City's street sweeping program was enhanced in an attempt to reduce sediment buildup in the storm sewer system. Under the enhanced program, the sweeping frequency was increased, air regenerative sweepers replaced mechanical sweepers, and the City also increased communications with residents, which helped raise awareness of the importance of the street sweeping program.

Statistically significant reductions were evident for TSS, lead, zinc, PAHs, and DEHP (see Table 2-3.1). Street sweeping, along with other source control activities, resulted in reductions of TSS at 31 percent, lead at 51 percent, zinc at 30 percent, DEHP at 56 percent, and PAHs (phenanthrene, pyrene, and indeno(1,2,3-c,d)pyrene) at 75-81 percent. PAH concentrations shown in Figure 5-1.1 show a fairly consistent decrease and then leveling off between WY2007 and WY2015 that occurred following the start of street sweeping and the cleaning of the storm lines. An apparent uptick in organics concentrations observed in the last eight years of monitoring was evaluated by the City, as discussed in Section 3.5.2. Recent results were determined to be representative, while earlier results were likely biased low. While this slight increase in organic concentrations is observed, concentrations remain substantially lower than the concentrations present early in the monitoring program (see boxplots in Appendix G).

General Source Control Activities In addition to the ongoing investigation and maintenance activities described above, the City has been and is continuing to implement other source control program elements in the OF230 drainage basin, which are described in more detail in Appendix A. Several other source control actions have been completed or are currently underway in this basin, including the Sauro's Cleanerama site remediation and the removal of USTs at various locations under TPCHD oversight. In addition, two new private treatment devices were installed in this basin in 2022 and one Notice of Violation letter was issued (see Appendix A).

5.1.3 Outfall 230 2023 Work Plan

As shown in Table 3-6 and Figures 3-5.1 to 3-5.8, TSS, lead, zinc, PAHs (phenanthrene, pyrene, and indeno(1,2,3-c,d)pyrene), and DEHP all show statistically significant improvement in OF230 stormwater quality from 2001 to present with an estimated 47 percent reduction for TSS, 81 percent for total lead, 51 percent for total zinc, 81-85 percent reduction for the three index PAHs (phenanthrene, pyrene, and indeno(1,2,3-c,d)pyrene), and 67 percent for DEHP in the 21-year period. While there is not a statistically significant trend for copper in WY2022, mean copper concentrations in OF230 are among the lowest relative to the other Foss outfalls (Figures F-5 and F-15). One moderate outlier for copper was observed in WY2021 and none were observed in WY2022 (Figure G-5). The City will be performing an outlier analysis in 2023.

As described in detail above, OF230 monitoring results generally show:

- Stormwater – Moderately lower TSS (-3) and significantly higher DEHP (+5) concentrations compared to other outfalls when evaluating the 21-year monitoring record (see Table 3-4). DEHP is moderately higher (+3) when looking at only the last two years of data. Copper (-3) is moderately lower in concentration compared to other outfalls based on the last eight years of data that are available. Concentrations of other COCs are generally similar to concentrations found in other outfalls.

- SSPM – Outfall results show moderately higher indeno(1,2,3-c,d)pyrene (+3) compared to other sediment trap locations (see Table 3-5) when evaluating the entire 21-year monitoring record. When looking only at more recent data, indeno(1,2,3,cd)pyrene is only slightly higher (+1). Over time, upline sediment traps have shown possible areas of concern primarily for mercury and PCBs, and to a lesser extent PAHs and phthalates. Source control efforts have either been completed or are ongoing as described above and in Appendix A.

Therefore, the following recommendations are included in the 2023 Work Plan for OF230:

- Continue follow-up on private property cleanups performed, and complete ongoing system cleaning and monitoring for PCBs and PAHs as appropriate in the areas draining to FD3A, FD3A New, FD18, and FD16
- Continue evaluation of potential sources of spring/summer outliers for copper to stormwater
- Review the WY2023 SSPM data to evaluate the potential for ongoing sources in the various investigation areas

5.2 Outfall 235

Many activities have occurred in the OF235 drainage basin during the monitoring period, some of which are contributing to improvements in stormwater and SSPM quality. Statistically significant improvements in all index COCs (TSS, lead, zinc, PAHs, and DEHP) have been observed in stormwater in OF235 (Table 3-6). In addition, copper has shown significant improvement in stormwater based on a more limited data set. It is, therefore, likely that the City's source control efforts have helped to reduce these constituents in OF235. Figure 5-1.2 shows the annual average concentrations for stormwater, baseflow, and SSPM.

This section provides a summary of water/sediment quality results within the OF235 drainage basin and compares the water/sediment data results with the major source control and other activities that have occurred within the basin. A more comprehensive description of source control activities performed to date is provided in Appendix A.

As indicated in Section 3, a new outfall, OF230A, was under construction throughout 2022. Upon completion, this new outfall is designed to carry approximately 98 percent of the stormwater previously discharging to OF230 and approximately 26 percent of the stormwater previously discharging to OF235. The City will be proposing a modification to the monitoring program in 2023.

Transition of flow from the drainage area to the new outfall did not begin until after the end of the water year, so all stormwater data from WY2022 will be evaluated consistent with data from the entire reporting period. Because the transition of flow took place from October through December of 2022, WY2023 data will represent only a portion of the year and will be discussed in further detail in the WY2023 report.

5.2.1 Water and SSPM Quality

Annual and seasonal data for stormwater and SSPM for the COCs and other parameters is used to identify ongoing areas of concern. The following paragraphs summarize the WY2001-WY2022 monitoring results for OF235, where COCs in this outfall are different from other Foss drainage basins, and where any subsequent source control activities may be focused.

5.2.1.a TSS and Metals

Stormwater Moderate TSS concentrations have been observed in stormwater from OF235 with mean and median TSS concentrations of 56.2 and 39.4 mg/L, respectively. The second highest maximum TSS concentration (441 mg/L) during the monitoring program was observed at OF235 in WY2001 (see Table 3-3.1 and Figures F-1 and F-11).

TSS in OF235 is slightly lower (-1) compared to other outfalls when looking at the entire 21-year monitoring record in the Foss Watershed (see Table 3-4). As shown in Table 3-6 and Figure 3-5.1, TSS shows a statistically significant improvement in stormwater quality from 2001 to present with an estimated 78 percent reduction of TSS in 21 years. The trend is gradual over time and does not lend itself to be a direct result of any one action. Figures 5-1.2, G-1, and G-11 also show the gradual downward trend of TSS over the last 21 years.

The highest mean and median concentrations of lead (54.19 and 41.15 µg/L, respectively) were observed in OF235 stormwater. In addition, the highest overall copper concentration (162 µg/L) occurred in OF235 in 2015 (Table 3-3.1). This outlier appears to be relatively isolated, although one other high outlier occurred in 2012 and high and moderate outliers are present throughout available data. Two outliers were present in WY2021, but no outliers were present in WY2022 (see Figures G-5 and G-15). OF235 is significantly elevated in lead (+6) and copper (+6), and slightly elevated in zinc (+2) compared to all other outfalls when looking at the 21-year monitoring record (see Table 3-4). It should be noted that the data set for copper is smaller and the statistical analysis less robust than for other constituents. When only the last two years of monitoring data for OF235 is evaluated, lead is still significantly elevated (+6) while copper is moderately elevated (+4). Zinc remains slightly elevated relative to other drains (+1).

As shown in Table 3-6 and Figures 3-5.3 and 3-5.4, lead and zinc show a statistically significant improvement in stormwater quality from 2001 to present, with an estimated 78 percent and 64 percent reduction respectively in 21 years. OF235 also shows a statistically significant improvement in stormwater quality for copper based on available data, with an estimated 44 percent reduction in concentrations. The trends are gradual over time and do not lend themselves to be a direct result of any one action. Figure 5-1.2 shows the gradual decreasing trend of zinc over the last 21 years, and the boxplots in Appendix G also show this decreasing trend for both lead and zinc. It is, therefore, possible that the City's source control efforts have helped to reduce lead and zinc in OF235. However, the continuing relatively higher stormwater concentrations indicate that there may be a source(s) of lead and copper in OF235 since levels are greater than those found throughout the Foss Waterway Watershed. Source control investigations are continuing at this time as described further below.

SSPM Consistent with stormwater results, total lead in SSPM is slightly elevated in OF235 (+2) during the last 21 years (see Table 3-5). Results for all other metals are the same or only slightly different relative to other outfalls with copper, mercury, and zinc at +1, 0, and 0, respectively. When looking at only the last five years, all metals are neutral or slightly elevated (copper, mercury, and zinc all at 0, and lead at +1) in OF235 SSPM compared to other outfalls.

5.2.1.b PAHs

Stormwater OF235 stormwater contained the highest mean and maximum concentrations of the very light end compounds naphthalene and 2-methylnaphthalene, with the maximum concentrations detected early in the monitoring program (see Table 3-3.1). ANOVA results show that OF235 is neutral to slightly higher than average for PAHs (phenanthrene and indeno(1,2,3-c,d)pyrene at 0, and pyrene at +2) when looking at the entire 21-year monitoring record (see Table 3-4 and boxplots in Appendix F). As shown in Figure 5-1.2 and in the boxplots in Appendix G, LPAH and HPAH concentrations in stormwater generally decreased between 2007 and 2009-2010, and remained fairly consistent until WY2014. These decreases are believed to be due in large part to the storm line cleaning project (see Section 5.2.2). Concentrations have remained fairly consistent over the last eight years. When only the last two years of monitoring data are evaluated, phenanthrene concentrations are slightly lower (-1) while indeno(1,2,3-c,d)pyrene and pyrene are neutral (0) compared to other outfalls.

As shown in Table 3.6 and Figures 3-5.5, 3-5.6, and 3-5.7, PAHs (phenanthrene, pyrene and indeno(1,2,3-c,d)pyrene) show statistically significant improvement in stormwater quality from 2001 to present. The best-fit regression equations result in an estimated 76-88 percent reduction in each of these PAHs in OF235 in the 21-year monitoring period. The apparent uptick in organics concentrations observed in the last eight years of monitoring was evaluated by the City, as discussed in Section 3.5.2, and recent results were determined to be representative while earlier results were likely biased low. While this observed slight increase in organic concentrations is observed, concentrations remain substantially lower than the concentrations present early in the monitoring program (see boxplots in Appendix G).

SSPM PAH concentrations are relatively neutral for SSPM at OF235 compared to the other outfalls during both the 21-year monitoring period (-1 to +1) and the last five years (all at 0). As shown in Figure 2-1.2, PAH concentrations in storm sediment are considered low level and are similar to other outfall and upland locations. In fact, LPAH and HPAH concentrations in storm sediment have remained fairly consistent in this basin over the last 21 years (see Figure 5-1.2).

5.2.1.c Phthalates

Stormwater The highest mean and maximum stormwater concentrations of DEHP during the 21-year monitoring period were observed in OF235 (4.03 and 97 µg/L). Unusually high peak concentrations of DEHP were observed in WY2003 (Year 2) in OF235, but these appear to be isolated occurrences (October 2002 and December 2002) and are not evident in recent years (see Table 3-3.1, Figure 5-1.2 and boxplots in Appendices F and G). The cause of the outliers during WY2003 is unknown.

DEHP is usually the phthalate compound with the most frequent detections and the highest median concentrations. However, the maximum concentration of diethylphthalate was also detected in OF235 stormwater (590 µg/L) in December 2002. The cause of this occurrence is also unknown and may be related to the high concentrations of DEHP in October and December 2002. OF235 contains significantly elevated DEHP concentrations (+5) relative to other outfalls when looking at the entire 21-year monitoring period (see Table 3-4). When only the last two years of monitoring data are evaluated, DEHP concentrations in OF235 are only slightly elevated (+2) compared to other outfalls. The relatively elevated level of DEHP in the entire 21-year monitoring period is likely a result of several high outliers observed in this basin over time (see Figure G-8).

As shown in Table 3-6 and Figure 3-5.8, DEHP shows a statistically significant improvement in stormwater quality from 2001 to present. The best-fit regression equations result in an estimated 82 percent reduction in DEHP in OF235 in the 21-year monitoring period. In particular, there is a consistent decrease in phthalate concentrations from the highest concentrations in WY2003 (Year 2) to WY2013 (Year 12) (see Figures 5-1.2, G-8, and G-18) which is believed to be due to the storm line cleaning project and other source control activities (see Section 5.2.2). The apparent uptick in organics concentrations observed in the last seven years of monitoring was evaluated by the City, as discussed in Section 3.5.2, and recent results were determined to be representative while earlier results were likely biased low. While this observed slight increase in organic concentrations is observed, concentrations remain substantially lower than the concentrations present early in the monitoring program (see boxplots in Appendix G).

SSPM Even though DEHP in OF235 was significantly elevated in stormwater (+5), in storm sediment, the average concentration is only slightly elevated (+1) compared to the other outfalls in the 21-year monitoring period and neutral in the last five years (see Table 3-5 and Figures F-29 and F-41). As shown in Figure 2-1.3, phthalate concentrations are at low levels in OF235, and concentrations are similar to other outfall and upland locations. Discrepancies between the stormwater and storm sediment data sets may be caused by differential transport of pollutants in dissolved and particulate phases.

5.2.1.d Pesticides

Stormwater Analysis for bifenthrin in stormwater began in WY2021 under the 2020 QAPP. Statistical analysis will be performed when sufficient data is available.

SSPM Analysis for bifenthrin began in WY2015 under the 2014 QAPP and while there are fewer data points available for statistical analysis, the results are significant ($p<0.05$), and concentrations are neutral (0) in OF235 relative to other outfalls based on available data.

5.2.1.e PCBs

Stormwater PCBs are not a COC tested for under the 2020 QAPP.

SSPM Of 235 was neutral (0) relative to other outfalls when looking at the entire 21-year monitoring record. There were no significant differences between outfalls when looking at the last five years of data (see Table 3-5).

At FD6, concentrations increased to medium levels for the first time in WY2019, with a concentration of 280 µg/kg and further increased to high levels WY2020 with a concentration of 420 µg/kg (see Figure 2-1.4). PCBs were not detected at this location in WY2021 or WY2022. Following a thorough analysis, no cause for the increased PCB levels that were consistently present in WY2020 results was identified. Therefore, it was determined that WY2020 results were not accurate and will not be used to determine steps forward in source tracing investigations.

5.2.2 Source Control Program Activities

Outfall 235 Stormwater and Baseflow Lead, PAHs, and Phthalates Source Investigation
Based on stormwater monitoring in OF235, this basin was identified as having ongoing issues with lead in stormwater. In August 2014, staff began an investigation to identify possible sources of the elevated lead concentrations in stormwater. Elevated concentrations of phthalates and PAHs were also observed in historic baseflow discharges. The intent of this work was to identify specific problem areas within the drainage basin for further investigation.

Through these investigations, three locations were identified where potentially contaminated groundwater was seeping from the hillside and discharging to the City's stormwater system. Construction activities are ongoing in two of these areas which will likely provide some level of control.

Through 2022, the City monitored the sites in this area with active construction to ensure proper BMPs were maintained. This project was on hold while the new Foss Waterway outfall was being constructed. The construction for the new outfall and the re-routing of the stormwater system was completed in December 2022 and it is anticipated that construction for the Tacoma Center Project will continue in 2023. Upon completion of the development project, it will be determined whether construction in this area will eliminate runoff from possible contaminated groundwater in this drainage basin.

More detailed information regarding this investigation can be found in Appendix A.

Outfall 230/235 Copper Outlier Investigation Copper was newly identified as a contaminant of concern within OF235 and to a lesser extent OF230 in WY2021 due to intermittent elevated concentrations in stormwater with other potential outliers beginning in WY2016. All of these outliers as well as those detected since that time have been detected in the spring and summer. Due to the seasonal and intermittent nature of the outlier copper concentrations showing up in stormwater samples, it was theorized that it is possible that excess copper is caused by a seasonal commercial cleaning or maintenance operation taking place in the drainage basin. Copper is used as a moss killer on roofs and sidewalks as well as being present in some herbicides.

In initiating this investigation, City staff identified buildings with copper exteriors as possible contributors. Tacoma's Union Station was identified as a possible source due to its large copper roof. On April 27, 2022, the City sampled five private catch basins around the property of Union Station, multiple of which had roof drain connections. The copper results ranged from 86 ppm to 4,360 ppm and all of the catch basins were heavily impacted with sediment. The stormwater leaving this site splits with approximately half going to OF230 and half going to OF235.

Based on these results, in June 2022, EC staff reached out to the property manager for this facility and requested that they clean their catch basins and connecting laterals. This work was to occur in January 2023, and the City will follow up with the property management company in February 2023 to ensure the work occurred and follow-up further with other concerns at this site such as the application of moss killers and herbicides and confirmation as to the drainage locations of the facility's cooling towers.

The City will continue to look for other potential sources of copper within this drainage basin if needed based on future sampling results.

More detailed information regarding this investigation can be found in Appendix A.

Storm System Cleaning In 2007, the municipal storm system in OF235 was cleaned and video inspected. The objective of this project was to remove residual sediments in the storm drains that may contain legacy contaminants. As discussed in detail in the WY2011 report, storm system cleaning contributed to significant reductions in stormwater concentrations. Sewer line cleaning is an important component of the City's source control program, and the City is currently on a schedule of cleaning each storm system area on a 20-year cycle. Additional cleaning is performed on an as needed basis to address specific maintenance needs. In combination with other source control activities, storm system cleaning appears to have been effective at removing all seven of the compounds tested. The City is statistically evaluating the results to determine whether a maintenance schedule different from the City-wide schedule for pipe cleaning projects is needed within this sensitive basin.

Statistically significant reductions were evident for TSS, lead, zinc, PAHs and DEHP (see Table 2-2). Line cleaning, along with other source control activities, resulted in reductions of TSS at 59 percent, lead at 57 percent, zinc at 43 percent, DEHP at 75 percent, and PAHs (phenanthrene, pyrene, and indeno(1,2,3-c,d)pyrene) at 75-78 percent.

Enhanced Street Sweeping Program In January 2007, the City's street sweeping program was enhanced in an attempt to reduce sediment buildup in the storm sewer system. Under the enhanced program, the sweeping frequency was increased, air regenerative sweepers replaced mechanical sweepers, and the City also increased communications with residents, which helped raise awareness of the importance of the street sweeping program.

Statistically significant reductions were evident for TSS, lead, zinc, PAHs and DEHP (see Table 2-3.1). Street sweeping, along with other source control activities, resulted in reductions of TSS at 60 percent, lead at 58 percent, zinc at 44 percent, DEHP at 76 percent, and PAHs (phenanthrene, pyrene, and indeno(1,2,3-c,d)pyrene) at 73-76 percent.

General Source Control Activities In addition to the ongoing maintenance activities described above, the City is continuing to implement other source control program elements in the OF235 drainage basin which are summarized here and described in more detail in Appendix A. Several other source control actions have been completed or are currently underway in this basin, including the removal of a UST at one location under TPCHD oversight and one new treatment device was installed on a private property.

5.2.3 Outfall 235 2023 Work Plan

TSS, lead, zinc, DEHP, and PAHs have all shown a statistically significant improvement in stormwater quality from 2001 to present (see Table 3-6 and Figures 3-5.1 to 3-5.8). As shown in Table 3-6, TSS shows an estimated 78 percent reduction over 21 years, lead at 78 percent, zinc at 64 percent, DEHP at 82 percent and PAHs (both light and heavy PAH fractions) at 76-88 percent reductions. In addition, with eleven years of copper data now available for OF235 an overall evaluation of the source control program can include trends for this outfall, however, the results are not as statistically robust, so are not directly comparable. Copper concentrations in stormwater at OF235 show statistically significant improvement during this period with an estimated 44 percent reduction.

As described in detail above, OF235 results generally show:

- Stormwater – Slightly higher pyrene (+2) and zinc, and significantly higher lead (+6), copper (+6) and DEHP (+5) as compared to other outfalls when evaluating available data from the 21-year monitoring record (see Table 3-4). It should be noted that the data set for copper is smaller and the statistical analysis less robust than for other constituents. When looking at only the last two years of data, lead (+6) remain significantly elevated, copper moderately elevated (+4), and DEHP (+2) is only slightly elevated.

- SSPM – Slightly higher lead (+2) compared to other sediment trap locations when evaluating the entire 21-year monitoring record but very little notable difference in SSPM quality at OF235 when looking at only the last five years (see Table 3-5).

Therefore, the following recommendation is included in the 2023 Work Plan for the OF235 drainage basin:

- Evaluate the need for additional source control work for lead, copper and DEHP in stormwater following completion of construction activities in this area. These construction activities are expected to have a positive impact on controlling the flow of potentially contaminated groundwater into the storm drainage system.

- Continue evaluation of potential sources of spring/summer outliers for copper to stormwater.

5.3 OUTFALL 237A

Many source control efforts have been targeted in the OF237A drainage basin and have resulted in improvements in stormwater and SSPM quality. TSS, lead, zinc, phenanthrene, pyrene, and DEHP concentrations have all shown a statistically significant improvement in stormwater quality from 2001 to present. Indeno(1,2,3-c,d)pyrene showed statistically significant improvement for many years, however that trend was not present in WY2021 and WY2022, apparently due to several higher concentrations detected in WY2021. It is likely that the City's source control efforts have helped to reduce concentrations of the key constituents in OF237A. Figure 5-1.3 shows the annual average concentrations for stormwater, baseflow, and SSPM.

This section provides a summary of water/sediment quality results within the OF237A drainage basin and compares the water/sediment data results with the major source control and other activities that have occurred within the basin. A more detailed description of source control activities is provided in Appendix A.

5.3.1 Water and SSPM Quality

Annual and seasonal data for baseflow, stormwater and SSPM for the COCs and other parameters is used to identify ongoing areas of concern. The following paragraphs summarize the WY2002-WY2022 monitoring results for OF237A[22], where COCs in this outfall are different

[22] As described in Section 3.2.4 of the WY2012 report, the OF237A (for data prior to February 26, 2006) and OF237A New data sets (for data after February 26, 2006) were merged in 2012. While the data sets are generally the same, the box plots in Appendix G appear to show a change in the data in between

from other Foss drainage basins, and where subsequent source control activities may be focused.

5.3.1.a TSS and Metals

Stormwater Stormwater TSS, lead and zinc concentrations at OF237A (-2, -3 and -1, respectively) are slightly to moderately below average in the 21-year monitoring period (see Table 3-4). Concentrations are more neutral to slightly higher when looking at only the last two years of data (0, -2, and 0, respectively). Analysis for copper at this outfall began in WY2015 so less data is currently available for a comprehensive statistical analysis. Based on available data, copper has moderately lower concentrations than other outfalls (-4) when looking at all eight years of data and slightly lower when looking at only the last two years (-2).

In stormwater, OF237A has the among the lowest mean and the second lowest median TSS concentrations at 49.1 and 33.9 mg/L, respectively (see Table 3-3.1 and Figures F-1 and F-11), despite having the highest TSS concentration detected during the monitoring period in WY2017 (668 mg/L in May 2017). The reason for this outlier is unknown but appears to be an anomalous event.

As shown in Figures 3-5.1, 3-5.3, 3-5.4 and Table 3-6, TSS, lead, and zinc have all shown statistically significant improvement, with TSS showing a 52 percent reduction, lead showing a 71 percent reduction, and zinc showing a 56 percent reduction in stormwater quality from 2001 to present. A statistically significant reduction is not yet realized for copper with a more limited data set.

SSPM OF237A exhibits lower concentrations of lead and mercury in SSPM compared to the smaller drains OF230, OF235 and OF243, and is lower for zinc in these same outfalls as well as OF245, (see boxplots in Appendix F). Boxplots for copper will be added in WY2023. ANOVA statistical tests on SSPM showed that OF237A is slightly lower in metals concentrations (lead and mercury at -1, and zinc at 0) compared to other outfalls for the 21-year monitoring record (see Table 3-5). When looking at only the last five years of monitoring data, OF237A is neutral (0) for lead, mercury, and zinc in comparison to other outfalls. Analysis for copper at this outfall began in WY2015 so less data is currently available for a comprehensive statistical analysis. Based on the eight years of available data, copper is slightly lower (-1) when looking at all available data, and neutral compared to other outfalls (0) when looking at just the last five years.

5.3.1.b PAHs

Stormwater OF237A stormwater quality shows evidence of being somewhat enriched in HPAHs with higher max, mean and median concentrations of several HPAHs observed (see Table 3-3.1 and boxplots in Appendix F) compared to other drains. The maximum concentrations occurred in 2007. PAH concentrations over the last fourteen years (Years

---

WY2006 (Year 5) and WY2007 (Year 6). This suggests that there are small differences in the two sampling locations. The OF237A New monitoring location measures contributions from the entire basin whereas the OF237A monitoring location was upstream of the smaller FD2A branch of OF237A storm drain system

8 through 21) are relatively low compared to the previous monitoring years (see boxplots in Appendix G).

ANOVA results show that OF237A is significantly higher than average for indeno(1,2,3-c,d)pyrene (+5), moderately higher for pyrene (+3), and slightly higher for phenanthrene (+1) relative to other drainages over the 2021-year monitoring record (see Table 3-4). When looking at only the most recent two-year monitoring record, OF237A is moderately higher in concentration for phenanthrene (+4), and significantly higher than other outfalls for pyrene and indeno(1,2,3-c,d)pyrene (+5 and +6). High outliers have been identified periodically throughout the monitoring period including an extreme outlier for indeno(1,2,3-c,d)pyrene in WY2022, and these are likely contributing to this observation (see Figure G-6). The City is evaluating potential causes and seasonality for these outlier concentrations.

As shown in Table 3-6 and Figures 3-5.5, 3-5.6, and 3-5.7, phenanthrene and pyrene show a statistically significant improvement in stormwater quality from 2001 to present. There is an estimated 70 and 78 percent reduction in these PAHs, respectively in 21 years. This is likely due to a combination of actions including the point source removals and sewer line cleaning projects. While there has been a statistically significant improvement in indeno(1,2,3-c,d)pyrene concentrations in past years, this trend was not present in WY2021 or WY2022, likely due to several higher concentrations detected during these monitoring years. Boxplots in Appendix G also show the decreasing trends of PAHs in stormwater. A summary of the City's evaluation of the cause of the slight uptick in results over the past several years is included in Section 3.5.2.

SSPM As shown in Table 3-5, storm sediment in OF237A is slightly to moderately enriched in the indicator PAHs phenanthrene, indeno(1,2,3-c,d)pyrene and pyrene (+2, +4, and +2, respectively) during the 21-year monitoring period. When looking at just the last five years, all three indicator PAHs remain slightly elevated (+2, +1 and +2, respectively). PAHs in SSPM have remained fairly stable over the last 21 years (see Figure 5-1.3) with the exception of WY2009 which had slightly lower concentrations, immediately after the cleaning project.

Figure 2-1.2 shows that PAH concentrations at FD13B were elevated at high or medium levels from WY2003 to WY2011 but dropped to low levels in WY2012 and have remained there since that time. Because the FD13B sediment trap was submerged since construction of the stormwater treatment vault in this area, a new sediment trap (FD13B New) was placed in a location one manhole upstream from the FD13B trap, and the new trap is not affected by the backwater from the treatment vault. FD13B is no longer deployed as of WY2019. Between WY2013, when it was installed through WY2020, FD13B New fluctuated between medium and high levels of PAHs, with high levels detected in WY2017 and medium levels detected in WY2018 through WY2020. These results led to a source control investigation and identification of source(s) which are described further below. While this source control work is continuing at this time, actions to date led to the concentrations at FD13B New being detected at relatively low levels in WY2021 for the first time since this sediment trap was installed and they remained at these lower levels in WY2022. In WY2022, all other sediment traps in the OF237A basin were at low levels (see Figure 2-1.2).

5.3.1.c Phthalates

Stormwater As shown in Table 3-6 and Figure 3-5.8, DEHP shows a statistically significant improvement in stormwater quality from 2001 to present. There is an estimated 49 percent reduction in 21 years. The trend is gradual over time and does not lend itself to be a direct result of any one action (see boxplots in Appendix G and Figure 5-1.3) although concentrations did decrease somewhat immediately following the basin cleaning effort.

In comparison to other outfalls, DEHP in OF237A is of slightly better quality (-1) over the entire 21-year monitoring record and slightly higher (+2) when looking at only the last two years (see Table 3-4).

SSPM DEHP concentrations in OF237A is neutral (0) when looking at the 21-year monitoring record and the last five years of monitoring (see Table 3-5). Butylbenzylphthalate is slightly lower in concentration (-2) and total phthalates are neutral (0) relative to other outfalls when looking at the 21-year monitoring period. Butylbenzylphthalate and total phthalates are both neutral relative to other outfalls based on the last five years of data.

All sediment trap locations in this basin have consistently had low level concentrations since at least WY2014, and phthalates are no longer analyzed at any of the sediment traps located up in the basin for source control purposes.

5.3.1.d Pesticides

Stormwater Analysis for bifenthrin in stormwater began in WY2021 under the 2020 QAPP. Statistical analysis will be performed when sufficient data is available.

SSPM Analysis for bifenthrin began in WY2015 under the 2014 QAPP and while there are fewer data points available for statistical analysis, the results are significant ($p<0.05$). OF237A concentrations of bifenthrin are slightly higher relative to other locations in the 21-year monitoring record and the last two years (+2 and +1 respectively) (see Table 3-5). The highest average and median concentrations of bifenthrin are present in OF237A (32 and 33 ug/Kg, respectively) (Table 3-3.2).

5.3.1.e PCBs

Stormwater PCBs are not a COC tested for under the 2020 QAPP.

SSPM PCB concentrations at OF237A are neutral (0) relative to other outfalls when looking at the entire 21-year monitoring record, and there are no significant differences between outfalls when looking at just the last five years of data (see Table 3-5).

After the pipe cleaning project in 2007, PCB concentrations in SSPM at FD10 and FD10C decreased in concentration from previous medium to low levels. In WY2013, however, PCB concentrations increased back to medium levels at both locations (see Figure 2-1.4). Concentrations at FD10 generally decreased to low levels since WY2013, with the exception of one medium level detection in WY2016. This detection was right at the limit between the low and medium levels shown on Figure 2-1.4 (120 µg/Kg). As a result, this sediment trap has been removed at this time. Concentrations at FD10C, however, have fluctuated between medium and high levels since WY2013. A source control investigation is currently underway in this area as further described below and in Appendix A.

At FD2A, concentrations increased to medium levels for the first time in WY2016, with a concentration of 170 µg/kg, but returned to low levels in WY2017 with a concentration of 99 µg/kg. In WY2018, concentrations returned to the medium range where they remained through WY2020. Concentrations during these three years ranged in concentration from 210 to 280 µg/kg. In WY2021, concentrations returned to the low range with a concentration of 100 µg/kg and in WY2022 they were not detected. At FD2, concentrations measured at the medium level in WY2015 and WY2020 with concentrations during those years measuring at 150 and 390 µg/kg, respectively. In WY2021, the concentration remained in the medium range with a concentration of 180 µg/kg and in WY2022, PCBs were not detected. Following a thorough analysis, no cause for the across-the-board increased PCB levels in WY2020 was identified (see Section 3.5.2). WY2021 SSPM concentrations returned to expected levels where they remained in WY2022. Therefore, it was determined that WY2020 results were not accurate and will not be used to determine steps forward in source tracing investigations.

5.3.2 Source Control Program Activities

Storm System Cleaning Targeted areas in the northern portion of the OF237A system were cleaned in 2008. The objective of this project was to remove residual sediments in the storm drains that may contain legacy contaminants. As discussed in detail in the WY2011 report, storm system cleaning contributed to significant reductions in stormwater concentrations. Sewer line cleaning is an important component of the City's source control program, and the City is currently on a schedule of cleaning each storm system area on a 20-year cycle. A second cleaning of approximately 17 percent of the OF237A system occurred in 2021. Additional cleaning is performed on an as needed basis to address specific maintenance needs. The City is statistically evaluating the results to determine whether a maintenance schedule different from the City-wide schedule for pipe cleaning projects is needed within this sensitive basin.

In combination with other source control activities, the original storm system cleaning was effective at reducing all seven of the compounds tested. With less post-cleaning data available following the second cleaning, statistics are not as robust, however reductions were observed for lead and zinc, while an increase was seen for indeno(1,2,3-c,d)pyrene.

Following the first cleaning, statistically significant reductions were evident for TSS, lead, zinc, PAHs, and DEHP (see Table 2-2). Line cleaning, along with other source control activities, resulted in reductions of TSS at 17 percent, lead at 32 percent, zinc at 30 percent, DEHP at 59 percent and PAHs (phenanthrene, pyrene and indeno(1,2,3-c,d)pyrene) at 66-76 percent. The second cleaning, along with other ongoing source control activities resulted in further reductions of lead at 55 percent and zinc at 42 percent. A statistically significant increase of 69 percent was observed for indeno(1,2,3-c,d)pyrene. An extreme outlier for this constituent was detected in OF237A, which may be the cause of this apparent increase (see Figure G-6).

Enhanced Street Sweeping Program In January 2007, the City's street sweeping program was enhanced in an attempt to reduce sediment buildup in the storm sewer system. Under the enhanced program, the sweeping frequency was increased, air regenerative sweepers replaced mechanical sweepers, and the City also increased communications with residents, which helped raise awareness of the importance of the street sweeping program.

Statistically significant reductions were evident for TSS, lead, zinc, PAHs and DEHP (see Table 2-3.1). Street sweeping, along with other source control activities, resulted in reductions of TSS at 9.1 percent, lead at 27 percent, zinc at 29 percent, DEHP at 54 percent and PAHs (phenanthrene, pyrene and indeno(1,2,3-c,d)pyrene) at 55-67 percent.

FD13 PAH Investigation / Media Filtration System Installation In 2010, the City installed a media filtration system that treats stormwater from the FD13 sub-basin, approximately 50 acres in size. Upstream of FD13, the FD13B sediment trap had been submerged since construction of this stormwater treatment vault. As a result, a new sediment trap (FD13B New) was placed in a location one manhole upstream from the FD13B trap, and the new trap is not affected by the backwater from the treatment vault. Since WY2013 when this new trap was installed, levels of PAHs have fluctuated between medium and high levels at FD13B-New, leading to the initiation of a source control investigation in this area. FD13B is no longer deployed as of WY2019.

During the investigation, City staff identified a significant concentration of PAHs discharging to the City's stormwater collection system from The News Tribune (TNT) employee parking lot. As a result of this finding, the City worked with the business owner and Ecology implement a cleanup plan and the City followed up with a plan for inspecting their private stormwater system quarterly.

Follow-up sampling indicated that the source was not yet eliminated, as PAH results at FD13B-New remained in the high range. Further investigative work led to additional cleanup at the TNT site. In addition, the City performed additional investigative work in the drainage area and determined that more sources were likely present at other private properties. The City is continuing to work with property owners in this area to clean and maintain their private drainage systems. The City will monitor the sediment trap results to determine whether these efforts have been successful or if there are any additional sources of PAHs in this drainage area. WY2021 results showed a significant decrease in PAH concentrations (from 282,110 µg/kg in WY2020 to 159,944 µg/kg in WY2021), and the downward trend continued in WY2022 with a concentration of 142,919 µg/kg, indicating the success of source control actions performed to date.

More detailed information regarding this investigation can be found in Appendix A.

FD10C Source Investigation The FD10C sediment trap drainage area was initially tracked for several years as a potential phthalate concern due to sediment trap monitoring results that showed moderately elevated phthalate levels since monitoring of this trap began in 2003. Starting in 2011, phthalate concentrations began decreasing, coinciding with a large business in the basin moving out, while mercury and PCB levels remained slightly elevated. Therefore, the tracking in this area continued with a focus on PCBs, and starting in 2015, on the moderately elevated mercury concentrations.

The stormwater system was cleaned in January 2014 to remove residual contamination. Following cleaning of the system, FD10C continued to show moderately elevated PCBs as well as mercury. As a result of these detections, an investigation was initiated in 2016 including sampling of catch basins in the drainage area as well as performance of business inspections. Through this work, the area for additional investigation was narrowed down to a smaller area.

Ongoing inspections and sampling have not identified a source for this contamination. During 2022, staff reviewed the private systems in this basin and confirmed that they are accurately represented on the City's mapping system. Additionally, short term sediment traps were installed at two new locations along Lawrence Street upstream from FD-10C in attempt to identify the source of PCBs in the larger drainage area. These locations isolated several private drainage systems that discharge to Lawrence Street, helping to identify the source of PCBs in the larger drainage area. The short-term trap towards the north end of Lawrence exhibited a concentration of 65 mg/Kg while the downstream sediment trap exhibited a concentration of 230 mg/Kg. The municipal storm system where the short-term traps were installed were heavily impacted by sediment, making it difficult to determine if the contamination is ongoing or historic.

There were several construction projects on Lawrence Street completed in 2022 so it is possible that the sediment impacting the storm main could be from those activities. The City cleaned the entire storm system in this drainage basin, and the short-term traps were requested to be re-installed in December 2022.

Once the short-term sediment traps have been collected and analyzed (anticipated in early 2023) and if concentrations warrant it, City staff will sample private systems and building materials of businesses whose private system connect to the locations with the highest PCB concentrations. Overall, PCB concentrations continue to decrease in the FD10C drainage area since the highest concentration was measured in WY2017.

More detailed information regarding this investigation can be found in Appendix A.

General Source Control Activities In addition to the ongoing investigation and maintenance activities described above, the City is continuing to implement other source control program elements in the OF237A drainage basin which are summarized here and described in more detail in Appendix A. Several other source control actions are currently underway in this basin, including UST removal actions at numerous sites under TPCHD oversight and installation of six new private treatment devices. (see Appendix A).

5.3.3 Outfall 237A 2023 Work Plan

In Basin 237A, TSS, lead, zinc, phenanthrene, pyrene and DEHP concentrations have all shown a statistically significant improvement in stormwater quality from 2001 to present with an estimated 52 percent reduction in TSS concentration, 71 percent reduction in lead, 56 percent reduction of zinc, 49 percent reduction in DEHP, 70 percent reduction in phenanthrene, and 78 percent reduction in pyrene concentrations over the 21 years of monitoring (Table 3-6 and Figures 3-5.1 to 3-5.8). The decrease in these concentrations appears to have resulted not only from removal/control of point sources, but also from the combination of many other activities.

As described in detail above, OF237A results generally show:

- Stormwater – Slightly to moderately lower levels of TSS (-2), copper (-4), lead (-3), zinc (-1), and DEHP (-1) compared to other outfalls, and slightly to significantly higher phenanthrene (+1), pyrene (+3) and indeno(1,2,3-c,d)pyrene (+5) when evaluating the 21-year monitoring record (see Table 3-4). These levels are generally the same or more neutral when looking at only the last two years of data, except that zinc and DEHP becomes slightly higher (+1 and +2), phenanthrene become moderately elevated (+4), and pyrene and indeno(1,2,3-c,d)pyrene become more significantly elevated (+5 and +6).

- SSPM – Slightly lower butylbenzylphthalate (-2), slightly higher bifenthrin, pyrene and phenanthrene (all at +2), and moderately higher indeno(1,2,3-c,d)pyrene (+4) compared to other sediment trap locations (see Table 3-5) when evaluating the entire 21-year monitoring record. Levels are generally the same or more neutral when looking at only the last five years of data.

Therefore, the following recommendations are included in the 2023 Work Plan for OF237A:

- Continue to work in the area at and around The News Tribune to eliminate source(s) of PAHs to the municipal drainage system. Monitor upcoming SSPM results and catch basin sample results near FD13B-New to evaluate whether source control work done to date in this area has been successful in eliminating this source.

- Continue evaluation of possible sources of PCBs to FD10C.
- Evaluate potential sources and seasonality of occasional outliers of indeno(1,2,3-cd)pyrene and other PAHs in stormwater.

5.4 OUTFALL 237B

OF237B exhibits the best overall baseflow and stormwater quality with some of the lowest median concentrations for the COCs in baseflow, stormwater and stormwater SSPM found during the monitoring program (see figures in Appendix F). Figure 5-1.4 shows the annual average concentration for stormwater, baseflow and SSPM. All indicator parameters (TSS, metals, PAHs and DEHP) have shown a statistically significant improvement in stormwater concentrations through WY2022.

This section provides a summary of water/sediment quality results within the OF237B drainage basin and compares the water/sediment data results with the major source control and other activities that have occurred within the basin. A more comprehensive description of source control activities performed to date is provided in Appendix A.

5.4.1 Water and SSPM Quality

Annual and seasonal data for stormwater and SSPM for the COCs and other parameters is used to identify ongoing areas of concern. The following paragraphs summarize the WY2001-WY2022 monitoring results for OF237B, where COCs in this outfall are different from other Foss drainage basins, and where subsequent source control activities may be focused.

5.4.1.a TSS and Metals

Stormwater As shown in Table 3-6 and Figures 3-5.1, 3-5.3 and 3-5.4, TSS, lead and zinc concentrations show a statistically significant improvement in stormwater quality from 2001 to present. The best-fit regression equations result in an estimated 73 percent reduction in TSS, 83 percent reduction in lead, and 65 percent reduction in zinc concentrations in OF237B in the 21-year period. In addition, copper analysis was performed between WY2010 and WY2012 for stormwater at this outfall, and then began again in WY2015. With this amount of data, trends have been assessed since WY2015, although with less data, they are not fully comparable to the trends assessed for the other constituents. OF237B showed statistically significant improvement during this time period, and the best-fit regression equation resulted in an estimated 50 percent reduction in copper.

In comparison to the other outfalls, TSS concentrations are slightly better (-2) while copper (-5), lead (-4) and zinc (-6) concentrations are moderately to significantly lower than other outfalls when looking at the 21-year monitoring record (11 years for copper) (see Table 3-4). When only the last two years of monitoring data are evaluated, OF237B results are similar with TSS at -2, copper at -6, lead at -3, and zinc at -6.

SSPM As shown in Table 3-5, SSPM in OF237B contains moderately to significantly lower concentrations of lead, mercury, and zinc (-3, -3 and -5) (also see boxplots in Appendix F). In addition, copper was added as an analyte in the 2014 QAPP. While statistical evaluation of this constituent will become more comparable in future years, based on available data, concentrations of copper are moderately better in SSPM in OF237B compared to other outfalls (-3). Within the OF237B drainage basin, there were no areas with elevated mercury concentrations in the upline sediment traps since WY2013 and is no longer analyzed at the one remaining upline trap (see Figure 2-1.1).

5.4.1.b PAHs

Stormwater As shown in Table 3-4, stormwater in OF237B contains moderately to significantly lower concentrations of phenanthrene and pyrene (-5 and -4, respectively), while indeno(1,2,3-c,d)pyrene is slightly lower at -1 when looking at the 21-year monitoring record. When looking only at the last two years of monitoring data, concentrations are the same or more neutral for all three indicator PAHs (-1 to -4) when compared to other outfalls.

PAH concentrations in stormwater have shown a statistically significant improvement from WY2002 through WY2022 with an 82-86 percent reduction in pyrene, phenanthrene and indeno(1,2,3-c,d)pyrene in 21 years (see Table 3-6).

SSPM As shown in Table 3-5, PAH concentrations in SSPM in OF237B are slightly lower for the indicator PAHs, phenanthrene, pyrene and indeno(1,2,3-c,d)pyrene (-2, -2, and -1, respectively) when looking at both the 21-year monitoring period or only the last five years (0 to -1).

5.4.1.c Phthalates

Stormwater As shown in Table 3-6 and Figure 3-5.8, DEHP concentrations have shown a statistically significant improvement in stormwater quality from 2001 to present. The best fit regression equations result in an estimated 72 percent reduction in the 21-year monitoring period.

In comparison to other outfalls, DEHP in OF237B is slightly better in quality over both the entire 21-year monitoring record and in only the last two years of monitoring (both at -2) (see Table 3-4).

SSPM DEHP (-3), butylbenzylphthalate (-3) and total phthalate (-4) concentrations in SSPM are moderately lower than observed in other locations over the entire 21-year monitoring record (see Table 3-5 and boxplots in Appendix F). These results are generally similar, but much less pronounced when looking at only the last five years (0 to -1). No new areas of concern have been identified in the upline sediment traps and phthalates have been removed as an analyte from all upline locations.

5.4.1.d Pesticides

Stormwater Analysis for bifenthrin in stormwater began in WY2021 under the 2020 QAPP. Statistical analysis will be performed when sufficient data is available.

SSPM Analysis for bifenthrin began in WY2015 under the 2014 QAPP and while there are fewer data points available for statistical analysis, the results are significant ($p<0.05$). OF237B concentrations were slightly lower (-1) to neutral (0) relative to other outfalls for bifenthrin when looking either all available data or only the last five years, respectively.

5.4.1.e PCBs

Stormwater PCBs are not a COC tested for under the 2020 QAPP.

SSPM PCB concentrations at OF237B were slightly lower (-1) relative to other outfalls when looking at the entire 21-year monitoring record and there were no significant differences between outfalls when looking at only the last five years of data (see Table 3-5).

5.4.2 Source Control Program Activities

PCB Source Tracing in FD34 and FD35. PCBs were found intermittently over time in the sub-basins draining to FD34 and FD35 (see Figure 2-1.4). In an attempt to remove any legacy contamination, the City completed a stormline cleaning project in the summer of 2011 that covered the majority of the OF237B drainage basin, including the FD34/FD35 area. In WY2011, concentrations in both sediment traps dropped to below levels of concern. However, in WY2012 and WY2013, the PCB concentrations in FD35 increased back to high levels, while the concentrations in FD34 remained low. A source tracing investigation to try to narrow the source of PCBs in this area was initiated in 2012.

Ultimately it was determined that the source of the contamination was one of the materials used during construction of a roadway in the area in 1975, specifically the sealant used to seal the roadway at the curb line, that likely contained PCBs. The City completed replacement of this roadway to remove this source in summer 2016. The WY2018 sample at FD35 was the first representing a full year of the area in its remediated condition, and the concentration was in the low range (92 µg/kg). WY2019 PCB concentrations in FD35 remained in the low range (94 µg/kg), however WY2020 concentrations increased back to the medium range (250 µg/kg). Following a thorough data analysis, no cause for the increased PCB levels in WY2020 was identified. Because results were higher than usual at all locations where PCBs were detected, it was determined that these results were not accurate and will not be used to determine steps forward in source tracing investigations. However, to ensure that the PCB source in this area had been removed, SSPM was again monitored in WY2021 and WY2022, and PCBs were not detected. Therefore, the source control action is considered successful and the sediment trap at this location has been removed.

More information on this investigation is included in Appendix A.

Storm System Cleaning In 2010-2011, the majority of the OF237B system was cleaned and video inspected. The objective of this project was to remove residual sediments in the storm drains that may contain legacy contaminants. As discussed in detail in the WY2011 report, storm system cleaning contributed to significant reductions in stormwater concentrations. Sewer line cleaning is an important component of the City's source control program, and the City is currently on a schedule of cleaning each storm system area on a 20-year cycle. Additional cleaning is performed on an as needed basis to address specific maintenance needs. In combination with other source control activities, storm system cleaning appears to have been effective at removing all seven of the compounds tested. The City is statistically evaluating the results to determine whether a maintenance schedule different from the City-wide schedule for pipe cleaning projects is needed within this sensitive basin.

Statistically significant reductions were evident for TSS, lead, zinc, PAHs and DEHP (see Table 2-2). Line cleaning, along with other source control activities, resulted in reductions of TSS at 55 percent, lead at 63 percent, zinc at 46 percent, DEHP at 68 percent and PAHs (phenanthrene, pyrene and indeno(1,2,3-c,d)pyrene) at 76-80 percent.

Enhanced Street Sweeping Program. In January 2007, the City's street sweeping program was enhanced in an attempt to reduce sediment buildup in the storm sewer system. Under the enhanced program, the sweeping frequency was increased, air regenerative sweepers replaced mechanical sweepers, and the City also increased communications with residents, which helped raise awareness of the importance of the street sweeping program.

Statistically significant reductions were evident for TSS, lead, zinc, PAHs and DEHP (see Table 2-3.1). Street sweeping, along with other source control activities, resulted in reductions of TSS at 47 percent, lead at 56 percent, zinc at 44 percent, DEHP at 65 percent and PAHs (phenanthrene, pyrene, and indeno(1,2,3-c,d)pyrene) at 70-76 percent.

General Source Control Activities. In addition to the ongoing investigation and maintenance activities described above, the City is continuing to implement other source control program elements in the OF237B drainage basin which are summarized here and described in more detail in Appendix A. Several other source control actions are currently underway in this basin, including a UST removal action at one site under TPCHD oversight. In addition, one warning letter was issued to a business in this drainage basin in 2022 for failure of a sanitary side sewer on the property. Finally, twelve new private treatment devices were installed in this basin in 2022.

5.4.3 Outfall 237B 2023 Work Plan

TSS, metals (copper, lead, and zinc), PAHs and DEHP concentrations in stormwater have shown a statistically significant improvement from WY2002 through WY2022 (see Figures 3-5.1 to 3-5.8). There has been an estimated 73 percent reduction in TSS, 83 percent reduction in lead, 65 percent reduction in zinc, and a 72 percent reduction of DEHP concentrations in the 21-year monitoring period (see Table 3-6). PAHs showed an 82-86 percent reduction in 21 years for the index PAHs (phenanthrene, pyrene, and indeno(1,2,3-c,d)pyrene). In addition, with eleven years of copper data now available for OF237B an overall evaluation of the source control program includes trends for this outfall, however, the results are not as statistically robust, so are not directly comparable. Based on available data, OF237B shows a statistically significant improvement in stormwater quality for copper during this period with an estimated 50 percent reduction.

These improvements are believed to be the result of the combination of all source control activities within the basin, including business and multi-family inspections, source control actions, maintenance activities and public education.

OF237B exhibits the best overall baseflow and stormwater quality with some of the lowest median concentrations for the COCs in stormwater (see Table 3-3.1 and Table 3-4, and Appendix F). SSPM quality in OF237B is also generally of better quality than other Foss basins (see Table 3-5).

As described in detail above, OF237B results generally show:

- Stormwater – Slightly lower TSS (-2), DEHP (-2) and indeno(1,2,3-c,d) (-1), moderately lower pyrene (-4), and lead (-4), and significantly lower copper (-5), phenanthrene (-5) and zinc (-6) compared to other outfalls when evaluating the 21-year monitoring record (see Table 3-4). These levels are generally similar when looking at only the last two years of data.

- SSPM – Moderately to significantly lower copper (-3), lead (-3), mercury (-3), zinc (-5), TPH-Heavy Oil (-5), DEHP (-3), butylbenzylphthalate (-3), and total phthalates (-4), and slightly lower phenanthrene and pyrene (both at -2) compared to other sediment trap locations (see Table 3-5) when evaluating the entire 21-year monitoring record. These levels are generally similar but less pronounced when looking at only the last five years of data.

Therefore, there are no source control activities included in the 2023 Work Plan for the OF237B drainage basin.

5.5 OUTFALL 243

Many activities have occurred in OF243 drainage basin in recent years. Some of these activities have resulted in improvements in stormwater and SSPM quality. Figure 5-1.5 shows the annual average contaminant concentrations for stormwater, baseflow and SSPM. Lead, zinc, PAHs and DEHP concentrations have shown a statistically significant improvement in stormwater quality since the beginning of the monitoring program (see Table 3-6).

This section provides a summary of water/sediment quality results within the OF243 drainage basin and compares the water/sediment data results with the major source control and other activities that have occurred within the basin. A more comprehensive description of source control activities performed to date is provided in Appendix A.

5.5.1 Water and SSPM Quality

Annual and seasonal data for stormwater and SSPM for the COCs and other parameters is used to identify ongoing areas of concern. The following paragraphs summarize the WY2001-WY2022 monitoring results for OF243, where COCs in this outfall are different from other Foss drainage basins, and where any subsequent source control activities may be focused.

5.5.1.a TSS and Metals

Stormwater TSS is neutral in concentration (0) while total lead is moderately elevated (+4) in concentration at OF243 as compared to other outfalls. Zinc has moderately lower concentrations in stormwater (-3) compared to all other basins when looking at the 21-year monitoring period. When looking at just the last two years, each of these is the same or more neutral with TSS at 0, lead at +1 and zinc at +1 (see Table 3-4 and boxplots in Appendix F). Analysis for copper at this outfall began in WY2015 so statistical analysis is less robust compared to other outfalls. Based on analysis of all available data as well as only the last two years, copper is moderately higher in concentration (+3 for all data and +4 for more recent data) relative to other outfalls. The highest overall total lead concentration (379 µg/L) occurred in OF243 in 2009 (Table 3-3.1). This outlier appears to be relatively isolated occurrence, although additional high and moderate outliers have occurred throughout the monitoring program (see Figures G-2 and G-12). In addition, the highest overall zinc concentration (1,170 µg/L) occurred at OF243 in 2004 (Table 3-3.1). This outlier also appears to be relatively isolated occurrence (see Figure G-3).

As shown in Figure 5-1.5, TSS concentrations in stormwater have fluctuated some over the last 21 years, in particular since 2012. TSS showed statistically significant improvement in WY2022 with a 53 percent reduction measured. Lead and zinc also show statistically significant improvement, with lead showing a 79 percent reduction, and zinc showing a 59 percent reduction in stormwater concentrations from 2001 to present (Table 3-6).

SSPM Storm sediment in OF243 is moderately elevated in lead (+3), mercury (+4) and zinc (+4) when looking at the 21-year monitoring record (see Table 3-5). When only looking at the most recent five-year data set, concentrations are generally similar or only slightly elevated with lead at +2 and zinc and mercury at +1. Analysis for copper at this outfall began in WY2015 so less data is currently available for a comprehensive statistical analysis. Based on available data, copper is moderately elevated (+3) when looking at all available data, and slightly elevated compared to other outfalls (+1) when looking at just the last five years.

Most of the highest SSPM concentrations of lead, mercury, and zinc have been detected at FD23 (see Figures F-21 through F-23 and F-33 through F-35). As shown on Table 3-3.2, the highest mean and median concentrations of all metals are found in this drainage basin. Figures 5-1.5 and 5-2.5 show that zinc concentrations in SSPM samples have remained fairly consistent over the last 21 years while mercury concentrations appeared to have decreased early in the program and generally remained at the lower levels until WY2018, when the detected concentration increased back to nearly the high level in FD23 (see Figure 2-1.1). The concentration returned to the reduced level in WY2019 where it remained in WY2022. The source control investigation in this area is continuing. Additional information is available in Appendix A.

While somewhat elevated relative to other outfalls, lead and zinc are not currently of concern for recontamination in the Thea Foss Waterway sediments, but additional source control work may be considered when additional results are available. As described further below and in Appendix A, a street sweeping pilot project is underway and results show that an increased sweeping frequency is helping to reduce metals concentrations in industrial areas. This analysis of the effectiveness of this program is described further below.

5.5.1.b PAHs

Stormwater PAH concentrations in OF243 are neutral to slightly lower (phenanthrene at -1, pyrene at -2, and indeno(1,2,3-c,d)pyrene at 0) in comparison to other outfalls when looking at the entire 21-year monitoring period. When looking at only the last two years, phenanthrene is neutral (0) while pyrene and indeno(1,2,3-c,d)pyrene (bot at -1) are slightly lower relative to other locations (see Table 3-4 and boxplots in Appendix F). The highest dibenz(a,h)anthracene concentration (0.684 µg/L) detected at any location during the monitoring period occurred at OF243 in WY2017. This outlier appears to be an isolated occurrence with no apparent explanation and subsequent sample results are in the more typical range.

As shown in Table 3-6 and Figures 3-5.5, 3-5.6 and 3-5.7, PAHs (phenanthrene, pyrene, and indeno(1,2,3-c,d)pyrene) are showing a statistically significant improvement in stormwater quality from 2001 to present. The best-fit regression equations result in an estimated 64-73 percent reduction in PAHs in OF243 in the 21-year monitoring period. As shown in Figure 5-1.5, PAH concentrations in stormwater were fairly stable from

WY2002 until WY2007. From WY2007 to WY2009 the concentrations decreased, and they remained fairly stable between WY2009 and WY2012. Gradual but consistent increases were noted after the minimum concentrations were detected in 2012. This is likely partially if not fully explained by the apparent uptick seen since implementation of the 2014 QAPP began. This apparent uptick in organics concentrations observed was evaluated by the City, as discussed in Section 3.5.2 and recent results were determined to be representative while earlier results were likely biased low. While this observed slight increase in organic concentrations is observed, concentrations remain substantially lower than the concentrations present early in the monitoring program (see boxplots in Appendix G).

SSPM In SSPM, phenanthrene, indeno(1,2,3-c,d)pyrene and pyrene concentrations at OF243 are similar (+1, 0 and +1) compared to other outfalls when looking at the entire 21-year monitoring period (see Table 3-5). PAH concentrations are neutral compared to other outfalls when looking at only the last five years (all three indicator PAHs at 0).

5.5.1.c Phthalates

Stormwater DEHP concentrations in OF243 were significantly lower when looking at both the 21-year monitoring period and the last two years (-5 and -6, respectively) (see Table 3-4). DEHP generally appears to be relatively consistent among all outfalls except OF230 and OF235 which are significantly higher, as discussed above. Figure 5-1.5 shows total phthalate concentrations in stormwater at OF243 were fairly stable from WY2002 to WY2008 and then decreased in WY2009. One unusually high peak concentration of DEHP (41 µg/L) was observed in 2008 stormwater in OF243 (see Table 3-3.1 and boxplots in Appendix G), but this appears to be an isolated occurrence and the source is unknown. Concentrations from WY2009 to WY2022 have fluctuated somewhat, but concentrations remain relatively low with the lowest mean concentration overall (see Figure 3-3.1 and Figures F-8 and F-18).

As shown in Table 3-6 and Figure 3-5.8, DEHP is showing a statistically significant improvement in stormwater quality from 2001 to present. The best-fit regression equations result in an estimated 75 percent reduction in the 21-year monitoring period.

SSPM OF243 is slightly enriched in DEHP, butylbenzylphthalate, and total phthalates (+1, +2 and +1, respectively) when looking at the entire 21-year monitoring period, while all are neutral (0) between outfalls when looking at only the last five years (see Table 3-5). OF243, along with OF245, exhibit a notably different phthalate composition compared to other outfalls that has higher relative concentrations of butylbenzylphthalate. Figures F-30 and F-42 show butylbenzylphthalate average, median and maximum concentrations in SSPM at OF243 well above all outfalls except OF245.

In Figure 2-1.3, total phthalate concentration levels at FD23 were at medium levels in WY2002 and WY2003. Since WY2004, total phthalate concentration levels at FD23 have been low relative to the threshold concentration set on this figure.

5.5.1.d Pesticides

Stormwater Analysis for bifenthrin in stormwater began in WY2021 under the 2020 QAPP. Statistical analysis will be performed when sufficient data is available.

SSPM Analysis for bifenthrin began in WY2015 under the 2014 QAPP and while there are fewer data points available for statistical analysis, the results are significant ($p<0.05$). OF243 is neutral (0) relative to other outfalls during the monitoring period.

5.5.1.e PCBs

Stormwater PCBs are not a COC tested for under the 2020 QAPP.

SSPM Concentrations of PCBs in OF243 were neutral (0) compared to other outfalls when reviewing the entire 21-year monitoring record. There are no significant differences between outfalls when looking at only the last five years of data (see Table 3-5).

As shown in Figure 5-1.5, from WY2009 to WY2012 PCBs were not detected at this location. PCBs were not required analytes at FD23 in WY2013 and WY2014. PCBs were in the medium range at FD23 in WY2015, just over the threshold concentration distinguishing low and medium levels on Figure 2-1.4. Since WY2016, PCBs have not been detected in FD23, indicating that the WY2015 results were likely an anomaly.

5.5.2 Source Control Program Activities

Enhanced Street Sweeping Program In January 2007, the City's street sweeping program was enhanced in an attempt to reduce sediment buildup in the storm sewer system. Under the enhanced program, the sweeping frequency was increased, air regenerative sweepers replaced mechanical sweepers, and the City also increased communications with residents, which helped raise awareness of the importance of the street sweeping program.

When comparing the standard sweeping schedule in place prior to 2006 to the enhanced schedule implemented from January 2007 through September 2013, statistically significant reductions were evident for zinc, PAHs and DEHP (see Table 2-3.1). Street sweeping, along with other source control activities, resulted in reductions of zinc at 36 percent, DEHP at 42 percent and PAHs (phenanthrene, pyrene, and indeno(1,2,3-c,d)pyrene) at 53-70 percent.

Street Sweeping Pilot Project Because OF243 and OF245 have shown somewhat elevated levels of lead and zinc in both stormwater and baseflow relative to other drains, it was theorized the increased amount of trucking in this industrial area may be the cause. Based on these results, the City initiated a pilot program in WY2014 to determine whether an increased frequency of street sweeping in this area would have an effect on these results. Starting on October 1, 2013, the City began sweeping the ROW within the OF243 and OF245 drainage basins at a frequency of once every two weeks rather than the usual frequency of once per month for industrial areas. The pilot project continued in WY2022 and is ongoing at this time.

With several years of data available, statistical analysis of the effectiveness of this pilot sweeping schedule was done, although results will be more statistically robust as additional data becomes available. Based on this analysis, a statistically significant reduction was evident for TSS, lead, and zinc (see Table 2-3.2). When comparing data from the enhanced street sweeping program that was implemented between 2007 and 2013 to the more frequent street sweeping schedule which began in WY2013, it was found that this increased street sweeping, along with other source control activities, resulted in an additional 34 percent reduction in TSS, 68 percent reduction in lead concentrations and a 34 percent reduction in zinc concentrations. A statistically significant 34 percent increase in indeno(1,2,3-c,d)pyrene was also apparent in this analysis.

Outfall 243 Mercury Source Tracing Mercury has been found in the medium to high range of concentrations in all samples analyzed from FD23 since WY2002 (see Figure 2-1.1). Some source tracing work was completed in 2008 and 2009, but no likely point-source of mercury was identified. After working with BNSF in 2009-2010 to gain access to the BNSF yard, the City completed focused business inspections for most of the yard. A follow up inspection, including the inspection of onsite ditches and swales, was conducted in 2012.

As moderately increased concentrations of mercury persisted, additional investigations of the right-of-way, the WSDOT pond and the LRI and BNSF sites, and other businesses were completed over the next several years. While several actions were required at the sites to bring them into compliance (including cleaning and maintaining onsite drainage systems, cleanup of spilled material and a regular inspection process), no significant sources of mercury were detected.

In 2019, while reviewing past investigations and the extents of the drainage basin it was discovered that a small portion of this drainage basin was not included in previous investigations. Through additional investigation, a roof drain from a specific property was identified as being a likely source of mercury contamination. During 2021, the City worked with the property owner to ensure the roof drains from their property were adequately cleaned and subsequently re-cleaned the City's catch basin and the curbline adjacent to the property.

During 2022 staff resampled the identified catch basin to determine if there is an ongoing mercury issue at that location. The catch basin was sampled on June 21, 2022, and the results were 1.38 mg/kg. Catch basin concentrations continue to trend downward and there are no other probable sources to investigate at this location. During 2023, the City will have the catch basin re-cleaned and sampled after sediment accumulates to determine if there is a continued source or residual contamination from the previously remediated source.

While the FD23 sediment trap results showed a very slight uptick in mercury concentrations within the basin over the past year, concentrations have shown an overall decrease from 2018 to 2022. The 2018 sediment trap concentrations were 0.6610 mg/kg which have decreased significantly in 2021 and 2022 with concentrations of 0.206 mg/kg and 0.214 mg/kg, respectively.

Mercury concentrations in WY2010 through WY2022 remained in the mid-range of concentrations as represented in Figure 2-1.1 with concentrations ranging from 0.206 to 0.661 mg/kg during this portion of the monitoring period. The WY2021 mercury concentration in FD23 was the lowest detected during this time while the WY2018 mercury concentration of 0.661 mg/kg was the highest. WY2023 SSPM results will be reviewed to monitor control of this persistent source.

A summary of the ongoing investigation is provided in Appendix A.

General Source Control Activities In addition to the ongoing investigation and maintenance activities described above, the City is continuing to implement other source control program elements in the OF243 drainage basin which are summarized here and described in more detail in Appendix A. This includes removal of a UST at one location under TPCHD oversight.

5.5.3 Outfall 243 2023 Work Plan

TSS, lead, zinc, PAHs and DEHP concentrations in stormwater have shown a statistically significant improvement in OF243 from WY2002 through WY2021 (see Figures 3-5.3 through

3-5.8). There has been an estimated 53 percent reduction in TSS, 79 percent reduction in lead, 59 percent reduction in zinc, and 75 percent reduction in concentration for DEHP in 21 years (see Table 3-6). PAHs have shown a 64-73 percent reduction in 21 years for the index PAHs (phenanthrene, pyrene and indeno(1,2,3-c,d)pyrene).

As described in detail above, OF243 results generally show:

- Stormwater – Moderately higher lead (+4) and copper (+3, based on a smaller data set), moderately lower zinc (-3), and significantly lower DEHP (-5) compared to other outfalls when evaluating the 21-year monitoring record. When looking at only the last two years copper remains moderately elevated (+4) relative to other outfalls while DEHP remains significantly lower (-6) (see Table 3-4).
- SSPM – Moderately higher lead (+3), copper (+3, based on a smaller data set), mercury (+4) and zinc (+4) compared to other sediment trap locations (see Table 3-5) when evaluating the entire 21-year monitoring record. These differences are less pronounced, but still present when looking at only the last five years of data (+2, +1, +1, and +1, respectively). Butylbenzylphthalate is slightly elevated (+2) when looking at the entire 21-year monitoring record but neutral in the last five years (0).

Therefore, the following recommendations are included in the 2023 Work Plan for OF243:

- Perform follow-up work with business owner and system cleaning work in the area where elevated mercury concentrations were identified in catch basins in the FD23 drainage area.
- Review WY2023 sediment trap results for FD23 to evaluate the need for further work in this area.
- Continue evaluation of the effectiveness of the street sweeping pilot project on lead and zinc concentrations in the industrial area as additional data become available.

5.6 OUTFALL 245

A number of source control activities have occurred in the OF245 drainage basin since the beginning of the monitoring program. Some of these activities have resulted in statistically significant improvements in stormwater quality. Figure 5-1.6 shows the annual average contaminant concentrations for stormwater, baseflow, and SSPM. Several of the businesses in the area not only discharge stormwater to OF245 but discharge stormwater to the adjacent outfalls, OF248 and OF249.

This section provides a summary of water/sediment quality results within the OF245 drainage basin and compares the water/sediment data results with the major source control and other activities that have occurred within the basin. A more comprehensive description of source control activities performed to date is provided in Appendix A.

5.6.1 Water and SSPM Quality

Annual and seasonal data for stormwater and SSPM for the COCs and other parameters is used to identify ongoing areas of concern. The following paragraphs summarize the WY2001-WY2022 monitoring results for OF245, where COCs in this outfall are different from other Foss drainage basins, and where subsequent source control activities may be focused.

5.6.1.a TSS and Metals

Stormwater Stormwater TSS concentrations are slightly higher in OF245 when looking at the entire 21-year monitoring record or the most recent two-year data set (+2 and +1, respectively) (see Table 3-4).

Lead concentrations are moderately better than average in OF245 when looking at either the entire 21-year monitoring record or at only the most recent two-year data set (both at -4) (see Table 3-4). Copper concentrations in OF245 are slightly higher (+1) when looking at all of the available data and slightly lower (-2) when looking at only the last two years.

The highest maximum mercury and cadmium concentrations found in stormwater during the monitoring program were found in OF245 in WY2008 and WY2011, respectively (see Table 3-3.1). In addition, the highest mean and median cadmium in stormwater were found in OF245 with concentrations of 0.302 µg/L and 0.216 µg/L, respectively.

The highest mean and median stormwater zinc concentrations are also found in OF245 with concentrations of 133.2 µg/L and 106 µg/L, respectively (see Table 3-3.1). Zinc is moderately elevated (+4) in OF245 in the 21-year monitoring record, while the two-year record shows that the outfall is only slightly elevated (+1) (see Table 3-4). Several high outliers for zinc have been detected throughout the 21-year monitoring period, particularly early in the program. Additional high outliers are present in more recent years, including one in WY2020, no high outliers were present in WY2021 or WY2022 (see Figure G-3).

As shown in Table 3-6 and Figures 3-5.1, 3-5.3, and 3-5.4, TSS, lead, and zinc all show a statistically significant improvement in stormwater quality from 2001 to present. The best-fit regression equations result in an estimated 53 percent reduction in TSS, 78 percent reduction in lead, and a 66 percent reduction in zinc in the 21-year monitoring period. In addition, copper shows a statistically significant improvement based on available data with an estimated 34 percent reduction.

SSPM When looking at the entire 21-year monitoring program, zinc is neutral (0) compared to the other outfalls, while lead (-3) and mercury (-1) are moderately and slightly lower than the other outfalls, respectively (see Table 3-5 and boxplots in Appendix F). When looking at only the last five years, these differences are still present but somewhat less pronounced with zinc and mercury both neutral (0) while lead is slightly better at (-1). Available copper data indicates that concentrations in OF245 are slightly elevated (+1) based on all available data, and neutral (0) relative to other outfalls over the last five years.

Within the basins for OF 245/248, mercury has been detected at medium concentrations periodically at FD22 (WY2002, WY2010, WY2014, WY2015, and WY2016) (see Figure 2-1.1). When looking at the data for these moderate level concentrations, all are just over the concentration (0.20 mg/kg) which was set to differentiate the levels on Figure 2-1.1, ranging from 0.208 to 0.257 mg/kg). WY2017 concentrations returned to the low range where they remained through WY2021. Other sediment trap/sump locations in these basins have had low levels. As a result, mercury was no analyzed for FD22 in WY2022.

5.6.1.b PAHs

Stormwater OF245 is slightly higher for phenanthrene (+1) and moderately to significantly lower for other index PAHs (pyrene at -3 and indeno(1,2,3-c,d)pyrene at -6) in comparison to other outfalls (see Table 3-4 and boxplots in Appendix F) when looking at the entire 21-year monitoring record. When looking at only the last two years of data, the results are more neutral with phenanthrene and pyrene (both at -1), and indeno(1,2,3-c,d)pyrene (-3).

In stormwater, the highest maximum concentrations for several LPAHs including acenaphthene, acenaphthylene, fluorene, and phenanthrene were observed in OF245 (see Table 3-3.1). These maximum concentrations were all detected in 2004. The high concentrations have not been observed since the Northern Pacific Rail yard oil pipeline area was remediated in 2008 (see Appendix A).

As shown in Table 3-6 and Figures 3-5.5, 3-5.6 and 3-5.7, PAHs (phenanthrene, pyrene, and indeno(1,2,3-c,d)pyrene) are showing a statistically significant improvement in stormwater quality from 2001 to present. The best-fit regression equations result in an estimated 68-77 percent reduction in PAHs in the 21-year monitoring period. As shown in Figure 5-1.6, PAH concentrations in stormwater were fairly stable from WY2002 until WY2007. From WY2008 to WY2009 the concentrations decreased when the Northern Pacific Rail Line was remediated and have remained generally stable from WY2009 to present. The apparent uptick in organics concentrations observed in the last eight years of monitoring was evaluated by the City, as discussed in Section 3.5.2 and recent results were determined to be representative while earlier results were likely biased low. While this observed slight increase in organic concentrations is observed, concentrations remain substantially lower than the concentrations present early in the monitoring program (see boxplots in Appendix G).

SSPM OF245 SSPM has moderately to significantly lower concentrations of phenanthrene (-4), pyrene (-4) and indeno(1,2,3-c,d)pyrene (-5) relative to all other outfalls (see Table 3-5 and boxplots in Appendix F) when looking at the 21-year monitoring period. All three indicator PAHs remain slightly lower than other outfalls (-2 to -1) when looking at only the last five years of data. All three sediment traps/sumps throughout the OF245/OF248 basin have had low levels of PAHs throughout the 21-year monitoring period and as a result, PAHs have been removed from the analyte list for the source tracing sediment traps (FD21 and FD22) (see Figure 2-1.2).

5.6.1.c Phthalates

Stormwater DEHP appears to be relatively consistent among outfalls (except OF230 and OF235 as discussed above), with mean concentrations slightly lower (-1) in OF245 when looking at the entire 21-year monitoring record, and neutral (0) when looking at only the last two years of data (see Table 3-4).

Unusually elevated DEHP concentrations were found in OF245 stormwater in WY2003 (Year 2) (see total phthalates in Figure 5-1.6 and Figures G-8 and G-18). A possible source of phthalates in this drain is believed to be the former bulk liquid phthalate transloading facility located in the basin. This source is believed to be controlled since the water quality is improving and most of the peak phthalate concentrations occurred earlier in the monitoring program (2002 through 2005) (see Figure 5-1.6 and boxplots in Appendix G) and have remained relatively consistent since that time.

Like OF243, OF245 exhibits a notably different phthalate composition that contains higher relative concentrations of butylbenzylphthalate in both stormwater and SSPM. The highest maximum butylbenzylphthalate stormwater concentration found in the monitoring program (290 µg/L) was found in OF245 in 2003. Overall, the OF245 mean butylbenzylphthalate concentration is 9.186 µg/L as compared to approximately 0.3-0.9 µg/L in the other outfalls. An elevated concentration of diethylphthalate in stormwater (430 µg/L) was also detected at OF245 in 2002.

As shown in Table 3-6 and Figure 3-5.8, DEHP is showing a statistically significant improvement in stormwater quality from 2001 to present. The best-fit regression equations result in an estimated 73 percent reduction in DEHP in OF245 in the 21-year monitoring period.

SSPM OF245 is neutral (0) for DEHP, moderately enriched in butylbenzylphthalate (+4), and slightly enriched in total phthalates (+1) when looking at the 21-year monitoring period (see Table 3-5). As with stormwater, SSPM composition is dominated by butylbenzylphthalate. Butylbenzylphthalate remains slightly higher (+1) relative to other outfalls when looking at only the last five years, while DEHP and total phthalates are neutral (0). Figures F-30 and F-42 show OF245 butylbenzylphthalate average, median and maximum concentrations in SSPM well above all other outfalls. An extreme elevated outlier of 160,000 µg/kg for butylbenzylphthalate was detected at OF245 in 2003. An outlier analysis is planned for WY2023.

Within OF245 and the adjacent OF248, additional sediment traps were located around a suspected source of phthalates, the former MPS site (see Section 5.6.2). At FD21 (OF245) total phthalate concentrations were in the high range in WY2002 and WY2003, decreased to medium range in WY2004, and have been in the low range since that time (see Figure 2-1.3). At FD22 (OF248), total phthalate concentrations fluctuated for many years between high (WY2003, WY2004, WY2005, and WY2010) and medium concentrations (WY2006 through WY2009, W2011, and WY2013). WY2012 and WY2014 through WY2022 concentrations have been in the low range. As discussed in Section 5.6.2, source control investigation and monitoring at the Truck Rail Handling (TRH) site (formerly MPS) has been an ongoing issue for many years due to the historically different phthalate signature for this area and the general ongoing observation of phthalates in waterway sediments. The City will continue to monitor work at this site to identify any ongoing issues.

5.6.1.d Pesticides

Stormwater Analysis for bifenthrin in stormwater began in WY2021 under the 2020 QAPP. Statistical analysis will be performed when sufficient data is available.

SSPM Analysis for bifenthrin began in WY2015 under the 2014 QAPP and while there are fewer data points available for statistical analysis, the results are significant ($p<0.05$). Based on available data, bifenthrin concentrations are slightly lower (-1) in OF245.

5.6.1.e PCBs

Stormwater PCBs are not a COC tested for under the 2020 QAPP.

SSPM PCB levels in all of the outfalls are fairly equivalent when looking at the entire 21-year monitoring record with levels ranging from -1 to +1. PCB concentrations at OF245 were neutral (0) relative to all other outfalls in the entire monitoring period and there were no significant differences between outfalls when looking at only the last five years of data (see Table 3-5).

5.6.2 Source Control Program Activities

Enhanced Street Sweeping Program In January 2007, the City's street sweeping program was enhanced in an attempt to reduce sediment build-up in the storm sewer system. Under the enhanced program, the sweeping frequency was increased, air regenerative sweepers replaced mechanical sweepers, and the City also increased communications with residents and business owners, which helped raise awareness of the importance of the street sweeping program.

When comparing the standard sweeping schedule in place prior to 2006 to the enhanced schedule implemented from January 2007 through September 2013, statistically significant reductions were evident for TSS, lead, PAHs, and DEHP (see Table 2-3.1). Street sweeping, along with other source control activities, resulted in reductions of TSS at 31 percent, lead at 22 percent, DEHP at 74 percent, and PAHs (phenanthrene, pyrene, and indeno(1,2,3-c,d)pyrene) at 62-68 percent.

Street Sweeping Pilot Project Because OF243 and OF245 showed somewhat elevated levels of lead and zinc in both stormwater and baseflow relative to other drains, it was theorized that the increased amount of trucking in this industrial area may be the cause. Based on these results, the City initiated a pilot program in WY2014 to determine whether an increased frequency of street sweeping in this area would have an effect on these results. Starting on October 1, 2013, the City began sweeping the ROW within the OF243 and OF245 drainage basins at a frequency of once every two weeks rather than the usual frequency of once per month for industrial areas. The pilot project continued in WY2022 and is ongoing at this time.

With several years of data available, statistical analysis of the effectiveness of this pilot sweeping schedule was completed, although results will be more statistically robust as additional data becomes available. Based on this analysis, a statistically significant reduction was evident for lead, zinc, and pyrene (see Table 2-3.2). When comparing data from the enhanced street sweeping program that was implemented between 2007 and 2013 to the more frequent street sweeping schedule which began in WY2013, it was found that this increased street sweeping, along with other source control activities, resulted in an additional reduction in concentration of lead at 49 percent, zinc at 45 percent and pyrene at 9 percent.

Former MPS Site Investigation Investigation at this site has been ongoing through the years of this program. Additional information on this work can be found in Appendix A. With decreased phthalate levels in the sediment traps, it appears that efforts to date have been effective in addressing the issues at this site. However, the City will continue coordination with the property owner, and sediment traps will continue to be monitored to ensure that levels remain at the reduced levels.

General Source Control Activities In addition to the ongoing investigation and maintenance activities described above, the City is continuing to implement other source control program elements in the OF245 drainage basin which are summarized here and described in more detail in Appendix A.

5.6.3 Outfall 245 2023 Work Plan

TSS, metals (lead and zinc), PAHs and DEHP concentrations in stormwater have shown a statistically significant improvement from WY2002 through WY2022 (see Table 3-6 and Figures 3-5.1 to 3-5.8). There has been an estimated 53 percent reduction in TSS, 78 percent reduction in lead, and 66 percent reduction in zinc concentrations in the 21-year monitoring program. Based on more limited data, there has also been a 34 percent reduction in copper concentrations. In addition, there has been an estimated 73 percent reduction in concentration for DEHP, and PAHs showed an 68-77 percent reduction in 21 years for the index PAHs (phenanthrene, pyrene, and indeno(1,2,3-c,d)pyrene).

As described in detail above, OF245 results generally show:

- Stormwater – Moderately higher zinc (+4), moderately lower lead (-4) and pyrene (-3), and significantly lower indeno(1,2,3-c,d)pyrene (-6) compared to other outfalls when evaluating the 21-year monitoring record (see Table 3-4). When looking at only the last two years of data, lead and indeno(1,2,3-c,d)pyrene are moderately lower (-4 and -3, respectively). DEHP is also slightly lower to neutral when looking at either the 21-year monitoring period or the last two years (-1 and 0, respectively).
- SSPM – Moderately higher butylbenzylphthalate (+4) and moderately to significantly lower lead (-3), phenanthrene (-4), indeno(1,2,3-c,d)pyrene (-5), and pyrene (-4) compared to other sediment trap locations (see Table 3-5) when evaluating the entire 21-year monitoring record. When looking at only the last five years of data, butylbenzylphthalate remains slightly higher (+1) while PAHs, lead and bifenthrin remain slightly lower (-1 to -2) compared to other outfalls.

Therefore, the following recommendations are included in the 2023 Work Plan for OF245:

- Continue evaluation of the effectiveness of the street sweeping pilot project on lead and zinc concentrations in the industrial area as additional data become available.

5.7 OUTFALL 254

Several source control activities have occurred in the OF254 drainage basin since the beginning of the monitoring program. Some of these activities have resulted in statistically significant improvements in stormwater quality. Figure 5-1.7 shows the annual average contaminant concentrations for stormwater and baseflow. Note that there are no sediment traps in the OF254 drainage basin due to tidal influence.

This section provides a summary of stormwater quality results within the OF254 drainage basin and compares these results with the major source control and other activities that have occurred within the basin. A more comprehensive description of source control activities performed to date is provided in Appendix A.

5.7.1 Water Quality

Annual and seasonal data for stormwater for the COCs and other parameters is used to identify ongoing areas of concern. The following paragraphs summarize the WY2001-WY2022 monitoring results for OF254, where COCs in this outfall are different from other Foss drainage basins, and where subsequent source control activities may be focused.

5.7.1.a TSS and Metals

Stormwater TSS concentrations in OF254 stormwater are significantly above average when looking at the entire 21-year monitoring record (+6) but only moderately higher when looking at the last two years of data (+3) (see Table 3-4). OF254 has the highest mean TSS (91.0 mg/L) and median (69.0 mg/L) of all the basins (see Table 3-3.1 and Figures F-1 and F-11). Considerable amounts of unpaved industrial area are present in this drainage basin, likely leading to these elevated concentrations. As shown on Figure 5-1.7, TSS concentrations have remained fairly consistent during the monitoring period with a slight decrease in WY2019 and WY2020 coinciding with an increased level of sweep that began in a portion of this drainage basin in January 2019 generally stabilizing since that time.

Analysis for copper at this outfall began in WY2015. Based on available data, copper appears slightly elevated in OF254 compared to other outfalls (+2). Copper is moderately elevated (+4), when looking at only the last two years of data. This is due to two moderate outliers detected during WY2022.

Lead concentrations are neutral (0) in OF254 when looking at the entire 21-year monitoring record and slightly lower (-1) when looking at only the most recent two-year data set (see Table 3-4).

Zinc is moderately elevated (+3) in OF254 when looking at the 21-year monitoring record, while the two-year record shows that the outfall is only slightly elevated (+1) (Table 3-4 and Figures F-3 and F-13). Since OF245 is similarly elevated in zinc, this indicates that there may be a source(s) of zinc present in the industrialized basins. As discussed in Section 5.6.2, truck traffic is a source of zinc but may not be the only source.

As shown in Table 3-6 and Figures 3-5.3 and 3-5.4, lead and zinc are showing statistically significant improvements in stormwater quality from 2001 to present. The best-fit regression equations result in an estimated 79 percent reduction in lead and 71 percent reduction in zinc in the 21-year monitoring period.

SSPM No sediment traps are installed in OF254.

5.7.1.b PAHs

Stormwater. PAHs in OF254 are neutral to moderately elevated (phenanthrene at +3, pyrene at +4, and indeno(1,2,3-c,d)pyrene at 0) in comparison to other outfalls when looking at the entire 21-year monitoring record (see Table 3-4 and boxplots in Appendix F). When looking at only the last two years of data, all three indicator PAHs are more similar to other outfalls (-1 to +1).

OF254 has had some relatively higher concentrations of PAHs in water quality in the Thea Foss Basin (see boxplots in Appendix F), but these concentrations have generally improved since WY2008 (see boxplots in Appendix G). The highest mean, median, and or maximum concentrations of several LPAHs and HPAHs in stormwater were reported at OF254 including acenaphthylene, anthracene, fluorene, phenanthrene, total LPAHs, chrysene, benzo(a)anthracene, fluoranthene, pyrene, and total HPAHs (see Table 3-3.1), but the maximum concentrations occurred in 2002 and concentrations are much lower in more recent sampling.

As shown in Table 3-6 and Figures 3-5.5, 3-5.6, and 3-5.7, PAHs (phenanthrene, pyrene, and indeno(1,2,3-c,d)pyrene) show a statistically significant improvement in stormwater quality from 2001 to present. The best-fit regression equations result in an estimated 80-90 percent reduction in the indicator PAHs in the 21-year monitoring period. In particular, there was a consistent decrease from WY2007 to WY2011 (see Figure 5-1.7) that occurred following cleaning of the storm lines, with a slight increasing trend observed since that time in part due the organics uptick described above. The apparent uptick in organics concentrations observed in the last seven years of monitoring was evaluated by the City, as discussed in Section 3.5.2 and recent results were determined to be representative while earlier results were likely biased low. While this observed slight increase in organic concentrations is observed, concentrations remain substantially lower than the concentrations present early in the monitoring program (see boxplots in Appendix G).

SSPM No sediment traps are installed in OF254.

5.7.1.c Phthalates

Stormwater DEHP appears to be relatively consistent among outfalls (with the exception of OF230 and OF235 as discussed above) (see Table 3-4). OF254 is slightly lower in concentration for DEHP when looking at the 21-year monitoring record (-1) and slightly higher (+1) when looking at only the last two years. Figure 5-1.7 shows total phthalate concentrations in stormwater were fairly stable from WY2002 to WY2009 when they decreased.

As shown in Table 3-6 and Figure 3-5.8, DEHP shows a statistically significant improvement in stormwater quality from 2001 to present. The best-fit regression equations result in an estimated 48 percent reduction in the 21-year monitoring period.

SSPM No sediment traps are installed in OF254.

5.7.1.d Pesticides

Stormwater Analysis for bifenthrin in stormwater began in WY2021 under the 2020 QAPP. Statistical analysis will be performed when sufficient data is available.

SSPM No sediment traps are installed in OF254.

5.7.1.e PCBs

Stormwater PCBs are not a COC tested for under the 2020 QAPP.

SSPM No sediment traps are installed in OF254.

5.7.2 Source Control Program Activities

Storm System Cleaning. In 2006, the municipal storm system in OF254 was cleaned and video inspected. The objective of this project was to remove residual sediments in the storm drains that may contain legacy contaminants. As discussed in detail in the WY2011 report, storm system cleaning contributed to significant reductions in stormwater concentrations. Sewer line cleaning is an important component of the City's source control program, and the City is currently on a schedule of cleaning each storm system area on a 20-year cycle. A second cleaning of approximately 82 percent of the OF254 system occurred in 2021. Additional cleaning is performed on an as needed basis to address specific maintenance needs. The City is statistically evaluating the results to determine whether a maintenance schedule different from the City-wide schedule for pipe cleaning projects is needed within this sensitive basin.

In combination with other source control activities, initial storm system cleaning was effective at removing all seven of the compounds tested. With less post-cleaning data available following the second cleaning, statistics are not as robust, however reductions were observed for lead and zinc.

Following the first cleaning statistically significant reductions were evident for lead, zinc, PAHs, and DEHP (see Table 2-2). Line cleaning, along with other source control activities, resulted in reductions of lead at 29 percent, zinc at 41 percent, DEHP at 21 percent and PAHs (phenanthrene, pyrene and indeno(1,2,3-c,d)pyrene) at 68-82 percent. The second cleaning, along with other ongoing source control activities resulted in further reductions of lead at 67 percent and zinc at 48 percent.

Enhanced Street Sweeping Program In January 2007, the City's street sweeping program was enhanced in an attempt to reduce sediment buildup in the storm sewer system. Under the enhanced program, the sweeping frequency was increased, air regenerative sweepers replaced mechanical sweepers, and the City also increased communications with residents and business owners, which helped raise awareness of the importance of the street sweeping program.

Statistically significant reductions were evident for lead, zinc, PAHs and DEHP (see Table 2-3.1). Street sweeping, along with other source control activities, resulted in reductions of lead at 26 percent, zinc at 40 percent, DEHP at 18 percent, and PAHs (phenanthrene, pyrene, and indeno(1,2,3-c,d)pyrene) at 69-82 percent.

As described above, a pilot study has been underway in the drainage basins for OF243 and OF245 since WY2014. This pilot study has shown that an increased level of street sweeping in industrial areas has been effective in further reducing concentrations of some indicator constituents. The City has expanded the reach of the pilot study into a portion of the OF254 drainage basin, but due to resource constraints, this expansion throughout the basin has not been fully implemented at this time. Some additional sweeping did occur in this basin during WY2022, and the City will continue to work toward full expansion into this drainage basin as resources allow. Based on enhanced sweeping performed to date in a portion of this basin, statistically significant reductions were evident for TSS, lead and zinc (see Table 2-3.2). Enhanced street sweeping, along with other source control activities, resulted in reductions of TSS at 44 percent, lead at 63 percent, and zinc at 41 percent.

General Source Control Activities In addition to the ongoing investigation and maintenance activities described above, the City is continuing to implement other source control program elements in the OF254 drainage basin which are summarized here and described in more detail in Appendix A. This includes removal of a UST at one location under TPCHD oversight.

5.7.3 Outfall 254 2023 Work Plan

TSS, lead, zinc, PAHs and DEHP concentrations in stormwater have shown a statistically significant improvement in OF254 from WY2002 through WY2022 (see Table 3-6 and Figures 3-5.3 to 3-5.8). There has been an estimated 40 percent reduction in TSS, 79 percent reduction for lead, and a 71 percent reduction in zinc concentration in 21 years. DEHP concentration reductions are estimated at 48 percent and index PAHs (phenanthrene, pyrene, and indeno(1,2,3-c,d)pyrene) showed a 80-90 percent reduction in the 21-year monitoring period.

As described in detail above, OF254 results generally show:

- Stormwater – Significantly higher TSS (+6) and moderately elevated zinc (+3), phenanthrene (+3) and pyrene (+4) compared to other outfalls when evaluating the 21-year monitoring record (see Table 3-4). When evaluating only the last two years of data, TSS and copper are moderately elevated (+3 and +4), while other constituents are relatively neutral (+1 to -1) compared to other outfalls.

Therefore, the following recommendation is included in the 2023 Work Plan for the OF254 drainage basin:

- Continue to work toward expansion of the area of increased street sweeping frequency to the remainder of basin as resources become available.

5.8 SUMMARY OF CONSTITUENTS OF CONCERN BY OUTFALL

While overall trends show decreasing concentrations, analytical data has identified some areas where relatively higher concentrations of certain contaminants remain present in the drainage basins and source control investigations are currently underway as described above. Source control efforts are focused on the COCs for each basin and whether it is found in stormwater or SSPM at the outfall as follows:

Constituents of Interest in Each Basin

		230	235	237A	237B	243	245	254
TSS	Baseflow							
	Stormwater							✓
Copper[1]	Stormwater		✓			✓		✓
	SSPM					✓		n/a
Mercury	Baseflow							
	Stormwater	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	SSPM					✓		n/a
Zinc	Baseflow							
	Stormwater						✓	✓
	SSPM					✓		n/a
Lead	Baseflow							
	Stormwater		✓			✓		
	SSPM					✓		n/a
LPAHs[2]	Baseflow							
	Stormwater			✓				
	SSPM	✓						n/a
HPAHs[3]	Baseflow							
	Stormwater			✓				
	SSPM	✓		✓				n/a
Phthalates	Baseflow							
	Stormwater	✓	✓					
	SSPM							n/a
PCBs	SSPM	✓						n/a

✓ chemical of concern.
[1] For OF230, OF237A, OF243, and OF254, evaluation is based on only eight years of data
[2] As represented by indicator COC phenanthrene
[3] As represented by indicator COCs indeno(1,2,3-c,d)pyrene and pyrene
(grey shading) shows statistically significant improvement.
n/a – not applicable

The 2023 Source Control Work Plan is included in Section 6.

The City believes some minor additional improvements in stormwater quality may be realized in the future with ongoing NPDES Permit programs and continuing improvements in source control implementation. Sediment trap results are valuable in that they provide an early warning of potential stormwater sources to the waterway sediments that can be investigated and addressed before SQO exceedances requiring action are identified in the waterways. The City is continuing to move forward with ongoing source tracing investigations.

This page is intentionally left blank

6.0 POLLUTANT LOADING ESTIMATES AND 2023 WORK PLAN

The improvements in stormwater quality since the mid-1990s indicate that source control efforts in the Foss Waterway Watershed have been effective in the reduction of chemical concentrations in stormwater. With the City's comprehensive 21-year monitoring data set, updated statistical analyses have been completed. Forty-eight statistically significant time trends (48 out of 49 tests or approximately 98 percent of the tests) were observed in Tacoma's stormwater monitoring record. All trends were in the direction of decreasing concentrations. This is the same number of and constituents with significant reductions that was observed in WY2021, when a trend was added for TSS at OF254, while the previously observed significant decreasing trend for indeno(1,2,3-c,d)pyrene was not observed.

In addition to the 49-time trend tests that have been evaluated in past years, the 2014 QAPP requires the City to analyze and evaluate total copper. For three outfalls, OF235, OF237B, and OF245, the data collected from WY2015 through WY2021 has been added to data previously collected under the NPDES program between WY2010 and WY2012. With more data available, an evaluation of time trends has been performed for these outfalls for the last several years. Although with less data available, the statistical results are not fully comparable to data for the remaining constituents. With these seven tests added, there are 51 statistically significant time trends (51 out of 56 tests, or approximately 91 percent of the tests) shown in Year 21, with all trends in the direction of decreasing concentrations. As additional data becomes available, time trends for copper will become somewhat more comparable to remaining tests.

Overall, these results are significant and a testament to the City's ongoing comprehensive source control program. Source control activities currently being implemented by the City include business inspections, response to spills and illicit discharges, mapping/maintenance/cleaning of the stormwater system, pollutant source tracing, and implementation of the City's Surface Water Management Manual through our stormwater ordinance. With continued monitoring, enhanced maintenance, and ongoing source control actions, coupled with implementation of Phase 1 NPDES Permit programs, further improvements in stormwater quality may be realized.

It should be noted, however, that while considerable improvements to stormwater quality have been made, the largest changes were realized in the earlier years of the program when major sources were identified and eliminated. Because the source control program has been so effective through the years, fewer major issues remain, and the program is beginning to approach an equilibrium or maintenance mode. In other words, the concentrations of contaminants of concern in the stormwater in the Foss Waterway Watershed are reaching a level where the opportunities for large reductions are more limited. While this may over time lead to the appearance of fewer decreasing trends in contaminant concentrations if looking only at results from more recent years, the fact remains that the City's stormwater source control and monitoring program have been very effective in reducing contaminant levels in stormwater and SSPM.

Reduction of overall contaminant loads to the Foss Waterway has been achieved through the City's implementation of these stormwater source controls. Control of other sources, many of which are outside the City's jurisdiction and must be coordinated by other federal, state, and local authorities, have also led to reduction in contaminant loads. Reductions of air and marina pollution are achieved through Ecology's Air Program and through the Marina Source Control Program which was developed specifically for the Foss Waterway. Reductions in air pollution will decrease not only the direct loads from atmospheric fallout to the surface of the waterway but will also decrease the pollutant loads washed off upland surfaces and entrained in stormwater runoff. The marina improvements implemented by the Foss Waterway Marina, Foss Landing Marina, Johnny's Dock Marina, and Delin Docks, including installation of facility improvements, have undoubtedly translated into reduced source loads for marinas. Finally, upland and in-water remedial actions implemented by Ecology and the Utilities in 2003 and 2004 were directed at controlling tar seeps in the head of the waterway. The effectiveness of these combined actions will continue to be verified through long-term monitoring of stormwater, storm sediment, and marine sediment, and supplemented by source monitoring programs conducted by other parties.

6.1 THEA FOSS WATERWAY SEDIMENT MONITORING PROGRAM

When the waterway sediment remediation projects were completed, the majority of the sediment surface had no, or very low concentrations of contaminants present since the surface was for the most part either dredged to clean sediments or covered with new, clean capping materials. It was anticipated that ongoing low level source contributions to the waterway would cause concentrations of contaminants to increase gradually. Over time, the goal is to have the contaminant concentrations equilibrate at a level below the sediment cleanup standards set by the EPA.

The sediments in the waterway are the true barometer, however, of whether additional source controls are needed for compliance with regulatory requirements. The last sediment monitoring was performed by the City in 2018 in the portion of the waterway generally north of the SR509 Bridge and by the Utilities in the remainder of the waterway. An analysis of the results shows that the concentrations have generally stabilized and that the risk of wide scale recontamination appears low. In many cases, sediment concentrations remained relatively stable between the Year 7 and Year 12 monitoring events, indicating that waterway sediment concentrations appear to have largely equilibrated with modern sources since the completion of the remedial action in 2006. As a result, the risk of recontamination is not expected to be substantially higher in the future unless there is a change in the nature, strength, or distribution of waterway sources. EPA has initiated the process of deleting the waterway from the Commencement Bay Superfund site. This process is expected to be completed in 2023.

Long Term Monitoring Plans (LTMPs) are in place for the waterway for continued monitoring of site. In the City's work area, the LTMP covers monitoring to be performed through 2028, and for the Utilities' work area, the LTMP covers monitoring through 2037. New LTMP's are expected to be prepared for EPA approval when work under the existing plans is completed. The intent is that sediment monitoring results will be available from throughout the waterway to support EPA's development of each of their Five-Year Review reports. The next in waterway sediment monitoring in both work areas will take place in 2023.

6.2 POLLUTANT LOAD ANALYSIS

As indicated in the 2020 QAPP, basin specific rainfall-runoff correlations were developed in WY2016 based on continuous flow data. Based on this information, mass loading calculations were done for WY2022 as described below. A summary of annual mass loadings for each outfall is compiled in Tables 6-1.1 through 6-1.7. The mass loading calculations were performed as described in the Pollutant Loading SOP (Thornburg and Lowe 2009), as modified per the procedures described below to incorporate the basin-specific rainfall-runoff relationship.

- The rain record was separated into discrete storm events based on previously established criteria for threshold rain amounts and antecedent dry periods.
- The five minute rainfall amounts were summed to provide a total rain depth for each storm. The corresponding runoff depth was then estimated from the rainfall-runoff correlations.
- The runoff depths (in inches) were converted to discharge volumes (in acre-feet) by multiplying by the basin area (in acres), with appropriate unit conversions. These were then converted to event mean flow rates by dividing the event discharge volume by the duration of the storm. The storm fraction was calculated as the ratio of the storm flow to the combined storm plus baseflow for each event.
- The total wet season, dry season, and annual discharge volumes were calculated by summing over the appropriate storm events. Mean seasonal storm flow rates were calculated by dividing the total discharge volume (wet season or dry season volume) by the time period of interest.
- Stormwater concentrations were “unmixed” from the combined flow concentrations (i.e., “as measured” concentrations) using the mass balance equations described in the Pollutant Load SOP. In a few instances, negative concentrations resulted from the “unmixing” calculation. Typically, these instances occurred when there were higher concentrations in baseflow, such that baseflow accounted for all (and more) of the combined storm flow concentration, and in some instances, they were an artifact of undetected concentrations with variable detection limits. In any instance where negative “unmixed” stormwater concentrations were calculated, these values were replaced with half the detection limit values (essentially, they are equivalent to undetected stormwater concentrations).
- Mean annual stormwater concentrations were calculated as volume-weighted average concentrations. The estimated storm volumes were paired with their corresponding analytical results and provided the weighting functions for calculating a volume-weighted concentration. A volume-weighted mean rather than a flow weight mean will be used because it is believed to provide a better statistic since it captures the significance of a storm event in terms of both flow and duration.
- The mean seasonal and annual baseflow and storm flow rates, the storm fraction in the combined discharges, and the mean annual baseflow and stormwater concentrations were input to the pollutant load worksheet provided in the Pollutant Load SOP. The worksheet calculated the seasonal and annual baseflow and stormwater pollutant loads as per the Pollutant Load SOP.
- Since baseflow is no longer monitored for the Foss on a regular basis, baseflow data from the last water year of baseflow analysis (WY2011) will be used in the calculator for most parameters. Since WY2011, new parameters have been analyzed and some

analytical methods are analyzed at lower method detection limits. In WY2016 and WY2019, baseflow characterization data were collected at all outfalls to evaluate the effect of these changes.

Tables 6-1.1 through 6-1.7 include the following information:

- Mean annual stormwater and baseflow[23] concentrations for stormwater contaminants of concern (COCs) and stormwater/baseflow concentration ratios; the mean annual concentrations are based on volume-weighted averages;
- Mean annual pollutant loads [in pounds], as well as itemized loads for baseflow and stormwater components, and wet season and dry season components; and
- Mean annual pollutant load densities [pounds per acre], as well as itemized load components as described above.

Stormwater mass loadings were not calculated for analytical parameters with fewer than 10 percent detected concentrations or only one detected sample in stormwater. Many of the constituents with low detection frequencies in stormwater were never detected in baseflow samples. Mass loadings were not calculated for grab sample parameters, since these parameters represent a single moment in time and are not average concentrations for the sampled volume.

It is further noted that constituents with less than 25 percent detections and/or less than five detected results (or less than three detected results in baseflow) will generate estimated mass loads with a high degree of uncertainty, even though mass loads may still be calculated. Cells are highlighted in Tables 6-1.1 through 6-1.7 to identify constituents that are confounded by low detection frequencies to identify mass loading estimates which are more uncertain.

6.2.1 Rainfall-Runoff Correlations

The City installed flow meters in its three NPDES drainage basins (OF235, OF237B, and OF245) and collected continuous flow data during all of WY2010, as required by the Phase I Permit. During WY2011, the flow records from WY2010 were analyzed to develop rainfall-runoff correlations for the three basins. The rainfall-runoff correlations for these basins are shown on Figures B2-8, B2-11, and B2-16 in Appendix B. The runoff has been normalized to basin size, such that both rainfall and runoff are presented in depth units, and the slope of the regression line is the runoff coefficient. Separate correlations were developed for wet season and dry season conditions. The estimated runoff parameters are presented in Tables B9-1.2, B9-1.4, and B9-1.6, and summarized in Table B9-2 in Appendix B.

During WY2016, the flow records from WY2015 and WY2016 were analyzed to develop rainfall-runoff correlations for OF230, OF237A, OF243, and OF254. The rainfall-runoff correlations are shown on Figures B2-6, B2-10, B2-13, and B2-18 in Appendix B. The runoff has been normalized to basin size, such that both rainfall and runoff are presented in depth units, and the slope of the regression line is the runoff coefficient. Separate correlations were developed for wet season and dry season conditions. The estimated runoff parameters are presented in Tables B9-1.1, B9-1.3, B9-1.5, and B9-1.7 and summarized in Table B9-2 in Appendix B.

---

[23] WY2016 and WY2019 baseflow concentrations were used in the calculations as an approximation of WY2019 baseflow quality.

Basin Comparisons Higher runoff coefficients were observed in OF235 compared to the larger basins OF230, OF237A, and OF237B. This was expected given the smaller basin size in comparison, the steeper slopes and higher percentage of impervious area in the OF235 basin, which is comprised of a large portion of downtown Tacoma.

The highest runoff coefficients were observed in OF245 and OF254, 0.99 and 0.84, respectively. This may be caused by the relatively small size and prevalence of hardened surfaces in these industrial drainages. However, the coefficients in this low-gradient and tidally influenced drain may also be artificially inflated to some degree by back-flushing tidal water. Separating tidal flows and storm flows was difficult in the eastside outfalls (OF 243, OF245 and OF254) and complicated the analysis of the flow record.

Seasonal Comparisons The runoff coefficients for dry season conditions are consistently the same or lower than the coefficients for wet season conditions. This may be an indication that the ground is more saturated during the wet season and has less capacity for infiltration, leading to a higher percentage of runoff. The coefficient of determination (r^2) for the regression models shows a distinct seasonal effect, as shown in Appendix B on Figures B2-6, B2-8, B2-10, B2-11, B2-13, B2-16, and B2-18 (OF230, OF235, OF237A, OF237B, OF243, OF245, and OF254, respectively). Specifically, the rainfall-runoff relationship is better defined in the wet season, as evidenced by significantly higher r^2 values. The lower correlations during the dry season may be indicative of more erratic and variable runoff conditions.

Seasonal comparison is limited for OF230, OF237A, OF243, and OF254 because of the low number of dry weather storm events that weren't tidally influenced in WY2015 and WY2016.

Rain Threshold In the large basin for OF237B, there is a threshold of precipitation of a few hundredths of an inch, below which no runoff occurs. This is a large, primarily residential basin (see Appendix B, Figure B2-3) with more vegetated cover and soft shoulders on streets, and thus has more capacity to infiltrate compared to the other basins. The threshold is determined by the intercept of the regression line (see Figure B2-11) and indicates a capacity for the basin to assimilate some amount of rain before runoff occurs. As expected, the threshold is higher during the dry season (i.e., the dry ground has a greater capacity to assimilate incipient rainfall).

Results from WY2021 indicate that this might also be the case for the large mixed-use basin for OF237A, although it is difficult to discern at this time. The City has plans to refine rainfall runoff correlations to better determine the conditions in this basin.

6.2.2 Residential Pollutant Loading – OF237B

The following constituents were excluded from loading calculations because they were detected only once or not at all in this outfall during the WY2022 monitoring year: total and dissolved cadmium, total and dissolved mercury, acenaphthene, acenaphthylene, anthracene, fluorene, dibenz(a,h)anthracene, butylbenzylphthalate, diethylphthalate, dimethlyphthalate, di-n-octylphthalate, and bifenthrin. Baseflow values were estimated as average concentrations from the WY2016 and WY2019 baseflow data for OF237B. Following are the key results of the mass loading calculations for OF237B:

- As shown on Appendix B, Table B9-2, baseflow accounts for approximately four-fifths (78 percent) of the total discharge from OF237B.
- Stormwater concentrations are substantially higher than baseflow concentrations for a majority of the constituents (see Table 6-1.4). Concentration ratios are especially high

for TSS (32 times higher in stormwater compared to baseflow), and total lead (134 times higher). total and dissolved copper, total and dissolved zinc and dissolved lead exhibited slightly lower ratios with concentrations ranging from 13 to 27 times higher than baseflow concentrations. Concentrations of organic constituents ranged from 2 to 16 times higher in stormwater.

- Even though baseflow accounts for 81 percent of the discharge from OF237B, because stormwater can exhibit substantially higher concentrations than those seen in baseflow, stormwater accounts for a large majority of the mass loading. Specifically, stormwater accounts for 90 percent of the TSS load, 79-97 percent of the total and dissolved metals loads, and 34-82 percent of the loads from organic compounds.
- When a large number of stormwater and baseflow concentrations are non-detected and where OF237B baseflow accounts for 81 percent of the discharge, the largest contribution of mass loadings is estimated from baseflow. This is seen for a few constituents with less than 25 percent detections and/or less than five detected results that generate estimated mass loads with a high degree of uncertainty, even though mass loads may still be calculated using one-half the detection limit for that non-detected value (four PAHs and one Phthalate).
- Because approximately 90 percent of the storm flow in OF237B occurs during the wet season, significantly higher mass loadings occur during the wet season. Specifically, the wet season accounts for 87 percent of the TSS load, 59-73 percent of the nutrient loads, 83-89 percent of the total and dissolved metals loads, and 69-85 percent of the loads from organic compounds.
- MBAS, BOD_5, and nutrients appear to be similar in quality or higher in baseflow when comparing stormwater and baseflow concentrations. BOD_5 is confounded by low detection frequencies in baseflow that have generated estimated mass loads with a high degree of uncertainty. During WY2022, stormwater concentrations are three times higher than baseflow concentrations for MBAS, approximately two times higher for BOD_5, and approximately three times higher for total phosphorus. The remaining nutrients exhibit higher concentrations in baseflow, than in stormwater. Baseflow accounts for 55 percent of the MBAS load, 67 percent of the BOD_5 load, and 53-97 percent of the nutrient loads.

6.2.3 Commercial Pollutant Loading – OF235

The following constituents were excluded from loading calculations because they were detected only once or not at all in this outfall during the WY2022 monitoring year: dissolved cadmium, total and dissolved mercury, acenaphthene, acenaphylene, fluorene, dibenz(a,h)anthracene, dimethlyphthalate, di-n-octylphthalate and bifenthrin. Baseflow values were estimated as average concentrations from WY2016 and WY2019 baseflow data for OF235.

Following are the key results of the mass loading calculations for OF235:

- As shown on Appendix B, Table B9-2, baseflow accounts for approximately two-fifths (37 percent) of the total discharge from OF235.
- Stormwater concentrations are higher than baseflow concentrations for a majority of the constituents (see Table 6-1.2). The concentration ratio is especially high for TSS (12 times higher in stormwater compared to baseflow). The concentration ratio for the majority of metals ranges from 1 to 12 times higher for stormwater. Concentrations of many other constituents, both inorganic and organic, are from one time to 13 times

higher in stormwater. The main exceptions are nutrients which exhibit higher concentrations in baseflow (see discussion below).

- Because storm flow accounts for approximately 63 percent of the discharge from OF235, and because stormwater concentrations are typically higher than baseflow concentrations, stormwater accounts for a large majority of the mass loading for most constituents. Specifically, stormwater accounts for 95 percent of the TSS load; 71 percent of the MBAS load, 80 percent of the BOD load, and 60 percent of the total phosphorous; 86-95 percent of the total and dissolved metals loads (except total cadmium at 65 percent), and 70-96 percent of the loads from organic compounds.
- Because 89 percent of the storm flow in OF235 occurs during the wet season, significantly higher mass loadings occur during the wet season. Specifically, the wet season accounts for 86 percent of the TSS load, 64-76 percent of the nutrient loads, 77-86 percent of the total and dissolved metals loads, and 79-87 percent of the loads from organic compounds.
- Nutrient concentrations (total phosphorous, orthophosphorous, total nitrogen and nitrate/nitrite) appear to be either similar in quality or higher in baseflow. The mean annual baseflow and stormwater concentrations for total phosphorous are 0.13 mg/L and 0.12 mg/L, respectively. Other nutrients are 2 to 7 times higher in baseflow than stormwater concentrations for these nutrients. Specifically, baseflow accounts for 40 percent of the total phosphorus loads and 60 percent to 80 percent of the other nutrient loads.

6.2.4 Industrial Pollutant Loading – OF245

The following constituents were excluded from loading calculations because they were detected only once or not at all in this outfall during the WY2022 monitoring year: total and dissolved mercury, acenaphthene, acenaphthylene, anthracene, dibenz(a,h)anthracene, butylbenzylphthalate, diethylphthalate, dimethlyphthalate, di-n-octylphthalate, and bifenthrin. Following are the key results of the mass loading calculations for OF245:

- As shown on Appendix B, Table B9-2 there is no measurable baseflow component in the discharge from OF245. Therefore, 100 percent of the mass loading from OF245 is attributed to stormwater.
- Because 86 percent of the storm flow in OF245 occurs during the wet season, significantly higher mass loadings occur during the wet season (see Table 6-1.6). Specifically, the wet season accounts for 88 percent of the loadings for all stormwater COCs. This percentage does not vary because the same average COC concentrations were assumed for both wet season and dry season discharges; there is not yet enough data to determine whether there are statistically significant seasonal effects in stormwater quality.
- The estimated runoff coefficients are quite high for this basin (78-99 percent runoff in dry and wet seasons, respectively; see Appendix B, Figure B2-16). Therefore, it is suspected that the predicted runoff, and thus the resultant pollutant loads, may be overestimated due to the inclusion of some amount of backflushing tidal water in the discharge estimate.

There is a greater degree of uncertainty associated with the mass loadings from OF245 because this storm sewer has a low slope and elevation and is strongly influenced by tidal inundations. Significant portions of the flow record are obscured by tidal fluctuations. Tidal fluctuations also make it more difficult to sample this drain and estimate event mean concentrations. Tidal inundations have been estimated using WISKI programming. Refinements will be made in WISKI and will be used over time to estimate tidal inundations and recalculate runoff coefficients for OF245.

6.2.5 Overall Pollutant Loading

Annual flow and pollutant loadings were calculated for all outfalls in WY2022. Some of these annual flows may be artificially inflated due to tidally induced flows (see Section 6.2.1). Annual total flow for stormwater and baseflow are presented in Appendix B, Table B9-2. In WY2022, the total combined annual flow was 20,689 acre feet, with the fraction of stormwater at 34 percent (7,069 acre feet). Most of the annual flows are from OF237A and OF237B and the percentages are follows:

Percent of Total Foss Basin	OF237A	OF237B	237A and 237B
% of Foss Basin Acreage	49.1%	34.7%	83.8%
Annual flow	34%	57%	91%
Baseflow	29%	68%	97%
Storm	43%	37%	80%
Pollutant Loadings (TSS Pounds per Year)			
Annual	45%	35%	81%
Baseflow	39%	51%	90%
Storm	46%	34%	80%

Consistent with having the highest flow, the highest pollutant loadings for TSS and for most other constituents are from 237A and 237B (all but dissolved cadmium, dissolved lead, acenaphthene, anthracene, naphthalene, and diethyl-phthalate). When a large number of stormwater and baseflow concentrations are non-detected and where OF237A and OF237B baseflow accounts for 71 percent of the overall annual discharge, the largest contribution of mass loadings is estimated from baseflow. This is seen for a few constituents with less than 25 percent detections and/or less than five detected results that generate estimated mass loads with a high degree of uncertainty, even though mass loads may still be calculated using one-half the detection limit for that non-detected value (see Table 6-4).

Loadings for these constituents were higher in OF235 for dissolved lead in storm and total flow, and butylbenzylphthalate and diethylphthalate in base, storm, and total flow; OF230 for dissolved cadmium in baseflow and total mercury in base, storm and total; and OF254 for dissolved cadmium in storm flow (see Table 6-4). These higher loadings are due to a greater amount of detections for these constituents than were detected in the other outfalls.

Pollutant loadings were also normalized to pounds per acre for each outfall. These results are shown in Table 6-3. Normalizing the loadings per acre illustrates where more pounds of constituents are found in an acre. This metric can be used to direct source control efforts where these efforts may result in a larger reduction of pollutants. In general, a greater number of constituents with maximum pounds per acre were found in four outfalls: OF237A (10 different constituents), OF245 (9 different constituents) and OF235 and OF254 (8 different constituents each). Maximum pounds per acre for some metals and organics were also found in OF237B (3), and OF243 (3). There were no maximum pounds per acre found in OF230 during WY2022.

OF237A exhibited the maximum pounds per acre for acenaphthylene and the majority of the HPAHs, including total HPAHs and bifenthrin. OF245 exhibited the maximum pounds per acre for total and dissolved cadmium, four LPAHs (2-methylnaphthalene, fluorene, naphthalene, and total LPAHs), and three phthalates (DEHP, di-n-butyl phthalate, and total phthalates).

OF235 exhibited the maximum pounds per acre for total phosphorus, orthophosphorus, total and dissolved lead, dissolved copper, benzo(a)anthracene, butyl benzyl phthalate and dichlobenil. In addition to two HPAHs (indeno(1,2,3-c,d)pyrene and pyrene), OF254 exhibited the maximum pounds per acre for TSS, MBAs, total copper, total and dissolved zinc, and one LPAH (phenanthrene). Similar to previous years, the residential area discharging to OF237B discharged the highest loads per acre for BOD_5, and both nitrogen constituents. OF243 exhibited the highest loading per acre for two LPAH (acenaphthene and anthracene) and Dimethyl-phthalate. There were no maximum loadings per acre seen in OF230 (Table 6-3).

6.2.6 Water Year Comparison – 237B, 235 and 245

Table 6-2.1 presents a summary of estimated pollutant loads (normalized on a per-acre basis) for WY2010-2012 and WY2015-2022 in the three monitoring basins (237B, 235, and 245), and the percent difference in the estimated loads for WY2022 compared to the previous water years. The majority of the estimated mass load comparisons for each WY to WY2022 were relatively consistent and within a factor of two of each other (i.e., the percent difference ranged from – 75 percent to +100 percent from each WY to WY2022). Such differences are not unexpected given the inherent variability in stormwater quality from year to year and from storm to storm. The statistical confidence in the estimated mass loads for these three basins will improve as more monitoring years are collected and included in the analysis.

Ninety-two percent of the estimated mass load comparisons for each WY to WY2022 were within a factor of two of each other. Annual Rainfall in WY2022 (44.92 inches) was greater than the average (40.84 inches) for all water years (WY2002-WY2022) (see Table 3-1). WY 2016 and WY2017 had the greatest rainfall amount for all the years with 50.11 inches and 51.73 inches, respectively. Not all constituent loads showed a consistent load increase in direct response to greater rainfall amounts. Lower concentrations would offset an increase due to rainfall volumes and/or rainfall intensities.

- **PAHs** Most of the WY2022 constituent PAH loads exhibit similar loadings when compared with past years with the following exceptions.
    - Benzo(a)pyrene (OF235). The loadings at OF235 for this constituent showed a decrease from WY2017 – WY2019 with percent differences ranging from 87 percent to 228 percent difference when compared with WY2022 loadings. Loadings for benzo(a)pyrene peaked during WY2019 with the lowest pollutant loadings seen in WY2021. There was a 35 percent increase in loadings for WY2022 when compared with the previous year.

- LPAHs OF245. Loadings for LPAHs in OF245 exhibited similar concentrations to previous years with the exception of loadings for 2-methylnaphthalene and naphthalene. Loadings ranged from 168 percent to 499 percent higher in WY2022 when compared to WY2010-WY2012 for these constituents. In addition, loadings for 2-methylnaphthalene and naphthalene were 249 percent and 320 percent higher respectively and total LPAHs 85 percent higher when compared to loadings in WY2020. Loadings for both of these PAHs decreased during WY2022 from the previous year.
- Loadings for HPAHs in OF235 exhibited an increase for loadings of three HPAHs (benzo(a)anthracene, benzo(a)pyrene, and benzo(b,k)fluoranthenes) during WY2022. The majority of HPAHs loadings in WY2010-WY2012 saw the highest percent difference when compared to loadings in WY2022. In addition, loadings for benzo(a)pyrene were 158 percent-228 percent higher when compared to loadings in WY2022.

- **TSS and Metals** During WY2022, OF235, OF237B, and OF245 exhibited less or similar TSS loads than all years. The most significant difference was seen at OF237B with loading comparison to WY2011 with TSS loads 76 percent less in WY2022. Though there was a 22 percent increase in TSS loads from the previous water year this was still within normal variations.

  During WY2022, the majority of metal loads remained within normal variations (some increase and some decrease) with the exception of a few comparisons with previous monitoring years. In OF237B, WY2011 total lead was 84 percent less than WY2022 loadings. In OF245 the majority of metal loads, respectively, were lower in WY2022 when compared to previous monitoring years. Some metals are strongly correlated with particulate matter; therefore, a portion of the large decreases may be a proportionate response to the decrease in the TSS load exhibited. TSS and metal mass load comparison varies from one year to the next. Significant decreases were seen when comparing metal loads in WY2011, WY2016, and WY2017 to metal loads in WY2022.

- **Phthalates** All except several phthalates, estimated mass load comparisons for previous years were relatively consistent and within a factor of two of each other (i.e., the percent difference ranged from – 75 percent to +100 percent from each previous year to WY2022). Di-n-butyl-phthalate loadings were 185 percent higher in WY2022 at OF237B when compared to WY2017. Di-n-butyl-phthalate exhibited the most significant differences at OF245 with loadings ranging from 110 percent to 676 percent higher during WY2022.

- **Dichlobenil** The majority of the differences in the WY2022 comparison are within a factor of two of the previous loadings. Dichlobenil loading in WY2022 exhibited greater than a factor of two for several mass load estimates: OF235 WY2012 (127 percent), WY2018 (125 percent) and WY2021 (140 percent); OF237B WY2017 (132 percent). There were two comparisons that exhibited less than a factor of two for mass load estimates: OF235 WY2010 (-86 percent) and OF237B WY2016 (-82 percent). All mass load comparisons at OF245 were within normal variations.

6.2.7 Water Years 2016 through 2022 Comparison

Tables 6-2.1 and 6-2.2 presents a summary of estimated pollutant loads (normalized on a per-acre basis) for WY2016 through WY2022 and the percent difference in the estimated loads for WY2016-21 compared to WY2022. Ninety-three percent of the estimated mass load comparisons for WY2016 to WY2022 were relatively consistent and within a factor of two of each other (i.e., the percent difference ranged from – 75 percent to +100 percent from WY2016-21 to WY2022). Such differences are not unexpected given the inherent variability in stormwater quality from year to year and from storm to storm. The statistical confidence in the estimated mass loads for these three basins will improve as more monitoring years are collected and included in the analysis.

Seven percent of the estimated mass load comparisons for WY2016-21 to WY2022 weren't within a factor of two of each other with a mix of some loads being greater and some less. Annual Rainfall in WY2022 (44.92 inches) was greater than the average (40.84 inches) for all water years (WY2002-WY2022) see Table 3-1. WY2016 and WY2017 had the greatest rainfall amount for all the years with 50.11 inches and 51.73 inches, respectively. Not all constituent loads showed a consistent load decrease in direct response to the lower rainfall amount. Higher concentrations would offset a decrease due to rainfall volumes.

- Most of the WY2022 constituent loads that show greater percent differences when compared to other monitoring years were at OF237A and OF243. In OF237A, TSS, , four LPAHs and all but one HPAH exhibited greater loadings in WY2022 compared to previous monitoring years. In OF243, the majority of the greater percent differences were due to lower values exhibited during WY2020 and WY2021. Other OF243 loading increases in WY2022 include loads for dissolved lead and diethyl-phthalate.
- All of the metals, LPAHs, HPAHs, and phthalates comparisons showed similar loadings in OF230 except for 2-methylnapthanlene and naphthalene.
- Other mass load comparisons greater than a factor of two were seen in OF254 for dissolved lead when compared to all water years (195 percent to 649 percent).

6.2.8 Pollutant Loading Summary – WY2022

WY2022 discharge volume and chemical loadings are presented in Table 6-5. In WY2022, 70 percent of the freshwater volume discharging to the waterways is from baseflow, mainly from OF237A, OF237B, OF235, and OF230 (see Appendix B, Table B9-2).

For WY2022, baseflow was characterized by reduced maximum values and less frequent detections than in stormwater. When a large number of stormwater and baseflow concentrations are identified as non-detected and in OF237A and OF237B where baseflow accounts for 70 percent of the overall annual discharge, the largest contribution of mass loadings is estimated from baseflow. This is seen for a few constituents with less than 25 percent detections and/or less than five detected results that generate estimated mass loads with a high degree of uncertainty, even though mass loads may still be calculated using one-half the detection limit for that non-detected value (orthophosphorus, both nitrogen constituents, total cadmium, and two phthalates, see Table 6-4). The proportion of the WY2022 contaminant load attributed to baseflow for the following indicator parameters is (see Table 6-5 and Table 6-4):

- 22 percent of the load for phenanthrene
- 7 percent of the load for pyrene
- 8 percent for dibenz(a,h)anthracene
- 27 percent of the total load for DEHP

The largest proportion of chemicals discharging into the waterways from municipal outfalls is from stormwater. The WY2022 contaminant loading from stormwater is:

- 78 percent of the total load for phenanthrene

- 93 percent of the total load for pyrene
- 92 percent for dibenz(a,h)anthracene
- 73 percent of the total load for DEHP

As shown in Table 6-3, a greater number of constituents with maximum pounds per acre were found in four outfalls: OF237A (10 different constituents), OF245 (9 different constituents), and OF235 and OF254 (8 different constituents each). Maximum pounds per acre for only three constituents were found in OF237B (3) and OF243 (3). There were no maximum pounds per acre found in OF230 during WY2022.

OF237A exhibited the maximum pounds per acre for acenaphthylene and the majority of the HPAHs, including total HPAHs and bifenthrin. OF245 exhibited the maximum pounds per acre for total and dissolved cadmium, four LPAHs (2-methylnaphthalene, fluorene, naphthalene, and Total LPAHs), and three phthalates (DEHP, di-n-butyl phthalate, and total phthalates).

OF235 exhibited the maximum pounds per acre for total phosphorus, orthophosphorus, total and dissolved lead, dissolved copper, benzo(a)anthracene, butyl benzyl phthalate and dichlobenil. In addition to two HPAHs (indeno(1,2,3-c,d)pyrene and pyrene), OF254 exhibited the maximum pounds per acre for TSS, MBAS, total copper, total and dissolved zinc, one LPAH (phenanthrene). Similar to previous years, the residential area discharging to OF237B discharged the highest loads per acre for BOD_5, and both nitrogen constituents. OF243 exhibited the highest loading per acre for two LPAH (acenaphthene and anthracene) and Dimethyl-phthalate. There were no maximum loadings per acre seen in OF230 (Table 6-3).

6.3 2023 Work Plan

In December 2020, EPA determined that the City had fully performed the sediment remedial action in the Thea Foss and Wheeler-Osgood. As such, and because the waterway sediments have reached equilibrium with modern sources at levels generally below EPA's required cleanup levels for the Superfund site, there is generally not a need for new source control actions at this time. Several source control investigations and actions are underway at this time and will be carried out to completion. In addition, if future monitoring identifies the potential of a new source that may be affecting sediment quality in the waterway, additional source control actions will be undertaken. The WY2023 source control work plan is provided below:

- **OF230:** Continue follow-up on private property cleanups performed, and complete ongoing system cleaning and monitoring for PCBs and PAHs as appropriate in the areas draining to FD3A, FD3ANew, FD18, and FD16.
- **OF230/OF235:** Continue to evaluate potential sources of spring/summer outliers for copper to stormwater.
- **OF235:** Evaluate the need for additional source control work for lead, copper, and DEHP in stormwater following completion of construction activities in this area. These construction activities are expected to have a positive impact on controlling the flow of potentially contaminated groundwater into the storm drainage system.
- **OF237A:** Continue to work in the area at and around The News Tribune to eliminate source(s) of PAHs to the municipal drainage system. Monitor upcoming SSPM results and catch basin sample results near FD13BNew to evaluate whether source control work done to date in this area has been successful in eliminating this source.

- **OF237A:** Continue evaluation of possible sources of PCBs to FD10C.
- **OF237A**: Evaluate potential sources and seasonality of occasional outliers of indeno(1,2,3-cd)pyrene and other PAHs in stormwater.
- **OF243:** Perform follow-up work with the business owner and system cleaning work in the area where elevated mercury concentrations were identified in catch basins in the FD23 drainage area.
- **OF243/OF245/OF254:** Continue evaluation of the effectiveness of the street sweeping pilot project on lead and zinc concentrations in the industrial area as additional data become available.

In addition, the City will perform a number of tasks as part of the source control program:

- Continue Foss Stormwater Monitoring for WY2023.
- All: Review WY2023 SSPM data in all areas when available to evaluate the effectiveness of treatment systems installed and confirm the effectiveness of source control actions that have been taken over time.
- Monitor the major construction activities throughout the watershed including the WSDOT Nalley Valley Viaduct/SR-16 rebuild.
- Monitor and conduct inspections at new developments as completed to review appropriate BMPs for each site.
- Implement the City's Stormwater Management Manual, 2021 Edition.
- Continue NPDES business inspections program and document the inspections using the business inspections database. Respond and track all complaints/spills in the complaints database.
- Monitor TPCHD and Ecology UST/LUST removal projects along with any other remediation projects in the watershed.

It should be noted that there are other sources that could also potentially affect sediment quality in the waterways, including groundwater seeps, marinas, atmospheric fallout, NPDES-permitted industrial discharges, and other private stormwater discharges. These sources are outside the scope of the City's Source Control Strategy for municipal stormwater, and largely outside the City's jurisdiction.

This page is intentionally left blank

7.0 REFERENCES

Ecology 2001. Administrative Water Quality Order No. DE01WQHQ-3241 against the City of Tacoma, September 17, 2001. Washington State Department of Ecology. September 2001.

Ecology 2004. Administrative Water Quality Order No. DE01WQHQ-3241A-01 against the City of Tacoma, August 11, 2004. Washington State Department of Ecology. August 2004.

Ecology 2012. Phase I Municipal Stormwater Permit. National Pollutant Discharge Elimination System and State Waste Discharge General Permit (Issued August 1, 2012). Washington State Department of Ecology.
http://www.ecy.wa.gov/programs/wq/stormwater/municipal/phaseIpermit/phipermit.html

Ecology 2019. Phase I Municipal Stormwater Permit. National Pollutant Discharge Elimination System and State Waste Discharge General Permit (Effective August 1, 2019). Washington State Department of Ecology.
https://ecology.wa.gov/Regulations-Permits/Permits-certifications/Stormwater-general-permits/Municipal-stormwater-general-permits/Municipal-Stormwater-Phase-I-Permit

Tacoma 2001. Sampling and Analysis Plan for Thea Foss and Wheeler-Osgood Waterways. City of Tacoma. September 2001.

Tacoma 2009a. Thea Foss and Wheeler-Osgood Waterways Stormwater Monitoring, August 2001-2008 Report. City of Tacoma. March 2009

Tacoma 2009b. 2008 Stormwater Source Control Report. Thea Foss and Wheeler-Osgood Waterways. City of Tacoma. March 2009.

Tacoma 2012. 2011 Stormwater Source Control Report and Water Year 2011 Stormwater Monitoring Report. City of Tacoma. March 31, 2012.

Tacoma 2013. 2012 Stormwater Source Control Report and Water Year 2012 Stormwater Monitoring Report. City of Tacoma. March 29, 2013.

Tacoma 2014. 2013 Stormwater Source Control Report and Water Year 2013 Stormwater Monitoring Report. City of Tacoma. March 27, 2014.

Tacoma 2014b. Stormwater Monitoring Quality Assurance Project Plan for Thea Foss and Wheeler-Osgood Waterways dated September 2014 prepared by City of Tacoma approved by Ecology August 28, 2014.

Tacoma 2017. 2016 Stormwater Source Control Report and Water Year 2016 Stormwater Monitoring Report. City of Tacoma. March 31, 2017.

Tacoma 2018. 2017 Stormwater Source Control Report and Water Year 2017 Stormwater Monitoring Report. City of Tacoma. March 30, 2018.

Tacoma 2018b. Thea Foss and Wheeler-Osgood Waterways Remediation Project, Long Term Monitoring Plan. City of Tacoma. May 2018.

Tacoma 2019. 2018 Stormwater Source Control Report and Water Year 2018 Stormwater Monitoring Report. City of Tacoma. March 29, 2019.

Tacoma 2020. 2019 Stormwater Source Control Report and Water Year 2019 Stormwater Monitoring Report. City of Tacoma. March 31, 2020.

Tacoma 2020b. 2020. Thea Foss and Wheeler-Osgood Waterways Stromwater Monitoring Quality Assurance Project Plan. City of Tacoma. August 2020.

Tacoma 2021. 2020 Stormwater Source Control Report and Water Year 2020 Stormwater Monitoring Report. City of Tacoma. March 31, 2021.

Tacoma 2022. 2021 Stormwater Source Control Report and Water Year 2021 Stormwater Monitoring Report. City of Tacoma. March 31, 2022.

TABLES

This page is intentionally left blank

Table 2-1
Sediment Trap Monitoring Locations for 2002-2022

Dates Deployed		WY2002	WY2003	WY2004	WY2005	WY2006	WY2007	WY2008	WY2009	WY2010	WY2011	WY2012	WY2013	WY2014	WY2015	WY2016	WY2017	WY2018	WY2019	WY2020	WY2021	WY2022
		8/31/01 3/25/02-3/26/02	8/27/02-8/29/02 4/28/03	8/27/03 4/8/04	8/24/04- 8/26/04 4/05	8/26/05- 8/30/05 4/06/06	8/21/06- 8/23/06 3/1/07-4/20/07	8/21/07- 8/24/07 4/3/08-4/4/08	8/28/2008 5/4/09-5/8/09	8/27/2009 8/23/10- 8/24/10	8/2310- 8/24/10 8/25/11- 8/26/11	8/24/11- 8/25/11 8/14/12- 8/23/12	8/13/12- 8/23/12 8/30/13	7/10/13- 8/23/13 8/25/14- 8/27/14	8/26/14- 9/3/14 8/10/15- 8/14/15	8/10/15- 8/17/15 8/15/16- 8/26/16	8/15/16 - 8/26/16 8/21/17- 8/23/17	8/21/17 - 8/23/17 8/17/18 - 8/21/18	8/17/18 - 8/21/18 8/19/19 - 8/21/19	8/19/19 - 8/21/19 8/17/20 - 8/18/20	8/17/20 - 8/18/20 8/24/21- 8/25/21	8/24/21 - 8/25/21 8/22/22- 8/23/22
OF237A	FD2	X	X	X	X	X 9/26/05	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	FD2A	X	Pulled 3/10/03	Site gone	X	X 1/9/06	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	FD5	X	X	X	X	X	X	X	X	X	X	X	X									
	FD10		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	pulled *		
	FD10B		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	pulled *		
	FD10C		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	FD13		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	pulled *		
	FD13B		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				
	FD13B NEW												X	X	X	X	X 10/4/16	X	X	X	X	X
OF237B	FD1	X	X	X	X	X 9/26/05	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	FD30		X		X			X	X													
	FD31		X		X			X	X	X	X	X	X	X	X	X	X	X	X	X	pulled *	
	FD32		X		X			X	X													
	FD33		X		X			X	X													
	FD34		X		X			X	X	X	X	X	X	X	X	X	X	X	X	pulled *		
	FD35		X		X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	FD36		X		X			X	X													
	FD37		X		X			X	X													
	FD38		X		X			X	X													
OF230	FD3NEW	X	X	X	X	X	X *	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	FD3	X	X	X	X	X	X *	X	X	X	X	X	X									
	FD3A	X	X	X	X	X	X *	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X*
	FD3B	X	Pulled	X	X	X	X *	X	X	X	X	X	X	X	X	X	X	X	X	pulled *		
	FD16		Lost	X	X	X	X *	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	FD16B		X	X	X	X	X *	X	X	X	X	X	X									
	FD18		X	X	X	X	X *	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	FD18B		X	X	X	X	X *	X	X	X	X 1/24/11	X	X	X	X	X	X	X	X	X	pulled *	
OF235	FD6	X	X	X	X	X	X *	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	FD6-A					X 10/7/05	X *	X	X	X	X	X	X									
	FD6-B					X 10/6/05	X *	X	X	X	X	X	X									
OF243	FD23	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
OF245	MH390	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	FD21	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
OF248	FD22	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

** Removed on December 17, 2021 due to construction of new OF230A. This sediment trap will be moved due to infrastruture re-routing during WY2023.*

Table 2-2
Stormwater Summary Statistics, Before and After Line Cleaning

	TSS (mg/l)		Lead (ug/l)		Zinc (ug/l)		Phenanthrene (ug/l)		Pyrene (ug/l)		Indeno(1,2,3-c,d)pyrene (ug/l)		Bis(2EH)phthalate (ug/l)	
	Pre-Cleaning	Post-Cleaning	Pre-Cleaning	Post-Cleaning	Pre-Cleaning	Post-Cleaning	Pre-Cleaning	Post-Cleaning	Pre-Cleaning	Post-Cleaning	Pre-Cleaning	Post-Cleaning	Pre-Cleaning	Post-Cleaning
OF230*														
Count	49	142	50	147	50	147	50	147	50	147	50	147	49	147
Minimum	13.9	4.8	7.8	2.1	53.6	31.8	0.011	0.002	0.035	0.005	0.005	0.002	0.50	0.14
Median	49.5	26.9	22.6	8.3	120.0	72.2	0.143	0.026	0.307	0.040	0.102	0.014	4.90	1.53
Arithmetic Mean	61.3	44.7	28.9	14.5	136.7	98.5	0.181	0.039	0.368	0.067	0.110	0.025	5.59	2.40
Maximum	232.0	322.0	125.0	229.0	721.0	670.0	0.653	0.235	1.200	0.467	0.346	0.161	24.90	44.10
Standard Deviation	43.3	54.2	20.0	21.9	98.3	81.8	0.150	0.040	0.276	0.079	0.083	0.032	4.24	3.87
Standard Error	6.2	4.5	2.8	1.8	13.9	6.7	0.021	0.003	0.039	0.007	0.012	0.003	0.61	0.32
t-statistic	3.879		7.697		4.322		11.320		11.959		9.138		6.977	
p-value	<0.001		<0.001		<0.001		<0.001		<0.001		<0.001		<0.001	
Significant? (p < 0.05)	**Yes**		**Yes**		**Yes**		**Yes**		**Yes**		**Yes**		**Yes**	
Percent Reduction in Mean	**27%**		**50%**		**28%**		**78%**		**82%**		**77%**		**57%**	
OF235*														
Count	54	170	54	175	54	174	54	176	54	176	54	176	53	176
Minimum	10.4	5.6	23.2	2.5	37.3	34.3	0.009	0.002	0.034	0.002	0.005	0.002	0.50	0.32
Median	78.0	33.2	80.0	32.4	137.5	76.5	0.138	0.024	0.328	0.053	0.073	0.013	6.10	1.55
Arithmetic Mean	101.0	41.9	95.8	41.4	165.1	93.8	0.170	0.037	0.339	0.080	0.080	0.020	9.55	2.36
Maximum	441.0	247.0	368.0	204.0	475.0	598.0	0.479	0.689	1.010	0.854	0.280	0.145	97.00	19.30
Standard Deviation	77.8	34.2	57.0	26.4	95.3	64.6	0.108	0.060	0.215	0.092	0.055	0.022	13.46	2.50
Standard Error	10.6	2.6	7.8	2.0	13.0	4.9	0.015	0.005	0.029	0.007	0.008	0.002	1.85	0.19
t-statistic	7.991		10.212		7.211		12.308		11.956		10.002		10.847	
p-value	<0.001		<0.001		<0.001		<0.001		<0.001		<0.001		<0.001	
Significant? (p < 0.05)	**Yes**		**Yes**		**Yes**		**Yes**		**Yes**		**Yes**		**Yes**	
Percent Reduction in Mean	**59%**		**57%**		**43%**		**78%**		**76%**		**75%**		**75%**	
OF237B*														
Count	92	104	92	114	92	115	92	116	92	116	92	116	91	116
Minimum	3.6	7.8	1.5	1.4	15.0	15.9	0.002	0.004	0.010	0.005	0.003	0.002	0.35	0.14
Median	53.3	24.2	11.9	4.5	63.5	36.9	0.052	0.016	0.127	0.031	0.039	0.011	2.50	0.87
Arithmetic Mean	68.6	30.6	15.4	5.7	81.9	44.3	0.080	0.019	0.180	0.036	0.054	0.012	3.10	1.00
Maximum	278.0	107.0	64.2	23.8	243.0	285.0	0.838	0.063	1.493	0.128	0.546	0.046	12.00	2.95
Standard Deviation	51.2	20.7	11.6	4.4	50.0	30.7	0.104	0.012	0.210	0.025	0.071	0.010	2.61	0.59
Standard Error	5.3	2.0	1.2	0.4	5.2	2.9	0.011	0.001	0.022	0.002	0.007	0.001	0.27	0.05
t-statistic	7.304		9.866		8.158		8.743		9.806		7.714		9.047	
p-value	<0.001		<0.001		<0.001		<0.001		<0.001		<0.001		<0.001	
Significant? (p < 0.05)	**Yes**		**Yes**		**Yes**		**Yes**		**Yes**		**Yes**		**Yes**	
Percent Reduction in Mean	**55%**		**63%**		**46%**		**76%**		**80%**		**77%**		**68%**	
OF243* First Cleaning in 2021. Pre-cleaning: 2001 through August 29, 2021. Post-cleaning: November 25, 2021 to present														
Count	126	5	129	5	129	5	129	5	129	5	129	5	128	5
Minimum	4.4	9.2	0.1	2.4	12.3	28.3	0.002	0.012	0.012	0.023	0.002	0.003	0.18	0.54
Median	42.7	37.0	17.2	9.1	69.1	42.6	0.033	0.020	0.057	0.039	0.016	0.014	1.03	0.66
Arithmetic Mean	66.2	27.5	35.1	7.9	94.9	44.2	0.051	0.022	0.098	0.040	0.029	0.013	1.95	0.73
Maximum	300.0	41.7	379.0	14.5	1170.0	59.7	0.221	0.031	0.620	0.052	0.620	0.020	41.00	1.21
Standard Deviation	60.1	15.4	52.7	4.9	111.5	11.9	0.046	0.008	0.102	0.012	0.059	0.007	3.84	0.28
Standard Error	5.4	6.9	4.6	2.2	9.8	5.3	0.004	0.003	0.009	0.005	0.005	0.003	0.34	0.12
t-statistic	1.858		2.135		2.421		1.356		1.283		0.605		1.058	
p-value	0.065		0.035		0.017		0.177		0.202		0.546		0.292	
Significant? (p < 0.05)	**No**		**Yes**		**Yes**		**No**		**No**		**No**		**No**	
Percent Reduction in Mean	**--**		**77%**		**53%**		**--**		**--**		**--**		**--**	
OF245* First Cleaning in 2021. Pre-cleaning: 2001 through September 20, 2021. Post-cleaning: October 1, 2021 to present														
Count	182	10	188	11	187	11	186	11	186	11	186	11	184	11
Minimum	6.2	10.5	0.9	1.1	27.7	35.8	0.0	0.0	0.0	0.0	0.0	0.0	0.20	0.74
Median	51.5	20.5	8.2	2.0	112.0	46.4	0.0	0.0	0.1	0.0	0.0	0.0	1.40	0.95
Arithmetic Mean	62.8	23.0	10.2	2.2	138.3	47.0	0.1	0.0	0.1	0.0	0.0	0.0	2.41	1.01
Maximum	296.0	41.2	60.0	3.5	585.0	58.8	1.7	0.0	1.3	0.1	0.1	0.0	31.00	1.41
Standard Deviation	44.6	9.7	8.6	0.6	97.7	8.0	0.1	0.0	0.1	0.0	0.0	0.0	3.61	0.21
Standard Error	3.3	3.1	0.6	0.2	7.1	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.27	0.06
t-statistic	3.749		5.818		4.852		2.919		1.377		1.756		1.605	
p-value	<0.001		<0.001		<0.001		0.004		0.170		0.081		0.110	
Significant? (p < 0.05)	**Yes**		**Yes**		**Yes**		**Yes**		**No**		**No**		**No**	
Percent Reduction in Mean	**63%**		**79%**		**66%**		**69%**		**--**		**--**		**--**	
First Cleaning in 2008. OF237A* Pre-cleaning: 2001 through April 28, 2008. Post-cleaning: August 8, 2008 through July 7, 2021														
Count	60	126	60	128	60	128	60	127	60	127	60	127	59	127
Minimum	3.5	5.3	1.7	1.4	41.8	30.6	0.005	0.002	0.035	0.005	0.005	0.002	0.50	0.20
Median	49.0	27.0	12.7	6.6	105.5	62.7	0.125	0.025	0.326	0.048	0.096	0.021	3.30	1.17
Arithmetic Mean	56.5	46.7	15.0	10.2	117.1	82.4	0.162	0.047	0.423	0.102	0.126	0.043	3.41	1.41
Maximum	281.0	668.0	43.2	80.6	361.0	352.0	0.893	0.831	2.930	1.730	0.680	0.578	13.70	5.48
Standard Deviation	41.0	72.6	8.4	11.5	52.7	58.1	0.159	0.093	0.446	0.197	0.130	0.071	2.50	0.93
Standard Error	5.3	6.5	1.1	1.0	6.8	5.1	0.021	0.008	0.058	0.017	0.017	0.006	0.32	0.08
t-statistic	3.503		5.305		5.758		9.136		11.058		7.263		6.634	
p-value	0.001		<0.001		<0.001		<0.001		<0.001		<0.001		<0.001	
Significant? (p < 0.05)	**Yes**		**Yes**		**Yes**		**Yes**		**Yes**		**Yes**		**Yes**	
Percent Reduction in Mean	**17%**		**32%**		**30%**		**71%**		**76%**		**66%**		**59%**	
Second Cleaning in 2021. OF237A* Pre-cleaning: August 8, 2008 through July 7, 2021. Post-cleaning: September 21, 2021 to present														
Count	126	9	128	9	128	9	127	9	127	9	127	9	127	9
Minimum	5.3	11.7	1.4	1.7	30.6	33.4	0.002	0.020	0.005	0.034	0.002	0.015	0.20	0.84
Median	27.0	32.1	6.6	4.1	62.7	46.3	0.025	0.038	0.048	0.105	0.021	0.044	1.17	1.32
Arithmetic Mean	46.7	30.8	10.2	4.6	82.4	48.2	0.047	0.042	0.102	0.099	0.043	0.072	1.41	1.25
Maximum	668.0	74.1	80.6	10.1	352.0	69.7	0.831	0.070	1.730	0.221	0.578	0.313	5.48	1.86
Standard Deviation	72.6	18.7	11.5	2.5	58.1	10.5	0.093	0.018	0.197	0.057	0.071	0.092	0.93	0.34
Standard Error	6.5	6.2	1.0	0.8	5.1	3.5	0.008	0.006	0.017	0.019	0.006	0.031	0.08	0.11
t-statistic	0.683		2.474		2.380		-1.204		-1.345		-2.083		-0.227	
p-value	0.496		0.015		0.019		0.231		0.181		0.039		0.821	
Significant? (p < 0.05)	**No**		**Yes**		**Yes**		**No**		**No**		**Yes**		**No**	
Percent Reduction in Mean	**--**		**55%**		**42%**		**--**		**--**		**-69%**		**--**	
First Cleaned in 2006: OF254* Pre-cleaning: 2001 through Jan 26, 2006. Post-cleaning: June 15 2006 through September 23, 2021														
Count	37	112	37	115	37	115	37	114	37	114	37	114	37	114
Minimum	5.2	14.3	4.2	1.6	73.7	38.9	0.018	0.002	0.086	0.002	0.012	0.002	0.50	0.14
Median	77.0	69.2	16.7	8.8	157.0	81.7	0.133	0.039	0.402	0.063	0.060	0.014	2.20	1.31
Arithmetic Mean	83.4	94.4	20.4	13.8	181.9	105.5	0.159	0.051	0.572	0.103	0.071	0.018	2.61	2.03
Maximum	240.0	354.0	49.5	68.0	427.0	334.0	0.657	0.283	4.120	0.773	0.239	0.110	6.60	10.20
Standard Deviation	48.2	74.4	10.7	12.7	83.1	62.8	0.116	0.047	0.654	0.131	0.042	0.020	1.73	2.02
Standard Error	7.9	7.0	1.8	1.2	13.7	5.9	0.019	0.004	0.108	0.012	0.007	0.002	0.28	0.19
t-statistic	-0.436		4.172		6.330		8.544		10.757		9.392		2.508	
p-value	0.663		<0.001		<0.001		<0.001		<0.001		<0.001		0.013	
Significant? (p < 0.05)	No		**Yes**		**Yes**		**Yes**		**Yes**		**Yes**		**Yes**	
Percent Reduction in Mean	**--**		**29%**		**41%**		**68%**		**82%**		**74%**		**21%**	
Second Cleaning in 2021. OF254* Pre-cleaning: June 15 2006 through September 23, 2021. Post-cleaning: October 7, 2021 to present														
Count	112	9	115	9	115	9	114	9	114	9	114	9	114	9
Minimum	14.3	12.7	1.6	1.4	38.9	27.6	0.002	0.009	0.002	0.020	0.002	0.007	0.14	0.37
Median	69.2	44.3	8.8	4.5	81.7	59.4	0.039	0.032	0.063	0.069	0.014	0.014	1.31	1.01
Arithmetic Mean	94.4	52.5	13.8	4.5	105.5	54.8	0.051	0.029	0.103	0.065	0.018	0.014	2.03	0.96
Maximum	354.0	98.3	68.0	7.0	334.0	72.1	0.283	0.050	0.773	0.143	0.110	0.022	10.20	1.55
Standard Deviation	74.4	27.1	12.7	1.9	62.8	14.7	0.047	0.014	0.131	0.036	0.020	0.005	2.02	0.34
Standard Error	7.0	9.0	1.2	0.6	5.9	4.9	0.004	0.005	0.012	0.012	0.002	0.002	0.19	0.11
t-statistic	1.921		3.277		3.142		1.507		0.314		-0.571		1.307	
p-value	0.057		0.001		0.002		0.134		0.754		0.569		0.194	
Significant? (p < 0.05)	No		**Yes**		**Yes**		**No**		**No**		**No**		**No**	
Percent Reduction in Mean	**--**		**67%**		**48%**		**--**		**--**		**--**		**--**	

Notes:

**Following are the dates of the City's sewer-line cleaning activities:*

OF230: March 12 through May 14, 2007.

OF235: May 15 through June 25, 2007

OF237A: April 28 through August 8, 2008 (only the northern half of this drainage basin was cleaned), July 8 through Sept 20, 2021 (FS08 and FS04 497 acres cleaned (17%)). Will be evaluated in WY2022

OF237B: November 7, 2010 to February 24, 2011

OF243: August 31 through October 12, 2021. Will be evaluated in WY2022

OF245: September 21 through 23, 2021. Will be evaluated in WY2022

OF254: January 26 through June 14, 2006. September 24 through October 6, 2021. Will be evaluated in WY2022

**Any monitoring events within the window of cleaning activities were excluded from the analysis.*

OF237A location includes data from OF237A New sampling location for all data collected after to 2/26/06.

Table 2-3.1
Stormwater Summary Statistics, Before and After Street Sweeping

	TSS (mg/l)		Lead (ug/l)		Zinc (ug/l)		Phenanthrene (ug/l)		Pyrene (ug/l)		Indeno(1,2,3-c,d)pyrene (ug/l)		Bis(2EH)phthalate (ug/l)	
	Pre-Sweeping	Post-Sweeping	Pre-Sweeping	Post-Sweeping	Pre-Sweeping	Post-Sweeping	Pre-Sweeping	Post-Sweeping	Pre-Sweeping	Post-Sweeping	Pre-Sweeping	Post-Sweeping	Pre-Sweeping	Post-Sweeping
Outfall 230*														
Count	41	144	41	150	41	150	41	150	41	150	41	150	40	150
Minimum	13.9	4.8	7.8	2.1	53.6	31.8	0.011	0.002	0.035	0.005	0.005	0.002	0.50	0.14
Median	49.5	26.9	24.4	8.4	122.0	72.7	0.157	0.026	0.316	0.042	0.102	0.014	4.55	1.56
Arithmetic Mean	64.9	44.8	30.4	14.8	141.1	98.8	0.192	0.042	0.383	0.073	0.112	0.028	5.65	2.47
Maximum	232.0	322.0	125.0	229.0	721.0	670.0	0.653	0.235	1.200	0.553	0.346	0.228	24.90	44.10
Standard Deviation	45.6	53.8	21.4	21.8	106.0	81.2	0.161	0.044	0.296	0.092	0.089	0.037	4.66	3.86
Standard Error	7.1	4.5	3.3	1.8	16.6	6.6	0.025	0.004	0.046	0.008	0.014	0.003	0.74	0.32
t-statistic	3.905		7.174		4.141		10.060		10.318		7.699		5.794	
p-value	<0.001		<0.001		<0.001		<0.001		<0.001		<0.001		<0.001	
Significant? (p < 0.05)	**Yes**		**Yes**		**Yes**		**Yes**		**Yes**		**Yes**		**Yes**	
Percent Reduction in Mean	**31%**		**51%**		**30%**		**78%**		**81%**		**75%**		**56%**	
Outfall 235*														
Count	44	173	44	178	44	177	44	179	44	179	44	179	43	179
Minimum	10.4	5.6	23.2	2.5	37.3	34.3	0.009	0.002	0.034	0.002	0.005	0.002	0.50	0.32
Median	81.8	33.5	81.5	32.5	135.0	76.8	0.147	0.024	0.355	0.054	0.078	0.013	6.20	1.56
Arithmetic Mean	107.6	43.1	99.5	41.9	169.5	94.7	0.178	0.042	0.359	0.089	0.083	0.023	10.09	2.40
Maximum	441.0	247.0	368.0	204.0	475.0	598.0	0.479	0.776	1.010	1.164	0.280	0.338	97.00	19.30
Standard Deviation	82.6	35.5	61.1	26.5	102.7	64.7	0.115	0.082	0.224	0.126	0.058	0.034	14.76	2.51
Standard Error	12.5	2.7	9.2	2.0	15.5	4.9	0.017	0.006	0.034	0.009	0.009	0.003	2.3	0.2
t-statistic	7.553		9.480		6.599		10.683		10.576		8.745		9.812	
p-value	<0.001		<0.001		<0.001		<0.001		<0.001		<0.001		<0.001	
Significant? (p < 0.05)	**Yes**		**Yes**		**Yes**		**Yes**		**Yes**		**Yes**		**Yes**	
Percent Reduction in Mean	**60%**		**58%**		**44%**		**76%**		**75%**		**73%**		**76%**	
Outfall 237A*														
Count	44	148	44	149	44	149	44	148	44	148	44	148	43	148
Minimum	13.1	3.5	5.0	1.4	41.8	30.6	0.005	0.002	0.041	0.005	0.005	0.002	0.50	0.20
Median	51.7	29.1	13.4	6.6	105.5	63.0	0.126	0.028	0.341	0.055	0.100	0.023	2.60	1.19
Arithmetic Mean	53.1	48.2	14.5	10.7	118.6	83.8	0.163	0.056	0.405	0.133	0.118	0.053	3.37	1.55
Maximum	120.0	668.0	31.5	80.6	361.0	352.0	0.893	0.831	1.770	2.930	0.669	0.680	13.70	7.90
Standard Deviation	23.4	71.2	6.8	11.8	55.7	57.5	0.146	0.111	0.324	0.306	0.115	0.092	2.70	1.18
Standard Error	3.5	5.8	1.0	1.0	8.4	4.7	0.022	0.009	0.049	0.025	0.017	0.008	0.41	0.10
t-statistic	3.146		4.528		4.984		7.830		8.986		5.655		5.038	
p-value	0.002		<0.001		<0.001		<0.001		<0.001		<0.001		<0.001	
Significant? (p < 0.05)	**Yes**		**Yes**		**Yes**		**Yes**		**Yes**		**Yes**		**Yes**	
Percent Reduction in Mean	**9.1%**		**27%**		**29%**		**66%**		**67%**		**55%**		**54%**	
Outfall 237B*														
Count	45	150	45	160	45	161	45	162	45	162	45	162	44	162
Minimum	7.5	3.6	3.8	1.4	31.3	15.0	0.005	0.002	0.028	0.002	0.005	0.002	0.50	0.14
Median	60.3	30.2	14.3	5.4	70.5	40.8	0.091	0.017	0.242	0.032	0.061	0.011	3.00	0.95
Arithmetic Mean	76.4	40.8	18.0	7.9	93.3	52.4	0.102	0.029	0.238	0.056	0.066	0.020	3.87	1.34
Maximum	278.0	211.0	64.2	54.8	232.0	285.0	0.423	0.838	0.972	1.493	0.277	0.546	12.00	8.70
Standard Deviation	55.1	36.6	12.5	7.7	54.0	38.1	0.071	0.069	0.174	0.128	0.051	0.047	3.02	1.27
Standard Error	8.2	3.0	1.9	0.6	8.0	3.0	0.011	0.005	0.026	0.010	0.008	0.004	0.46	0.10
t-statistic	5.529		7.283		6.560		10.809		11.223		8.520		7.796	
p-value	<0.001		<0.001		<0.001		<0.001		<0.001		<0.001		<0.001	
Significant? (p < 0.05)	**Yes**		**Yes**		**Yes**		**Yes**		**Yes**		**Yes**		**Yes**	
Percent Reduction in Mean	**47%**		**56%**		**44%**		**72%**		**76%**		**70%**		**65%**	
Outfall 243*[a,b] Note: Includes comparison of Standard Sweeping schedule in place prior to 2006 to enhanced schedule implemented from January 2007 through September 2013. New, increased street sweeping frequency in this area started in October 2013 at locations 243 and 245 and a comparison of those results is provided on Table 2-3.2.														
Count	32	37	32	38	32	38	32	38	32	38	32	38	31	38
Minimum	10.7	4.4	9.7	1.4	51.1	19.6	0.023	0.005	0.033	0.012	0.005	0.002	0.50	0.20
Median	58.4	49.0	27.1	28.3	99.9	67.7	0.098	0.019	0.163	0.039	0.033	0.005	3.10	0.53
Arithmetic Mean	69.4	78.8	46.5	52.1	147.2	94.7	0.100	0.030	0.180	0.070	0.041	0.019	3.33	1.94
Maximum	220.0	300.0	353.0	379.0	1170.0	392.0	0.221	0.116	0.620	0.452	0.121	0.113	8.40	41.00
Standard Deviation	50.2	72.3	61.5	70.0	193.8	76.1	0.055	0.028	0.124	0.096	0.029	0.031	2.11	6.58
Standard Error	8.9	11.9	10.9	11.4	34.3	12.3	0.010	0.004	0.022	0.016	0.005	0.005	0.38	1.07
t-statistic	0.182		0.402		2.641		7.867		6.032		5.440		5.927	
p-value	0.856		0.689		0.010		<0.001		<0.001		<0.001		<0.001	
Significant? (p < 0.05)	No		No		**Yes**		**Yes**		**Yes**		**Yes**		**Yes**	
Percent Reduction in Mean	--		--		**36%**		**70%**		**61%**		**53%**		**42%**	
Outfall 245*[a] Note: Includes comparison of Standard Sweeping schedule in place prior to 2006 to enhanced schedule implemented from January 2007 through September 2013. New, increased street sweeping frequency in this area started in October 2013 at locations 243 and 245 and a comparison of those results is provided on Table 2-3.2.														
Count	41	57	41	61	41	60	41	60	41	60	41	60	40	59
Minimum	17.6	6.2	2.7	1.7	54.8	27.7	0.019	0.002	0.026	0.002	0.005	0.002	0.75	0.20
Median	72.4	51.2	12.2	9.2	146.0	135.0	0.083	0.025	0.123	0.026	0.025	0.004	3.40	0.93
Arithmetic Mean	83.8	58.2	14.8	11.5	186.9	160.5	0.136	0.043	0.162	0.056	0.026	0.010	5.58	1.46
Maximum	243.0	186.0	38.8	60.0	585.0	498.0	1.650	0.477	1.310	0.295	0.057	0.051	31.00	6.90
Standard Deviation	52.9	39.4	8.5	10.1	122.8	107.6	0.256	0.065	0.200	0.070	0.014	0.012	6.54	1.44
Standard Error	8.3	5.2	1.3	1.3	19.2	13.9	0.040	0.008	0.031	0.009	0.002	0.002	1.03	0.19
t-statistic	2.830		2.662		1.560		6.466		6.730		7.280		7.636	
p-value	0.006		0.009		0.122		<0.001		<0.001		<0.001		<0.001	
Significant? (p < 0.05)	**Yes**		**Yes**		**No**		**Yes**		**Yes**		**Yes**		**Yes**	
Percent Reduction in Mean	**31%**		**22%**		**--**		**68%**		**65%**		**62%**		**74%**	
Outfall 254* Note: Includes comparison of Standard Sweeping schedule in place prior to 2019. New, increased street sweeping frequency in a portion of the 254 basin started in January 2019 and a comparison of those results is provided on Table 2-3.2.														
Count	35	88	35	90	35	90	35	90	35	90	35	90	35	90
Minimum	5.2	14.3	8.6	3.0	73.7	38.9	0.018	0.002	0.086	0.002	0.012	0.002	0.50	0.14
Median	78.8	80.8	17.3	11.0	179.0	89.3	0.133	0.034	0.402	0.059	0.060	0.013	2.20	1.31
Arithmetic Mean	86.0	102.7	21.0	15.6	186.6	111.8	0.161	0.051	0.584	0.104	0.073	0.019	2.62	2.16
Maximum	240.0	354.0	49.5	68.0	427.0	334.0	0.657	0.283	4.120	0.773	0.239	0.110	6.60	10.20
Standard Deviation	48.0	80.2	10.6	13.6	83.0	65.1	0.118	0.050	0.670	0.143	0.042	0.022	1.78	2.22
Standard Error	8.1	8.6	1.8	1.4	14.0	6.9	0.020	0.005	0.113	0.015	0.007	0.002	0.30	0.23
t-statistic	-0.555		3.443		5.688		8.144		10.133		9.014		2.197	
p-value	0.580		0.001		<0.001		<0.001		<0.001		<0.001		0.030	
Significant? (p < 0.05)	No		**Yes**		**Yes**		**Yes**		**Yes**		**Yes**		**Yes**	
Percent Reduction in Mean	--		**26%**		**40%**		**69%**		**82%**		**74%**		**18%**	

Notes:

**Street sweeping program started in January 2006 and was in full swing by January 2007. Any monitoring events within the startup window (1/1/06 to 1/1/07) were excluded from the analysis.*
237A location includes data from 237A New sampling location for all data collected after to 2/26/06.

[a] Includes comparison of Standard Sweeping schedule to enhanced schedule implemented from January 2007 through September 2013. New increased street sweeping frequency started in October 2013 at locations 243 and 245 and those results are shown on Table 2-3.2.

[b] Indeno(1,2,3-cd)pyrene value of 0.62 ug/l on 11/15/2016 was excluded from this analysis as an outlier.

Table 2-3.2

Stormwater Summary Statistics, Before and After Street Sweeping - Enhanced[a]

	TSS (mg/l)		Lead (ug/l)		Zinc (ug/l)		Phenanthrene (ug/l)		Pyrene (ug/l)		Indeno(1,2,3-c,d)pyrene (ug/l)		Bis(2EH)phthalate (ug/l)	
	Sweeping	Enh Sweeping	Sweeping	Enh Sweeping	Sweeping	Enh Sweeping	Sweeping	Enh Sweeping	Sweeping	Enh Sweeping	Sweeping	Enh Sweeping	Sweeping	Enh Sweeping
Outfall 243[ab]														
Count	37	60	38	62	38	62	38	62	38	62	38	62	38	62
Minimum	4.4	7.6	1.4	0.1	19.6	12.3	0.005	0.002	0.012	0.012	0.002	0.002	0.20	0.18
Median	49.0	35.2	28.3	10.5	67.7	53.2	0.019	0.029	0.039	0.048	0.005	0.015	0.53	0.81
Arithmetic Mean	78.8	51.9	52.1	16.5	94.7	62.4	0.030	0.032	0.070	0.058	0.019	0.025	1.94	1.05
Maximum	300.0	289.0	379.0	115.0	392.0	233.0	0.116	0.074	0.452	0.293	0.113	0.620	41.00	3.95
Standard Deviation	72.3	54.0	70.0	19.9	76.1	34.0	0.028	0.015	0.096	0.043	0.031	0.078	6.58	0.75
Standard Error	11.9	7.0	11.4	2.5	12.3	4.3	0.004	0.002	0.016	0.005	0.005	0.010	1.07	0.10
t-statistic	2.170		4.564		2.735		-1.699		-0.881		-2.039		-1.169	
p-value	0.032		<0.001		0.007		0.092		0.380		0.044		0.245	
Significant? (p < 0.05)	**Yes**		**Yes**		**Yes**		No		No		**Yes**		No	
Percent Reduction in Mean	**34%**		**68%**		**34%**		--		--		**-34%**		**--**	
	TSS (mg/l)		**Lead (ug/l)**		**Zinc (ug/l)**		**Phenanthrene (ug/l)**		**Pyrene (ug/l)**		**Indeno(1,2,3-c,d)pyrene (ug/l)**		**Bis(2EH)phthalate (ug/l)**	
	Sweeping	Enh Sweeping	Sweeping	Enh Sweeping	Sweeping	Enh Sweeping	Sweeping	Enh Sweeping	Sweeping	Enh Sweeping	Sweeping	Enh Sweeping	Sweeping	Enh Sweeping
Outfall 245[a]														
Count	57	85	61	88	60	88	60	87	60	87	60	87	59	87
Minimum	6.2	10.0	1.7	0.9	27.7	29.4	0.002	0.002	0.002	0.011	0.002	0.002	0.20	0.31
Median	51.2	41.5	9.2	5.0	135.0	81.0	0.025	0.029	0.026	0.044	0.004	0.008	0.93	1.24
Arithmetic Mean	58.2	50.0	11.5	5.8	160.5	88.4	0.043	0.031	0.056	0.051	0.010	0.009	1.46	1.35
Maximum	186.0	296.0	60.0	33.8	498.0	306.0	0.477	0.105	0.295	0.173	0.051	0.026	6.90	3.39
Standard Deviation	39.4	40.0	10.1	4.5	107.6	49.4	0.065	0.018	0.070	0.029	0.012	0.006	1.44	0.66
Standard Error	5.2	4.3	1.3	0.5	13.9	5.3	0.008	0.002	0.009	0.003	0.002	0.001	0.19	0.07
t-statistic	1.062		5.274		5.621		0.321		-2.270		-1.464		-1.979	
p-value	0.290		<0.001		<0.001		0.748		0.025		0.145		0.050	
Significant? (p < 0.05)	No		**Yes**		**Yes**		No		**Yes**		No		**No**	
Percent Reduction in Mean	**--**		**49%**		**45%**		**--**		**9%**		**--**		**--**	
	TSS (mg/l)		**Lead (ug/l)**		**Zinc (ug/l)**		**Phenanthrene (ug/l)**		**Pyrene (ug/l)**		**Indeno(1,2,3-c,d)pyrene (ug/l)**		**Bis(2EH)phthalate (ug/l)**	
	Sweeping	Enh Sweeping	Sweeping	Enh Sweeping	Sweeping	Enh Sweeping	Sweeping	Enh Sweeping	Sweeping	Enh Sweeping	Sweeping	Enh Sweeping	Sweeping	Enh Sweeping
Outfall 254[c]														
Count	88	31	90	32	90	32	90	31	90	31	90	31	90	31
Minimum	14.3	12.7	3.0	1.4	38.9	27.6	0.002	0.009	0.002	0.020	0.002	0.003	0.14	0.37
Median	80.8	57.0	11.0	5.4	89.3	63.1	0.034	0.040	0.059	0.069	0.013	0.014	1.31	1.11
Arithmetic Mean	102.7	57.1	15.6	5.8	111.8	66.3	0.051	0.041	0.104	0.078	0.019	0.015	2.16	1.29
Maximum	354.0	128.0	68.0	13.0	334.0	135.0	0.283	0.106	0.773	0.203	0.110	0.029	10.20	3.18
Standard Deviation	80.2	26.8	13.6	2.7	65.1	21.0	0.050	0.021	0.143	0.040	0.022	0.006	2.22	0.63
Standard Error	8.6	4.8	1.4	0.5	6.9	3.7	0.005	0.004	0.015	0.007	0.002	0.001	0.23	0.11
t-statistic	2.906		5.239		4.268		-0.033		-0.880		-0.796		0.773	
p-value	0.004		<0.001		<0.001		0.974		0.380		0.428		0.441	
Significant? (p < 0.05)	**Yes**		**Yes**		**Yes**		No		No		No		No	
Percent Reduction in Mean	**44%**		**63%**		**41%**		**--**		**--**		**--**		**--**	

Notes:

[a] Provides a comparison of sweeping schedule in place from January 2007 through September 2013 to the new street sweeping frequency started in October 2013 at locations 243 and 245 and continuing through 2022.

[b] Indeno(1,2,3-cd)pyrene value of 0.62 ug/l on 11/15/2016 was excluded from this analysis as an outlier.

[c] Provides a comparison of sweeping schedule in place from January 2007 through December 2019 to the new street sweeping frequency started in January 2019 in a portion of 254 Basin and continuing through 2022.

Table 3-1
Total Rain Depth (Inches) During Past and Present Monitoring Years

		WY2002	WY2003	WY2004	WY2005	WY2006	WY2007	WY2008	WY2009	WY2010	WY2011	WY2012	WY2013	WY2014	WY2015	WY2016	WY2017	WY2018	WY2019	WY2020	WY2021	WY2022	WY2002 -WY2022 Average	Historical Monthly Mean NCDC 1971-2000	Historical Monthly Mean NCDC 1981 - 2010
WET	October	3.32	0.41	8.88	3.61	3.00	1.28	3.64	2.36	4.18	4.64	3.39	5.97	1.57	6.20	5.92	10.57	5.60	3.89	3.66	3.06	5.03	4.29	3.39	3.70
	November	10.13	2.96	6.15	2.81	6.25	15.81	2.64	7.61	7.74	5.37	5.98	7.12	3.40	6.53	8.22	7.57	9.38	4.15	1.85	5.41	10.54	6.55	6.10	6.68
	December	6.82	6.58	4.65	4.03	6.28	8.05	8.36	4.03	2.67	6.83	6.44	8.33	1.91	4.88	12.22	3.66	5.74	6.93	7.36	5.64	5.55	6.05	5.89	5.52
	January	6.68	8.5	6.79	4.71	11.93	6.92	4.63	7.15	7.40	5.17	7.02	3.31	4.29	3.98	7.20	2.99	7.90	3.70	9.66	8.65	7.28	6.47	5.38	5.93
	February	3.56	1.71	2.55	0.79	2.59	4.09	2.84	1.61	3.95	3.54	3.19	1.58	7.68	4.61	5.55	9.24	2.75	4.19	3.35	4.00	3.56	3.66	4.44	3.86
	March	4.16	5.08	2.18	3.14	1.91	6.09	4.16	4.68	4.91	6.57	7.11	2.50	8.81	3.89	5.80	8.27	2.15	1.86	3.47	2.06	3.10	4.38	4.18	4.06
	April	3.64	3.3	0.91	4.74	2.46	1.34	1.76	3.31	2.90	5.13	3.74	4.52	4.22	1.56	1.37	4.67	5.81	2.65	1.24	0.85	3.34	3.02	2.87	3.00
DRY	May	1.14	0.55	2.56	3.34	1.56	1.31	1.01	3.03	4.15	3.77	2.33	2.86	3.23	0.74	0.58	2.02	0.09	0.46	2.49	1.29	3.04	1.98	2.01	2.11
	June	1.36	0.36	0.64	1.26	2.25	1.44	1.26	0.33	3.05	1.40	2.54	1.85	0.94	0.22	1.41	1.54	0.69	0.19	1.90	1.85	2.72	1.39	1.58	1.57
	July	0.42	0.13	0.00	1.16	0.11	1.30	0.26	0.00	0.78	0.74	0.87	0.01	0.57	0.47	0.61	0.00	0.02	0.77	0.20	0.00	0.19	0.41	0.86	0.68
	August	0.06	0.29	2.75	0.04	0.00	0.90	2.32	1.04	0.24	0.27	0.00	1.05	1.72	2.21	0.10	0.09	0.10	1.19	0.42	0.05	0.57	0.73	0.83	0.82
	September	0.36	0.69	3.26	0.92	0.74	2.22	0.39	2.82	3.93	0.96	0.02	8.29	2.26	1.12	1.13	1.11	1.54	2.69	2.30	3.20	0.00	1.90	1.42	1.29
	Wet Season	38.31	28.54	32.11	23.83	34.42	43.58	28.03	30.75	33.75	37.25	36.87	33.33	31.88	31.65	46.28	46.97	39.33	27.37	30.59	29.67	38.40	34.42	32.25	32.75
	Dry Season	3.34	2.02	9.21	6.72	4.66	7.17	5.24	7.22	12.15	7.14	5.76	14.06	8.72	4.76	3.83	4.76	2.44	5.30	7.31	6.39	6.52	6.42	6.70	6.47
	Total	41.65	30.56	41.32	30.55	39.08	50.75	33.27	37.97	45.90	44.39	42.63	47.39	40.60	36.41	50.11	51.73	41.77	32.67	37.90	36.06	44.92	40.84	38.95	39.22

Key:

	Months	*Seasons/Years*
	> 2" above historical monthly average	*> 8" above historical seasonal/yearly average*
	> 1" above historical monthly average	*> 4" above historical seasonal/yearly average*
	≤ 1" above/below historical monthly average	*≤ 4" above/below historical seasonal/yearly average*
	> 1" below historical monthly average	*> 4" below historical seasonal/yearly average*
	> 2" below historical monthly average	*> 8" below historical seasonal/yearly average*

Key:

	Months	*Seasons/Years*
	> 2" above historical monthly average	*> 8" above historical seasonal/yearly average*
	> 1" above historical monthly average	*> 4" above historical seasonal/yearly average*
	≤ 1" above/below historical monthly average	*≤ 4" above/below historical seasonal/yearly average*
	> 1" below historical monthly average	*> 4" below historical seasonal/yearly average*
	> 2" below historical monthly average	*> 8" below historical seasonal/yearly average*

Table 3-2.1
Summary Statistics for WY2001-WY2011 Baseflow

	Overall Data						OF230				OF235				OF237A				OF237B				OF243				OF245				OF254			
	Overall Detections	% Detections	Arithmetic Mean	Weighted Mean	Max	Date of Max	Min	Max	Arithmetic Mean	Median	Min	Max	Arithmetic Mean	Median	Min	Max	Arithmetic Mean	Median	Min	Max	Arithmetic Mean	Median	Min	Max	Arithmetic Mean	Median	Min	Max	Arithmetic Mean	Median	Min	Max	Arithmetic Mean	Median
Conventionals																																		
Hardness (mg/L as CaCO3)	281/281	100		N/A	N/A	N/A	27.9	249	144	142	123	199	155	149	85.4	134	105	105	61	129	111	113	463	2,310	1418	1,345	136	2,880	874	808	386	4,410	2799	3,030
pH (pH units)	296/296	100		N/A	N/A	N/A	6.8	9.0	7.7	7.7	7.1	8.0	7.7	7.7	6.8	7.8	7.4	7.4	5.9	8.0	7.2	7.3	6.6	7.8	7.1	7.1	7.1	8.0	7.4	7.4	6.7	7.6	7.1	7.2
TSS (mg/L)	273/295	93	12.29	12.2	319	3/12/09	0.26	319	15.8	5.90	0.31	258	25.4	6.85	0.26	16.3	3.08	2.1	0.26	16.9	2.54	1.3	1.5	42.7	13.6	10.7	0.3	78.9	9.6	6.40	1.8	140	16.1	7.7
Metals in ug/L																																		
Lead	209/289	72	5.52	5.53	112	8/7/06	0.97	29.8	5.56	4.0	1.64	112	14.29	6.5	*0.06*	6.11	1.21	0.70	*0.07*	6.6	0.99	0.60	*0.385*	43.9	7.56	3.99	*0.13*	18.2	3.30	1.65	*0.24*	39.0	5.75	2.9
Mercury	18/293	6	0.03	0.03	0.38	7/26/04	*0.025*	0.250	0.036	*0.025*	*0.025*	0.38	0.041	*0.025*	*0.025*	0.196	0.031	*0.025*	*0.025*	*0.025*	*0.025*	*0.025*	*0.025*	0.075	0.029	*0.025*	*0.025*	*0.125*	*0.029*	*0.025*	*0.025*	*0.055*	*0.026*	*0.025*
Zinc	283/286	99	46.55	47.5	1,950	8/28/07	19.3	108	46.6	34.0	6.6	355	41.9	17.20	1.65	27.0	9.5	9.3	1.05	14.2	4.43	3.7	5.3	73.6	21.60	15.4	11.8	1,950	174.1	52.3	7.24	95.2	27.7	23.6
Dissolved Lead	169/288	59	2.88	2.86	47.2	8/28/07	*0.140*	5.5	1.52	1.25	*0.210*	6.0	1.56	1.10	*0.051*	*4.5*	*0.81*	*0.60*	*0.016*	4.0	0.83	*0.65*	0.013	35.6	5.38	2.13	*0.007*	18.9	2.80	0.80	*0.013*	47.2	7.26	2.10
Dissolved Mercury	9/289	3	0.028	0.03	0.193	7/27/04	*0.025*	0.059	0.031	*0.025*	*0.025*	*0.025*	*0.025*	*0.025*	*0.025*	0.135	0.031	*0.025*	*0.025*	*0.025*	*0.025*	*0.025*	*0.025*	0.193	0.030	*0.025*	*0.025*	*0.125*	*0.029*	*0.025*	*0.025*	0.114	0.028	*0.025*
Dissolved Zinc	274/286	96	25.3	25.9	1,220	8/28/07	6.42	95.0	29.15	24.4	3.80	29.9	10.78	9.24	2.30	12.6	7.7	7.4	*0.60*	14.3	4.6	3.7	*0.130*	45.8	12.3	8.9	0.600	1,220	91.4	20.9	*0.325*	54.7	21.3	16.3
PAHs in ug/L																																		
2-Methylnaphthalene	55/297	19	0.015	0.015	2.100	2/12/02	*0.002*	0.122	0.013	*0.005*	*0.002*	0.023	0.006	*0.005*	*0.002*	2.100	0.063	*0.005*	*0.002*	0.019	0.005	*0.005*	*0.002*	*0.006*	*0.004*	*0.005*	*0.002*	0.018	0.005	*0.005*	0.002	0.022	0.006	*0.005*
Acenaphthene	124/297	42	0.014	0.014	0.103	11/21/02	*0.002*	0.013	0.005	*0.005*	*0.002*	0.032	0.011	0.012	*0.002*	0.031	0.005	*0.005*	*0.002*	*0.005*	*0.004*	*0.005*	0.005	0.069	0.030	0.028	*0.002*	0.103	0.031	0.026	*0.002*	0.096	0.012	*0.005*
Acenaphthylene	7/297	2	0.004	0.004	0.019	7/17/08	*0.002*	*0.005*	*0.004*	*0.005*	*0.002*	*0.005*	*0.004*	*0.005*	*0.002*	0.016	0.004	*0.005*	*0.002*	*0.005*	*0.004*	*0.005*	*0.002*	*0.005*	*0.004*	*0.005*	*0.002*	*0.008*	*0.004*	*0.005*	*0.002*	0.019	0.005	*0.005*
Anthracene	36/297	12	0.006	0.006	0.077	7/17/05	*0.002*	0.012	0.004	*0.005*	*0.002*	0.031	0.006	*0.005*	*0.002*	*0.005*	*0.004*	*0.005*	*0.002*	*0.005*	*0.004*	*0.005*	*0.002*	0.022	0.007	*0.005*	*0.002*	0.014	0.006	*0.005*	*0.002*	0.077	0.008	*0.005*
Fluorene	56/291	19	0.006	0.006	0.086	2/12/02	0.002	0.012	0.005	*0.005*	*0.002*	0.060	0.009	*0.005*	*0.002*	0.086	0.007	*0.005*	*0.002*	*0.005*	*0.004*	*0.005*	*0.002*	0.013	0.005	*0.005*	*0.002*	0.017	0.006	*0.005*	*0.002*	0.060	0.008	*0.005*
Naphthalene	139/297	47	0.023	0.023	3.000	2/12/02	*0.005*	0.228	0.026	0.014	*0.003*	0.054	0.011	0.009	*0.002*	3.000	0.088	0.010	*0.002*	0.025	0.007	*0.005*	*0.001*	0.017	0.007	*0.006*	*0.003*	0.057	0.011	0.009	*0.002*	0.034	0.008	*0.005*
Phenanthrene	134/297	45	0.013	0.013	0.684	7/17/05	*0.002*	0.060	0.012	0.011	*0.002*	0.115	0.014	0.005	*0.002*	0.149	0.011	*0.005*	*0.002*	*0.008*	*0.004*	*0.005*	0.002	0.057	0.011	*0.005*	*0.002*	0.028	0.011	0.008	*0.002*	0.684	0.028	0.005
Total LPAHs[1,2]	496/1776	28	0.066	0.011	3.276	N/A	0.016	0.270	0.056	0.043	*0.013*	0.206	0.056	0.045	*0.010*	3.276	0.119	0.031	*0.011*	0.050	0.028	*0.030*	0.025	0.151	0.065	0.061	0.013	0.181	0.068	0.064	0.010	0.898	0.068	0.030
Benzo(a)anthracene	72/297	24	0.012	0.012	1.110	1/13/09	*0.001*	0.066	0.007	*0.005*	*0.001*	0.114	0.013	*0.005*	*0.001*	0.022	0.006	*0.005*	*0.001*	0.045	0.005	*0.005*	*0.001*	0.055	0.008	*0.005*	*0.001*	0.021	0.006	*0.005*	*0.001*	1.110	0.043	0.005
Benzo(a)pyrene	42/297	14	0.007	0.007	0.142	1/24/06	*0.002*	0.057	0.006	*0.005*	*0.002*	0.142	0.013	*0.005*	*0.002*	0.020	0.006	*0.005*	*0.002*	0.041	0.005	*0.005*	*0.002*	0.042	0.007	*0.005*	*0.002*	0.048	0.006	*0.005*	*0.002*	0.131	0.010	*0.005*
Benzo(g,h,i)perylene	52/297	18	0.007	0.007	0.166	8/7/06	*0.002*	0.023	0.007	*0.005*	*0.002*	0.166	0.012	*0.005*	*0.002*	0.022	0.006	*0.005*	*0.002*	0.044	0.006	*0.005*	*0.002*	0.046	0.008	*0.005*	*0.002*	0.033	0.006	*0.005*	*0.002*	0.055	0.008	*0.005*
Benzo(b,k)fluoranthenes	115/297	39	0.015	0.015	0.376	7/17/05	*0.002*	0.113	0.013	0.007	*0.002*	0.344	0.026	0.006	*0.002*	0.047	0.011	*0.005*	*0.002*	0.107	0.008	*0.005*	0.002	0.105	0.013	*0.005*	*0.002*	0.062	0.009	*0.005*	*0.002*	0.376	0.027	0.013
Chrysene	76/297	26	0.011	0.011	0.362	3/12/09	*0.002*	0.087	0.010	*0.005*	*0.002*	0.199	0.018	*0.005*	*0.002*	0.026	0.006	*0.005*	*0.002*	0.060	0.005	*0.005*	*0.002*	0.098	0.011	*0.005*	*0.002*	0.063	0.008	*0.005*	*0.002*	0.362	0.020	0.005
Dibenz(a,h)anthracene	14/297	5	0.005	0.005	0.028	8/7/06	*0.002*	0.011	0.005	*0.005*	*0.002*	0.028	0.005	*0.005*	*0.002*	0.010	*0.005*	*0.005*	*0.002*	0.011	*0.005*	*0.005*	*0.002*	0.012	*0.005*	*0.005*	*0.002*	0.013	*0.005*	*0.005*	*0.002*	0.017	0.005	*0.005*
Fluoranthene	177/297	60	0.021	0.021	1.140	3/12/09	*0.003*	0.133	0.017	0.011	*0.003*	0.295	0.029	0.012	*0.002*	0.046	0.010	0.005	*0.003*	0.088	0.007	*0.005*	*0.003*	0.133	0.022	0.015	*0.003*	0.046	0.013	0.011	*0.003*	1.140	0.051	0.013
Indeno(1,2,3-c,d)pyrene	32/297	11	0.006	0.006	0.115	8/7/06	*0.002*	0.019	0.005	*0.005*	*0.002*	0.115	0.009	*0.005*	*0.002*	0.018	0.005	*0.005*	*0.002*	0.039	0.005	*0.005*	*0.002*	0.034	0.006	*0.005*	*0.002*	0.018	0.005	*0.005*	*0.002*	0.053	0.007	*0.005*
Pyrene	234/297	79	0.026	0.026	0.879	7/17/05	*0.004*	0.173	0.021	0.015	*0.003*	0.253	0.034	0.018	*0.002*	0.056	0.013	0.005	*0.002*	0.078	0.007	*0.005*	*0.005*	0.116	0.030	0.021	0.004	0.081	0.024	0.023	0.002	0.879	0.051	0.022
Total HPAHs[1]	814/2673	30	0.112	0.012	3.287	N/A	0.025	0.671	0.091	0.060	*0.025*	1.639	0.162	0.068	*0.022*	0.249	0.067	0.045	*0.022*	0.513	0.052	*0.045*	0.031	0.606	0.109	0.072	0.029	0.368	0.081	0.073	0.024	3.287	0.222	0.078
Total PAHs[1]	1310/4449	29	0.178	0.012	4.185	N/A	0.041	0.840	0.147	0.121	*0.038*	1.845	0.217	0.116	*0.034*	3.464	0.186	0.087	*0.033*	0.543	0.081	0.075	0.055	0.757	0.174	0.133	0.042	0.436	0.149	0.141	0.034	4.185	0.290	0.116
Phthalates in ug/L																																		
Bis(2-ethylhexyl)phthalate	85/290	29	1.07	1.06	33.0	3/23/10	*0.26*	33.00	2.00	*0.50*	*0.20*	21.30	1.84	0.72	*0.20*	1.60	0.56	*0.50*	*0.20*	*0.80*	*0.50*	*0.50*	*0.20*	16.00	1.03	*0.50*	*0.20*	3.30	0.72	*0.50*	*0.08*	10.00	0.82	*0.50*
Butylbenzylphthalate	29/297	10	0.56	0.56	16.0	7/28/04	*0.09*	*0.70*	*0.39*	*0.50*	0.09	1.60	*0.44*	*0.50*	0.09	*0.50*	*0.37*	*0.50*	*0.05*	*0.50*	*0.36*	*0.50*	*0.09*	*1.80*	*0.43*	*0.50*	*0.09*	16.00	1.49	*0.50*	0.09	1.40	*0.41*	*0.50*
Diethylphthalate	65/297	22	0.92	0.92	32.0	2/5/03	*0.07*	8.40	0.69	*0.50*	*0.04*	15.00	0.91	*0.50*	0.04	32.00	1.99	*0.50*	*0.04*	17.00	0.99	*0.50*	*0.05*	10.00	0.71	*0.50*	0.04	4.40	0.65	*0.50*	0.04	3.80	0.48	*0.50*
Dimethylphthalate	2/297	1	0.36	0.36	*0.5*	N/A	*0.02*	*0.50*	*0.36*	*0.50*	*0.02*	*0.50*	*0.36*	*0.50*	*0.02*	*0.50*	*0.35*	*0.50*	*0.02*	*0.50*	*0.35*	*0.50*	*0.02*	*0.50*	*0.38*	*0.50*	*0.02*	*0.50*	*0.35*	*0.50*	*0.02*	*0.50*	*0.36*	*0.50*
Di-n-butylphthalate	59/297	20	0.43	0.43	4.3	3/23/10	*0.10*	*0.50*	*0.40*	*0.50*	*0.05*	*0.50*	*0.40*	*0.50*	*0.05*	*0.50*	*0.41*	*0.50*	*0.05*	*0.50*	*0.39*	*0.50*	*0.05*	4.30	*0.55*	*0.50*	0.15	1.30	*0.46*	*0.50*	0.05	*0.50*	*0.40*	*0.50*
Di-n-octyl phthalate	5/297	2	0.38	0.38	3.9	7/26/04	*0.04*	*2.00*	*0.40*	*0.50*	*0.04*	3.90	*0.44*	*0.50*	*0.04*	*0.50*	*0.35*	*0.50*	*0.04*	*0.50*	*0.35*	*0.50*	*0.04*	*0.50*	*0.37*	*0.50*	*0.04*	*0.50*	*0.36*	*0.50*	*0.04*	*0.50*	*0.36*	*0.50*
Total Phthalates[3]	245/1782	14			33.4	N/A	*0.23*	33.40	4.44	0.94	0.12	22.90	4.06	1.60	0.20	32.00	4.60	1.00	0.20	32.10	5.28	1.21	0.10	22.87	3.14	1.10	0.21	18.70	3.91	1.30	0.22	13.80	2.21	1.27

Notes:

1 = PAH summations based on 1/2 detection limit for nondetects.

2 = Calculation of Total LPAHs does not include 2-Methylnaphthalene.

3 = Phthalate summations exclude nondetect values.

OF237Anew isn't included in the count of samples.

Highest average or highest median concentration detected in Years 1-10 monitoring.

Highest maximum concentration detected in Years 1-10 monitoring.

Results in italics indicate nondetected values.

Table 3-2.2
Summary Statistics for WY2016 and WY2019 Baseflow

	Overall Data						OF230					OF235				
	Overall Detections	% Detections	Arithmetic Mean	Weighted Mean	Max	Date of Max	Min	Max	Arithmetic Mean	Weighted Mean	Median	Min	Max	Arithmetic Mean	Weighted Mean	Median
Conventionals																
Anionic Surfactants - MBAS (ug/L)	30/40	75	0.03	0.0	0.0962	7/26/16	0.0125	0.0464	0.0302	0.151	0.0327	0.005	0.054	0.0309	0.216	0.029
BOD (mg/L)	3/39	8	1.24	1.0	6.20	6/21/19	1.0	4.9	1.8	8.9	1.0	1.0	1.0	1.0	7.0	1.0
Chloride (mg/L)	38/38	100	N/A	N/A	N/A	N/A	13.3	44.4	21.6	108	17.2	15.8	50.4	27.3	163.9	22.3
Conductivity (uS/cm)	44/44	100	N/A	N/A	N/A	N/A	126	20900	3202	22413	248	323	714	419	2934	337
Hardness (mg CaCO3/L)	44/44	100	N/A	N/A	N/A	N/A	67.0	150	103	722	97.1	129	155	139	972	136
pH (pH units)	44/44	100	N/A	N/A	N/A	N/A	7.0	8.1	7.7	53.7	7.9	6.9	8.1	7.7	54.1	7.8
TSS (mg/L)	36/44	82	4.80	4.2	21.8	10/2/19	1.7	12.7	5.3	37.4	2.7	0.50	4.27	1.98	13.9	1.80
Turbidity (NTU)	40/40	100	5.49	4.5	27.3	10/2/19	1.84	15.5	6.5	32.6	5.39	0.80	9.53	3.17	22.22	1.74
Nutrients																
Nitrate+Nitrite as N (mg/L)	42/42	100	1.56	1.4	3.68	3/31/16	0.513	1.57	0.998	6.0	0.934	0.980	1.280	1.160	8.120	1.210
Phosphate, Ortho (mg/L)	41/42	98	0.283	0.240	1.280	8/14/19	0.057	0.165	0.116	0.7	0.113	0.980	1.280	1.160	8.120	1.210
Phosphorus, Total (mg/L)	41/41	100	0.124	0.106	0.595	10/2/19	0.070	0.184	0.128	0.8	0.126	0.093	0.143	0.119	0.716	0.125
Total Nitrogen (mg/L)	42/42	100	1.66	1.5	3.35	10/2/19	0.600	2.00	1.09	6.6	1.06	1.080	1.630	1.337	9.360	1.350
Metals (ug/L)																
Cadmium (ug/L)	10/44	23	0.14	0.1	2.50	9/13/16	0.017	0.062	0.036	0.252	0.031	0.009	0.250	0.054	0.380	0.030
Cadmium, Dissolved (ug/L)	7/44	16	0.12	0.1	1.25	9/13/16	0.013	0.040	0.024	0.166	0.0250	0.011	0.250	0.119	0.836	0.025
Copper (ug/L)	37/43	86	2.89	2.4	23.7	7/31/19	2.89	10.1	5.00	35.0	4.04	1.34	6.00	3.20	22.4	2.60
Copper, Dissolved (ug/L)	43/43	100	1.49	1.2	7.06	6/21/19	1.78	7.06	3.19	22.3	2.68	1.02	4.50	2.03	14.20	1.73
Lead (ug/L)	37/44	84	1.748	1.523	25.4	10/2/19	0.380	3.55	1.25	8.76	0.748	0.51	4.79	1.88	13.1	1.65
Dissolved Lead (ug/L)	26/44	59	0.264	0.219	2.73	6/21/19	0.010	0.386	0.202	1.42	0.232	0.08	2.73	0.74	5.16	0.39
Mercury (ug/L)	12/44	27	0.0024	0.0021	0.004	8/23/19	0.0008	0.004	0.002	0.014	0.001	0.0008	0.004	0.0027	0.0189	0.0025
Dissolved Mercury (ug/L)	1/44	2	0.0028	0.0024	0.0045	6/21/19	0.0009	0.0045	0.0026	0.0180	0.0025	0.0009	0.0045	0.0028	0.0199	0.0025
Zinc (ug/L)	43/43	100	11.01	9.1	125	8/23/19	10.3	85.7	29.4	206	15.0	5.00	10.5	6.60	46.2	5.93
Dissolved Zinc (ug/L)	43/43	100	5.65	4.7	74.9	6/21/19	6.47	34.2	14.3	100.4	11.3	3.64	5.38	4.27	29.9	4.11
Insecticides																
Chlorpyrifos (ug/L)	0/44	0	0.027	0.023	0.031	N/A	0.026	0.030	0.027	0.19	0.026	0.026	0.030	0.027	0.19	0.026
PAHs																
LPAHs																
2-Methylnaphthalene (ug/L)	7/44	16	0.006	0.005	0.029	10/2/19	0.005	0.013	0.007	0.049	0.005	0.0015	0.015	0.006	0.042	0.005
Acenaphthene (ug/L)	11/44	25	0.011	0.009	0.132	10/20/19	0.0025	0.007	0.005	0.035	0.005	0.0025	0.005	0.005	0.033	0.005
Acenaphthylene (ug/L)	2/44	5	0.005	0.004	0.007	8/6/16	0.0015	0.005	0.004	0.031	0.005	0.0015	0.005	0.005	0.032	0.005
Anthracene (ug/L)	13/44	30	0.007	0.007	0.053	10/2/19	0.003	0.008	0.005	0.034	0.005	0.003	0.008	0.005	0.034	0.005
Fluorene (ug/L)	5/44	11	0.005	0.004	0.013	8/23/16	0.004	0.007	0.006	0.039	0.005	0.003	0.005	0.004	0.031	0.005
Naphthalene (ug/L)	10/44	23	0.009	0.007	0.026	10/2/19	0.005	0.026	0.015	0.107	0.015	0.005	0.02	0.008	0.056	0.005
Phenanthrene (ug/L)	23/44	52	0.009	0.008	0.037	10/2/19	0.008	0.026	0.017	0.118	0.017	0.005	0.020	0.008	0.055	0.005
Total LPAHs	28/44	64	0.040	0.034	0.223	10/2/19	0.035	0.07	0.047	0.3	0.046	0.012	0.06	0.027	0.187	0.019
HPAHs in ug/L																
Benzo(a)anthracene (ug/L)	4/44	9	0.005	0.004	0.008	3/31/16	0.003	0.008	0.005	0.034	0.005	0.003	0.005	0.004	0.030	0.005
Benzo(a)pyrene (ug/L)	5/44	14	0.005	0.004	0.010	3/31/16	0.002	0.01	0.005	0.035	0.005	0.002	0.005	0.004	0.029	0.005
Benzo(g,h,i)perylene (ug/L)	4/44	9	0.009	0.008	0.026	3/31/16	0.005	0.026	0.011	0.078	0.01	0.005	0.011	0.008	0.058	0.01
Benzo(b,k)fluoranthenes (ug/L)	9/44	20	0.005	0.004	0.011	8/6/19	0.003	0.01	0.005	0.034	0.004	0.003	0.005	0.004	0.029	0.005
Chrysene (ug/L)	7/44	16	0.005	0.004	0.018	6/20/19	0.002	0.007	0.005	0.034	0.005	0.002	0.005	0.004	0.026	0.005
Dibenz(a,h)anthracene (ug/L)	1/44	2	0.004	0.004	0.005	6/21/19	0.002	0.005	0.004	0.030	0.005	0.002	0.005	0.004	0.029	0.005
Fluoranthene (ug/L)	16/44	36	0.007	0.006	0.032	10/2/19	0.004	0.015	0.008	0.058	0.007	0.003	0.005	0.004	0.030	0.005
Indeno(1,2,3-cd)pyrene (ug/L)	2/44	5	0.005	0.004	0.013	3/31/16	0.003	0.013	0.006	0.040	0.005	0.003	0.005	0.005	0.032	0.005
Pyrene (ug/L)	19/44	43	0.008	0.007	0.053	10/2/19	0.004	0.016	0.007	0.049	0.005	0.003	0.011	0.005	0.038	0.005
Total HPAHs	20/44	45	0.037	0.032	0.131	10/2/19	0.023	0.107	0.042	0.295	0.034	0.022	0.04	0.027	0.187	0.024
Total PAHs	29/44	66	0.076	0.066	0.353	10/2/19	0.061	0.143	0.089	0.624	0.084	0.036	0.09	0.05	0.374	0.041
Phthalates																
bis(2-Ethylhexyl)phthalate (ug/L)	8/44	18	0.536	0.469	5.60	5/11/16	0.188	0.820	0.484	3.39	0.515	0.188	0.515	0.37	2.59	0.483
Butyl benzyl phthalate (ug/L)	0/44	0	0.413	0.358	0.525	N/A	0.213	0.520	0.429	3.00	0.51	0.213	0.520	0.390	2.73	0.505
Diethylphthalate (ug/L)	10/44	23	0.438	0.381	1.20	3/31/16	0.139	1.20	0.600	4.20	0.52	0.139	0.520	0.364	2.54	0.505
Dimethyl phthalate (ug/L)	0/44	0	0.397	0.345	0.525	N/A	0.134	0.520	0.414	2.90	0.51	0.134	0.520	0.370	2.59	0.505
Di-n-butylphthalate (ug/L)	10/44	23	0.343	0.294	0.521	8/23/16	0.138	0.521	0.359	2.52	0.51	0.140	0.520	0.374	2.62	0.505
Di-n-Octyl phthalate (ug/L)	0/44	0	0.405	0.351	0.525	N/A	0.174	0.520	0.421	2.95	0.51	0.174	0.520	0.380	2.66	0.505
Total Phthalates	10/44	23	0.420	0.377	5.81	5/11/16	--	2.26	0.716	5.01	--	--	0.5	0.11	0.766	--
Herbicides																
2,4-D (ug/L)	12/42	29	0.088	0.073	0.970	8/14/19	0.044	0.970	0.211	1.26	0.05	0.017	0.061	0.044	0.305	0.050
Dichlobenil (ug/L)	2/44	5	0.045	0.039	0.0525	3/31/16	0.020	0.052	0.043	0.302	0.0505	0.010	0.052	0.039	0.274	0.046
TPH																
NWTPH-Diesel (mg/L)	0/27	0	0.022	0.020	0.050	N/A	0.015	0.050	0.022	0.11	0.015	0.015	0.050	0.022	0.110	0.015
NWTPH-Gasoline (ug/L)	0/27	0	6.87	6.4	25.0	N/A	2.3	25.0	6.9	34.4	2.34	2.3	25.0	6.87	34.4	2.34
NWTPH-Heavy Oil (mg/L)	0/27	0	0.101	0.094	0.105	N/A	0.100	0.105	0.102	0.51	0.10	0.100	0.105	0.102	0.510	0.10
Bacteria																
Coliform, Fecal (CFU/100 ml)	23/27	85	1,237.5	1,145.8	16,000	2/1/19	10	2,400	669	3,343	110	110	16,000	5,062	25,310	2400
BTEX																
Benzene (ug/L)	5/27	19	0.32	0.30	1.00	7/26/16	0.100	0.250	0.220	1.10	0.250	0.500	1.000	0.740	3.70	0.700
Ethylbenzene (ug/L)	3/278	11	0.21	0.20	0.250	N/A	0.100	0.250	0.220	1.10	0.250	0.100	0.250	0.190	0.95	0.200
m,p-Xylene (ug/L)	1/27	4	0.82	0.76	1.00	N/A	0.200	1.000	0.840	4.20	1.00	0.200	1.000	0.720	3.60	1.00
o-Xylene (ug/L)	0/27	0	0.22	0.20	0.250	N/A	0.100	0.250	0.220	1.10	0.250	0.100	0.250	0.220	1.10	0.250
Toluene (ug/L)	4/27	15	0.21	0.20	0.250	N/A	0.100	0.250	0.220	1.10	0.250	0.100	0.250	0.190	0.95	0.200

	OF237A					OF237B					OF243					OF245/254				
	Min	Max	Arithmetic Mean	Weighted Mean	Median	Min	Max	Arithmetic Mean	Weighted Mean	Median	Min	Max	Arithmetic Mean	Weighted Mean	Median	Min	Max	Arithmetic Mean	Weighted Mean	Median
Conventionals																				
Anionic Surfactants - MBAS (ug/L)	0.0048	0.0466	0.02	0.194	0.0125	0.0125	0.0299	0.02	0.112	0.0169	0.0267	0.0962	0.06	0.424	0.0586	0.0251	0.0553	0.043	0.2	0.0468
BOD (mg/L)	1.0	1.0	1.0	9.0	1.0	1.0	3.6	1.4	8.6	1.0	1.0	1.0	1.0	7.0	1.0	1.0	6.2	2.0	10.2	1.0
Chloride (mg/L)	11.5	21.3	16.3	163.3	15.95	8.6	90.6	25.3	126.3	9.13	2490	13100	8143	57000	8080	18.2	13900	4485	22,423.1	3980
Conductivity (uS/cm)	304	423	347.6	3476	334.5	261	281	272.0	1632	273	8080	35300	22685	181480	23200	6170	38100	22695	136,170.0	22950
Hardness (mg CaCO3/L)	126	141	130.8	1308	131	109	124	116.7	700	117.5	808	3770	2215	17718	1915	728	4430	2581.3	15,488.0	2600
pH (pH units)	7.1	8.1	7.7	77.3	7.9	7.1	7.7	7.4	44.5	7.4	7	7.5	7.3	58.1	7.3	7.3	7.6	7.5	44.8	7.45
TSS (mg/L)	0.5	2.94	1.7	17.3	1.68	0.5	2.8	1.2	7.4	0.91	4.92	21.8	13.7	109.7	14.9	2.0	20.8	8.4	50.3	7.0
Turbidity (NTU)	0.53	2	1.1	10.80	1.01	0.74	2.49	1.3	8.09	1.23	7.36	27.3	15.3	107.18	14.8	2.75	13.8	7.1	35.5	5.06
Nutrients																				
Nitrate+Nitrite as N (mg/L)	2.160	2.560	2.369	23.7	2.395	2.900	3.480	3.107	18.6	3.06	0.046	0.306	0.161	1.3	0.151	0.196	3.68	0.962	4.8	0.334
Phosphate, Ortho (mg/L)	0.028	0.042	0.034	0.3	0.0335	0.028	0.051	0.034	0.2	0.030	0.003	0.139	0.070	0.5	0.063	0.037	0.176	0.096	0.5	0.097
Phosphorus, Total (mg/L)	0.023	0.037	0.029	0.3	0.0295	0.028	0.037	0.033	0.2	0.034	0.181	0.566	0.310	2.2	0.267	0.080	0.595	0.254	1.0	0.171
Total Nitrogen (mg/L)	2.180	2.450	2.299	23.0	2.270	2.940	3.150	3.042	18.3	3.035	0.420	0.790	0.541	4.3	0.480	0.430	3.35	1.522	7.6	0.980
Metals (ug/L)																				
Cadmium (ug/L)	0.0105	0.25	0.1	1.153	0.030	0.007	0.25	0.1	0.597	0.030	0.0215	2.5	0.4	3.013	0.0705	0.072	1.1	0.3	1.8	0.151
Cadmium, Dissolved (ug/L)	0.0	0.25	0.2	1.600	0.250	0.0	0.25	0.1	0.348	0.025	0.0	1.25	0.2	1.807	0.055	0.0	0.183	0.1	0.6	0.1
Copper (ug/L)	0.1835	1.060	0.466	4.7	0.4455	0.1235	0.677	0.325	1.9	0.28075	2.53	10.5	5.456	38.2	4.89	1.43	23.7	11.977	71.9	12.85
Copper, Dissolved (ug/L)	0.2	0.538	0.3	3.13	0.3	0.0	0.284	0.2	1.06	0.2	0.3	3.42	1.7	12.04	1.6	0.6	3.63	1.7	10.0	1.3
Lead (ug/L)	0.037	0.520	0.152	1.5	0.079	0.014	0.092	0.044	0.3	0.039	0.788	25.4	5.416	43.3	2.655	0.201	2.230	0.849	5.093	0.678
Dissolved Lead (ug/L)	0.007	0.080	0.029	0.29	0.019	0.006	0.070	0.031	0.19	0.026	0.017	1.810	0.322	2.58	0.088	0.017	0.083	0.061	0.363	0.083
Mercury (ug/L)	0.0008	0.004	0.0028	0.0278	0.0025	0.0008	0.004	0.0027	0.0163	0.0025	0.0010	0.004	0.0017	0.0138	0.0012	0.0008	0.004	0.0035	0.0208	0.0040
Dissolved Mercury (ug/L)	0.0009	0.0045	0.0029	0.0294	0.0025	0.0009	0.0045	0.0029	0.0174	0.0025	0.0025	0.0045	0.0028	0.0220	0.0025	0.0009	0.0045	0.0039	0.0234	0.0045
Zinc (ug/L)	0.99	4.090	2.585	25.9	2.775	0.9	2.760	1.635	9.8	1.545	4.33	30.300	14.839	103.9	13.4	9.39	125	50.448	302.7	28.7
Dissolved Zinc (ug/L)	0.7	3.39	1.9	19.3	2.0	0.8	1.83	1.3	7.9	1.3	2.5	11.9	6.4	44.8	5.3	4.3	74.9	28.7	172.1	23.2
Insecticides																				
Chlorpyrifos (ug/L)	0.026	0.030	0.027	0.27	0.026	0.026	0.030	0.028	0.17	0.02775	0.026	0.0305	0.026	0.21	0.026	0.030	0.0305	0.030	0.2	0.030
PAHs																				
LPAHs																				
2-Methylnaphthalene (ug/L)	0.004	0.005	0.005	0.049	0.005	0.005	0.005	0.005	0.030	0.005	0.005	0.005	0.005	0.040	0.005	0.0015	0.029	0.008	0.1	0.005
Acenaphthene (ug/L)	0.0025	0.005	0.005	0.048	0.005	0.0025	0.023	0.008	0.047	0.005	0.005	0.132	0.032	0.254	0.00925	0.0025	0.035	0.015	0.1	0.012
Acenaphthylene (ug/L)	0.0015	0.005	0.005	0.047	0.005	0.0015	0.005	0.004	0.027	0.005	0.005	0.007	0.005	0.042	0.005	0.0015	0.005	0.004	0.0	0.005
Anthracene (ug/L)	0.003	0.005	0.004	0.042	0.005	0.003	0.005	0.004	0.024	0.004	0.005	0.053	0.019	0.153	0.013	0.003	0.017	0.009	0.1	0.008
Fluorene (ug/L)	0.003	0.005	0.005	0.045	0.005	0.003	0.005	0.004	0.026	0.0045	0.005	0.005	0.005	0.040	0.005	0.003	0.013	0.005	0.0	0.004
Naphthalene (ug/L)	0.004	0.01	0.006	0.064	0.006	0.005	0.01	0.007	0.042	0.007	0.003	0.01	0.006	0.049	0.005	0.006	0.022	0.010	0.1	0.009
Phenanthrene (ug/L)	0.004	0.016	0.007	0.065	0.005	0.004	0.013	0.006	0.039	0.005	0.005	0.019	0.008	0.061	0.006	0.004	0.037	0.016	0.1	0.012
Total LPAHs	0.019	0.04	0.024	0.244	0.020	0.019	0.05	0.028	0.167	0.024	0.019	0.2225	0.072	0.579	0.045	0.026	0.122	0.057	0.3	0.049
HPAHs in ug/L																				
Benzo(a)anthracene (ug/L)	0.004	0.006	0.005	0.047	0.005	0.003	0.005	0.004	0.025	0.004	0.003	0.006	0.005	0.038	0.005	0.00	0.0035	0.0031667	0.019	0.004
Benzo(a)pyrene (ug/L)	0.004	0.006	0.005	0.047	0.005	0.002	0.005	0.004	0.024	0.004	0.004	0.007	0.005	0.041	0.005	0.002	0.009	0.004	0.024	0.004
Benzo(g,h,i)perylene (ug/L)	0.006	0.011	0.009	0.090	0.01	0.005	0.011	0.008	0.047	0.008	0.006	0.018	0.011	0.085	0.010	0.005	0.019	0.008	0.046	0.006
Benzo(b,k)fluoranthenes (ug/L)	0.003	0.005	0.004	0.042	0.005	0.003	0.005	0.004	0.024	0.004	0.003	0.011	0.006	0.047	0.005	0.003	0.008	0.004	0.023	0.003
Chrysene (ug/L)	0.002	0.006	0.004	0.042	0.005	0.002	0.005	0.004	0.021	0.004	0.005	0.014	0.007	0.054	0.005	0.002	0.018	0.005	0.031	0.002
Dibenz(a,h)anthracene (ug/L)	0.002	0.005	0.004	0.044	0.005	0.002	0.005	0.004	0.024	0.004	0.004	0.005	0.005	0.039	0.005	0.002	0.004	0.003	0.019	0.004
Fluoranthene (ug/L)	0.004	0.009	0.005	0.050	0.005	0.004	0.005	0.004	0.026	0.004	0.008	0.032	0.013	0.103	0.009	0.004	0.020	0.007	0.042	0.004
Indeno(1,2,3-cd)pyrene (ug/L)	0.003	0.005	0.005	0.046	0.005	0.003	0.005	0.004	0.027	0.005	0.005	0.008	0.005	0.043	0.005	0.003	0.005	0.004	0.023	0.005
Pyrene (ug/L)	0.003	0.010	0.005	0.048	0.005	0.003	0.005	0.004	0.025	0.004	0.007	0.053	0.018	0.141	0.012	0.008	0.038	0.016	0.097	0.009
Total HPAHs	0.022	0.05	0.029	0.289	0.025	0.022	0.03	0.026	0.158	0.025	0.036	0.1305	0.060	0.480	0.044	0.030	0.110	0.054	0.324	0.039
Total PAHs	0.040	0.08	0.05	0.533	0.045	0.041	0.08	0.05	0.325	0.047	0.059	0.353	0.13	1.059	0.095	0.060	0.19	0.111	0.667	0.092
Phthalates																				
bis(2-Ethylhexyl)phthalate (ug/L)	0.189	0.515	0.37	3.75	0.472	0.190	0.515	0.35	2.11	0.352	0.197	5.60	1.10	8.81	0.508	0.189	2.820	0.63	3.79	0.194
Butyl benzyl phthalate (ug/L)	0.213	0.515	0.398	3.98	0.505	0.215	0.515	0.369	2.21	0.372	0.238	0.525	0.478	3.82	0.510	0.214	0.239	0.228	1.37	0.233
Diethylphthalate (ug/L)	0.265	0.575	0.430	4.30	0.488	0.140	0.510	0.328	1.97	0.315	0.182	0.525	0.471	3.77	0.510	0.140	0.183	0.167	1.00	0.178
Dimethyl phthalate (ug/L)	0.134	0.515	0.381	3.81	0.505	0.135	0.515	0.346	2.07	0.357	0.207	0.525	0.474	3.79	0.510	0.135	0.208	0.182	1.09	0.203
Di-n-butylphthalate (ug/L)	0.139	0.515	0.303	3.03	0.218	0.138	0.515	0.326	1.96	0.327	0.142	0.515	0.352	2.81	0.365	0.142	0.507	0.232	1.39	0.145
Di-n-Octyl phthalate (ug/L)	0.174	0.515	0.389	3.89	0.505	0.175	0.515	0.357	2.14	0.364	0.222	0.525	0.476	3.81	0.510	0.174	0.224	0.205	1.23	0.218
Total Phthalates	--	1.0	0.36	3.646	0.334	--	0.5	0.08	0.452	--	--	5.81	0.84	6.699	0.099	--	3.1	0.61	3.636	0.000
Herbicides																				
2,4-D (ug/L)	0.009	0.093	0.048	0.428	0.050	0.009	0.050	0.031	0.185	0.034	0.009	0.570	0.110	0.879	0.050	0.009	0.026	0.014	0.081	0.0085
Dichlobenil (ug/L)	0.020	0.052	0.046	0.464	0.051	0.020	0.052	0.044	0.265	0.048	0.047	0.0525	0.051	0.405	0.051	0.020	0.047	0.037	0.224	0.046
TPH																				
NWTPH-Diesel (mg/L)	0.015	0.050	0.022	0.110	0.015	0.015	0.050	0.022	0.110	0.015	0.015	0.050	0.022	0.110	0.015	0.050	0.050	0.050	0.100	0.050
NWTPH-Gasoline (ug/L)	2.3	25.0	6.87	34.4	2.34	2.3	25.0	6.87	34.4	2.34	2.3	25.0	6.87	34.4	2.34	25.0	25.0	25.0	50.0	25.0
NWTPH-Heavy Oil (mg/L)	0.095	0.105	0.101	0.505	0.10	0.100	0.105	0.101	0.505	0.10	0.100	0.105	0.101	0.505	0.10	0.100	0.100	0.100	0.200	0.100
Bacteria																				
Coliform, Fecal (CFU/100 ml)	40	490	257	1,285	220	10	68	31	156	20	10	790	169	843	13	20	45	33	65	33
BTEX																				
Benzene (ug/L)	0.100	0.250	0.220	1.10	0.250	0.100	0.250	0.220	1.10	0.250	0.100	0.250	0.220	1.10	0.250	0.100	0.100	0.100	0.20	0.100
Ethylbenzene (ug/L)	0.100	0.250	0.220	1.10	0.250	0.100	0.250	0.220	1.10	0.250	0.100	0.250	0.220	1.10	0.250	0.100	0.100	0.100	0.20	0.100
m,p-Xylene (ug/L)	0.200	1.000	0.840	4.20	1.00	0.200	1.000	0.840	4.20	1.00	0.200	1.000	0.840	4.20	1.00	0.200	0.200	0.200	0.40	0.200
o-Xylene (ug/L)	0.100	0.250	0.220	1.10	0.250	0.100	0.250	0.220	1.10	0.250	0.100	0.250	0.220	1.10	0.250	0.100	0.100	0.100	0.20	0.100
Toluene (ug/L)	0.100	0.250	0.210	1.05	0.250	0.100	0.250	0.220	1.10	0.250	0.100	0.250	0.220	1.10	0.250	0.100	0.100	0.100	0.20	0.100

Highest average or highest median concentration detected in WY2016 and WY2019 monitoring. (green shading)
Highest maximum concentration detected in WY2016 and WY2019 monitoring. (orange shading)
Results in italics indicate nondetected values.

Table 3-3.1
Summary Statistics for Stormwater

	Overall Data						OF230					OF235					OF237A New					OF237B					OF243					OF245					OF254				
	Overall Detections	% Detections	Arithmetic Mean[4]	Weighted Mean[5]	Max	Date of Max	Min	Max	Arithmetic Mean	Weighted Mean	Median	Min	Max	Arithmetic Mean	Weighted Mean	Median	Min	Max	Arithmetic Mean	Weighted Mean	Median	Min	Max	Arithmetic Mean	Weighted Mean	Median	Min	Max	Arithmetic Mean	Weighted Mean	Median	Min	Max	Arithmetic Mean	Weighted Mean	Median	Min	Max	Arithmetic Mean	Weighted Mean	Median
Conventionals																																									
Anionic Surfactants - MBAS (ug/L)	445/470	95	0.054	0.055	0.665	8/22/11	0.006	0.199	0.044	2.244	0.036	0.006	0.665	0.062	5.604	0.045	0.006	0.096	0.042	2.542	0.039	0.006	0.357	0.051	4.303	0.0391	0.006	0.158	0.046	2.230	0.043	0.006	0.434	0.069	5.561	0.055	0.006	0.175	0.066	3.580	0.054
BOD (mg/L)	334/420	80	3.3	3.3	69.0	6/8/17	1.0	8.8	3.8	202.5	3.2	1.0	8.4	3.5	265	3.2	1.0	7.0	3.0	169	2.75	1.0	8.5	3.0	210	2.65	1.0	8.5	3.1	144.4	2.7	1.0	8.1	3.1	220.7	2.7	1.0	69	3.8	182.7	2.4
Chloride (mg/L)	458/463	99	N/A	N/A	25400	10/7/16	0.82	551.00	17.62	951.38	4.16	0.82	114.00	10.40	874	4.44	1.79	154.00	12.66	760	7.04	1.87	68.60	6.23	511	4.71	261	25400	1967.92	96428	1200	0.63	1260	144.17	11389	71	493	8000	2341	128728	2220
Conductivity (uS/cm)	911/911	100	N/A	N/A	23000	2/21/22	14.9	2260	116.9	15782.5	56.1	7.2	1590	128.2	21029	81.8	7.5	1190	113.8	15364	88.4	39.5	708	133.0	19291	123	942	13300	5128.3	466672	4210	46.8	6360	575.1	77642	323.0	4.9	23000	6228	660116	5505
Hardness (mg CaCO3/L)	1339/1339	100	N/A	N/A	3150	N/A	8.7	206	20.6	4103.0	15.9	9.8	63.9	30.0	6900	28.0	14.5	68.8	30.1	5966	28.3	20.7	1220	54.5	11504	48	59.3	3150	517.5	70891	430	14	626	73.8	14694	52	49.5	2380	587	96779	495
pH (pH units)	1339/1339	100	N/A	N/A	10.6	N/A	5.0	10.6	6.9	1381.8	7.0	5.4	8.6	7.0	1614	7.1	5.3	8.3	6.9	1353	6.9	5.7	8.8	6.9	1473	7.0	6.1	7.8	7.0	965	7.1	5.6	8.4	7.0	1388	7.0	6.2	8.1	7.1	1166	7.1
TSS (mg/L)	1303/1303	100	59.8	58.7	668	5/4/17	4.8	322.0	49.0	9460.5	30.8	5.6	441	56.2	12644	39.4	3.5	668	49.1	9664	33.9	3.6	278	49.0	9796	35	4.4	300	64.2	8597	41.8	6.2	296	60.7	11663	51.0	5.2	354	91	14677	69.0
Turbidity (NTU)	347/392	89	34.6	33.9	216	N/A	5.5	85.2	18.4	958.3	13.7	5.1	79.5	18.9	1150	15.9	6.1	57	19.7	1200	17.9	7.2	50.2	20	1131	18.5	0.2	169	48.2	2315	34.2	11.1	139.0	46.1	2719	38.0	0.5	216	70.8	3822	57.0
Nutrients																																									
Nitrate+Nitrite as N (mg/L)	563/563	100	0.380	0.431	2.720	3/21/15	0.062	0.434	0.148	10.060	0.123	0.028	1.650	0.334	36.73	0.237	0.161	1.090	0.407	29.28	0.374	0.190	2.720	1.179	126.18	1.110	0.089	0.799	0.250	13.28	0.215	0.034	1.010	0.203	18.69	0.143	0.036	0.287	0.142	8.661	0.132
Phosphate, Total (mg/L)	557/558	100	0.180	0.163	0.689	10/26/18	0.042	0.688	0.124	8.455	0.084	0.019	0.532	0.119	12.889	0.094	0.041	1.150	0.110	7.920	0.085	0.017	0.564	0.105	11.085	0.088	0.043	3.680	0.451	23.913	0.212	0.054	1.510	0.184	16.60	0.140	0.068	1.090	0.167	10.208	0.120
Phosphorus, Ortho (mg/L)	571/575	99	0.029	0.029	3.680	9/17/21	0.004	0.098	0.028	2.055	0.023	0.004	0.097	0.027	3.00	0.024	0.009	0.054	0.023	1.636	0.021	0.006	0.128	0.024	2.592	0.021	0.009	0.138	0.034	1.79	0.031	0.002	0.689	0.042	4.06	0.026	0.007	0.097	0.027	1.725	0.023
Total Nitrogen (mg/L)	557/563	99	0.76	0.80	3.28	8/22/11	0.13	2.10	0.54	36.72	0.46	0.02	3.28	0.77	84.68	0.63	0.36	2.03	0.69	49.76	0.61	0.13	3.19	1.28	136.60	1.23	0.26	2.11	0.74	39.37	0.73	0.02	2.90	0.75	68.71	0.61	0.03	1.95	0.59	35.70	0.49
Metals in ug/L																																									
Cadmium (ug/L)	473/670	71	0.158	0.156	2.410	3/12/11	0.007	0.466	0.083	6.806	0.064	0.007	0.960	0.131	18.99	0.087	0.007	0.615	0.077	6.063	0.061	0.007	0.455	0.086	10.47	0.063	0.007	1.250	0.235	13.63	0.173	0.007	2.410	0.302	36.00	0.216	0.053	0.543	0.189	12.29	0.160
Cadmium, Dissolved (ug/L)	338/670	50	0.064	0.063	1.850	3/12/11	0.005	0.125	0.028	2.238	0.025	0.005	0.379	0.048	7.03	0.025	0.005	0.073	0.023	1.782	0.021	0.005	0.106	0.034	4.13	0.025	0.005	0.173	0.083	4.82	0.083	0.005	1.850	0.134	15.99	0.075	0.005	0.273	0.095	6.10	0.089
Copper (ug/L)	668/668	100	15.51	15.97	162	7/26/15	3.72	66.40	11.25	922.36	8.26	3.45	162.00	28.05	4067	22.50	4.43	69.10	10.23	808	7.87	2.93	27.90	7.89	947	6.47	3.22	110	21.13	1225	17.15	3	42.60	13.82	1644	12.30	5.81	56.30	16.21	1054	12.90
Copper, Dissolved (ug/L)	660/664	99	4.62	5.23	79.10	8/22/11	0.84	18.10	4.13	334.59	3.24	1.79	79.10	11.77	1718	9.64	1.51	12.10	3.31	261	2.76	0.75	8.06	2.61	305	2.22	0.95	8.58	4	222	3.61	0.02	26.10	3.75	442	3.03	0.53	11.30	2.95	191.9	2.23
Lead (ug/L)	1329/1338	99	21.80	22.09	379	9/5/09	2.09	229	18.31	3643.58	11.40	2.46	368.00	54.19	12465	41.15	1.40	80.60	11.55	2286	8.21	1.40	64.20	10.10	2120	6.70	0.12	379	33.67	4613	16.20	0.87	60	9.80	1950	7.83	1.40	68	15.00	2475	10.80
Lead, Dissolved (ug/L)	1000/1339	75	1.751	1.823	145	8/6/04	0.091	9.050	0.891	176.459	0.550	0.156	28	6.122	1414	4.500	0.081	3.460	0.535	106.0	0.364	0.003	11.400	0.541	115	0.280	0.003	145	2.660	364	0.350	0.010	6.270	0.504	100.4	0.280	0.012	12.200	1.003	164	0.253
Mercury (ug/L)	467/1341	35	0.0226	0.0223	0.870	5/20/08	0.0004	0.1300	0.0223	4.4332	0.0250	0.0004	0.1900	0.0242	5.60	0.0250	0.0004	0.1000	0.0175	3.4673	0.0250	0.0004	0.2160	0.0200	4.25	0.0250	0.0008	0.1880	0.0257	3.52	0.0250	0.0004	0.8700	0.0217	4.32	0.0250	0.0004	0.3070	0.0265	4.38	0.0250
Mercury, Dissolved (ug/L)	112/1339	8	0.0162	0.0161	0.552	7/23/14	0.0009	0.1000	0.0152	3.0050	0.0250	0.00	0.1000	0.0153	3.53	0.0250	0.0009	0.1000	0.0154	3.0306	0.0250	0.0009	0.1000	0.0157	3.34	0.0250	0.0009	0.5520	0.0187	2.56	0.0250	0.0009	0.1080	0.0158	3.15	0.0250	0.0009	0.2110	0.0175	2.89	0.0250
Zinc (ug/L)[6]	1337/1337	100	102.7	102.5	1170	8/6/04	31.8	721.0	108.4	21577.5	81.0	34.3	598	110.6	25330	86.5	30.6	361	91.8	18167	72.8	15.0	285	61.3	12925	45.4	12.3	1170	92.4	12662	67.0	27.7	585	133.2	26375	106	27.6	427	121.1	19982	96
Zinc, Dissolved (ug/L)[6]	1335/1337	100	43.2	43.4	910	8/6/04	11.5	543.0	55.2	10933.3	42.6	9.7	347	42.5	9743	33.4	16.9	289	46.5	9204	35.3	6.3	260	24.7	5233	19.1	5.6	910	34.2	4682	22.7	0.8	335	54.8	10845	37.7	5.1	239	44.5	7340	31.8
Insecticides																																									
2,4-D (ug/L)	223/395	56	0.245	0.289	12.0	4/5/17	0.009	1.700	0.179	7.889	0.048	0.009	12.000	0.590	49.52	0.140	0.009	2.500	0.299	14.93	0.135	0.009	2.100	0.344	24.74	0.170	0.009	0.190	0.049	1.612	0.037	0.009	1.500	0.167	12.03	0.037	0.009	1.000	0.091	3.625	0.029
Carbaryl (ug/L)	1/184	1	0.15	0.15	0.25	N/A	0.03	0.25	0.13	3.48	0.08	0.03	0.25	0.12	4.12	0.03	0.03	0.25	0.14	4.36	0.13	0.03	0.25	0.13	3.46	0.13	0.03	0.25	0.18	3.27	0.25	0.03	0.25	0.14	3.86	0.25	0.03	0.25	0.18	4.18	0.25
Chlorpyrifos (ug/L)	13/541	2	0.027	0.026	1.420	2/23/20	0.003	1.420	0.039	2.749	0.009	0.003	0.707	0.024	2.617	0.009	0.003	0.365	0.025	1.796	0.009	0.003	0.061	0.019	1.783	0.009	0.003	0.443	0.030	1.519	0.019	0.003	0.754	0.026	2.381	0.009	0.003	0.320	0.027	1.438	0.009
Bifenthrin (ug/L)	14/159	9	0.005	0.005	0.054	11/4/21	0.000	0.005	0.005	0.120	0.005	0.000	0.005	0.005	0.130	0.005	0.000	0.054	0.009	0.187	0.005	0.000	0.005	0.005	0.118	0.005	0.000	0.005	0.005	0.080	0.005	0.000	0.005	0.005	0.115	0.005	0.000	0.005	0.005	0.095	0.005
PAHs in ug/L																																									
LPAHs in ug/L																																									
2-Methylnaphthalene (ug/L)	913/1336	68	0.021	0.021	4.130	3/16/02	0.002	0.469	0.024	4.875	0.013	0.001	4.130	0.034	7.86	0.010	0.001	0.104	0.015	2.877	0.011	0.002	0.250	0.012	2.525	0.006	0.002	0.136	0.012	1.701	0.009	0.001	1.143	0.027	5.25	0.011	0.001	0.435	0.022	3.56	0.012
Acenaphthene (ug/L)	545/1337	41	0.012	0.011	0.855	8/6/04	0.002	0.080	0.007	1.338	0.005	0.002	0.086	0.009	2.02	0.005	0.002	0.532	0.010	1.891	0.005	0.002	0.063	0.006	1.175	0.005	0.002	0.105	0.021	2.831	0.018	0.002	0.855	0.017	3.28	0.009	0.002	0.352	0.016	2.68	0.008
Acenaphthylene (ug/L)	382/1337	29	0.007	0.007	0.095	8/6/04	0.002	0.060	0.006	1.131	0.005	0.001	0.060	0.006	1.46	0.005	0.001	0.061	0.005	1.045	0.005	0.002	0.064	0.005	1.053	0.005	0.002	0.064	0.008	1.153	0.005	0.001	0.095	0.008	1.62	0.005	0.001	0.070	0.010	1.64	0.005
Anthracene (ug/L)	627/1337	47	0.016	0.015	0.389	2/21/02	0.002	0.122	0.010	2.073	0.006	0.002	0.138	0.014	3.13	0.006	0.002	0.207	0.011	2.185	0.005	0.002	0.097	0.007	1.509	0.005	0.002	0.079	0.029	3.948	0.027	0.002	0.289	0.011	2.23	0.005	0.002	0.389	0.031	5.03	0.009
Fluorene (ug/L)	703/1337	53	0.014	0.013	0.928	8/6/04	0.002	0.246	0.012	2.310	0.005	0.001	0.083	0.011	2.56	0.005	0.001	0.110	0.010	1.899	0.005	0.002	0.078	0.007	1.589	0.005	0.002	0.098	0.014	1.901	0.010	0.001	0.928	0.022	4.27	0.008	0.001	0.159	0.019	3.19	0.010
Naphthalene (ug/L)	935/1325	71	0.028	0.029	4.430	3/16/02	0.003	0.528	0.032	6.349	0.020	0.000	4.430	0.043	9.77	0.015	0.002	0.150	0.023	4.573	0.018	0.003	0.130	0.017	3.479	0.013	0.003	0.135	0.022	2.989	0.018	0.002	0.795	0.035	6.74	0.021	0.002	0.126	0.025	4.03	0.020
Phenanthrene (ug/L)	1251/1337	94	0.066	0.067	1.650	8/6/04	0.002	0.653	0.076	15.166	0.036	0.002	0.776	0.071	16.5	0.028	0.002	0.893	0.082	16.14	0.037	0.002	0.838	0.045	9.612	0.021	0.002	0.221	0.049	6.774	0.032	0.002	1.650	0.061	12.10	0.034	0.002	0.657	0.079	12.89	0.044
Total LPAHs[1,2]	1330/1328	100	0.137	0.135	4.930	3/16/02	0.008	0.92	0.134	26.469	0.075	0.009	4.930	0.148	34.1	0.066	0.003	1.09	0.134	26.32	0.075	0.006	1.13	0.080	16.794	0.054	0.030	0.47	0.138	18.743	0.120	0.007	4.61	0.148	28.86	0.084	0.005	1.24	0.175	28.53	0.102
HPAHs in ug/L																																									
Benzo(a)anthracene (ug/L)	1023/1337	77	0.042	0.042	0.915	2/21/02	0.001	0.439	0.046	9.209	0.017	0.001	0.555	0.043	9.90	0.018	0.001	0.902	0.063	12.41	0.022	0.001	0.685	0.030	6.270	0.011	0.001	0.615	0.034	4.615	0.016	0.001	0.247	0.018	3.49	0.008	0.001	0.915	0.060	9.76	0.019
Benzo(a)pyrene (ug/L)	1012/1337	76	0.044	0.044	0.865	2/18/07	0.002	0.563	0.055	11.019	0.022	0.001	0.498	0.045	10.40	0.020	0.001	0.865	0.071	13.97	0.029	0.002	0.690	0.035	7.384	0.013	0.002	0.654	0.034	4.658	0.017	0.001	0.133	0.018	3.56	0.011	0.002	0.428	0.052	8.49	0.025
Benzo(b,k)fluoranthenes (ug/L)	1138/1337	85	0.122	0.122	2.430	9/4/07	0.002	1.396	0.152	30.298	0.053	0.002	1.199	0.113	26.1	0.053	0.005	2.430	0.217	42.70	0.088	0.002	1.763	0.096	20.375	0.036	0.005	1.430	0.090	12.271	0.041	0.002	0.414	0.046	9.05	0.025	0.005	1.662	0.140	22.9	0.065
Benzo(g,h,i)perylene (ug/L)	1173/1337	88	0.049	0.050	0.794	9/4/07	0.002	0.457	0.063	12.445	0.028	0.002	0.410	0.052	12.1	0.027	0.002	0.794	0.080	15.66	0.039	0.002	0.614	0.043	9.048	0.019	0.002	0.503	0.036	4.974	0.020	0.002	0.112	0.025	4.96	0.018	0.002	0.253	0.046	7.59	0.030
Chrysene (ug/L)	1203/1337	90	0.087	0.087	1.906	2/21/02	0.002	0.860	0.101	20.058	0.032	0.002	0.678	0.085	19.7	0.034	0.002	1.490	0.133	26.25	0.052	0.002	0.965	0.063	13.368	0.022	0.002	0.788	0.064	8.733	0.028	0.002	0.420	0.041	8.00	0.017	0.002	1.906	0.124	20.3	0.046
Dibenz(a,h)anthracene (ug/L)	542/1337	41	0.011	0.011	0.684	11/15/16	0.002	0.088	0.013	2.639	0.005	0.002	0.154	0.010	2.39	0.004	0.002	0.305	0.018	3.59	0.005	0.001	0.143	0.009	1.834	0.004	0.002	0.684	0.012	1.671	0.004	0.002	0.027	0.005	1.04	0.004	0.002	0.071	0.011	1.73	0.005
Fluoranthene (ug/L)	1317/1337	99	0.140	0.140	3.964	2/21/02	0.003	1.687	0.156	31.124	0.053	0.002	1.550	0.143	33.0	0.054	0.003	2.640	0.217	42.78	0.080	0.003	1.835	0.095	20.176	0.036	0.013	0.444	0.090	12.265	0.053	0.002	1.720	0.066	12.94	0.033	0.003	3.964	0.213	34.9	0.078
Indeno(1,2,3-cd)pyrene (ug/L)	1041/1337	78	0.037	0.037	0.680	9/4/07	0.002	0.346	0.048	9.528	0.021	0.002	0.338	0.035	8.20	0.019	0.002	0.680	0.069	13.63	0.032	0.002	0.546	0.031	6.470	0.014	0.002	0.620	0.028	3.878	0.016	0.002	0.058	0.014	2.71	0.009	0.002	0.239	0.031	5.12	0.019
Pyrene (ug/L)	1313/1337	98	0.140	0.140	4.120	2/21/02	0.005	1.200	0.146	29.003	0.056	0.002	1.164	0.146	33.6	0.066	0.005	2.930	0.199	39.28	0.085	0.002	1.493	0.098	20.771	0.041	0.012	0.620	0.095	12.957	0.055	0.002	1.310	0.083	16.31	0.048	0.002	4.120	0.216	35.4	0.084
Retene (ug/L)	308/150	205	0.013	0.013	0.222	11/4/21	0.003	0.026	0.009	0.223	0.008	0.003	0.115	0.014	0.4	0.009	0.003	0.222	0.026	0.49	0.012	0.003	0.022	0.007	0.161	0.007	0.003	0.016	0.009	0.142	0.009	0.003	0.021	0.011	0.26	0.011	0.008	0.027	0.015	0.3	0.014
Total HPAHs[1]	1327/1335	99	0.662	0.568	13.56	2/21/02	0.025	6.68	0.769	153.074	0.260	0.027	6.50	0.666	153	0.291	0.029	12.26	1.050	206.8	0.400	0.019	8.73	0.494	104.149	0.188	0.031	5.84	0.472	64.661	0.247	0.011	4.39	0.306	60.26	0.173	0.027	13.558	0.88	17	0.373
Total PAHs[1]	2657/2663	100	0.801	0.400	14.68	2/21/02	0.037	7.49	0.91	179.361	0.353	0.045	7.55	0.814	187	0.355	0.033	13.30	1.188	232.9	0.507	0.028	9.87	0.576	120.860	0.257	0.065	6.05	0.61	83.323	0.374	0.020	9.01	0.45	88.69	0.266	0.040	14.681	1.06	174	0.475
Phthalates in ug/L																																									
bis(2-Ethylhexyl)phthalate (ug/L)	1014/1166	87	2.50	2.63	97	10/3/02	0.14	44.10	3.23	638.7	2.00	0.32	97	4.03	927	1.99	0.20	13.70	2.00	392.1	1.40	0.14	12	1.90	401.8	1.12	0.18	41	1.88	255.3	0.93	0.20	31	2.33	455.2	1.34	0.14	10.20	2.13	0	1.47
Butyl benzyl phthalate (ug/L)	487/1337	36	1.789	1.826	290	2/15/03	0.085	8.400	0.464	92.3	0.290	0.085	7.930	0.919	212	0.500	0.085	2.920	0.384	75.7	0.290	0.085	2.800	0.331	70.3	0.219	0.085	9.200	0.812	111.3	0.220	0.085	290	9.186	1809.7	0.270	0.085	6.100	0.427	70.0	0.236
Diethylphthalate (ug/L)	392/1337	29	1.526	1.612	590	12/10/02	0.077	9.300	0.561	111.7	0.268	0.077	590	3.016	697	0.273	0.079	230	1.917	377.7	0.244	0.050	52	0.980	207.7	0.190	0.070	7.600	0.436	59.8	0.216	0.077	430	2.542	500.9	0.214	0.070	120	1.227	201	0.198
Dimethyl phthalate (ug/L)	99/1331	7	0.269	0.268	4.7	9/29/05	0.016	4.700	0.303	60.4	0.174	0.016	2.400	0.257	58.8	0.174	0.016	0.500	0.245	48.0	0.172	0.016	0.550	0.245	51.7	0.174	0.016	1.000	0.257	34.9	0.173	0.016	1.100	0.256	50.2	0.175	0.016	3.200	0.320	52.4	0.202
Di-n-butylphthalate (ug/L)	495/1337	37	0.382	0.382	4.8	6/12/04	0.050	1.600	0.386	76.8	0.414	0.050	1.600	0.344	79.4	0.331	0.095	4.800	0.390	76.8	0.400	0.095	1	0.337	71.4	0.331	0.050	1.270	0.340	46.5	0.278	0.104	1.650	0.471	92.8	0.500	0.100	1.300	0.405	66.5	0.455
Di-n-Octyl phthalate (ug/L)	333/1329	25	0.363	0.367	4.5	8/6/04	0.042	3.200	0.475	93.7	0.394	0.042	3.200	0.429	98.7	0.219	0.042	2.500	0.345	67.2	0.250	0.042	2.300	0.320	67.5	0.185	0.042	1.490	0.303	41.0	0.185	0.042	4.100	0.299	58.9	0.182	0.042	4.500	0.370	60.6	0.218
Total Phthalates[3]	933/1334	70	5.60	5.81	596.4	12/10/02	0.000	44.1	4.21	837	2.661	0.000	596	7.90	1824	2.970	0.000	230.0	4.00	788.5	1.857	0.000	66.2	2.87	606.1	1.472	0.000	41.00	2.75	376.4	1.300	0.000	593.1	13.9	2735	1.83	0.000	123.20	3.56	576	1.82
Herbicides																																									
Dichlobenil (ug/L)	369/609	61	0.055	0.062	3.39	3/21/15	0.010	0.730	0.074	6.846	0.050	0.004	3.390	0.092	12.36	0.034	0.010	1.080	0.070	6.216	0.046	0.009	1.380	0.069	7.931	0.037	0.004	0.046	0.019	1.214	0.012	0.004	0.167	0.028	3.182	0.021	0.004	0.263	0.031	0.000	0.020
Total Petroleum Hydrocarbons																																									
NWTPH-Diesel (mg/L)	37/359	10	0.06	0.05	0.34	1/24/12	0.02	0.13	0.05	2.60	0.05	0.02	0.31	0.05	3.76	0.05	0.02	0.32	0.05	2.63	0.05	0.02	0.34	0.05	4.10	0.05	0.02	0.19	0.05	2.15	0.05	0.02	0.33	0.06	4.08	0.05	0.02	0.16	0.07	0.00	0.05
NWTPH-Gasoline (mg/L)	59/376	16	19.4	19.6	395	1/24/12	2.3	25.0	18.1	833	25.0	2.3	50.0	18.3	1225	25.0	2.3	25.0	18.1	832.8	25.0	2.3	395	24.1	1683.9	25.0	2.3	25.0	19.8	693.7	25.0	2.3	62.3	19.2	1211.3	25.0	2.3	25.0	18.3	897	25.0
NWTPH-Heavy Oil (mg/L)	319/403	79	0.5	0.5	4.2	12/15/20	0.03	1.90	0.63	32.0	0.54	0.03	1.70	0.61	44.33	0.54	0.03	2.10	0.58	30.16	0.57	0.03	1.30	0.48	35.63	0.42	0.02	0.83	0.33	13.02	0.33	0.03	1.10	0.36	24.60	0.34	0.03	4.20	0.75	33.2	0.55
Bacteria																																									
Coliform, Fecal (CFU/100 ml)	345/345	100	13,722	13,833	1,300,000	9/17/21	80	1,300,000	37,092	1,891,680	3,500	80	160,000	11,190	760,940	3,500	230	80,000	5,623	286,790	2,200	130	280,000	8,716	627,580	2,400	170	49,000	6,725	262,290	2,400	50	240,000	14,737	943,160	2,300	220	170,000	11,972	-	3,150
E.Coli (CFU/100 ml)	87/87	100	15,502	18,836	240,000	9/17/21	90	33,000	11,027	77,190	11,000	1,300	7,900	4,480	22,400	4,900	1,100	14,000	4,214	29,500	2,800	790	140,000	25,532	153,190	3,150	130	8,000	2,369	16,580	1,300	5	240,000	38,606	270,244	3,500	1	110,000	22,284	1,069,608	2,500
Enterococci (CFU/100 ml)	57/47	121	63,873	63,312	820,000	9/17/21	6,200	210,000	40,543	283,800	9,300	3,700	350,000	78,500	471,000	21,500	3,400	110,000	20,714	145,000	4,500	3,100	220,000	36,429	255,000	6,700	3,000	110,000	23,514	164,600	10,000	1,500	820,000	171,771	1,202,400	48,000	2,200	410,000	75,643	453,857	13,000
BTEX																																									
Benzene (ug/L)	25/269	9	0.1	0.1	1.2	5/5/15	0.1	1.2	0.1	5.7	0.1	0.1	1.2	0.3	12.0	0.1	0.1	0.1	0.1	4.6	0.1	0.1	0.3	0.1	5.0	0.1	0.1	0.1	0.1	3.5	0.1	0.1	0.1	0.1	4.2	0.1	0.1	0.1	0.1	0.6	0.1
Ethylbenzene (ug/L)	19/270	7	0.1	0.1	0.8	11/21/14	0.1	0.4	0.1	5.1	0.1	0.1	0.4	0.1	6.0	0.1	0.1	0.1	0.1	4.6	0.1	0.1	0.8	0.1	5.5	0.1	0.1	0.1	0.1	3.5	0.1	0.1	0.1	0.1	4.2	0.1	0.1	0.1	0.1	0.7	0.1
m,p-Xylene (ug/L)	10/263	4	0.2	0.2	3.5	11/21/14	0.2	1.1	0.2	11.4	0.2	0.2	0.6	0.2	10.4	0.2	0.2	0.2	0.2	9.2	0.2	0.2	3.5	0.3	12.9	0.2	0.2	0.6	0.2	7.4	0.2	0.2	0.2	0.2	8.4	0.2	0.2	0.2	0.2	0.0	0.2
o-Xylene (ug/L)	10/307	3	0.1	0.1	1.6	11/21/14	0.1	0.5	0.1	5.7	0.1	0.1	0.1	0.1	4.6	0.1	0.1	0.1	0.1	4.6	0.1	0.1	1.6	0.1	6.3	0.1	0.1	0.1	0.1	3.5	0.1	0.1	0.1	0.1	4.2	0.1	0.1	0.1	0.1	4.4	0.1
Toluene (ug/L)	78/307	25	0.2	0.2	4.0	11/21/14	0.1	1.2	0.2	8.1	0.1	0.1	1.2	0.2	7.9	0.1	0.1	0.8	0.1	5.7	0.1	0.1	4.0	0.2	8.8	0.1	0.1	0.5	0.1	4.5	0.1	0.1	0.5	0.1	4.9	0.1	0.1	1.0	0.2	7.1	0.1

Notes:
1 = PAH summations based on 1/2 detection limit for nondetects.
2 = Calculation of Total LPAHs does not include 2-Methylnaphthalene.
3 = Phthalate summations exclude nondetect values.
4 = Overall data arithmetic mean is average of individual outfall means.
5 = Overall data weighted mean is average of all sample results.

(green) Highest average or highest median concentration detected in Years 1-18 monitoring.
(orange) Highest maximum concentration detected in Years 1-18 monitoring.

Table 3-3.2
Summary Statistics for SSPM

	Overall Data								OF230					OF235					OF237A New					OF237B					OF243					OF245				
	Overall Detections	% Detections	Arithmetic Mean[4]	Weighted Mean[5]	Highest Mean	Highest Median	Max	Date of Max	Min	Max	Arithmetic Mean	Weighted Mean	Median	Min	Max	Arithmetic Mean	Weighted Mean	Median	Min	Max	Arithmetic Mean	Weighted Mean	Median	Min	Max	Arithmetic Mean	Weighted Mean	Median	Min	Max	Arithmetic Mean	Weighted Mean	Median	Min	Max	Arithmetic Mean	Weighted Mean	Median
Conventionals																																						
Total Organic Carbon (mg/Kg)	123/123	100	N/A	N/A	8	8	17	2021	2.64	13.5	6.6	138.8	6	3.45	8	6	118.2	6	2.86	17	7	144.4	6	0.572	11	3	62.0	2	3.71	14	8	138.3	8	0.933	14	5	107.8	4
Total Solids (%)	127/127	100	N/A	N/A	71	71	92	2021	30.1	65	51	1,072.5	51	54.5	73	64	1,333.7	63	48.6	92	62	1,292.7	61	56.6	83	71	1,484.4	71	18.6	47	32	667.2	31	43.8	81	66	1,459.6	69
Total Volatile Solids (%)	48/48	100	N/A	N/A	21	21	31	2022	6.1	22	13	103.0	11	10.4	15	13	101.2	13	8.8	19	13	107.8	14	3.1	6	5	36.9	5	17	25	21	165.2	21	3	31	14	108.5	12
Nutrients																																						
Phosphorus, Total (mg/Kg)	45/45	100	2271	2005	8892	9570	13700	2021	543	1560	1034	7,239	1110	549	1180	883	7,066	899	584	1880	1016	8,126	867	375	658	525	4,196	520	1900	13700	8892	53,350	9570	587	3290	1280	10,236	967
Metals in ug/L																																						
Cadmium (mg/Kg dry)	55/55	100	1.1	1.1	3.3	2.9	5.6	2011	0.286	0.926	0.535	3.744	0.502	0.057	0.819	0.465	4.648	0.575	0.399	0.853	0.577	5.189	0.538	0.034	2.030	0.518	5.179	0.363	1.790	5.550	3.271	29.44	2.870	0.541	1.800	1.059	10.59	0.881
Copper (mg/Kg dry)	56/56	100	112.4	113.0	224.8	224.0	288.0	2011	48.2	132	79	553.7	81	84.4	173	127	1,274	131	57.7	100	79	709	70	30.9	64	43	433	40	174	288	225	2,023	224	45.2	276	121	1,334.2	114
Lead (mg/Kg dry)	122/122	100	176.0	163.6	515.8	433.0	1420.0	2006	56.9	1420	208.8	4,176.7	143.5	88.2	286	151.5	3,181	144.0	50.9	114.0	83.4	1,752	80.8	20.6	129.0	47.7	1,003	41.7	343.0	913.0	515.8	8,769	433.0	8.3	98.4	48.8	1,072.6	48
Mercury (mg/Kg dry)	121/123	98	0.2	0.1	0.4	0.3	1.4	2008	0.0328	0.827	0.179	3.582	0.124	0.0479	1.35	0.142	2.983	0.078	0.029	0.129	0.067	1.397	0.066	0.0155	0.162	0.046	0.971	0.040	0.206	0.972	0.419	7.540	0.316	0.0075	0.211	0.069	1.510	0.054
Zinc (mg/Kg dry)	122/122	100	464.9	453.6	758.7	764.0	3200.0	2007	225	3200	632	12,642.0	440	219	789	433	9,101	377	220	492	348	7,299	327	123	277	195	4,102	192	440	936	759	12,898	764	80.9	679	422	9,293	439
TPH																																						
NWTPH-Diesel (mg/Kg)	102/126	81	189	190	348	200	2400	2001	7.2	960	168	3,523.2	120	9.5	1000	166	3,487.5	130	9.5	780	143	3,005	130	1.55	780	81	1,707	39	10	670	231	4,610	200	1.55	2400	348	7,646	155
NWTPH-Heavy Oil (mg/Kg)	126/126	100	3045	3036	4350	4100	10000	2001	25	8300	3628	76,195	3300	1600	4700	3038	63,800	2600	1400	4300	2781	58,400	2500	520	3000	1296	27,220	1200	1700	7400	4350	87,000	4100	230	10000	3177	69,900	2950
PAHs																																						
LPAHs																																						
2-Methylnaphthalene (ug/Kg)	81/126	64	74	74	117	106	355	2001	20.5	310	94	1982	72	25	150	74	1,547	65	2.5	184	72	1,518	54	3.5	120	34	720	32	29	260	117	2,341	106	8.5	355	55	1,218	36
Acenaphthene (ug/Kg)	84/126	67	74	74	128	127	350	2009	6.5	350	128	2691.5	127	18	270	68	1,419	50	11	300	94	1,970	66	3.5	170	48	1,008	28	6.5	211	64	1,283	50	6.5	248	41	903	29
Acenaphthylene (ug/Kg)	47/126	37	38	38	64	50	179	2010,11,12	14	93	44	920	40	8.5	179	37	786	28	2.5	50	30	627	28	4.5	50	26	536	17	16	130	64	1,287	50	7	115	30	650	21
Anthracene (ug/Kg)	111/126	88	232	231	334	320	1660	2001	26	640	298	6251	320	35	430	183	3,833	170	43	890	334	7,010	319	7.5	500	123	2,580	39	40	1000	308	6,163	295	7.5	1660	148	3,249	44
Fluorene (ug/Kg)	94/126	75	105	105	178	170	577	2020	24	577	178	3740	170	23	270	88	1,846	58	18	270	139	2,928	130	4	240	63	1,318	29	15	330	111	2,218	90	9.5	260	53	1,173	30
Naphthalene (ug/Kg)	92/126	73	102	101	183	170	480	2020	45	480	136	2866	120	25	251	89	1,867	79	13	220	103	2,154	110	4	160	38	802	30	52	393	183	3,656	170	9.5	150	61	1,336	51
Phenanthrene (ug/Kg)	124/126	98	1307	1301	2381	2400	5400	2009	238	5400	2381	50003	2400	263	2400	1056	22,185	966	247	4600	2241	47,066	2190	36	3500	927	19,458	559	134	2900	968	19,354	730	8.5	1410	267	5,863	163
Total LPAHs[1,2]	53/126	42	1977	1969	3637	3370	16513		406	6935	3166	66486	3370	476.5	3550	1539	32,316	1393	417.5	16513	3637	76,378	3040	82	4509	1224	25,701	802	264.5	4830	1698	33,961	1359	95	3726	601	13,219	329
HPAHs																																						
Benzo(a)anthracene (ug/Kg)	121/126	96	925	922	1764	1700	3740	2001	128	3400	1580	33180	1700	120	1300	606	12,719	550	194	3700	1764	37,034	1600	52	2200	579	12,156	357	91	1700	715	14,293	644	12.5	3740	310	6,820	84
Benzo(a)pyrene (ug/Kg)	120/126	95	937	933	1800	1710	5870	2014	253	5870	1800	37807	1600	184	1100	598	12,558	560	260	3300	1733	36,389	1710	62	2200	561	11,788	328	112	1200	705	14,102	650	22	2240	225	4,945	102
Benzo(b,k)fluoranthenes (ug/Kg)	124/126	98	873	869	1708	1400	9300	2021	78	3000	1431	30059	1200	176	1600	514	10,790	343	180	9300	1708	35,874	1400	47	2900	697	14,628	260	157	2100	683	13,663	515	34	1660	203	4,459	116
Benzo(g,h,i)perylene (ug/Kg)	122/126	97	2401	2389	4810	4530	17900	2010	641	17900	4810	101003	4530	439	2700	1354	28,439	1300	721	8500	4338	91,108	4220	147	7300	1696	35,610	900	287	4200	1859	37,176	1810	49.5	1870	347	7,631	192
Chrysene (ug/Kg)	125/126	99	1439	1432	2664	2500	6900	2004	283	5000	2302	48340	2310	297	1800	948	19,905	990	305	6900	2664	55,934	2500	68	3000	836	17,558	514	184	2400	1350	27,001	1300	49.5	6490	533	11,727	175
Dibenz(a,h)anthracene (ug/Kg)	96/126	76	236	235	480	360	2800	2005	22	2700	433	9086.5	342	15.5	900	125	2,627	75	37	2800	480	10,087	360	5.5	410	126	2,656	64	23	1700	189	3,782	103	8	616	61	1,348	33
Fluoranthene (ug/Kg)	125/126	99	1996	1987	3638	4000	7700	2005	368	6800	3621	76033	4000	432	2650	1359	28,542	1200	671	7700	3638	76,401	3750	77	4700	1396	29,307	1010	186	3770	1522	30,436	1450	49.5	3840	441	9,693	210
Indeno(1,2,3-c,d)pyrene (ug/Kg)	114/126	90	668	665	1399	1300	4260	2014	122	4260	1399	29377	1300	86.5	930	361	7,574	315	205	2800	1297	27,247	1300	65	1600	436	9,155	255	50	950	419	8,384	390	23.5	608	94	2,079	50
Pyrene (ug/Kg)	125/126	99	2515	2505	4217	4500	12100	2001	388	9400	4172	87602	4500	560	4200	1862	39,103	1900	551	9500	4217	88,551	4150	73	7400	1580	33,184	832	316	5700	2283	45,660	1865	49.5	12100	979	21,537	365
Retene	11/12	92	100	100	307	307	475	2022	31	42	37	73	37	73	119	96	192	96	138	475	307	613	307	16	22	19	38	19	70	154	112	224	112	22	34	28	56	28
Total HPAHs[1]	53/126	42	11964	11912	21568	21660	45680		2625	45680	21547	452487.5	21400	2913.5	14070	7846	164,763	7631	3305	40020	21568	452,930	21660	636	28310	7907	166,042	4454	1537	18206	9725	194,497	8750	420	33164	3193	70,245	1468
Total PAHs	126/126	100	13942	13881	25205	25345	49053		3030.5	49053	24713	518973	24780	3390	17620	9385	197,079	9529	3740	45870	25205	529,307	25345	718	32819	9131	191,743	5256	1801.5	20550	11423	228,457	11075	515	36890	3794	83,464	1827
Phthalates																																						
bis(2-Ethylhexyl)phthalate (ug/Kg)	125/126	99	11499	11456	16726	15300	43000	2008	3530	43000	16726	351240	15300	1600	22000	12704	266,790	13000	1300	24000	9584	201,260	6900	1360	17000	4193	88,060	3040	1830	41000	15565	311,300	13400	1150	34000	10220	224,850	4865
Butyl benzyl phthalate (ug/Kg)	124/126	98	6180	6315	25434	11000	160000	2003	42	4700	1012	21256	606	267	3800	1237	25,981	1200	140	2200	790	16,587	650	16	1700	296	6,216	149	150	51000	8308	166,168	3000	2500	160000	25434	559,540	11000
Diethylphthalate (ug/Kg)	35/126	28	52	53	77	46	820	2001	17	170	46	956.5	46	14	89	39	826	35	3.5	250	51	1,061	42	6.5	190	39	825	26	10.5	269	63	1,270	40	7.5	820	77	1,690	30
Dimethyl phthalate (ug/Kg)	78/126	62	246	249	505	109	9810	2001	3	1200	138	2897.5	50	43	310	105	2,214	81	15	2200	232	4,873	109	3	7200	387	8,133	24	13	390	106	2,121	55	4.5	9810	505	11,101	50
Di-n-butylphthalate (ug/Kg)	108/126	86	393	400	1121	250	15000	2003	15.5	2400	437	9187	250	41	370	187	3,919	170	49.5	731	273	5,734	232	10	490	106	2,226	60	15.5	725	233	4,654	186	48	15000	1121	24,663	225
Di-n-Octyl phthalate (ug/Kg)	89/126	71	932	927	1696	1000	9290	2014	7	9290	1696	35619	1000	14.5	2800	875	18,382	945	11.5	4800	966	20,283	920	7	2000	518	10,885	594	7	4000	1105	22,104	733	14.5	4250	431	9,475	132
Total Phthalates[3]	126/126	100	19224	19322	37648	19148	207260		3603	48810	19977	419524	17970	2960	28880	15095	316,998	16670	1664	31210	11836	248,550	10054	1568	21060	5475	114,967	3713	1993	96420	25314	506,282	19148	5333	207260	37648	828,246	14662
Insecticides																																						
Bifenthrin (ug/Kg)	47/48	98	18	18	32	33	142	2015	5	142	32	253	20	7	24	14	114	14	12	44	32	255	33	2	21	9	74	7	2	29	14	111	15	0.3	9	4	33	3
PCBs																																						
Aroclor-1016 (ug/Kg)	6/120	5	8.1	8.0	11.4	5	80	2015	0.32	40	8	170.48	5	0.315	40	8	176.5	5	0.5	40	8	178	4	0.5	40	8	170	4	0.5	80	11	181.8	3	0.5	17	4	81.2	3
Aroclor-1221 (ug/Kg)	7/120	6	8.6	8.5	11.4	5	80	2006	0.32	49	10	200.48	5	0.315	40	9	181.0	5	0.5	40	9	187	5	0.5	40	8	177	5	0.5	80	11	181.8	3	0.5	17	5	94.7	5
Aroclor-1232 (ug/Kg)	7/120	6	8.8	8.8	11.4	5	80	2006	0.32	74	11	223.98	5	0.315	40	9	180.0	5	0.5	49	10	206	5	0.5	40	8	173	4	0.5	80	11	181.8	3	0.5	17	4	86.7	3
Aroclor-1242 (ug/Kg)	8/120	7	12.4	12.5	28.4	4	420	2020	0.32	40	8	172.08	3	0.315	420	28	595.4	4	0.4	40	9	179	4	0.4	40	8	172	3	0.35	80	11	183.4	3	0.4	120	10	197.8	3
Aroclor-1248 (ug/Kg)	6/120	5	8.7	8.6	11.9	4	80	2015	0.32	40	9	184.42	4	0.315	40	9	187.2	4	0.4	40	9	191	4	0.4	40	9	183	4	0.35	80	12	189.7	3	0.4	17	5	94.6	3
Aroclor-1254 (ug/Kg)	44/120	37	59.7	60.5	193.3	119	581	2005	0.40	581	193	4058.65	119	0.5	280	36	761.0	19	0.4	390	50	1053	10	0.4	43	10	218	4	0.35	220	48	771.7	7	0.4	140	20	402.6	8
Aroclor-1260 (ug/Kg)	27/119	23	32.1	32.9	87.0	19	910	2020	0.32	910	87	1827.02	10	0.315	44	12	253.2	6	0.5	150	43	908	19	0.4	45	13	272	10	0.35	96	16	257.7	4	0.5	180	21	401.2	5
TOTAL PCBs[6]	52/117	44	84.9	80.4	276.3	220	910	2021	0.00	910	276	5802.90	220	0	420	54	1,134	0	0	390	81	1,695	64	0	88	9	0	0	0	220	49	0	0	0	440	41	773	0
Herbicides																																						
Dichlobenil (ug/L)	12/12	100	15.4	13.1	27.0	27	41	2022	21.00	33	27	54.00	27	6	41	24	47.00	24	19	25	22	44.00	22	2	2	2	4.00	2	2	6	4	4.0	4	10	18	14	4.0	14
Phenolics																																						
2-Methylphenol (ug/Kg dry)	8/21	38	23.9	26.6	39.5	25	119	8/25/2011	3.50	19	11	22.50	11	19	67	33	163.0	25	19	19	19	38	19	15.5	33	22	112	19	19	19	19	111.7	19	15.5	119	40	111.7	19
4-Methylphenol (ug/Kg dry)	30/38	79	669.3	533.4	1391.4	691	5400	4/28/2003	85.00	2300	862	3446.00	531	44	440	215	1721.0	175	56	4700	1391	6957	691	19	900	339	2715	273	14	5400	1161	2715.0	100	10	115	47	2715.0	37
Pentachlorophenol (ug/Kg dry)	11/18	61	900.8	1114.4	4497.0	490	17800	8/15/2012	149.00	830	490	979.00	490	5.5	17800	4497	17988.0	91	158	190	174	348	174	5.5	204	62	248	19	106	162	134	248.2	134	5.5	111	48	248.2	38

Notes:

1 = PAH summations based on 1/2 detection limit for nondetects.
2 = Calculation of Total LPAHs does not include 2-Methylnaphthalene.
3 = Phthalate summations exclude nondetect values.
4 = Overall data arithmetic mean is average of individual outfall means.
5 = Overall data weighted mean is average of all sample results.
6 = Calculation for PCBs is based on one-half detection limit for nondetected values. Maximum detected value is shown as the maximum.

Highest average or highest median concentration detected in Years 1-21 monitoring. (green)
Highest maximum concentration detected in Years 1-21 monitoring. (orange)

OF237A New location includes data from old OF 237A sampling location for all data collected prior to 2/26/06.

Table 3-4
Spatial Analysis of Stormwater Quality (ANOVA Results)

A. Parametric Outfall Pair Comparisons, Years 1-21							
Analyte	**OF230**	**OF235**	**OF237A**	**OF237B**	**OF243**	**OF245**	**OF254**
TSS	-3	-1	-2	-2	0	2	6
Total Copper [1]	-3	6	-4	-5	3	1	2
Total Lead	1	6	-3	-4	4	-4	0
Total Zinc	1	2	-1	-6	-3	4	3
DEHP	5	5	-1	-2	-5	-1	-1
Phenanthrene	1	0	1	-5	-1	1	3
Pyrene	0	2	3	-4	-2	-3	4
Indeno(1,2,3-c,d)pyrene	2	0	5	-1	0	-6	0

B. Parametric Outfall Pair Comparisons, Year 20-21							
Analyte	**OF230**	**OF235**	**OF237A**	**OF237B**	**OF243**	**OF245**	**OF254**
TSS	-1	-1	0	-2	0	1	3
Total Copper	-2	4	-2	-6	4	-2	4
Total Lead	1	6	0	-3	1	-4	-1
Total Zinc	1	1	1	-6	1	1	1
DEHP	3	2	2	-2	-6	0	1
Phenanthrene	1	-1	4	-4	0	-1	1
Pyrene	0	0	5	-4	-1	-1	1
Indeno(1,2,3-c,d)pyrene	0	0	6	-1	-1	-3	-1

[1] Stormwater analysis for copper was performed initially for OF235, OF237B and OF245 from WY2010 to WY2012, and began again in WY2015. Therefore, the ANOVA data set for these outfalls includes eleven years of non-sequential data. Stormwater analysis for OF230, OF237A, OF243 and OF254 began in WY2015 and have eight years of data. Therefore, copper results are not comparable to other results.

Key:
- *Well Below Average (-6 to -3)*
- *Below Average (-2 to -1)*
- *Neutral (0)*
- *Above Average (1 to 2)*
- *Well Above Average (3 to 6)*

Table 3-5
Spatial Analysis of Storm Sediment Quality (ANOVA Results)

A. Nonparametric Outfall Pair Comparisons, Years 1-21						
Analyte	**OF230**	**OF235**	**OF237A**	**OF237B**	**OF243**	**OF245**
Copper	-1	1	-1	-3	3	1
Lead	2	2	-1	-3	3	-3
Mercury	1	0	-1	-3	4	-1
Zinc	1	0	0	-5	4	0
TPH-OIL	1	1	1	-5	1	1
Bifenthrin	0	0	2	-1	0	-1
Phenanthrene	2	1	2	-2	1	-4
Indeno(1,2,3-cd)pyrene	3	-1	4	-1	0	-5
Pyrene	2	1	2	-2	1	-4
Total PCBs	1	0	0	-1	0	0
DEHP	1	1	0	-3	1	0
Butylbenzylphthalate	-1	0	-2	-3	2	4
Total Phthalates	1	1	0	-4	1	1

B. Nonparametric Outfall Pair Comparisons, Years 17-21						
Analyte	**OF230**	**OF235**	**OF237A**	**OF237B**	**OF243**	**OF245**
Copper	0	0	0	-1	1	0
Lead	0	1	0	-2	2	-1
Mercury	0	0	0	-1	1	0
Zinc	0	0	0	-1	1	0
TPH-OIL	0	0	0	-1	1	0
Bifenthrin	0	0	1	0	0	-1
Phenanthrene	0	0	2	-1	0	-1
Indeno(1,2,3-cd)pyrene	1	0	1	0	0	-2
Pyrene	0	0	2	-1	0	-1
Total PCBs	No Significant Differences					
DEHP	0	0	0	0	0	0
Butylbenzylphthalate	0	0	0	-1	0	1
Total Phthalates	0	0	0	0	0	0

Key:

Well Below Average (-6 to -3)
Below Average (-2 to -1)
Neutral (0)
Above Average (1 to 2)
Well Above Average (3 to 6)

Table 3-6
Regression Statistics of Stormwater Time Trends

Analyte	Outfall Number	Sample Count	S_x	S_y^2	slope	y-intercept	R^2	t - statistic	Significance Level	Year 1 Concentration (log)	Present Year Concentration (log)	Year 1 Concentration	Present Year Concentration (log)	Est % Reduction Over Study Period
Total Suspended Solids	OF230	193	2298	0.125	-0.00004	2.99	0.053	-3.28	99.9%	1.68	1.41	48.0	25.7	47%
	OF235	225	2233	0.121	-0.00009	5.15	0.306	-9.92	>99.9%	1.97	1.31	93.2	20.3	78%
	OF237A*	197	2231	0.102	-0.00004	3.24	0.083	-4.21	>99.9%	1.72	1.40	52.4	25.3	52%
	OF237B	200	2254	0.117	-0.00007	4.57	0.235	-7.80	>99.9%	1.85	1.29	71.0	19.4	73%
	OF243	134	2364	0.131	-0.00004	3.39	0.076	-3.30	99.9%	1.83	1.51	67.6	32.0	53%
	OF245	192	2300	0.099	-0.00004	3.44	0.099	-4.56	>99.9%	1.85	1.52	71.4	33.5	53%
	OF254	162	2305	0.096	-0.00003	3.02	0.045	-2.74	99.3%	1.96	1.75	92.3	55.7	40%
Copper [1]	OF235	145	1489	0.053	-0.00005	3.65	0.121	-4.44	>99.9%	1.52	1.26	32.9	18.3	44%
	OF237B	120	1496	0.040	-0.00006	3.54	0.225	-5.85	>99.9%	1.02	0.72	10.4	5.2	50%
	OF245	119	1466	0.055	-0.00004	2.70	0.057	-2.66	99.1%	1.18	1.00	15.3	10.1	34%
Lead	OF230	199	2275	0.133	-0.00009	4.98	0.349	-10.28	>99.9%	1.49	0.76	30.7	5.8	81%
	OF235	230	2212	0.081	-0.00009	5.21	0.456	-13.83	>99.9%	2.00	1.34	101.0	21.8	78%
	OF237A*	198	2232	0.099	-0.00007	3.83	0.249	-8.07	>99.9%	1.23	0.69	16.8	4.8	71%
	OF237B	210	2255	0.130	-0.00010	4.96	0.392	-11.59	>99.9%	1.26	0.49	18.2	3.1	83%
	OF243	137	2352	0.235	-0.00009	4.90	0.185	-5.53	>99.9%	1.63	0.95	42.4	8.9	79%
	OF245	199	2292	0.117	-0.00009	4.41	0.336	-9.99	>99.9%	1.22	0.55	16.5	3.6	78%
	OF254	165	2295	0.122	-0.00009	4.69	0.344	-9.24	>99.9%	1.40	0.72	25.1	5.2	79%
Zinc	OF230	199	2275	0.056	-0.00004	3.62	0.151	-5.91	>99.9%	2.13	1.82	133.8	65.6	51%
	OF235	229	2213	0.060	-0.00006	4.35	0.273	-9.23	>99.9%	2.21	1.77	162.3	58.3	64%
	OF237A*	198	2232	0.050	-0.00005	3.82	0.220	-7.42	>99.9%	2.09	1.73	123.2	53.9	56%
	OF237B	211	2249	0.066	-0.00006	4.11	0.264	-8.67	>99.9%	1.95	1.49	88.1	31.2	65%
	OF243	137	2352	0.072	-0.00005	3.93	0.195	-5.72	>99.9%	2.07	1.68	117.3	48.2	59%
	OF245	198	2298	0.075	-0.00006	4.52	0.258	-8.25	>99.9%	2.29	1.82	192.8	66.2	66%
	OF254	165	2295	0.061	-0.00007	4.88	0.424	-10.96	>99.9%	2.29	1.76	196.8	57.1	71%
Phenanthrene	OF230	199	2275	0.218	-0.00010	2.53	0.215	-7.35	>99.9%	-0.98	-1.72	0.104	0.019	81%
	OF235	231	2215	0.264	-0.00012	3.42	0.261	-9.00	>99.9%	-0.95	-1.86	0.112	0.014	88%
	OF237A*	197	2238	0.285	-0.00007	1.38	0.081	-4.14	>99.9%	-1.12	-1.64	0.076	0.023	70%
	OF237B	212	2252	0.203	-0.00010	2.57	0.258	-8.55	>99.9%	-1.19	-1.97	0.065	0.011	83%
	OF243	137	2352	0.141	-0.00007	1.38	0.188	-5.59	>99.9%	-1.18	-1.71	0.067	0.020	71%
	OF245	197	2295	0.164	-0.00008	1.98	0.224	-7.51	>99.9%	-1.10	-1.74	0.080	0.018	77%
	OF254	164	2292	0.166	-0.00009	2.43	0.263	-7.61	>99.9%	-0.93	-1.63	0.116	0.023	80%
Pyrene	OF230	199	2275	0.299	-0.00011	3.20	0.196	-6.94	>99.9%	-0.73	-1.55	0.186	0.028	85%
	OF235	231	2215	0.218	-0.00010	2.98	0.216	-8.05	>99.9%	-0.67	-1.44	0.211	0.037	83%
	OF237A*	197	2238	0.284	-0.00009	2.50	0.131	-5.43	>99.9%	-0.68	-1.34	0.208	0.045	78%
	OF237B	212	2252	0.256	-0.00011	3.20	0.240	-8.15	>99.9%	-0.86	-1.71	0.137	0.020	86%
	OF243	137	2352	0.150	-0.00007	1.83	0.202	-5.85	>99.9%	-0.90	-1.47	0.126	0.034	73%
	OF245	197	2295	0.178	-0.00006	1.32	0.120	-5.16	>99.9%	-1.03	-1.52	0.093	0.030	68%
	OF254	164	2292	0.288	-0.00013	4.24	0.299	-8.31	>99.9%	-0.48	-1.46	0.329	0.034	90%
Indeno(1,2,3-c,d)pyrene	OF230	199	2275	0.375	-0.00009	2.15	0.120	-5.19	>99.9%	-1.30	-2.02	0.050	0.010	81%
	OF235	231	2215	0.296	-0.00008	1.57	0.108	-5.27	>99.9%	-1.41	-2.03	0.039	0.009	76%
	OF237A*	197	2238	0.388	-0.00003	-0.26	0.012	-1.57	88.2%	-1.41	-1.64	0.039	0.023	42%
	OF237B	212	2252	0.311	-0.00010	2.15	0.156	-6.24	>99.9%	-1.46	-2.21	0.035	0.006	82%
	OF243	137	2352	0.247	-0.00006	0.55	0.076	-3.34	99.9%	-1.61	-2.05	0.025	0.009	64%
	OF245	197	2295	0.195	-0.00008	1.16	0.167	-6.25	>99.9%	-1.74	-2.35	0.018	0.005	75%
	OF254	164	2292	0.261	-0.00010	2.47	0.216	-6.67	>99.9%	-1.35	-2.14	0.045	0.007	84%
Bis(2-ethylhexyl)phthalate	OF230	198	2268	0.151	-0.00006	2.90	0.135	-5.52	>99.9%	0.59	0.11	3.9	1.3	67%
	OF235	230	2208	0.165	-0.00010	4.33	0.273	-9.25	>99.9%	0.78	0.04	6.0	1.1	82%
	OF237A *	196	2231	0.121	-0.00004	1.74	0.061	-3.55	>99.9%	0.32	0.02	2.1	1.1	49%
	OF237B	211	2246	0.152	-0.00007	3.08	0.175	-6.66	>99.9%	0.40	-0.16	2.5	0.7	72%
	OF243	136	2343	0.175	-0.00008	3.22	0.190	-5.61	>99.9%	0.35	-0.24	2.3	0.6	75%
	OF245	195	2294	0.142	-0.00007	3.20	0.201	-6.97	>99.9%	0.48	-0.09	3.0	0.8	73%
	OF254	164	2292	0.147	-0.00004	1.70	0.050	-2.91	99.6%	0.32	0.03	2.1	1.1	48%

237A - Includes data from 237A New site for all samples collected after 2/26/06.*

[1] Copper was added as a key constituent for stormwater and SSPM in the 2014 QAPP. Analysis for copper in stormwater began for OF235, OF237B and OF245 in WY2010 under the NPDES program, and continued through WY2012. Under the 2014 QAPP, analysis began for all of the outfalls in WY2015.

Table 6-1.1
Mass Loading Summary for OF230

	Conventals/Nutrients							Metals							LPAHs				
	TSS (mg/L)	MBAS (mg/L)	BOD_5 (mg/L)	Total P (mg/L)	Ortho-P (mg/L)	TN (mg/L)	Nitrate/ Nitrite (mg/L)	Total Cu (ug/L)	Dissolved Cu (ug/L)	Total Zn (ug/L)	Dissolved Zn (ug/L)	Total Cd (ug/L)	Total Pb (ug/L)	Dissolved Pb (ug/L)	2-Methyl-naphthalene (ug/L)	Anthracene (ug/L)	Naphthalene (ug/L)	Phenanthrene (ug/L)	Total LPAHs (ug/L)
Baseflow																			
Mean WY2011,2016&2019 Conc.	5.34	0.07	1.78	0.13	0.12	1.09	1.00	5.00	3.19	29.41	14.34	0.03	1.22	0.18	0.007	0.005	0.015	0.016	0.047
Number of Detects	7	4	1	6	6	6	6	7	7	7	7	2	7	6	2	1	6	7	7
Number of Samples	7	5	5	6	6	6	6	7	7	7	7	7	7	7	7	7	7	7	7
Detection Frequency	100%	80%	20%	100%	100%	100%	100%	100%	100%	100%	100%	29%	100%	86%	29%	14%	86%	100%	100%
Stormwater																			
Mean Annual Concentration	34.39	0.04	2.46	0.10	0.02	0.44	0.10	8.39	3.12	66.89	32.64	0.06	8.08	0.50	0.036	0.006	0.051	0.045	0.119
Number of Detects	12	9	8	11	11	10	11	12	12	12	12	3	12	12	8	3	7	11	11
Number of Samples	12	9	9	11	11	11	11	12	12	12	12	12	12	12	12	12	11	12	11
Detection Frequency	100%	100%	89%	100%	100%	91%	100%	100%	100%	100%	100%	25%	100%	100%	67%	25%	64%	92%	100%
Stormwater / Baseflow Concentration	6.44	0.543	1.38	0.77	0.21	0.40	0.10	1.68	0.98	2.27	2.28	1.88	6.64	2.75	5.15	1.22	3.30	2.88	2.52
Wet Season Load (Pounds)																			
Baseflow	2,141	28.02	714	51.3	46.3	438	400	2.0	1.3	11.8	5.8	0.01	0.5	0.1	0.003	0.002	0.006	0.006	0.019
Stormwater	48,764	53.81	3,487	139.8	34.7	617	141.7	11.9	4.4	94.8	46.3	0.08	11.5	0.7	0.051	0.008	0.072	0.064	0.168
Subtotal:	50,905	81.84	4,201	191	81	1,056	542	13.9	5.7	106.6	52.0	0.10	11.9	0.8	0.054	0.010	0.078	0.070	0.187
Dry Season Load (Pounds)																			
Baseflow	1,545	20.22	515	37.0	33.4	316	289	1.4	0.9	8.5	4.2	0.01	0.4	0.1	0.002	0.001	0.004	0.005	0.014
Stormwater	8,627	9.52	617	24.7	6.1	109.2	25.1	2.1	0.8	16.8	8.2	0.01	2.0	0.1	0.009	0.001	0.013	0.011	0.030
Subtotal:	10,173	29.74	1,132	61.7	39.6	426	314	3.6	1.7	25.3	12.3	0.02	2.4	0.2	0.011	0.003	0.017	0.016	0.043
Total Annual Load (Pounds)																			
Baseflow	3,686	48.25	1,229	88.3	79.8	755	689	3.5	2.2	20.3	9.9	0.02	0.8	0.1	0.005	0.003	0.011	0.011	0.032
Stormwater	57,391	63.33	4,104	164.6	40.9	726	167	14.0	5.2	111.6	54.5	0.10	13.5	0.8	0.060	0.010	0.084	0.075	0.198
Grand Total: (Pounds)	61,078	111.58	5,333	252.9	120.6	1,481	856	17.4	7.4	131.9	64.4	0.12	14.3	1.0	0.065	0.013	0.095	0.086	0.230
Stormflow Percent of Annual Load	94%	57%	77%	65%	34%	49%	19%	80%	70%	85%	85%	82%	94%	87%	93%	75%	89%	87%	86%
Wet Season Percent of Annual Load	83%	73%	79%	76%	67%	71%	63%	80%	77%	81%	81%	80%	83%	81%	83%	78%	82%	82%	81%
Wet Season Load Density (Pounds per Acre)																			
Baseflow	3.8	0.050	1.3	0.09	0.08	0.79	0.72	0.0036	0.0023	0.0212	0.0103	0.000023	0.0009	0.0001	0.000005	0.000003	0.000011	0.000011	0.000034
Stormwater	87.5	0.097	6.3	0.25	0.06	1.11	0.25	0.0213	0.0079	0.1703	0.0831	0.000151	0.0206	0.0013	0.000092	0.000015	0.000129	0.000114	0.000302
Subtotal:	91.4	0.147	7.5	0.34	0.15	1.90	0.97	0.0249	0.0102	0.1915	0.0934	0.000173	0.0214	0.0014	0.000097	0.000019	0.000140	0.000125	0.000336
Dry Season Load Density (Pounds per Acre)																			
Baseflow	2.8	0.036	0.9	0.07	0.06	0.57	0.52	0.0026	0.0017	0.0153	0.0075	0.000016	0.0006	0.0001	0.000004	0.000003	0.000008	0.000008	0.000024
Stormwater	15.5	0.017	1.1	0.04	0.01	0.20	0.04	0.0038	0.0014	0.0301	0.0147	0.000027	0.0036	0.0002	0.000016	0.000003	0.000023	0.000020	0.000053
Subtotal:	18.3	0.053	2.0	0.11	0.07	0.76	0.56	0.0064	0.0031	0.0454	0.0222	0.000043	0.0043	0.0003	0.000020	0.000005	0.000031	0.000028	0.000078
Total Annual Load Density (Pounds per Acre)																			
Baseflow	6.6	0.087	2.2	0.16	0.14	1.36	1.24	0.0062	0.0040	0.0365	0.0178	0.000039	0.0015	0.0002	0.000009	0.000006	0.000019	0.000019	0.000058
Stormwater	103.0	0.114	7.4	0.30	0.07	1.30	0.30	0.0251	0.0093	0.2004	0.0978	0.000177	0.0242	0.0015	0.000108	0.000018	0.000151	0.000134	0.000355
Grand Total: (Pounds per Acre)	109.7	0.200	9.6	0.45	0.22	2.66	1.54	0.0313	0.0133	0.2369	0.1156	0.000217	0.0257	0.0017	0.000117	0.000024	0.000170	0.000154	0.000413

Note: Stormwater mass loadings were not calculated for analytical parameters with fewer than 10 percent detected concentrations or only one detected sample in stormwater.

Drainage Area: 557 Acres

Baseflow Detects <3

Stormwater Detects <5

<25% Detection Frequency

	Wet Season	Dry Season
Mean Annual Baseflow (gpm)	157	157
Mean Annual Stormwater (gpm)	556	136

Table 6-1.1 Continued
Mass Loading Summary for OF230

	HPAHs										Phthalates				Herbicide
	Benzo(a)-anthracene (ug/L)	Benzo(a) pyrene (ug/L)	Benzo(g,h,i) perylene (ug/L)	Benzo(b,k)-fluoranthenes (ug/L)	Chrysene (ug/L)	Fluoranthene (ug/L)	Indeno(1,2,3-c,d)pyrene (ug/L)	Pyrene (ug/L)	Retene (ug/L)	Total HPAHs (ug/L)	DEHP (ug/L)	Diethyl-phthalate (ug/L)	Di-n-butyl-phthalate (ug/L)	Total Phthalates (ug/L)	Dichlobenil (ug/L)
Baseflow															
Mean WY2011&2016 Concentration	0.005	0.005	0.005	0.011	0.005	0.008	0.006	0.007	0.003	0.042	0.484	0.601	0.359	1.252	0.043
Number of Detects	1	2	1	3	2	5	1	2	0	4	2	3	2	3	1
Number of Samples	7	7	7	7	7	7	7	7	1	7	7	7	7	7	7
Detection Frequency	14%	29%	14%	43%	29%	71%	14%	29%	0%	57%	29%	43%	29%	43%	14%
Stormwater															
Mean Annual Concentration	0.018	0.024	0.032	0.029	0.039	0.066	0.024	0.069	0.008	0.340	1.334	0.185	0.223	1.535	0.081
Number of Detects	10	10	12	10	11	11	9	11	10	12	12	4	7	12	11
Number of Samples	12	12	12	12	12	12	12	12	12	12	12	12	12	12	11
Detection Frequency	83%	83%	100%	83%	92%	92%	75%	92%	83%	100%	100%	33%	58%	100%	100%
Stormwater / Baseflow Concentration	3.81	4.82	6.49	2.60	8.13	7.99	4.12	9.90	3.13	8.08	2.76	0.31	0.62	1.23	1.88
Wet Season Load (Pounds)															
Baseflow	0.002	0.002	0.002	0.004	0.002	0.003	0.002	0.003	0.001	0.017	0.19	0.24	0.14	0.50	0.017
Stormwater	0.026	0.034	0.045	0.041	0.056	0.093	0.033	0.097	0.011	0.482	1.89	0.26	0.32	2.18	0.115
Subtotal:	0.028	0.036	0.047	0.045	0.058	0.096	0.036	0.100	0.012	0.499	2.09	0.50	0.46	2.68	0.132
Dry Season Load (Pounds															
Baseflow	0.001	0.001	0.001	0.003	0.001	0.002	0.002	0.002	0.001	0.012	0.14	0.17	0.10	0.36	0.012
Stormwater	0.005	0.006	0.008	0.007	0.010	0.016	0.006	0.017	0.002	0.085	0.33	0.05	0.06	0.39	0.020
Subtotal:	0.006	0.007	0.009	0.010	0.011	0.019	0.008	0.019	0.003	0.097	0.47	0.22	0.16	0.75	0.033
Total Annual Load (Pounc															
Baseflow	0.003	0.003	0.003	0.008	0.003	0.006	0.004	0.005	0.002	0.029	0.33	0.41	0.25	0.86	0.030
Stormwater	0.031	0.040	0.053	0.048	0.066	0.110	0.039	0.114	0.013	0.567	2.23	0.31	0.37	2.56	0.135
Grand Total: (Pounds)	0.034	0.043	0.056	0.056	0.069	0.115	0.043	0.119	0.015	0.596	2.56	0.72	0.62	3.43	0.165
Stormflow Percent of Annual Load	90%	92%	94%	86%	95%	95%	91%	96%	88%	95%	87%	43%	60%	75%	82%
Wet Season Percent of Annual Load	82%	83%	83%	81%	84%	84%	83%	84%	82%	84%	81%	70%	74%	78%	80%
Wet Season Load Density (Pounds per Acre)															
Baseflow	0.000003	0.000004	0.000003	0.000008	0.000003	0.000006	0.000004	0.000005	0.000002	0.000030	0.0003	0.0004	0.0003	0.0009	0.00003
Stormwater	0.000047	0.000060	0.000080	0.000073	0.000101	0.000167	0.000060	0.000175	0.000020	0.000865	0.0034	0.0005	0.0006	0.0039	0.00021
Subtotal:	0.000051	0.000064	0.000084	0.000081	0.000104	0.000173	0.000064	0.000180	0.000022	0.000895	0.0037	0.0009	0.0008	0.0048	0.00024
Dry Season Load Density (Pounds per Acre)															
Baseflow	0.000003	0.000003	0.000003	0.000006	0.000003	0.000004	0.000003	0.000004	0.000001	0.000022	0.0003	0.0003	0.0002	0.0007	0.00002
Stormwater	0.000008	0.000011	0.000014	0.000013	0.000018	0.000030	0.000011	0.000031	0.000004	0.000153	0.0006	0.0001	0.0001	0.0007	0.00004
Subtotal:	0.000011	0.000013	0.000017	0.000019	0.000020	0.000034	0.000014	0.000034	0.000005	0.000175	0.0009	0.0004	0.0003	0.0013	0.00006
Total Annual Load Density (Pounds per Acre)															
Baseflow	0.000006	0.000006	0.000006	0.000014	0.000006	0.000010	0.000007	0.000009	0.000003	0.000052	0.0006	0.0007	0.0004	0.0016	0.00005
Stormwater	0.000055	0.000071	0.000094	0.000086	0.000118	0.000197	0.000071	0.000205	0.000023	0.001018	0.0040	0.0006	0.0007	0.0046	0.00024
Grand Total: (Pounds per Acre)	0.000061	0.000077	0.000100	0.000100	0.000124	0.000207	0.000078	0.000214	0.000027	0.001070	0.0046	0.0013	0.0011	0.0062	0.00030

Note: Stormwater mass loadings were not calculated for analytical parameters with fewer than 10 percent detected concentrations or only one detected sample in stormwater.

Drainage Area: 557 Acres

<3 Detects

<5 Detects

<25% Detection Frequency

	Wet Season	Dry Season
Mean Annual Baseflow (gpm)	157	157
Mean Annual Stormwater (gpm)	556	136

Table 6-1.2
Mass Loading Summary for OF235

	Conventals/Nutrients							Metals							LPAHs				
	TSS (mg/L)	MBAS (mg/L)	BOD_5 (mg/L)	Total P (mg/L)	Ortho-P (mg/L)	TN (mg/L)	Nitrate/ Nitrite (mg/L)	Total Cu (ug/L)	Dissolved Cu (ug/L)	Total Zn (ug/L)	Dissolved Zn (ug/L)	Total Cd (ug/L)	Total Pb (ug/L)	Dissolved Pb (ug/L)	2-Methyl-naphthalene (ug/L)	Anthracene (ug/L)	Naphthalene (ug/L)	Phenanthrene (ug/L)	Total LPAHs (ug/L)
Baseflow																			
Mean WY2011&2016 Concentration	1.98	0.031	1.00	0.13	0.12	1.34	1.16	3.20	2.03	6.60	4.27	0.05	1.88	0.74	0.006	0.005	0.008	0.006	0.025
Number of Detects	6	6	0	6	6	7	7	7	7	7	7	1	7	7	1	1	1	2	2
Number of Samples	7	7	7	6	6	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Detection Frequency	86%	86%	0%	100%	100%	100%	100%	100%	100%	100%	100%	14%	100%	100%	14%	14%	14%	29%	29%
Stormwater																			
Mean Annual Concentration	24.16	0.045	2.35	0.12	0.05	0.53	0.17	16.20	7.48	58.17	26.36	0.06	22.51	3.67	0.016	0.014	0.018	0.027	0.076
Number of Detects	12	8	8	10	10	9	10	12	12	12	12	2	12	12	8	3	5	11	11
Number of Samples	12	8	9	10	10	10	10	12	12	12	12	12	12	12	12	12	11	12	11
Detection Frequency	100%	100%	89%	100%	100%	90%	100%	100%	100%	100%	100%	17%	100%	100%	67%	25%	45%	92%	100%
Stormwater / Baseflow Concentration	12	1.46	2.35	0.91	0.40	0.40	0.14	5.06	3.69	8.81	6.17	1.11	12.0	4.98	2.75	2.94	2.25	4.30	2.99
Wet Season Load (Pounds)																			
Baseflow	556	8.65	280	35.6	33.4	374.7	325.0	0.9	0.6	1.8	1.2	0.02	0.5	0.2	0.002	0.001	0.002	0.002	0.007
Stormwater	17,175	32.06	1,672	82.4	33.9	379.1	119.5	11.5	5.3	41.4	18.7	0.04	16.0	2.6	0.012	0.010	0.013	0.019	0.054
Subtotal:	17,731	40.71	1,952	118.0	67.3	753.8	444.5	12.4	5.9	43.2	19.9	0.06	16.5	2.8	0.013	0.012	0.015	0.021	0.061
Dry Season Load (Pounds)																			
Baseflow	401	6.24	202	25.7	24.1	270.4	234.6	0.6	0.4	1.3	0.9	0.01	0.4	0.1	0.001	0.001	0.002	0.001	0.005
Stormwater	2,368	4.42	231	11.4	4.7	52.3	16.5	1.6	0.7	5.7	2.6	0.01	2.2	0.4	0.002	0.001	0.002	0.003	0.007
Subtotal:	2,769	10.66	433	37.1	28.8	322.7	251.0	2.2	1.1	7.0	3.4	0.02	2.6	0.5	0.003	0.002	0.003	0.004	0.013
Total Annual Load (Pounds)																			
Baseflow	957	14.89	482	61.3	57.6	645.0	559.6	1.54	0.98	3.2	2.1	0.026	0.9	0.36	0.003	0.002	0.004	0.003	0.012
Stormwater	19,543	36.48	1,903	93.8	38.5	431.4	135.9	13.11	6.05	47.1	21.3	0.049	18.2	2.97	0.013	0.012	0.015	0.022	0.062
Grand Total: (Pounds)	20,501	51.37	2,385	155.1	96.1	1,076.5	695.5	14.65	7.03	50.2	23.4	0.075	19.1	3.32	0.016	0.014	0.018	0.025	0.074
Stormflow Percent of Annual Load	95%	71%	80%	60%	40%	40%	20%	89%	86%	94%	91%	65%	95%	89%	82%	83%	79%	88%	83%
Wet Season Percent of Annual Load	86%	79%	82%	76%	70%	70%	64%	85%	84%	86%	85%	77%	86%	85%	83%	83%	82%	84%	83%
Wet Season Load Density (Pounds per Acre)																			
Baseflow	3.4	0.053	1.7	0.22	0.21	2.30	1.99	0.0055	0.0035	0.0113	0.0073	0.00009	0.0032	0.0013	0.000010	0.000008	0.000014	0.000011	0.000044
Stormwater	105.4	0.197	10.3	0.51	0.21	2.33	0.73	0.0707	0.0326	0.2537	0.1150	0.00026	0.0982	0.0160	0.000071	0.000062	0.000079	0.000119	0.000332
Subtotal:	108.8	0.250	12.0	0.72	0.41	4.62	2.73	0.0762	0.0361	0.2651	0.1223	0.00036	0.1014	0.0173	0.000081	0.000071	0.000092	0.000130	0.000376
Dry Season Load Density (Pounds per Acre)																			
Baseflow	2.5	0.038	1.2	0.16	0.15	1.66	1.44	0.0040	0.0025	0.0082	0.0053	0.00007	0.0023	0.0009	0.000007	0.000006	0.000010	0.000008	0.000032
Stormwater	14.5	0.027	1.4	0.07	0.03	0.32	0.10	0.0097	0.0045	0.0350	0.0159	0.00004	0.0135	0.0022	0.000010	0.000009	0.000011	0.000016	0.000046
Subtotal:	17.0	0.065	2.7	0.23	0.18	1.98	1.54	0.0137	0.0070	0.0432	0.0212	0.00010	0.0159	0.0031	0.000017	0.000015	0.000021	0.000024	0.000077
Total Annual Load Density (Pounds per Acre)																			
Baseflow	5.9	0.091	3.0	0.38	0.35	3.96	3.43	0.0095	0.0060	0.0195	0.0126	0.00016	0.0056	0.0022	0.000018	0.000014	0.000024	0.000019	0.000075
Stormwater	119.9	0.224	11.7	0.58	0.24	2.65	0.83	0.0804	0.0371	0.2887	0.1308	0.00030	0.1117	0.0182	0.000081	0.000071	0.000089	0.000136	0.000378
Grand Total: (Pounds per Acre)	125.8	0.315	14.6	0.95	0.59	6.60	4.27	0.0899	0.0431	0.3082	0.1435	0.00046	0.1173	0.0204	0.000099	0.000085	0.000113	0.000155	0.000453

Note: Stormwater mass loadings were not calculated for analytical parameters with fewer than 10 percent detected concentrations or only one detected sample in stormwater.

Drainage Area: 163 *Acres*

<3 Detects

<5 Detects

<25% Detection Frequency

	Wet Season	Dry Season
Mean Annual Baseflow (gpm)	110	110
Mean Annual Stormwater (gpm)	279	53

Table 6-1.2 Continued
Mass Loading Summary for OF235

	HPAHs										Phthalates					Herbicide
	Benzo(a)-anthracene (ug/L)	Benzo(a)-pyrene (ug/L)	Benzo(g,h,i)-perylene (ug/L)	Benzo(b,k)-fluoranthenes (ug/L)	Chrysene (ug/L)	Fluoranthene (ug/L)	Indeno(1,2,3-c,d)pyrene (ug/L)	Pyrene (ug/L)	Retene (ug/L)	Total HPAHs (ug/L)	Di(2-eh)-phthalate (ug/L)	Butylbenzyl-phthalate (ug/L)	Diethyl-phthalate (ug/L)	Di-n-butyl-phthalate (ug/L)	Total Phthalates (ug/L)	Dichlobenil (ug/L)
Baseflow																
Mean WY2011&2016 Concentration	0.003	0.003	0.008	0.007	0.004	0.004	0.005	0.005	0.003	0.027	0.264	0.226	0.165	0.189	0.480	0.039
Number of Detects	0	0	0	0	0	0	0	1	0	1	1	0	0	1	2	1
Number of Samples	7	7	7	7	7	7	7	7	1	7	7	7	7	7	7	7
Detection Frequency	0%	0%	0%	0%	0%	0%	0%	14%	0%	14%	14%	0%	0%	14%	29%	14%
Stormwater																
Mean Annual Concentration	0.025	0.022	0.026	0.061	0.038	0.057	0.018	0.072	0.014	0.322	1.127	0.627	0.255	0.257	2.022	0.093
Number of Detects	10	9	12	10	11	11	11	11	11	12	12	8	7	7	12	10
Number of Samples	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	11
Detection Frequency	83%	75%	100%	83%	92%	92%	92%	92%	92%	100%	100%	67%	58%	58%	100%	91%
Stormwater / Baseflow Concentration	9.01	6.78	3.16	8.41	10.19	13.23	3.93	13.47	5.62	11.94	4.27	2.77	1.55	1.36	4.21	2.38
Wet Season Load (Pounds)																
Baseflow	0.001	0.001	0.002	0.002	0.001	0.001	0.001	0.002	0.001	0.008	0.074	0.063	0.046	0.05	0.13	0.01
Stormwater	0.018	0.016	0.019	0.044	0.027	0.040	0.013	0.051	0.010	0.229	0.801	0.446	0.182	0.18	1.44	0.07
Subtotal:	0.018	0.017	0.021	0.046	0.028	0.042	0.014	0.053	0.011	0.237	0.875	0.509	0.228	0.24	1.57	0.08
Dry Season Load (Pounds)																
Baseflow	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.005	0.053	0.046	0.033	0.04	0.10	0.01
Stormwater	0.002	0.002	0.003	0.006	0.004	0.006	0.002	0.007	0.001	0.032	0.111	0.061	0.025	0.03	0.20	0.01
Subtotal:	0.003	0.003	0.004	0.007	0.004	0.006	0.003	0.008	0.002	0.037	0.164	0.107	0.058	0.06	0.30	0.02
Total Annual Load (Pounds)																
Baseflow	0.001	0.002	0.004	0.004	0.002	0.002	0.002	0.003	0.001	0.013	0.127	0.109	0.080	0.09	0.23	0.02
Stormwater	0.020	0.018	0.021	0.050	0.031	0.046	0.014	0.058	0.011	0.261	0.912	0.507	0.207	0.21	1.64	0.08
Grand Total: (Pounds)	0.021	0.019	0.025	0.053	0.032	0.048	0.016	0.061	0.013	0.274	1.039	0.616	0.286	0.30	1.87	0.09
Stormflow Percent of Annual Load	94%	92%	84%	93%	94%	96%	87%	96%	90%	95%	88%	82%	72%	70%	88%	80%
Wet Season Percent of Annual Load	86%	85%	83%	86%	86%	87%	84%	87%	85%	86%	84%	83%	80%	79%	84%	82%
Wet Season Load Density (Pounds per Acre)																
Baseflow	0.000005	0.000006	0.000014	0.000013	0.000006	0.000007	0.000008	0.000009	0.000004	0.000046	0.000454	0.000388	0.000283	0.0003	0.0008	0.0001
Stormwater	0.000108	0.000096	0.000114	0.000267	0.000165	0.000247	0.000077	0.000315	0.000061	0.001406	0.004917	0.002733	0.001113	0.0011	0.0088	0.0004
Subtotal:	0.000113	0.000102	0.000128	0.000280	0.000171	0.000255	0.000085	0.000324	0.000066	0.001453	0.005371	0.003121	0.001397	0.0014	0.0096	0.0005
Dry Season Load Density (Pounds per Acre)																
Baseflow	0.000003	0.000004	0.000010	0.000009	0.000005	0.000005	0.000006	0.000007	0.000003	0.000033	0.000328	0.000280	0.000204	0.0002	0.0006	0.00005
Stormwater	0.000015	0.000013	0.000016	0.000037	0.000023	0.000034	0.000011	0.000043	0.000008	0.000194	0.000678	0.000377	0.000154	0.0002	0.0012	0.00006
Subtotal:	0.000018	0.000017	0.000026	0.000046	0.000027	0.000039	0.000016	0.000050	0.000012	0.000227	0.001006	0.000657	0.000358	0.0004	0.0018	0.0001
Total Annual Load Density (Pounds per Acre)																
Baseflow	0.000008	0.000010	0.000024	0.000022	0.000011	0.000013	0.000013	0.000016	0.000007	0.000080	0.000782	0.000668	0.000488	0.0006	0.0014	0.0001
Stormwater	0.000123	0.000109	0.000129	0.000304	0.000188	0.000281	0.000088	0.000358	0.000070	0.001600	0.005595	0.003110	0.001267	0.0013	0.0100	0.0005
Grand Total: (Pounds per Acre)	0.000131	0.000119	0.000154	0.000326	0.000199	0.000294	0.000101	0.000374	0.000077	0.001680	0.006377	0.003778	0.001755	0.0018	0.0115	0.0006

Note: Stormwater mass loadings were not calculated for analytical parameters with fewer than 10 percent detected concentrations or only one detected sample in stormwater.

Drainage Area: 163 Acres

Baseflow Detects <3

Stormwater Detects <5

<25% Detection Frequency

	Wet Season	Dry Season
Mean Annual Baseflow (gpm)	110	110
Mean Annual Stormwater (gpm)	279	53

Table 6-1.3
Mass Loading Summary for OF237A

	Conventals/Nutrients							Metals								LPAHs					
	TSS (mg/L)	MBAS (mg/L)	BOD_5 (mg/L)	Total P (mg/L)	Ortho-P (mg/L)	TN (mg/L)	Nitrate/ Nitrite (mg/L)	Total Cu (ug/L)	Dissolved Cu (ug/L)	Total Zn (ug/L)	Dissolved Zn (ug/L)	Total Cd (ug/L)	Total Hg (ug/L)	Total Pb (ug/L)	Dissolved Pb (ug/L)	2-Methyl-naphthalene (ug/L)	Acenaphthylene (ug/L)	Fluorene (ug/L)	Naphthalene (ug/L)	Phenanthrene (ug/L)	Total LPAHs (ug/L)
Baseflow																					
Mean WY2011&2016 Concentration	1.73	0.02	1.00	0.03	0.03	2.30	2.37	0.48	0.31	2.49	1.93	0.12	0.0025	0.13	0.03	0.005	0.005	0.005	0.006	0.006	0.019
Number of Detects	7	4	0	10	10	10	10	7	10	10	10	0	0	7	6	1	0	0	1	4	4
Number of Samples	10	10	9	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Detection Frequency	70%	40%	0%	100%	100%	100%	100%	70%	100%	100%	100%	0%	0%	70%	60%	10%	0%	0%	10%	40%	40%
Stormwater																					
Mean Annual Concentration	36.54	0.05	3.72	0.09	0.01	0.32	-0.12	8.18	3.03	57.54	28.17	0.05	0.0051	5.85	0.26	0.013	0.009	0.009	0.023	0.054	0.109
Number of Detects	8	7	7	8	8	7	8	8	8	8	8	2	1	8	8	5	2	1	3	8	7
Number of Samples	8	7	7	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	7	8	7
Detection Frequency	100%	100%	100%	100%	100%	88%	100%	100%	100%	100%	100%	25%	13%	100%	100%	63%	25%	13%	43%	100%	100%
Stormwater / Baseflow Concentration	21.17	2.5	3.72	3.01	0.33	0.14	-0.05	16.86	9.69	23.14	14.58	0.41	2.05	45.13	9.01	2.58	1.91	2.02	3.69	9.39	5.80
Wet Season Load (Pounds)																					
Baseflow	10,797	117	6,255	183.9	212.7	14,381	14,819	3.0	2.0	15.6	12.1	0.72	0.016	0.8	0.2	0.031	0.029	0.028	0.040	0.036	0.118
Stormwater	265,104	336	27,018	641.4	82.5	2,357	-835.5	59.3	22.0	417.5	204.4	0.34	0.037	42.4	1.9	0.092	0.064	0.066	0.170	0.388	0.792
Subtotal:	275,901	453	33,274	825	295	16,737	13,983	62.4	23.9	433.0	216.5	1.07	0.053	43.2	2.1	0.123	0.094	0.094	0.210	0.424	0.910
Dry Season Load (Pounds)																					
Baseflow	7,792	84	4,514	132.7	153.5	10,379	10,695	2.2	1.4	11.2	8.7	0.52	0.011	0.6	0.1	0.022	0.021	0.020	0.029	0.026	0.085
Stormwater	36,138	46	3,683	87.4	11.2	321.2	-113.9	8.1	3.0	56.9	27.9	0.05	0.005	5.8	0.3	0.013	0.009	0.009	0.023	0.053	0.108
Subtotal:	43,930	130	8,197	220.2	164.7	10,700	10,581	10.3	4.4	68.1	36.6	0.57	0.016	6.4	0.4	0.035	0.030	0.029	0.052	0.079	0.193
Total Annual Load (Pounds)																					
Baseflow	18,588	201	10,770	316.6	366.2	24,759	25,513	5.2	3.4	26.8	20.8	1.24	0.027	1.4	0.3	0.053	0.050	0.048	0.068	0.061	0.203
Stormwater	301,242	382	30,701	728.8	93.7	2,678	-949	67.4	25.0	474.4	232.3	0.39	0.042	48.2	2.1	0.104	0.073	0.075	0.193	0.441	0.900
Grand Total: (Pounds)	319,831	583	41,471	1,045.5	459.9	27,437	24,564	72.6	28.4	501.2	253.1	1.63	0.069	49.6	2.4	0.157	0.123	0.123	0.262	0.503	1.103
Stormflow Percent of Annual Load	94%	65%	74%	70%	20%	10%	-4%	93%	88%	95%	92%	24%	61%	97%	87%	66%	59%	61%	74%	88%	82%
Wet Season Percent of Annual Load	86%	78%	80%	79%	64%	61%	57%	86%	84%	86%	86%	65%	76%	87%	84%	78%	76%	76%	80%	84%	83%
Wet Season Load Density (Pounds per Acre)																					
Baseflow	3.8	0.041	2.2	0.07	0.08	5.09	5.25	0.0011	0.0007	0.0055	0.0043	0.0003	0.0000055	0.0003	0.0001	0.000011	0.000010	0.000010	0.000014	0.000013	0.000042
Stormwater	93.9	0.119	9.6	0.23	0.03	0.83	-0.30	0.0210	0.0078	0.1479	0.0724	0.0001	0.0000132	0.0150	0.0007	0.000033	0.000023	0.000023	0.000060	0.000138	0.000281
Subtotal:	97.7	0.160	11.8	0.29	0.10	5.93	4.95	0.0221	0.0085	0.1534	0.0767	0.0004	0.0000187	0.0153	0.0007	0.000043	0.000033	0.000033	0.000074	0.000150	0.000322
Dry Season Load Density (Pounds per Acre)																					
Baseflow	2.8	0.030	1.6	0.05	0.05	3.68	3.79	0.0008	0.0005	0.0040	0.0031	0.0002	0.0000040	0.0002	0.0000	0.000008	0.000007	0.000007	0.000010	0.000009	0.000030
Stormwater	12.8	0.016	1.3	0.03	0.00	0.11	-0.04	0.0029	0.0011	0.0202	0.0099	0.0000	0.0000018	0.0020	0.0001	0.000004	0.000003	0.000003	0.000008	0.000019	0.000038
Subtotal:	15.6	0.046	2.9	0.08	0.06	3.79	3.75	0.0036	0.0016	0.0241	0.0130	0.0002	0.0000058	0.0023	0.0001	0.000012	0.000011	0.000010	0.000018	0.000028	0.000068
Total Annual Load Density (Pounds per Acre)																					
Baseflow	6.6	0.071	3.8	0.11	0.13	8.77	9.04	0.0018	0.0012	0.0095	0.0074	0.0004	0.0000095	0.0005	0.0001	0.000019	0.000018	0.000017	0.000024	0.000022	0.000072
Stormwater	106.7	0.135	10.9	0.26	0.03	0.95	-0.34	0.0239	0.0089	0.1680	0.0823	0.0001	0.0000150	0.0171	0.0008	0.000037	0.000026	0.000027	0.000069	0.000156	0.000319
Grand Total: (Pounds per Acre)	113.3	0.207	14.7	0.37	0.16	9.72	8.70	0.0257	0.0100	0.1775	0.0897	0.0006	0.0000245	0.0176	0.0009	0.000056	0.000044	0.000044	0.000093	0.000178	0.000391

Note: Stormwater mass loadings were not calculated for analytical parameters with fewer than 10 percent detected concentrations or only one detected sample in stormwater.

Drainage Area: 2,823 Acres

Baseflow Detects <3

Stormwater Detects <5

<25% Detection Frequency

	Wet Season	Dry Season
Mean Annual Baseflow (gpm)	2455	2455
Mean Annual Stormwater (gpm)	2848	538

Table 6-1.3 Continued
Mass Loading Summary for OF237A

	HPAHs											Phthalates					Insecticides/Herbicide	
	Benzo(a)-anthracene (ug/L)	Benzo(a)-pyrene (ug/L)	Benzo(g,h,i)-perylene (ug/L)	Benzo(b,k)-fluoranthenes (ug/L)	Chrysene (ug/L)	Dibenz(a,h)-anthracene (ug/L)	Fluoranthene (ug/L)	Indeno(1,2,3-c,d)pyrene (ug/L)	Pyrene (ug/L)	Retene (ug/L)	Total HPAHs (ug/L)	Di(2-eh)-phthalate (ug/L)	Butylbenzyl-phthalate (ug/L)	Di-n-butyl-phthalate (ug/L)	Di-n-octyl phthalate (ug/L)	Total Phthalates (ug/L)	Bifenthrin (ug/L)	Dichlobenil (ug/L)
Baseflow																		
Mean WY2011&2016 Concentration	0.005	0.005	0.004	0.009	0.004	0.004	0.005	0.005	0.005	0.003	0.024	0.375	0.398	0.303	0.389	0.365	0.005	0.046
Number of Detects	1	1	1	0	1	0	1	0	2	0	2	2	0	2	0	6	0	0
Number of Samples	10	10	10	10	10	10	10	10	10	1	10	10	10	10	10	10	1	10
Detection Frequency	10%	10%	10%	0%	10%	0%	10%	0%	20%	0%	20%	20%	0%	20%	0%	60%	0%	0%
Stormwater																		
Mean Annual Concentration	0.033	0.053	0.097	0.340	0.117	0.067	0.134	0.104	0.131	0.057	1.080	1.489	0.239	0.378	0.264	2.140	0.017	0.056
Number of Detects	7	7	8	8	8	2	8	8	8	7	8	8	1	5	1	8	2	7
Number of Samples	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	7
Detection Frequency	88%	88%	100%	100%	100%	25%	100%	100%	100%	88%	100%	100%	13%	63%	13%	100%	25%	100%
Stormwater / Baseflow Concentration	7.03	11.46	23.12	39.26	28.58	15.39	29.16	22.62	28.62	22.73	44.99	3.97	0.60	1.25	0.68	5.87	3.49	1.21
Wet Season Load (Pounds)																		
Baseflow	0.029	0.029	0.026	0.054	0.026	0.027	0.029	0.029	0.029	0.016	0.150	2.34	2.49	1.89	2.44	2.28	0.031	0.290
Stormwater	0.237	0.387	0.705	2.464	0.850	0.486	0.973	0.755	0.950	0.412	7.834	10.80	1.73	2.74	1.92	15.53	0.127	0.407
Subtotal:	0.266	0.416	0.731	2.518	0.876	0.513	1.002	0.784	0.979	0.428	7.985	13.15	4.22	4.64	4.35	17.81	0.158	0.697
Dry Season Load (Pounds																		
Baseflow	0.021	0.021	0.019	0.039	0.019	0.020	0.021	0.021	0.021	0.011	0.108	1.69	1.80	1.37	1.76	1.65	0.023	0.209
Stormwater	0.032	0.053	0.096	0.336	0.116	0.066	0.133	0.103	0.130	0.056	1.068	1.47	0.24	0.37	0.26	2.12	0.017	0.055
Subtotal:	0.053	0.074	0.115	0.375	0.134	0.086	0.153	0.124	0.150	0.068	1.176	3.16	2.03	1.74	2.02	3.76	0.040	0.265
Total Annual Load (Pounc																		
Baseflow	0.050	0.050	0.045	0.093	0.044	0.047	0.050	0.050	0.049	0.027	0.258	4.04	4.28	3.26	4.19	3.93	0.054	0.499
Stormwater	0.270	0.439	0.801	2.800	0.966	0.552	1.106	0.858	1.080	0.469	8.902	12.28	1.97	3.12	2.18	17.65	0.144	0.462
Grand Total: (Pounds)	0.320	0.489	0.846	2.893	1.010	0.599	1.156	0.908	1.129	0.496	9.161	16.31	6.25	6.38	6.37	21.57	0.198	0.962
Stormflow Percent of Annual Load	84%	90%	95%	97%	96%	92%	96%	95%	96%	95%	97%	75%	31%	49%	34%	82%	73%	48%
Wet Season Percent of Annual Load	83%	85%	86%	87%	87%	86%	87%	86%	87%	86%	87%	81%	68%	73%	68%	83%	80%	72%
Wet Season Load Density (Pounds per Acre)																		
Baseflow	0.000010	0.000010	0.000009	0.000019	0.000009	0.000010	0.000010	0.000010	0.000010	0.000006	0.000053	0.0008	0.0009	0.0007	0.0009	0.0008	0.00001	0.00010
Stormwater	0.000084	0.000137	0.000250	0.000873	0.000301	0.000172	0.000345	0.000267	0.000337	0.000146	0.002775	0.0038	0.0006	0.0010	0.0007	0.0055	0.00004	0.00014
Subtotal:	0.000094	0.000147	0.000259	0.000892	0.000310	0.000182	0.000355	0.000278	0.000347	0.000152	0.002828	0.0047	0.0015	0.0016	0.0015	0.0063	0.00006	0.00025
Dry Season Load Density (Pounds per Acre)																		
Baseflow	0.000007	0.000007	0.000007	0.000014	0.000007	0.000007	0.000007	0.000007	0.000007	0.000004	0.000038	0.0006	0.0006	0.0005	0.0006	0.0006	0.00001	0.00007
Stormwater	0.000011	0.000019	0.000034	0.000119	0.000041	0.000023	0.000047	0.000036	0.000046	0.000020	0.000378	0.0005	0.0001	0.0001	0.0001	0.0007	0.00001	0.00002
Subtotal:	0.000019	0.000026	0.000041	0.000133	0.000048	0.000030	0.000054	0.000044	0.000053	0.000024	0.000417	0.0011	0.0007	0.0006	0.0007	0.0013	0.00001	0.00009
Total Annual Load Density (Pounds per Acre)																		
Baseflow	0.000018	0.000018	0.000016	0.000033	0.000016	0.000017	0.000018	0.000018	0.000017	0.000010	0.000092	0.0014	0.0015	0.0012	0.0015	0.0014	0.00002	0.00018
Stormwater	0.000096	0.000156	0.000284	0.000992	0.000342	0.000196	0.000392	0.000304	0.000382	0.000166	0.003154	0.0043	0.0007	0.0011	0.0008	0.0063	0.00005	0.00016
Grand Total: (Pounds per Acre)	0.000113	0.000173	0.000300	0.001025	0.000358	0.000212	0.000409	0.000321	0.000400	0.000176	0.003245	0.0058	0.0022	0.0023	0.0023	0.0076	0.00007	0.00034

Note: Stormwater mass loadings were not calculated for analytical parameters with fewer than 10 percent detected concentrations or only one detected sample in stormwater.

Drainage Area: *2,823 Acres*

<3 Detects

<5 Detects

<25% Detection Frequency

	Wet Season	Dry Season
Mean Annual Baseflow (gpm)	2455	2455
Mean Annual Stormwater (gpm)	2848	538

Table 6-1.4
Mass Loading Summary for OF237B

	Conventals/Nutrients							Metals						LPAHs			
	TSS (mg/L)	MBAS (mg/L)	BOD_5 (mg/L)	Total P (mg/L)	Ortho-P (mg/L)	TN (mg/L)	Nitrate/ Nitrite (mg/L)	Total Cu (ug/L)	Dissolved Cu (ug/L)	Total Zn (ug/L)	Dissolved Zn (ug/L)	Total Pb (ug/L)	Dissolved Pb (ug/L)	2-Methyl-naphthalene (ug/L)	Naphthalene (ug/L)	Phenanthrene (ug/L)	Total LPAHs (ug/L)
Baseflow																	
Mean WY2011&2016 Concentration	0.98	0.019	1.43	0.03	0.03	3.04	3.11	0.32	0.18	1.51	1.18	0.04	0.02	0.004	0.007	0.005	0.025
Number of Detects	2	4	1	6	6	6	6	3	6	6	6	2	4	1	0	0	3
Number of Samples	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Detection Frequency	33%	67%	17%	100%	100%	100%	100%	50%	100%	100%	100%	33%	67%	17%	0%	0%	50%
Stormwater																	
Mean Annual Concentration	31.70	0.055	2.85	0.10	0.02	0.79	0.34	7.33	2.96	40.15	18.25	4.86	0.30	0.011	0.020	0.014	0.06
Number of Detects	10	8	8	10	10	10	10	11	11	11	11	11	11	4	4	6	10
Number of Samples	10	8	8	10	10	10	10	11	11	11	11	11	11	11	10	11	10
Detection Frequency	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	36%	40%	55%	100%
Stormwater / Baseflow Concentration	32	3	1.99	3.11	0.47	0.26	0.11	23	17	27	15	134	13	3	3	3	2
Wet Season Load (Pounds)																	
Baseflow	14,246	273	20,854	480.1	487.4	44,255	45,200	4.7	2.6	22.0	17.2	0.5	0.3	0.056	0.097	0.073	0.364
Stormwater	204,321	352	18,369	661.1	102.1	5,107	2,169.2	47.2	19.1	258.8	117.6	31.3	1.9	0.069	0.129	0.089	0.365
Subtotal:	218,567	625	39,223	1,141	590	49,362	47,370	52.0	21.6	280.8	134.8	31.9	2.3	0.125	0.226	0.162	0.730
Dry Season Load (Pounds)																	
Baseflow	10,282	197	15,050	346.5	351.8	31,939	32,621	3.4	1.8	15.9	12.4	0.4	0.2	0.040	0.070	0.053	0.263
Stormwater	22,089	38.08	1,986	71.5	11.0	552.1	234.5	5.1	2.1	28.0	12.7	3.4	0.2	0.007	0.014	0.010	0.039
Subtotal:	32,371	235	17,036	418	363	32,491	32,856	8.5	3.9	43.9	25.1	3.8	0.5	0.048	0.084	0.062	0.302
Total Annual Load (Pounds)																	
Baseflow	24,528	469	35,905	826.6	839.2	76,193	77,822	8.1	4.4	37.9	29.6	0.9	0.6	0.096	0.167	0.125	0.627
Stormwater	226,410	390	20,355	732.6	113.1	5,659	2,404	52.3	21.1	286.8	130.3	34.7	2.2	0.076	0.143	0.099	0.405
Grand Total: (Pounds)	250,938	860	56,260	1,559	952	81,852	80,225	60.5	25.5	324.6	160.0	35.6	2.7	0.172	0.310	0.224	1.032
Stormflow Percent of Annual Load	90%	45%	36%	47%	12%	7%	3%	87%	83%	88%	81%	97%	79%	44%	46%	44%	39%
Wet Season Percent of Annual Load	87%	73%	70%	73%	62%	60%	59%	86%	85%	86%	84%	89%	83%	72%	73%	72%	71%
Wet Season Load Density (Pounds per Acre)																	
Baseflow	6.6	0.127	9.7	0.22	0.23	20.61	21.05	0.0022	0.0012	0.0102	0.0080	0.0002	0.0002	0.000026	0.000045	0.000034	0.000170
Stormwater	95.2	0.164	8.6	0.31	0.05	2.38	1.01	0.0220	0.0089	0.1205	0.0548	0.0146	0.0009	0.000032	0.000060	0.000042	0.000170
Subtotal:	101.8	0.291	18.3	0.53	0.27	22.99	22.06	0.0242	0.0101	0.1308	0.0628	0.0148	0.0011	0.000058	0.000105	0.000075	0.000340
Dry Season Load Density (Pounds per Acre)																	
Baseflow	4.8	0.092	7.0	0.16	0.16	14.88	15.19	0.0016	0.0009	0.0074	0.0058	0.0002	0.0001	0.000019	0.000033	0.000024	0.000122
Stormwater	10.3	0.018	0.9	0.03	0.01	0.26	0.11	0.0024	0.0010	0.0130	0.0059	0.0016	0.0001	0.000003	0.000006	0.000004	0.000018
Subtotal:	15.1	0.109	7.9	0.19	0.17	15.13	15.30	0.0040	0.0018	0.0204	0.0117	0.0018	0.0002	0.000022	0.000039	0.000029	0.000141
Total Annual Load Density (Pounds per Acre)																	
Baseflow	11.4	0.219	16.7	0.39	0.39	35.49	36.25	0.0038	0.0021	0.0176	0.0138	0.0004	0.0003	0.000045	0.000078	0.000058	0.000292
Stormwater	105.5	0.182	9.5	0.34	0.05	2.64	1.12	0.0244	0.0098	0.1336	0.0607	0.0162	0.0010	0.000036	0.000067	0.000046	0.000188
Grand Total: (Pounds per Acre)	116.9	0.400	26.2	0.73	0.44	38.12	37.37	0.0282	0.0119	0.1512	0.0745	0.0166	0.0013	0.000080	0.000144	0.000104	0.000481

Note: Stormwater mass loadings were not calculated for analytical parameters with fewer than 10 percent detected concentrations or only one detected sample in stormwater.

Drainage Area: 2,147 Acres

Baseflow Detects <3

Stormwater Detects <5

<25% Detection Frequency

	Wet Season	Dry Season
Mean Annual Baseflow (gpm)	5711	5711
Mean Annual Stormwater (gpm)	2530	379

Table 6-1.4 Continued
Mass Loading Summary for OF237B

	HPAHs										Phthalates			Herbicide
	Benzo(a)-anthracene (ug/L)	Benzo(a)-pyrene (ug/L)	Benzo(g,h,i)-perylene (ug/L)	Benzo(b,k)-fluoranthenes (ug/L)	Chrysene (ug/L)	Fluoranthene (ug/L)	Indeno(1,2,3-c,d)pyrene (ug/L)	Pyrene (ug/L)	Retene (ug/L)	Total HPAHs (ug/L)	Di(2-eh)-phthalate (ug/L)	Di-n-butyl-phthalate (ug/L)	Total Phthalates (ug/L)	Dichlobenil (ug/L)
Baseflow														
Mean WY2011&2016 Concentration	0.003	0.003	0.002	0.005	0.002	0.003	0.003	0.003	0.003	0.026	0.194	0.167	0.452	0.022
Number of Detects	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Number of Samples	6	6	6	6	6	6	6	6	1	6	6	6	6	6
Detection Frequency	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	17%	0%
Stormwater														
Mean Annual Concentration	0.010	0.015	0.019	0.050	0.023	0.041	0.015	0.049	0.005	0.226	1.045	0.307	1.258	0.082
	4	9	11	10	8	11	9	11	7	11	11	7	11	10
	11	11	11	11	11	11	11	11	11	11	11	11	11	10
Detection Frequency	36%	82%	100%	91%	73%	100%	82%	100%	64%	100%	100%	64%	100%	100%
Stormwater / Baseflow Concentration	4	5	8	10	11	13	5	16	2	9	5	2	3	4
Wet Season Load (Pounds)														
Baseflow	0.040	0.042	0.034	0.076	0.030	0.045	0.042	0.044	0.036	0.383	2.83	2.43	6.58	0.326
Stormwater	0.064	0.097	0.124	0.324	0.145	0.262	0.096	0.315	0.035	1.458	6.74	1.98	8.11	0.527
Subtotal:	0.104	0.139	0.158	0.400	0.175	0.307	0.139	0.359	0.072	1.841	9.57	4.41	14.68	0.853
Dry Season Load (Pounds)														
Baseflow	0.029	0.031	0.025	0.055	0.022	0.032	0.031	0.032	0.026	0.277	2.04	1.76	4.75	0.235
Stormwater	0.007	0.010	0.013	0.035	0.016	0.028	0.010	0.034	0.004	0.158	0.73	0.21	0.88	0.057
Subtotal:	0.036	0.041	0.038	0.090	0.038	0.061	0.041	0.066	0.030	0.434	2.77	1.97	5.62	0.292
Total Annual Load (Pounds)														
Baseflow	0.069	0.073	0.058	0.132	0.052	0.077	0.073	0.075	0.063	0.660	4.87	4.19	11.32	0.562
Stormwater	0.071	0.107	0.138	0.359	0.161	0.291	0.106	0.349	0.039	1.616	7.46	2.19	8.98	0.583
Grand Total: (Pounds)	0.140	0.180	0.196	0.490	0.213	0.368	0.180	0.425	0.102	2.276	12.33	6.38	20.31	1.145
Stormflow Percent of Annual Load	51%	59%	70%	73%	75%	79%	59%	82%	39%	71%	61%	34%	44%	51%
Wet Season Percent of Annual Load	74%	77%	81%	82%	82%	83%	77%	85%	70%	81%	78%	69%	72%	74%
Wet Season Load Density (Pounds per Acre)														
Baseflow	0.000019	0.000020	0.000016	0.000036	0.000014	0.000021	0.000020	0.000020	0.000017	0.000178	0.0013	0.0011	0.0031	0.00015
Stormwater	0.000030	0.000045	0.000058	0.000151	0.000068	0.000122	0.000045	0.000147	0.000017	0.000679	0.0031	0.0009	0.0038	0.00025
Subtotal:	0.000049	0.000065	0.000074	0.000186	0.000082	0.000143	0.000065	0.000167	0.000033	0.000858	0.0045	0.0021	0.0068	0.00040
Dry Season Load Density (Pounds per Acre)														
Baseflow	0.000013	0.000014	0.000011	0.000026	0.000010	0.000015	0.000014	0.000015	0.000012	0.000129	0.0010	0.0008	0.0022	0.00011
Stormwater	0.000003	0.000005	0.000006	0.000016	0.000007	0.000013	0.000005	0.000016	0.000002	0.000073	0.0003	0.0001	0.0004	0.00003
Subtotal:	0.000017	0.000019	0.000018	0.000042	0.000017	0.000028	0.000019	0.000031	0.000014	0.000202	0.0013	0.0009	0.0026	0.00014
Total Annual Load Density (Pounds per Acre)														
Baseflow	0.000032	0.000034	0.000027	0.000061	0.000024	0.000036	0.000034	0.000035	0.000029	0.000307	0.0023	0.0020	0.0053	0.00026
Stormwater	0.000033	0.000050	0.000064	0.000167	0.000075	0.000135	0.000050	0.000163	0.000018	0.000753	0.0035	0.0010	0.0042	0.00027
Grand Total: (Pounds per Acre)	0.000065	0.000084	0.000091	0.000228	0.000099	0.000171	0.000084	0.000198	0.000047	0.001060	0.0057	0.0030	0.0095	0.00053

Note: Stormwater mass loadings were not calculated for analytical parameters with fewer than 10 percent detected concentrations or only one detected sample in stormwater.

Drainage Area: 2,147 Acres

<3 Detects

<5 Detects

<25% Detection Frequency

	Wet Season	Dry Season
Mean Annual Baseflow (gpm)	5711	5711
Mean Annual Stormwater (gpm)	2530	379

Table 6-1.5
Mass Loading Summary for OF243

	Conventals/Nutrients							Metals							
	TSS (mg/L)	MBAS (mg/L)	BOD5 (mg/L)	Total P (mg/L)	Ortho-P (mg/L)	TKN (mg/L)	Nitrate/ Nitrite (mg/L)	Total Cu (ug/L)	Dissolved Cu (ug/L)	Total Zn (ug/L)	Dissolved Zn (ug/L)	Total Cd (ug/L)	Dissolved Cd (ug/L)	Total Pb (ug/L)	Dissolved Pb (ug/L)
Baseflow															
Mean WY2011&2016 Concentration	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Number of Detects	8	7	0	7	6	8	8	7	7	7	7	3	2	8	3
Number of Samples	8	7	7	7	7	8	8	7	7	7	7	8	8	8	8
Detection Frequency	100%	100%	0%	100%	86%	100%	100%	100%	100%	100%	100%	38%	25%	100%	38%
Stormwater															
Mean Annual Concentration	27.60	0.041	2.55	0.24	0.027	0.53	0.23	13.54	4.04	46.07	19.85	0.21	0.07	8.57	0.29
Number of Detects	7	7	5	7	7	7	7	7	7	7	7	7	6	7	7
Number of Samples	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Detection Frequency	100%	100%	71%	100%	100%	100%	100%	100%	100%	100%	100%	100%	86%	100%	100%
Stormwater / Baseflow Concentration	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Wet Season Load (Pounds)															
Baseflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stormwater	4,348	6	401	37.2	4.3	84.2	35.5	2.1	0.6	7.3	3.1	0.0337	0.0113	1.35	0.0456
Subtotal:	4,348	6	401	37.2	4.3	84.2	35.5	2.1	0.6	7.3	3.1	0.0337	0.0113	1.35	0.0456
Dry Season Load (Pounds)															
Baseflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stormwater	357	1	33	3.1	0.4	6.9	2.9	0.2	0.052	0.6	0.3	0.0028	0.0009	0.11	0.0038
Subtotal:	357	1	33	3.1	0.4	6.9	2.9	0.2	0.052	0.6	0.3	0.0028	0.0009	0.11	0.0038
Total Annual Load (Pounds)															
Baseflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stormwater	4,705	7	434	40.3	4.7	91.1	38.4	2.3	0.7	7.9	3.4	0.0364	0.0122	1.46	0.05
Grand Total: (Pounds)	4,705	7	434	40.3	4.7	91.1	38.4	2.3	0.7	7.9	3.4	0.0364	0.0122	1.46	0.05
Stormflow Percent of Annual Load	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Wet Season Percent of Annual Load	92%	92%	92%	92%	92%	92%	92%	92%	92%	92%	92%	92%	92%	92%	92%
Wet Season Load Density (Pounds per Acre)															
Baseflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stormwater	73.7	0.11	6.8	0.63	0.07	1.43	0.60	0.036	0.011	0.123	0.053	0.00057	0.00019	0.0229	0.0008
Subtotal:	73.7	0.11	6.8	0.63	0.07	1.43	0.60	0.036	0.011	0.123	0.053	0.00057	0.00019	0.0229	0.0008
Dry Season Load Density (Pounds per Acre)															
Baseflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stormwater	6.1	0.01	0.6	0.05	0.01	0.12	0.05	0.003	0.001	0.010	0.004	0.00005	0.00002	0.0019	0.00006
Subtotal:	6.1	0.01	0.6	0.05	0.01	0.12	0.05	0.003	0.001	0.010	0.004	0.00005	0.00002	0.0019	0.00006
Total Annual Load Density (Pounds per Acre)															
Baseflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stormwater	79.7	0.12	7.4	0.68	0.08	1.54	0.65	0.039	0.012	0.133	0.057	0.0006	0.0002	0.0248	0.0008
Grand Total: (Pounds per Acre)	79.7	0.12	7.4	0.68	0.08	1.54	0.65	0.039	0.012	0.133	0.057	0.0006	0.0002	0.0248	0.0008

	LPAHs							
	2-Methyl-naphthalene (ug/L)	Acenaphthene (ug/L)	Acenaphthylene (ug/L)	Anthracene (ug/L)	Fluorene (ug/L)	Naphthalene (ug/L)	Phenanthrene (ug/L)	Total LPAHs (ug/L)
Baseflow								
Mean WY2011&2016 Concentration	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Number of Detects	0	5	1	6	1	1	5	7
Number of Samples	8	8	8	8	8	8	8	8
Detection Frequency	0%	63%	13%	75%	13%	13%	63%	88%
Stormwater								
Mean Annual Concentration	0.012	0.014	0.007	0.035	0.008	0.020	0.025	0.115
Number of Detects	4	3	1	7	1	3	7	6
Number of Samples	7	7	7	7	7	6	7	6
Detection Frequency	57%	43%	14%	100%	14%	50%	100%	100%
Stormwater / Baseflow Concentration	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Wet Season Load (Pounds)								
Baseflow	0	0	0	0	0	0	0	0
Stormwater	0.002	0.002	0.001	0.006	0.001	0.003	0.004	0.018
Subtotal:	0.002	0.002	0.001	0.006	0.001	0.003	0.004	0.018
Dry Season Load (Pounds)								
Baseflow	0	0	0	0	0	0	0	0
Stormwater	0.00015	0.00019	0.00010	0.00046	0.00010	0.00026	0.00032	0.00149
Subtotal:	0.00015	0.00019	0.00010	0.00046	0.00010	0.00026	0.00032	0.00149
Total Annual Load (Pounds)								
Baseflow	0	0	0	0	0	0	0	0
Stormwater	0.002	0.002	0.001	0.006	0.001	0.003	0.004	0.020
Grand Total: (Pounds)	0.002	0.002	0.001	0.006	0.001	0.003	0.004	0.020
Stormflow Percent of Annual Load	100%	100%	100%	100%	100%	100%	100%	100%
Wet Season Percent of Annual Load	92%	92%	92%	92%	92%	92%	92%	92%
Wet Season Load Density (Pounds per Acre)								
Baseflow	0	0	0	0	0	0	0	0
Stormwater	0.000032	0.000039	0.000020	0.000095	0.000021	0.000053	0.000067	0.000308
Subtotal:	0.000032	0.000039	0.000020	0.000095	0.000021	0.000053	0.000067	0.000308
Dry Season Load Density (Pounds per Acre)								
Baseflow	0	0	0	0	0	0	0	0
Stormwater	0.000003	0.000003	0.000002	0.000008	0.000002	0.000004	0.000005	0.000025
Subtotal:	0.000003	0.000003	0.000002	0.000008	0.000002	0.000004	0.000005	0.000025
Total Annual Load Density (Pounds per Acre)								
Baseflow	0	0	0	0	0	0	0	0
Stormwater	0.000034	0.000042	0.000021	0.000103	0.000023	0.000057	0.000072	0.000333
Grand Total: (Pounds per Acre)	0.000034	0.000042	0.000021	0.000103	0.000023	0.000057	0.000072	0.000333

Note: Stormwater mass loadings were not calculated for analytical parameters with fewer than 10 percent detected concentrations or only one detected sample in stormwater.

Drainage Area: 59 *Acres*

Baseflow Detects <3

Stormwater Detects <5

<25% Detection Frequency

	Wet Season	Dry Season
Mean Annual Baseflow (gpm)	0	0
Mean Annual Stormwater (gpm)	61.8	7.0

Table 6-1.5 Continued
Mass Loading Summary for OF243

	HPAHs										Phthalates				cticides/Herb
	Benzo(a)-anthracene (ug/L)	Benzo(a)-pyrene (ug/L)	Benzo(g,h,i)-perylene (ug/L)	Benzo(b,k)-fluoranthenes (ug/L)	Chrysene (ug/L)	Fluoranthene (ug/L)	Indeno(1,2,3-c,d)pyrene (ug/L)	Pyrene (ug/L)	Retene (ug/L)	Total HPAHs (ug/L)	Di(2-eh)-phthalate (ug/L)	Diethyl-phthalate (ug/L)	Di-n-butyl-phthalate (ug/L)	Total Phthalates (ug/L)	Dichlobenil (ug/L)
Baseflow															
Mean WY2011&2016 Concentration	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Number of Detects	2	2	1	5	2	8	1	8	0	8	2	0	3	0	0
Number of Samples	8	8	8	8	8	8	8	8	1	8	8	8	8	8	8
Detection Frequency	25%	25%	13%	63%	25%	100%	13%	100%	0%	100%	25%	0%	38%	0%	0%
Stormwater															
Mean Annual Concentration	0.011	0.013	0.014	0.036	0.019	0.033	0.014	0.038	0.009	0.180	0.697	0.623	0.175	1.377	0.016
Number of Detects	5	5	7	6	5	6	6	6	6	7	6	7	4	7	4
Number of Samples	7	7	7	7	7	7	7	7	7	7	7	7	7	7	6
Detection Frequency	71%	71%	100%	86%	71%	86%	86%	86%	86%	100%	86%	100%	57%	100%	67%
Stormwater / Baseflow Concentration	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Wet Season Load (Pounds)															
Baseflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stormwater	0.002	0.002	0.002	0.006	0.003	0.005	0.002	0.006	0.001	0.028	0.11	0.10	0.03	0.217	0.002
Subtotal:	0.002	0.002	0.002	0.006	0.003	0.005	0.002	0.006	0.001	0.028	0.11	0.10	0.03	0.217	0.002
Dry Season Load (Pounds)															
Baseflow	0	0	0	0	0	0	0	0	0	0	0.000	0	0	0	0
Stormwater	0.00014	0.00017	0.00019	0.00047	0.00024	0.00042	0.00019	0.00049	0.00012	0.00233	0.009	0.008	0.002	0.018	0.0002
Subtotal:	0.00014	0.00017	0.00019	0.00047	0.00024	0.00042	0.00019	0.00049	0.00012	0.00233	0.009	0.008	0.002	0.018	0.0002
Total Annual Load (Pounds)															
Baseflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stormwater	0.002	0.002	0.002	0.006	0.003	0.006	0.002	0.006	0.002	0.031	0.12	0.11	0.03	0.235	0.003
Grand Total: (Pounds)	0.002	0.002	0.002	0.006	0.003	0.006	0.002	0.006	0.002	0.031	0.12	0.11	0.03	0.235	0.003
Stormflow Percent of Annual Load	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Wet Season Percent of Annual Load	92%	92%	92%	92%	92%	92%	92%	92%	92%	92%	92%	92%	92%	92%	92%
Total Annual Load (Pounds)															
Baseflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stormwater	0.000029	0.000035	0.000038	0.000096	0.000050	0.000087	0.000038	0.000101	0.000024	0.000480	0.0019	0.0017	0.0005	0.00368	0.00004
Subtotal:	0.000029	0.000035	0.000038	0.000096	0.000050	0.000087	0.000038	0.000101	0.000024	0.000480	0.0019	0.0017	0.0005	0.00368	0.00004
Dry Season Load Density (Pounds per Acre)															
Baseflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stormwater	0.000002	0.000003	0.000003	0.000008	0.000004	0.000007	0.000003	0.000008	0.000002	0.000039	0.0002	0.0001	0.0000	0.00030	0.00000
Subtotal:	0.000002	0.000003	0.000003	0.000008	0.000004	0.000007	0.000003	0.000008	0.000002	0.000039	0.0002	0.0001	0.0000	0.00030	0.00000
Total Annual Load Density (Pounds per Acre)															
Baseflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stormwater	0.000032	0.000038	0.000041	0.000104	0.000054	0.000094	0.000042	0.000110	0.000026	0.000519	0.0020	0.0018	0.0005	0.00398	0.00005
Grand Total: (Pounds per Acre)	0.000032	0.000038	0.000041	0.000104	0.000054	0.000094	0.000042	0.000110	0.000026	0.000519	0.0020	0.0018	0.0005	0.00398	0.00005

Note: Stormwater mass loadings were not calculated for analytical parameters with fewer than 10 percent detected concentrations or only one detected sample in stormwater.

Drainage Area: *59* *Acres*

<3 Detects

<5 Detects

<25% Detection Frequency

	Wet Season	Dry Season
Mean Annual Baseflow (gpm)	0	0
Mean Annual Stormwater (gpm)	61.8	7.0

Table 6-1.6
Mass Loading Summary for OF245

	Conventals/Nutrients							Metals								LPAHs				
	TSS (mg/L)	MBAS (mg/L)	BOD5 (mg/L)	Total P (mg/L)	Ortho-P (mg/L)	TKN (mg/L)	Nitrate/ Nitrite (mg/L)	Total Cu (ug/L)	Dissolved Cu (ug/L)	Total Zn (ug/L)	Dissolved Zn (ug/L)	Total Cd (ug/L)	Dissolved Cd (ug/L)	Total Pb (ug/L)	Dissolved Pb (ug/L)	2-Methyl- naphthalene (ug/L)	Fluorene (ug/L)	Naphthalene (ug/L)	Phenanthrene (ug/L)	TotalLPAHs (ug/L)
Baseflow																				
Mean WY2016 & 2019 Concentration	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Number of Detects	6	5	1	5	6	5	5	6	6	6	6	4	3	6	0	2	1	1	5	6
Number of Samples	6	5	5	5	6	5	5	6	6	6	6	6	6	6	6	6	6	6	6	6
Detection Frequency	100%	100%	20%	100%	100%	100%	100%	100%	100%	100%	100%	67%	50%	100%	0%	33%	17%	17%	83%	100%
Stormwater																				
Mean Annual Concentration	20.48	0.05	2.17	0.10	0.03	0.43	0.10	6.71	2.264	44.43	20.55	0.118	0.058	2.04	0.11	0.023	0.007	0.066	0.019	0.109
Number of Detects	10	9	7	10	9	10	10	11	11	11	11	10	6	11	9	7	2	6	8	10
Number of Samples	10	9	9	10	10	10	10	11	11	11	11	11	11	11	11	11	11	10	11	10
Detection Frequency	100%	100%	78%	100%	90%	100%	100%	100%	100%	100%	100%	91%	55%	100%	82%	64%	18%	60%	73%	100%
Stormwater / Baseflow Concentration	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Wet Season Load (Pounds)																				
Baseflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stormwater	6,128	16.13	650	30.6	8.1	130.1	29.3	2.0	0.7	13.3	6.1	0.0354	0.0173	0.61	0.0331	0.007	0.002	0.020	0.006	0.033
Subtotal:	6,128	16.13	650	30.6	8.1	130.1	29.3	2.0	0.7	13.3	6.1	0.0354	0.0173	0.61	0.0331	0.007	0.002	0.020	0.006	0.033
Dry Season Load (Pounds)																				
Baseflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stormwater	854	2.25	91	4.3	1.1	18.1	4.1	0.3	0.094	1.9	0.9	0.0049	0.0024	0.09	0.0046	0.00094	0.00031	0.00274	0.00081	0.00456
Subtotal:	854	2.25	91	4.3	1.1	18.1	4.1	0.3	0.094	1.9	0.9	0.0049	0.0024	0.09	0.0046	0.00094	0.00031	0.00274	0.00081	0.00456
Total Annual Load (Pounds)																				
Baseflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stormwater	6,982	18.38	741	34.9	9.2	148.2	33.3	2.3	0.8	15.1	7.0	0.0404	0.0197	0.70	0.04	0.008	0.003	0.022	0.007	0.037
Grand Total: (Pounds)	6,982	18.38	741	34.9	9.2	148.2	33.3	2.3	0.8	15.1	7.0	0.0404	0.0197	0.70	0.04	0.008	0.003	0.022	0.007	0.037
Stormflow Percent of Annual Load	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Wet Season Percent of Annual Load	88%	88%	88%	88%	88%	88%	88%	88%	88%	88%	88%	88%	88%	88%	88%	88%	88%	88%	88%	88%
Wet Season Load Density (Pounds per Acre)																				
Baseflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stormwater	161	0.425	17.1	0.80	0.21	3.42	0.77	0.053	0.018	0.350	0.162	0.00093	0.00046	0.0161	0.0009	0.000178	0.000058	0.000517	0.000152	0.000861
Subtotal:	161	0.425	17.1	0.80	0.21	3.42	0.77	0.053	0.018	0.350	0.162	0.00093	0.00046	0.0161	0.0009	0.000178	0.000058	0.000517	0.000152	0.000861
Dry Season Load Density (Pounds per Acre)																				
Baseflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stormwater	22.5	0.059	2.4	0.11	0.03	0.48	0.11	0.007	0.002	0.049	0.023	0.00013	0.00006	0.0022	0.00012	0.000025	0.000008	0.000072	0.000021	0.000120
Subtotal:	22.5	0.059	2.4	0.11	0.03	0.48	0.11	0.007	0.002	0.049	0.023	0.00013	0.00006	0.0022	0.00012	0.000025	0.000008	0.000072	0.000021	0.000120
Total Annual Load Density (Pounds per Acre)																				
Baseflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stormwater	184	0.484	19.5	0.92	0.24	3.90	0.88	0.060	0.020	0.399	0.184	0.0011	0.0005	0.0183	0.0010	0.000202	0.000066	0.000589	0.000173	0.000981
Grand Total: (Pounds per Acre)	184	0.484	19.5	0.92	0.24	3.90	0.88	0.060	0.020	0.399	0.184	0.00106	0.0005	0.0183	0.0010	0.000202	0.000066	0.000589	0.000173	0.000981

Note: Stormwater mass loadings were not calculated for analytical parameters with fewer than 10 percent detected concentrations or only one detected sample in stormwater.

Drainage Area: 38 *Acres*

Baseflow Detects <3

Stormwater Detects <5

<25% Detection Frequency

	Wet Season	Dry Season
Mean Annual Baseflow (gpm)	0	0
Mean Annual Stormwater (gpm)	117	22.7

Table 6-1.6 Continued
Mass Loading Summary for OF245

	HPAHs									Phthalates			Herbicide
	Benzo(a)-pyrene (ug/L)	Benzo(g,h,i)-perylene (ug/L)	Benzo(b,k)-fluoranthenes (ug/L)	Chrysene (ug/L)	Fluoranthene (ug/L)	Indeno(1,2,3-c,d)pyrene (ug/L)	Pyrene (ug/L)	Retene (ug/L)	Total HPAHs (ug/L)	Di(2-eh)-phthalate (ug/L)	Di-n-butyl-phthalate (ug/L)	Total Phthalates (ug/L)	Dichlobenil (ug/L)
Baseflow													
Mean WY2011&2016 Concentration	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Number of Detects	1	1	1	2	2	0	6	0	5	1	2	2	0
Number of Samples	6	6	6	6	6	6	6	1	6	6	6	6	6
Detection Frequency	17%	17%	17%	33%	33%	0%	100%	0%	83%	17%	33%	33%	
Stormwater													
Mean Annual Concentration	0.005	0.011	0.016	0.010	0.021	0.005	0.031	0.008	0.104	0.982	1.311	2.341	0.022
Number of Detects	8	10	8	7	10	6	10	10	11	10	11	11	8
Number of Samples	11	11	11	11	11	11	11	11	11	11	11	11	10
Detection Frequency	73%	91%	73%	64%	91%	55%	91%	91%	100%	91%	100%	100%	80%
Stormwater / Baseflow Concentration	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Wet Season Load (Pounds)													
Baseflow	0	0	0	0	0	0	0	0	0	0	0	0	0
Stormwater	0.002	0.003	0.005	0.003	0.006	0.001	0.009	0.002	0.031	0.29	0.39	0.701	0.007
Subtotal:	0.002	0.003	0.005	0.003	0.006	0.001	0.009	0.002	0.031	0.29	0.39	0.701	0.007
Dry Season Load (Pounds)													
Baseflow	0	0	0	0	0	0	0	0	0	0.000	0	0	0
Stormwater	0.00022	0.00044	0.00066	0.00042	0.00086	0.00020	0.00129	0.00033	0.00436	0.041	0.055	0.098	0.0009
Subtotal:	0.00022	0.00044	0.00066	0.00042	0.00086	0.00020	0.00129	0.00033	0.00436	0.041	0.055	0.098	0.0009
Total Annual Load (Pounds)													
Baseflow	0	0	0	0	0	0	0	0	0	0	0	0	0
Stormwater	0.002	0.004	0.005	0.003	0.007	0.002	0.011	0.003	0.036	0.33	0.45	0.798	0.008
Grand Total: (Pounds)	0.002	0.004	0.005	0.003	0.007	0.002	0.011	0.003	0.036	0.33	0.45	0.798	0.008
Stormflow Percent of Annual Load	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Wet Season Percent of Annual Load	88%	88%	88%	88%	88%	88%	88%	88%	88%	88%	88%	88%	88%
Total Annual Load (Pounds)													
Baseflow	0	0	0	0	0	0	0	0	0	0	0	0	0
Stormwater	0.000041	0.000083	0.000124	0.000078	0.000163	0.000038	0.000243	0.000062	0.000822	0.0077	0.0103	0.01844	0.00018
Subtotal:	0.000041	0.000083	0.000124	0.000078	0.000163	0.000038	0.000243	0.000062	0.000822	0.0077	0.0103	0.01844	0.00018
Dry Season Load Density (Pounds per Acre)													
Baseflow	0	0	0	0	0	0	0	0	0	0	0	0	0
Stormwater	0.000006	0.000012	0.000017	0.000011	0.000023	0.000005	0.000034	0.000009	0.000115	0.0011	0.0014	0.00257	0.00002
Subtotal:	0.000006	0.000012	0.000017	0.000011	0.000023	0.000005	0.000034	0.000009	0.000115	0.0011	0.0014	0.00257	0.00002
Total Annual Load Density (Pounds per Acre)													
Baseflow	0	0	0	0	0	0	0	0	0	0	0	0	0
Stormwater	0.000047	0.000094	0.000141	0.000089	0.000186	0.000043	0.000277	0.000071	0.000937	0.0088	0.0118	0.02101	0.00020
Grand Total: (Pounds per Acre)	0.000047	0.000094	0.000141	0.000089	0.000186	0.000043	0.000277	0.000071	0.000937	0.0088	0.0118	0.02101	0.00020

Note: Stormwater mass loadings were not calculated for analytical parameters with fewer than 10 percent detected concentrations or only one detected sample in stormwater.

Drainage Area: *38 Acres*

<3 Detects

<5 Detects

<25% Detection Frequency

	Dry Season	Dry Season
Mean Annual Baseflow (gpm)	0	0
Mean Annual Stormwater (gpm)	20.3	20.3

Table 6-1.7
Mass Loading Summary for OF254

	Conventals/Nutrients							Metals								LPAHs							
	TSS (mg/L)	MBAS (mg/L)	BOD5 (mg/L)	Total P (mg/L)	Ortho-P (mg/L)	TKN (mg/L)	Nitrate/ Nitrite (mg/L)	Total Cu (ug/L)	Dissolved Cu (ug/L)	Total Zn (ug/L)	Dissolved Zn (ug/L)	Total Cd (ug/L)	Dissolved Cd (ug/L)	Total Pb (ug/L)	Dissolved Pb (ug/L)	2-Methyl-naphthalene (ug/L)	Acenaphthene (ug/L)	Acenaphthylene (ug/L)	Anthracene (ug/L)	Fluorene (ug/L)	Naphthalene (ug/L)	Phenanthrene (ug/L)	Total LPAHs (ug/L)
Baseflow																							
Mean WY2011&2016 Concentration	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Number of Detects	6	5	1	4	5	5	5	6	6	6	6	4	3	6	0	2	3	0	5	1	1	5	6
Number of Samples	6	5	5	4	5	5	5	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Detection Frequency	100%	100%	20%	100%	100%	100%	100%	100%	100%	100%	100%	67%	50%	100%	0%	33%	50%	0%	83%	17%	17%	83%	100%
Stormwater																							
Mean Annual Concentration	52.93	0.07	2.13	0.10	0.02	0.32	0.10	13.82	2.27	56.62	26.82	0.12	0.06	4.47	0.63	0.019	0.005	0.006	0.007	0.006	0.025	0.035	0.078
Number of Detects	9	7	5	7	8	6	7	9	9	9	9	8	7	9	7	7	1	1	3	1	4	7	8
Number of Samples	9	7	6	7	8	7	7	9	9	9	9	9	8	9	8	9	9	9	9	9	8	9	8
Detection Frequency	100%	100%	83%	100%	100%	86%	100%	100%	100%	100%	100%	89%	88%	100%	88%	78%	11%	11%	33%	11%	50%	78%	100%
Stormwater / Baseflow Concentration	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Wet Season Load (Pounds)																							
Baseflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stormwater	42,287	53.82	1,699	81.4	14.8	253.6	78.4	11.0	1.8	45.2	21.4	0.0943	0.0476	3.57	0.5065	0.015	0.004	0.005	0.006	0.005	0.020	0.028	0.062
Subtotal:	42,287	53.82	1,699	81.4	14.8	253.6	78.4	11.0	1.8	45.2	21.4	0.0943	0.0476	3.57	0.5065	0.015	0.004	0.005	0.006	0.005	0.020	0.028	0.062
Dry Season Load (Pounds)																							
Baseflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stormwater	2,606	3.317	105	5.0	0.9	15.6	4.8	0.7	0.112	2.8	1.3	0.0058	0.0029	0.22	0.0312	0.00094	0.00027	0.00029	0.00034	0.00030	0.00122	0.00173	0.00383
Subtotal:	2,606	3.317	105	5.0	0.9	15.6	4.8	0.7	0.112	2.8	1.3	0.0058	0.0029	0.22	0.0312	0.00094	0.00027	0.00029	0.00034	0.00030	0.00122	0.00173	0.00383
Total Annual Load (Pounds)																							
Baseflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stormwater	44,893	57.1	1,804	86.4	15.7	269.2	83.3	11.7	1.9	48.0	22.7	0.1001	0.0505	3.79	0.54	0.016	0.005	0.005	0.006	0.005	0.021	0.030	0.066
Grand Total: (Pounds)	44,893	57.1	1,804	86.4	15.7	269.2	83.3	11.7	1.9	48.0	22.7	0.1001	0.0505	3.79	0.54	0.016	0.005	0.005	0.006	0.005	0.021	0.030	0.066
Stormflow Percent of Annual Load	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Wet Season Percent of Annual Load	94%	94%	94%	94%	94%	94%	94%	94%	94%	94%	94%	94%	94%	94%	94%	94%	94%	94%	94%	94%	94%	94%	94%
Wet Season Load Density (Pounds per Acre)																							
Baseflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stormwater	355	0.452	14.3	0.68	0.12	2.13	0.66	0.093	0.015	0.380	0.180	0.00079	0.00040	0.0300	0.0043	0.000128	0.000037	0.000040	0.000046	0.000041	0.000166	0.000235	0.000523
Subtotal:	355	0.452	14.3	0.68	0.12	2.13	0.66	0.093	0.015	0.380	0.180	0.00079	0.00040	0.0300	0.0043	0.000128	0.000037	0.000040	0.000046	0.000041	0.000166	0.000235	0.000523
Dry Season Load Density (Pounds per Acre)																							
Baseflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stormwater	21.9	0.028	0.9	0.04	0.01	0.13	0.04	0.006	0.001	0.023	0.011	0.00005	0.00002	0.0019	0.00026	0.000008	0.000002	0.000002	0.000003	0.000003	0.000010	0.000014	0.000032
Subtotal:	21.9	0.028	0.9	0.04	0.01	0.13	0.04	0.006	0.001	0.023	0.011	0.00005	0.00002	0.0019	0.00026	0.000008	0.000002	0.000002	0.000003	0.000003	0.000010	0.000014	0.000032
Total Annual Load Density (Pounds per Acre)																							
Baseflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stormwater	377	0.480	15.2	0.73	0.13	2.26	0.70	0.099	0.016	0.404	0.191	0.0008	0.0004	0.0319	0.0045	0.000136	0.000039	0.000042	0.000049	0.000044	0.000177	0.000250	0.000555
Grand Total: (Pounds per Acre)	377	0.480	15.2	0.73	0.13	2.26	0.70	0.099	0.016	0.404	0.191	0.0008	0.0004	0.0319	0.0045	0.000136	0.000039	0.000042	0.000049	0.000044	0.000177	0.000250	0.000555

Note: Stormwater mass loadings were not calculated for analytical parameters with fewer than 10 percent detected concentrations or only one detected sample in stormwater.

Drainage Area: 119 *Acres*

Baseflow Detects <3

Stormwater Detects <5

<25% Detection Frequency

	Wet Season	Dry Season
Mean Annual Baseflow (gpm)	0	0
Mean Annual Stormwater (gpm)	313.6	26.8

Table 6-1.7 Continued
Mass Loading Summary for OF254

	HPAHs											Phthalates				Herbicide
	Benzo(a)-anthracene (ug/L)	Benzo(a)-pyrene (ug/L)	Benzo(g,h,i)-perylene (ug/L)	Benzo(b,k)-fluoranthenes (ug/L)	Chrysene (ug/L)	Dibenz(a,h)-anthracene (ug/L)	Fluoranthene (ug/L)	Indeno(1,2,3-c,d)pyrene (ug/L)	Pyrene (ug/L)	Retene (ug/L)	Total HPAHs (ug/L)	Di(2-eh)-phthalate (ug/L)	Diethyl-phthalate (ug/L)	Di-n-butyl-phthalate (ug/L)	Total Phthalates (ug/L)	Dichlobenil (ug/L)
Baseflow																
Mean WY2011&2016 Concentration	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Number of Detects	0	1	1	1	2	0	2	0	6	0	5	1	0	2	2	0
Number of Samples	6	6	6	6	6	6	6	6	6	1	6	6	6	6	6	6
Detection Frequency	0%	17%	17%	17%	33%	0%	33%	0%	100%	0%	83%	17%	0%	33%	33%	
Stormwater																
Mean Annual Concentration	0.016	0.020	0.025	0.071	0.041	0.003	0.063	0.016	0.076	0.016	0.331	1.073	0.172	0.257	1.252	0.023
Number of Detects	6	7	9	7	8	1	8	8	8	9	9	8	1	4	9	5
Number of Samples	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	8
Detection Frequency	67%	78%	100%	78%	89%	11%	89%	89%	89%	100%	100%	89%	11%	44%	100%	63%
Stormwater / Baseflow Concentration	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Wet Season Load (Pounds)																
Baseflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stormwater	0.013	0.016	0.020	0.056	0.033	0.003	0.051	0.013	0.060	0.013	0.264	0.86	0.14	0.21	1.000	0.018
Subtotal:	0.013	0.016	0.020	0.056	0.033	0.003	0.051	0.013	0.060	0.013	0.264	0.86	0.14	0.21	1.000	0.018
Dry Season Load (Pounds)																
Baseflow	0	0	0	0	0	0	0	0	0	0	0	0.000	0	0	0	0
Stormwater	0.00079	0.00097	0.00122	0.00348	0.00202	0.00017	0.00312	0.00080	0.00372	0.00079	0.01629	0.053	0.008	0.013	0.062	0.0011
Subtotal:	0.00079	0.00097	0.00122	0.00348	0.00202	0.00017	0.00312	0.00080	0.00372	0.00079	0.01629	0.053	0.008	0.013	0.062	0.0011
Total Annual Load (Pounds)																
Baseflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stormwater	0.014	0.017	0.021	0.060	0.035	0.003	0.054	0.014	0.064	0.014	0.281	0.91	0.15	0.22	1.062	0.019
Grand Total: (Pounds)	0.014	0.017	0.021	0.060	0.035	0.003	0.054	0.014	0.064	0.014	0.281	0.91	0.15	0.22	1.062	0.019
Stormflow Percent of Annual Load	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Wet Season Percent of Annual Load	94%	94%	94%	94%	94%	94%	94%	94%	94%	94%	94%	94%	94%	94%	94%	94%
Total Annual Load (Pounds)																
Baseflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stormwater	0.000108	0.000132	0.000166	0.000474	0.000275	0.000023	0.000425	0.000110	0.000507	0.000108	0.002221	0.0072	0.0012	0.0017	0.00840	0.00015
Subtotal:	0.000108	0.000132	0.000166	0.000474	0.000275	0.000023	0.000425	0.000110	0.000507	0.000108	0.002221	0.0072	0.0012	0.0017	0.00840	0.00015
Dry Season Load Density (Pounds per Acre)																
Baseflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stormwater	0.000007	0.000008	0.000010	0.000029	0.000017	0.000001	0.000026	0.000007	0.000031	0.000007	0.000137	0.0004	0.0001	0.0001	0.00052	0.00001
Subtotal:	0.000007	0.000008	0.000010	0.000029	0.000017	0.000001	0.000026	0.000007	0.000031	0.000007	0.000137	0.0004	0.0001	0.0001	0.00052	0.00001
Total Annual Load Density (Pounds per Acre)																
Baseflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stormwater	0.000115	0.000140	0.000176	0.000504	0.000292	0.000025	0.000451	0.000116	0.000538	0.000115	0.002358	0.0076	0.0012	0.0018	0.00892	0.00016
Grand Total: (Pounds per Acre)	0.000115	0.000140	0.000176	0.000504	0.000292	0.000025	0.000451	0.000116	0.000538	0.000115	0.002358	0.0076	0.0012	0.0018	0.00892	0.00016

Note: Stormwater mass loadings were not calculated for analytical parameters with fewer than 10 percent detected concentrations or only one detected sample in stormwater.

Drainage Area: 119 *Acres*

<3 Detects

<5 Detects

<25% Detection Frequency

	Wet Season	Dry Season
Mean Annual Baseflow (gpm)	0	0
Mean Annual Stormwater (gpm)	313.6	26.8

Table 6-2.1

Pollutant Loading Summary Comparison - WY2010-12 and WY2015-2022

	OF235 - Commercial											Percent Difference									
	WY2010	WY2011	WY2012	WY2015	WY2016	WY2017	WY2018	WY2019	WY2020	WY2021	WY2022	WY2010 to WY2022	WY2011 to WY2022	WY2012 to WY2022	WY2015 to WY2022	WY2016 to WY2022	WY2017 to WY2022	WY2018 to WY2022	WY2019 to WY2022	WY2020 to WY2022	WY2021 to WY2022
Conventionals (lbs per acre)																					
TSS	278	319	200	193	178	166	187	164	109	114	126	-55%	-61%	-37%	-35%	-30%	-24%	-33%	-23%	4%	11%
MBAS	0.33	0.52	0.51	0.39	0.29	0.39	0.28	0.30	0.29	0.21	0.32	-5%	-40%	-38%	-18%	7%	-19%	13%	6%	-28%	53%
BOD$_5$	21	20	25	14	27	16	13	18	19	16	15	-32%	-26%	-42%	6%	-45%	-7%	10%	-18%	-16%	-8%
Total Phosphorus	0.83	0.78	0.62	0.61	1.05	0.82	0.87	0.89	0.76	0.70	0.95	15%	21%	54%	55%	-9%	16%	9%	7%	-7%	35%
Orthophophorus	0.37	0.27	0.26	0.31	0.41	0.43	0.40	0.46	0.42	0.44	0.59	61%	117%	130%	90%	44%	36%	48%	28%	4%	34%
TN	6.5	4.7	4.0	3.2	5.2	5.3	4.9	6.4	6.5	6.2	6.6	2%	42%	64%	107%	28%	26%	36%	3%	-5%	7%
Nitrate/Nitrite -Total	5.7	3.7	3.4	4.8	4.5	4.7	4.4	4.4	4.1	4.5	4.3	-25%	16%	24%	-11%	-6%	-9%	-3%	-3%	8%	-4%
Metals (lbs/1000 per acre)																					
Cu - Total	173	181	170	124	148	129	120	103	96	91	90	-48%	-50%	-47%	-27%	-39%	-30%	-25%	-13%	-6%	-1%
Cu - Dissolved	65	64	60	60	62	59	43	50	47	40	43	-34%	-33%	-29%	-29%	-31%	-26%	-1%	-14%	-16%	8%
Zn - Total	547	567	551	369	444	406	380	334	316	282	308	-44%	-46%	-44%	-17%	-31%	-24%	-19%	-8%	-11%	9%
Zn - Dissolved	225	208	193	194	194	201	156	161	149	119	143	-36%	-31%	-26%	-26%	-26%	-28%	-8%	-11%	-20%	21%
Cd - Total	1.3	1.6	1.2	0.53	0.64	0.57	0.70	0.43	0.38	0.39	0.46	-63%	-71%	-63%	-14%	-29%	-19%	-35%	6%	5%	17%
Cd - Dissolved	0.6	0.6	0.5	0.23	0.25	0.25	0.30	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hg - Total [1]	0.304	0.214	0.208	0.050	0.038	0.038	0.033	0.039	--	--	--	--	--	--	--	--	--	--	--	--	--
Hg - Dissolved [1]	--	--	--	--	0.012	0.015	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pb - Total	307	293	253	144	208	166	155	116	126	156	117	-62%	-60%	-54%	-18%	-43%	-30%	-24%	1%	24%	-25%
Pb - Dissolved	38.7	30.6	30.9	23.1	28.0	22.2	17.6	21.8	22.5	23.1	20.4	-47%	-33%	-34%	-12%	-27%	-8%	16%	-7%	3%	-12%
LPAHs (lbs/1000 per acre)																					
2-Methylnaphthalene	0.070	0.075	0.065	0.047	0.156	0.082	0.097	0.069	0.053	0.052	0.099	42%	32%	51%	110%	-37%	20%	2%	42%	-1%	88%
Acenaphthene	0.040	0.035	0.032	--	0.062	0.046	0.029	--	0.042	0.047	--	--	--	--	--	--	--	--	--	13%	--
Acenaphthylene	0.026	0.029	0.026	--	--	0.056	0.050	0.048	--	--	--	--	--	--	--	--	--	--	--	--	--
Anthracene	0.035	0.044	0.033	0.047	0.061	0.090	0.081	0.090	0.058	0.065	0.085	146%	94%	156%	81%	39%	-5%	5%	-5%	12%	32%
Fluorene	0.040	0.067	0.065	--	0.053	0.068	0.047	0.043	--	--	--	--	--	--	--	--	--	--	--	--	--
Naphthalene	0.086	0.094	0.076	0.060	0.298	0.106	0.179	0.130	0.100	0.085	0.113	31%	20%	48%	90%	-62%	7%	-37%	-13%	-16%	34%
Phenanthrene	0.161	0.158	0.180	0.109	0.197	0.202	0.171	0.220	0.119	0.130	0.155	-4%	-2%	-14%	42%	-21%	-24%	-10%	-30%	9%	18%
LPAH - Total	0.395	0.436	0.378	0.351	0.737	0.556	0.545	0.560	0.345	0.371	0.453	15%	4%	20%	29%	-38%	-18%	-17%	-19%	8%	22%
HPAHs (lbs/1000 per acre)																					
Benzo(a)anthracene	0.033	0.066	0.066	0.066	0.066	0.269	0.253	0.254	0.081	0.077	0.131	296%	100%	99%	99%	99%	-51%	-48%	-48%	-6%	71%
Benzo(a)pyrene	0.057	0.050	0.064	0.064	0.064	0.043	0.046	0.036	0.096	0.088	0.119	107%	136%	87%	87%	87%	178%	158%	228%	-8%	35%
Benzo(g,h,i)perylene	0.090	0.100	0.106	0.106	0.106	0.393	0.395	0.419	0.162	0.142	0.154	71%	54%	46%	46%	46%	-61%	-61%	-63%	-12%	8%
Benzo(b,k)fluoranthenes	0.147	0.132	0.158	0.170	0.446	0.415	0.436	0.371	0.260	0.247	0.326	122%	148%	107%	91%	-27%	-22%	-25%	-12%	-5%	32%
Chrysene	0.127	0.118	0.102	0.130	0.302	0.271	0.256	0.257	0.183	0.162	0.199	57%	68%	94%	53%	-34%	-27%	-22%	-23%	-11%	23%
Dibenz(a,h)anthracene	--	--	0.021	0.037	0.052	0.044	0.047	0.039	0.028	--	--	--	--	--	--	--	--	--	--	--	--
Fluoranthene	0.281	0.274	0.270	0.204	0.417	0.385	0.388	0.407	0.255	0.234	0.294	5%	7%	9%	44%	-29%	-24%	-24%	-28%	-8%	26%
Indeno(1,2,3-c,d)pyrene	0.054	0.053	0.066	0.092	0.158	0.141	0.158	0.144	0.102	0.089	0.101	87%	92%	54%	10%	-36%	-28%	-36%	-30%	-13%	14%
Pyrene	0.309	0.313	0.279	0.251	0.574	0.476	0.464	0.476	0.322	0.261	0.374	21%	19%	34%	49%	-35%	-21%	-19%	-21%	-19%	43%
Retene	--	--	--	--	--	--	--	--	--	0.041	0.077	--	--	--	--	--	--	--	--	--	87%
HPAH - Total	1.14	1.12	1.10	1.18	2.54	2.21	2.25	2.162	1.445	1.282	1.680	47%	49%	53%	42%	-34%	-24%	-25%	-22%	-11%	31%
Phthalates (lbs/1000 per acre)																					
DEHP	10.7	8.2	7.2	8.6	18.3	13.5	10.4	10.02	6.71	5.63	6.38	-40%	-22%	-12%	-25%	-65%	-53%	-39%	-36%	-16%	13%
Butylbenzyl-phthalate	2.0	3.08	2.30	3.72	3.76	4.49	2.59	5.28	5.20	3.07	3.78	85%	23%	64%	1%	1%	-16%	46%	-28%	-41%	23%
Diethyl-phthalate	1.9	--	1.13	1.33	1.80	1.60	1.47	2.07	1.95	2.51	1.75	-5%	--	55%	32%	-3%	10%	19%	-15%	28%	-30%
Dimethyl-phthalate	0.29	--	--	1.24	2.11	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-butyl-phthalate	1.8	1.5	2.0	1.5	2.2	1.9	1.4	1.44	1.44	1.30	1.83	3%	24%	-8%	25%	-17%	-3%	28%	27%	-10%	41%
Di-n-octylphthalate	--	0.8	--	1.4	3.5	2.0	1.5	1.71	--	--	--	--	--	--	--	--	--	--	--	--	--
Phthalates - Total	16.2	11.9	10.0	13.1	25.5	19.0	13.4	17.39	13.69	10.40	11.46	-29%	-4%	14%	-13%	-55%	-40%	-14%	-34%	-24%	10%
Pesticides (lbs/1000 per acre)																					
Bifenthrin	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dichlobenil	4.22	0.74	0.26	0.67	0.50	0.39	0.26	0.30	0.25	0.24	0.58	-86%	-22%	127%	-14%	16%	47%	125%	94%	-2%	140%

Note: Mass loadings were not calculated for parameters with fewer than 10 percent detected concentrations or only one detected sample in stormwater.

[1] *In WY2015, total and dissolved mercury detection limits were lowered by a factor of 1,000 from parts per billion to part per trillion. The WY2012 loadings are based on ppb and may be a factor of 1000 higher than actual loadings.*

(yellow) The estimated mass load comparisons to WY2020 are greater than a factor of two of each other (i.e., the percent difference greater than 100%).

(green) The estimated mass load comparisons to WY2020 are less than a factor of two of each other (i.e., the percent difference less than – 75%)

Table 6-2.1
Pollutant Loading Summary Comparison - WY2010-12 and WY2015-2022

	OF237B - Residential																				
												Percent Difference									
	WY2010	WY2011	WY2012	WY2015	WY2016	WY2017	WY2018	WY2019	WY2020	WY2021	WY2022	WY2010 to WY2022	WY2011 to WY2022	WY2012 to WY2022	WY2015 to WY2022	WY2016 to WY2022	WY2017 to WY2022	WY2018 to WY2022	WY2019 to WY2022	WY2020 to WY2022	WY2021 to WY2022
Conventionals (lbs per acre)																					
TSS	270	494	144	131	209	161	178	105	133	96	117	-57%	-76%	-19%	-10%	-44%	-27%	-34%	11%	-12%	22%
MBAS	0.38	0.65	0.43	0.19	0.41	0.13	0.43	0.34	0.42	0.32	0.40	5%	-38%	-8%	115%	-3%	211%	-6%	19%	-5%	25%
BOD_5	21	24	31	16	52	8	46	20	27	25	26	24%	11%	-17%	60%	-50%	215%	-43%	33%	-1%	3%
Total Phosphorus	0.91	1.40	0.86	0.89	0.89	0.42	0.83	0.66	0.81	0.76	0.73	-20%	-48%	-16%	-18%	-19%	73%	-12%	10%	-11%	-5%
Orthophophorus	0.50	0.37	0.48	0.41	0.44	0.06	0.45	0.39	0.36	0.44	0.44	-11%	19%	-8%	7%	0%	615%	-2%	15%	23%	2%
TN	5.1	7.7	4.5	6.4	36.9	2.1	38.5	35.7	36.8	37.3	38.1	645%	393%	740%	499%	3%	1734%	-1%	7%	3%	2%
Nitrate/Nitrite -Total	36.4	36.7	32.2	37.2	36.8	1.2	38.0	35.0	34.8	37.3	37.4	3%	2%	16%	0%	2%	3122%	-2%	7%	7%	0%
Metals (lbs/1000 per acre)																					
Cu - Total	52	94	61	36	48	35	27	20	29	28	28	-46%	-70%	-54%	-21%	-41%	-19%	3%	39%	-3%	2%
Cu - Dissolved	19	25	25	13	14	11	10	7	11	10	12	-36%	-52%	-53%	-8%	-16%	9%	21%	71%	10%	17%
Zn - Total	276	511	278	216	278	264	174	125	188	162	151	-45%	-70%	-46%	-30%	-46%	-43%	-13%	21%	-20%	-7%
Zn - Dissolved	123	222	126	105	119	147	85	57	79	69	74	-39%	-66%	-41%	-29%	-37%	-49%	-13%	30%	-6%	7%
Cd - Total	1.6	1.5	1.1	0.67	0.61	0.23	0.30	0.15	0.24	0.23	--	--	--	--	--	--	--	--	--	--	--
Cd - Dissolved	1.6	0.8	0.8	0.61	0.25	0.09	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hg - Total[1]	0.585	--	--	0.043	0.046	0.035	0.023	0.060	--	--	--	--	--	--	--	--	--	--	--	--	--
Hg - Dissolved[1]	--	--	--	0.015	0.017	0.012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pb - Total	53	107	52	37	50	28	21	13	19	18	17	-69%	-84%	-68%	-56%	-67%	-42%	-20%	31%	-11%	-8%
Pb - Dissolved	2.1	2.5	2.5	1.4	4.5	0.8	1.0	1.1	1.3	1.0	1.3	-40%	-50%	-48%	-10%	-71%	55%	24%	12%	-2%	32%
LPAHs (lbs/1000 per acre)																					
2-Methylnaphthalene	0.072	0.070	0.225	0.055	0.079	0.031	0.065	0.096	0.096	0.064	0.080	12%	15%	-64%	46%	1%	162%	24%	-16%	-16%	25%
Acenaphthene	0.045	--	--	--	--	--	0.077	--	0.061	0.108	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	0.044	--	--	--	0.056	0.017	0.049	0.031	--	--	--	--	--	--	--	--	--	--	--	--	--
Anthracene	0.041	--	--	--	--	0.016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluorene	0.049	0.052	0.060	0.051	0.043	0.018	0.045	0.043	--	--	--	--	--	--	--	--	--	--	--	--	--
Naphthalene	0.149	0.136	0.223	0.122	0.174	0.056	0.161	0.147	0.138	--	0.144	--	--	--	--	--	--	--	--	5%	--
Phenanthrene	0.117	0.146	0.137	0.111	0.243	0.155	0.152	0.130	0.120	0.121	0.104	-11%	-28%	-24%	-6%	-57%	-32%	-31%	-20%	-13%	-13%
LPAH - Total	0.364	0.523	0.534	0.501	0.638	0.267	0.510	0.430	0.451	0.475	0.481	32%	-8%	-10%	-4%	-25%	80%	-6%	12%	7%	1%
HPAHs (lbs/1000 per acre)																					
Benzo(a)anthracene	0.052	0.102	0.053	0.062	0.145	0.081	0.078	0.062	0.068	0.051	0.065	25%	-36%	23%	5%	-55%	-20%	-17%	5%	-4%	29%
Benzo(a)pyrene	0.062	0.087	0.053	0.068	0.200	0.112	0.121	0.076	0.076	0.068	0.084	36%	-4%	59%	24%	-58%	-25%	-31%	11%	10%	24%
Benzo(g,h,i)perylene	0.103	0.143	0.053	0.085	0.185	0.131	0.115	0.116	0.124	0.091	0.091	-12%	-36%	72%	8%	-51%	-30%	-21%	-21%	-26%	0%
Benzo(b,k)fluoranthenes	0.155	0.230	0.075	0.118	0.469	0.259	0.285	0.179	0.198	0.178	0.228	48%	-1%	204%	94%	-51%	-12%	-20%	27%	15%	28%
Chrysene	0.090	0.142	0.051	0.073	0.279	0.175	0.140	0.104	0.113	0.092	0.099	10%	-30%	94%	36%	-64%	-43%	-29%	-4%	-12%	7%
Dibenz(a,h)anthracene	--	--	--	0.045	0.063	0.027	0.040	0.033	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluoranthene	0.159	0.233	0.125	0.133	0.373	0.252	0.200	0.169	0.182	0.139	0.171	8%	-26%	38%	29%	-54%	-32%	-14%	1%	-6%	23%
Indeno(1,2,3-c,d)pyrene	0.068	0.091	0.041	0.066	0.159	0.110	0.098	0.084	0.086	0.071	0.084	23%	-8%	105%	27%	-47%	-24%	-15%	0%	-3%	18%
Pyrene	0.181	0.286	0.144	0.150	0.450	0.285	0.224	0.190	0.226	0.148	0.198	9%	-31%	37%	32%	-56%	-31%	-12%	4%	-13%	33%
Retene	--	--	--	--	--	--	--	--	--	--	0.047	--	--	--	--	--	--	--	--	--	--
HPAH - Total	0.793	1.354	0.534	0.800	2.32	1.43	1.30	1.01	1.11	0.87	1.06	34%	-22%	98%	33%	-54%	-26%	-19%	5%	-4%	22%
Phthalates (lbs/1000 per acre)																					
DEHP	9.6	8.4	5.5	6.0	11.5	8.1	5.6	6.5	6.2	5.1	5.7	-40%	-32%	4%	-4%	-50%	-29%	2%	-12%	-8%	13%
Butylbenzyl-phthalate	2.1	--	--	2.25	2.99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Diethyl-phthalate	2.0	--	--	3.33	12.66	0.21	--	4.24	--	--	--	--	--	--	--	--	--	--	--	--	--
Dimethyl-phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-butyl-phthalate	3.2	2.4	3.7	2.4	1.8	1.0	1.6	2.3	2.6	2.6	3.0	-8%	23%	-19%	25%	67%	185%	85%	32%	15%	12%
Di-n-octylphthalate	--	1.2	0.9	1.3	3.6	1.1	--	2.6	--	--	--	--	--	--	--	--	--	--	--	--	--
Phthalates - Total	13.5	14.8	11.2	12.8	26.9	9.7	9.3	12.7	9.9	8.3	9.5	-30%	-36%	-15%	-26%	-65%	-2%	1%	-26%	-4%	13%
Pesticides (lbs/1000 per acre)																					
Bifenthrin	0.45	0.79	1.14	--	--	--	0.00			--	--	--	--	--	--	--	--	--	--	--	--
Dichlobenil	0.45	0.79	1.14	0.31	2.97	0.23	0.28	0.38	0.45	0.40	0.53	19%	-32%	-53%	74%	-82%	132%	89%	41%	17%	33%

Note: Mass loadings were not calculated for parameters with fewer than 10 percent detected concentrations or only one detected sample in stormwater.

[1] In WY2015, total and dissolved mercury detection limits were lowered by a factor of 1,000 from parts per billion to part per trillion. The WY2012 loadings are based on ppb and may be a factor of 1000 higher than actual loadings.

(yellow) *The estimated mass load comparisons to WY2020 are greater than a factor of two of each other (i.e., the percent difference greater than 100%).*

(green) *The estimated mass load comparisons to WY2020 are less than a factor of two of each other (i.e., the percent difference less than – 75%.*

Table 6-2.1 Continued
Pollutant Loading Summary Comparison - WY2010-12 and WY2015-2022

	OF245 - Industrial																				
												Percent Difference									
	WY2010	WY2011	WY2012	WY2015	WY2016	WY2017	WY2018	WY2019	WY2020	WY2021	WY2022	WY2010 to WY2022	WY2011 to WY2022	WY2012 to WY2022	WY2015 to WY2022	WY2016 to WY2022	WY2017 to WY2022	WY2018 to WY2022	WY2019 to WY2022	WY2020 to WY2022	WY2021 to WY2022
Conventionals (lbs per acre)																					
TSS	392	323	181	278	637	462	362	504	247	410	184	-53%	-43%	1%	-34%	-71%	-60%	-49%	-64%	-26%	-55%
MBAS	0.59	0.66	0.77	0.30	0.35	0.57	0.31	0.31	0.48	0.27	0.48	-18%	-27%	-37%	59%	37%	-16%	58%	59%	0%	78%
BOD_5	24	18	13	14	28	35	25	25	25	20	20	-19%	8%	47%	40%	-30%	-44%	-23%	-21%	-22%	-2%
Total Phosphorus	1.22	1.16	0.59	1.67	2.49	2.31	1.24	1.44	1.25	1.08	0.92	-25%	-21%	55%	-45%	-63%	-60%	-26%	-36%	-26%	-15%
Orthophophorus	0.19	0.09	0.11	0.41	0.26	0.57	0.25	0.30	0.25	0.18	0.24	28%	170%	130%	-41%	-8%	-58%	-1%	-18%	-2%	36%
TN	6.9	5.2	2.7	3.6	6.6	7.4	7.0	5.3	5.3	3.7	3.9	-43%	-25%	44%	8%	-41%	-47%	-44%	-26%	-26%	6%
Nitrate/Nitrite -Total	2.4	0.9	0.9	1.0	1.5	1.5	1.9	1.8	1.4	0.8	0.9	-63%	-4%	-6%	-11%	-43%	-43%	-54%	-50%	-37%	5%
Metals (lbs/1000 per acre)																					
Cu - Total	101	118	94	71	181	126	84	110	71	84	60	-40%	-49%	-36%	-15%	-67%	-52%	-28%	-45%	-16%	-29%
Cu - Dissolved	24	27	32	21	41	29	--	26	23.239	18.904	20	-15%	-25%	-36%	-3%	-51%	-30%	--	-22%	-13%	7%
Zn - Total	639	880	734	430	1116	796	694	787	607	556	399	-38%	-55%	-46%	-7%	-64%	-50%	-43%	-49%	-34%	-28%
Zn - Dissolved	300	491	368	181	338	290	324	210	291	176	184	-39%	-62%	-50%	2%	-45%	-36%	-43%	-12%	-37%	5%
Cd - Total	2.2	6.6	2.5	0.96	4.62	2.69	1.22	4.23	1.15	1.31	1.06	-52%	-84%	-57%	11%	-77%	-60%	-13%	-75%	-8%	-19%
Cd - Dissolved	0.8	4.2	1.4	0.36	1.98	1.04	0.49	1.35	0.47	0.44	0.52	-34%	-88%	-64%	46%	-117%	-50%	5%	-62%	10%	17%
Hg - Total[1]	0.247	--	--	0.030	0.067	0.047	0.023	0.030	0.040	0.035	--	--	--	--	--	--	--	--	--	--	--
Hg - Dissolved[1]	--	--	--	0.008	0.016	--	--	0.031	--	--	--	--	--	--	--	--	--	--	--	--	--
Pb - Total	61	69	44	34	106	74	41	50	25	35	18	-70%	-73%	-59%	-45%	-83%	-75%	-55%	-64%	-27%	-47%
Pb - Dissolved	3.5	2.5	2.0	0.9	2.7	1.2	1.2	1.7	1.2	1.1	1.0	-72%	-60%	-50%	5%	-63%	-19%	-14%	-40%	-15%	-6%
LPAHs (lbs/1000 per acre)																					
2-Methylnaphthalene	0.075	0.061	0.045	0.136	0.144	0.182	0.130	0.076	0.058	0.149	0.202	168%	232%	350%	49%	41%	11%	56%	166%	249%	36%
Acenaphthene	0.065	0.064	0.063	0.066	0.189	0.314	0.064	0.062	0.096	0.077	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	0.041	0.034	0.042	0.051	0.096	0.075	0.040	0.047	--	--	--	--	--	--	--	--	--	--	--	--	--
Anthracene	0.033	0.036	0.032	0.044	0.103	0.109	0.049	0.073	0.038	--	--	--	--	--	--	--	--	--	--	--	--
Fluorene	0.066	0.059	0.052	0.076	0.102	0.282	0.051	0.074	0.040	--	0.066	--	--	--	--	--	--	--	--	65%	--
Naphthalene	0.177	0.105	0.098	0.173	0.176	0.260	0.209	0.249	0.140	0.277	0.589	232%	461%	499%	241%	235%	126%	182%	137%	320%	113%
Phenanthrene	0.245	0.138	0.161	0.247	0.403	0.605	0.224	0.264	0.183	0.204	0.173	-29%	26%	8%	-30%	-57%	-71%	-23%	-34%	-5%	-15%
LPAH - Total	0.637	0.436	0.407	0.657	1.139	1.645	0.638	0.768	0.531	0.693	0.981	54%	125%	141%	49%	-14%	-40%	54%	28%	85%	42%
HPAHs (lbs/1000 per acre)																					
Benzo(a)anthracene	0.048	0.042	0.025	0.078	0.153	0.131	0.061	0.069	0.039	0.034	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)pyrene	0.044	0.035	--	0.081	0.212	0.149	0.086	0.095	0.050	0.076	0.047	5%	34%	--	-42%	-78%	-69%	-45%	-51%	-6%	-39%
Benzo(g,h,i)perylene	0.087	0.059	0.050	0.149	0.224	0.205	0.149	0.172	0.089	0.159	0.094	8%	60%	90%	-37%	-58%	-54%	-36%	-45%	6%	-41%
Benzo(b,k)fluoranthenes	0.112	0.080	--	0.137	0.456	0.326	0.208	0.222	0.129	0.171	0.141	27%	77%	--	3%	-69%	-57%	-32%	-36%	10%	-17%
Chrysene	0.092	0.067	0.039	0.166	0.219	0.272	0.113	0.151	0.074	0.118	0.089	-3%	33%	130%	-46%	-59%	-67%	-21%	-41%	21%	-24%
Dibenz(a,h)anthracene	--	--	--	0.052	0.053	0.044	0.030	0.028	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluoranthene	0.203	0.142	0.121	0.168	0.529	0.519	0.257	0.356	0.198	0.249	0.186	-8%	31%	54%	11%	-65%	-64%	-28%	-48%	-6%	-25%
Indeno(1,2,3-c,d)pyrene	0.044	0.031	0.025	0.095	0.147	0.134	0.081	0.158	0.046	0.052	0.043	-3%	38%	72%	-55%	-71%	-68%	-47%	-73%	-7%	-18%
Pyrene	0.242	0.203	0.153	0.344	0.853	0.617	0.372	0.512	0.295	0.470	0.277	15%	36%	81%	-19%	-68%	-55%	-26%	-46%	-6%	-41%
Retene	--	--	--	--	--	--	--	--	--	0.086	0.071	--	--	--	--	--	--	--	--	--	-18%
HPAH - Total	0.906	0.676	0.393	1.269	2.843	2.40	1.36	1.67	0.94	1.35	0.94	3%	39%	138%	-26%	-67%	-61%	-31%	-44%	-1%	-31%
Phthalates (lbs/1000 per acre)																					
DEHP	5.0	4.3	5.4	12.7	26.7	16.7	9.0	10.4	7.6	7.6	8.8	76%	107%	63%	-31%	-67%	-47%	-2%	-15%	16%	15%
Butylbenzyl-phthalate	1.8	--	1.34	2.27	3.33	2.30	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Diethyl-phthalate	1.3	--	--	--	3.96	2.13	--	3.03	--	--	--	--	--	--	--	--	--	--	--	--	--
Dimethyl-phthalate	0.23	--	--	--	1.82	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-butyl-phthalate	2.3	2.1	2.1	2.7	2.3	2.8	1.5	2.5	2.3	5.6	11.8	407%	460%	451%	330%	406%	320%	676%	366%	422%	110%
Di-n-octylphthalate	--	--	--	1.1	2.9	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phthalates - Total	11.1	7.2	6.7	17.3	35.9	21.5	9.7	14.6	9.6	13.1	21.0	89%	191%	212%	21%	-42%	-2%	118%	44%	118%	61%
Pesticides (lbs/1000 per acre)																					
Bifenthrin	0.24	0.14	0.16	--	--	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--
Dichlobenil	0.24	0.14	0.16	0.40	0.46	0.22	0.22	0.33	0.34	0.11	0.20	-14%	44%	27%	-50%	-56%	-6%	-8%	-38%	-41%	81%

Note: Mass loadings were not calculated for parameters with fewer than 10 percent detected concentrations or only one detected sample in stormwater.

[1] *In WY2015, total and dissolved mercury detection limits were lowered by a factor of 1,000 from parts per billion to part per trillion. The WY2012 loadings are based on ppb and may be a factor of 1000 higher than actual loadings.*

(yellow) The estimated mass load comparisons to WY2020 are greater than a factor of two of each other (i.e., the percent difference greater than 100%).

(green) The estimated mass load comparisons to WY2020 are less than a factor of two of each other (i.e., the percent difference less than – 75%).

Table 6-2.1
Pollutant Loading Summary Comparison - WY2010-12 and WY2015-2022

	OF235 - Commercial																					
												Percent Difference										
	WY2010	WY2011	WY2012	WY2015	WY2016	WY2017	WY2018	WY2019	WY2020	WY2021	WY2022	WY2010 to WY2022	WY2011 to WY2022	WY2012 to WY2022	WY2015 to WY2022	WY2016 to WY2022	WY2017 to WY2022	WY2018 to WY2022	WY2019 to WY2022	WY2020 to WY2022	WY2021 to WY2022
Conventionals (lbs per acre)																						
TSS	278	319	200	193	178	166	187	164	109	114	126	-55%	-61%	-37%	-35%	-30%	-24%	-33%	-23%	4%	11%
MBAS	0.33	0.52	0.51	0.39	0.29	0.39	0.28	0.30	0.29	0.21	0.32	-5%	-40%	-38%	-18%	7%	-19%	13%	6%	-28%	53%
BOD_5	21	20	25	14	27	16	13	18	19	16	15	-32%	-26%	-42%	6%	-45%	-7%	10%	-18%	-16%	-8%
Total Phosphorus	0.83	0.78	0.62	0.61	1.05	0.82	0.87	0.89	0.76	0.70	0.95	15%	21%	54%	55%	-9%	16%	9%	7%	-7%	35%
Orthophophorus	0.37	0.27	0.26	0.31	0.41	0.43	0.40	0.46	0.42	0.44	0.59	61%	117%	130%	90%	44%	36%	48%	28%	4%	34%
TN	6.5	4.7	4.0	3.2	5.2	5.3	4.9	6.4	6.5	6.2	6.6	2%	42%	64%	107%	28%	26%	36%	3%	-5%	7%
Nitrate/Nitrite -Total	5.7	3.7	3.4	4.8	4.5	4.7	4.4	4.4	4.1	4.5	4.3	-25%	16%	24%	-11%	-6%	-9%	-3%	-3%	8%	-4%
Metals (lbs/1000 per acre)																						
Cu - Total	173	181	170	124	148	129	120	103	96	91	90	-48%	-50%	-47%	-27%	-39%	-30%	-25%	-13%	-6%	-1%
Cu - Dissolved	65	64	60	60	62	59	43	50	47	40	43	-34%	-33%	-29%	-29%	-31%	-26%	-1%	-14%	-16%	8%
Zn - Total	547	567	551	369	444	406	380	334	316	282	308	-44%	-46%	-44%	-17%	-31%	-24%	-19%	-8%	-11%	9%
Zn - Dissolved	225	208	193	194	194	201	156	161	149	119	143	-36%	-31%	-26%	-26%	-26%	-28%	-8%	-11%	-20%	21%
Cd - Total	1.3	1.6	1.2	0.53	0.64	0.57	0.70	0.43	0.38	0.39	0.46	-63%	-71%	-63%	-14%	-29%	-19%	-35%	6%	5%	17%
Cd - Dissolved	0.6	0.6	0.5	0.23	0.25	0.25	0.30	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hg - Total [1]	0.304	0.214	0.208	0.050	0.038	0.038	0.033	0.039	--	--	--	--	--	--	--	--	--	--	--	--	--
Hg - Dissolved [1]	--	--	--	--	0.012	0.015	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pb - Total	307	293	253	144	208	166	155	116	126	156	117	-62%	-60%	-54%	-18%	-43%	-30%	-24%	1%	24%	-25%
Pb - Dissolved	38.7	30.6	30.9	23.1	28.0	22.2	17.6	21.8	22.5	23.1	20.4	-47%	-33%	-34%	-12%	-27%	-8%	16%	-7%	3%	-12%
LPAHs (lbs/1000 per acre)																						
2-Methylnaphthalene	0.070	0.075	0.065	0.047	0.156	0.082	0.097	0.069	0.053	0.052	0.099	42%	32%	51%	110%	-37%	20%	2%	42%	-1%	88%
Acenaphthene	0.040	0.035	0.032	--	0.062	0.046	0.029	--	0.042	0.047	--	--	--	--	--	--	--	--	--	13%	--
Acenaphthylene	0.026	0.029	0.026	--	--	0.056	0.050	0.048	--	--	--	--	--	--	--	--	--	--	--	--	--
Anthracene	0.035	0.044	0.033	0.047	0.061	0.090	0.081	0.090	0.058	0.065	0.085	146%	94%	156%	81%	39%	-5%	5%	-5%	12%	32%
Fluorene	0.040	0.067	0.065	--	0.053	0.068	0.047	0.043	--	--	--	--	--	--	--	--	--	--	--	--	--
Naphthalene	0.086	0.094	0.076	0.060	0.298	0.106	0.179	0.130	0.100	0.085	0.113	31%	20%	48%	90%	-62%	7%	-37%	-13%	-16%	34%
Phenanthrene	0.161	0.158	0.180	0.109	0.197	0.202	0.171	0.220	0.119	0.130	0.155	-4%	-2%	-14%	42%	-21%	-24%	-10%	-30%	9%	18%
LPAH - Total	0.395	0.436	0.378	0.351	0.737	0.556	0.545	0.560	0.345	0.371	0.453	15%	4%	20%	29%	-38%	-18%	-17%	-19%	8%	22%
HPAHs (lbs/1000 per acre)																						
Benzo(a)anthracene	0.033	0.066	0.066	0.066	0.066	0.269	0.253	0.254	0.081	0.077	0.131	296%	100%	99%	99%	99%	-51%	-48%	-48%	-6%	71%
Benzo(a)pyrene	0.057	0.050	0.064	0.064	0.064	0.043	0.046	0.036	0.096	0.088	0.119	107%	136%	87%	87%	87%	178%	158%	228%	-8%	35%
Benzo(g,h,i)perylene	0.090	0.100	0.106	0.106	0.106	0.393	0.395	0.419	0.162	0.142	0.154	71%	54%	46%	46%	46%	-61%	-61%	-63%	-12%	8%
Benzo(b,k)fluoranthenes	0.147	0.132	0.158	0.170	0.446	0.415	0.436	0.371	0.260	0.247	0.326	122%	148%	107%	91%	-27%	-22%	-25%	-12%	-5%	32%
Chrysene	0.127	0.118	0.102	0.130	0.302	0.271	0.256	0.257	0.183	0.162	0.199	57%	68%	94%	53%	-34%	-27%	-22%	-23%	-11%	23%
Dibenz(a,h)anthracene	--	--	0.021	0.037	0.052	0.044	0.047	0.039	0.028	--	--	--	--	--	--	--	--	--	--	--	--
Fluoranthene	0.281	0.274	0.270	0.204	0.417	0.385	0.388	0.407	0.255	0.234	0.294	5%	7%	9%	44%	-29%	-24%	-24%	-28%	-8%	26%
Indeno(1,2,3-c,d)pyrene	0.054	0.053	0.066	0.092	0.158	0.141	0.158	0.144	0.102	0.089	0.101	87%	92%	54%	10%	-36%	-28%	-36%	-30%	-13%	14%
Pyrene	0.309	0.313	0.279	0.251	0.574	0.476	0.464	0.476	0.322	0.261	0.374	21%	19%	34%	49%	-35%	-21%	-19%	-21%	-19%	43%
Retene	--	--	--	--	--	--	--	--	--	0.041	0.077	--	--	--	--	--	--	--	--	--	87%
HPAH - Total	1.14	1.12	1.10	1.18	2.54	2.21	2.25	2.162	1.445	1.282	1.680	47%	49%	53%	42%	-34%	-24%	-25%	-22%	-11%	31%
Phthalates (lbs/1000 per acre)																						
DEHP	10.7	8.2	7.2	8.6	18.3	13.5	10.4	10.02	6.71	5.63	6.38	-40%	-22%	-12%	-25%	-65%	-53%	-39%	-36%	-16%	13%
Butylbenzyl-phthalate	2.0	3.08	2.30	3.72	3.76	4.49	2.59	5.28	5.20	3.07	3.78	85%	23%	64%	1%	1%	-16%	46%	-28%	-41%	23%
Diethyl-phthalate	1.9	--	1.13	1.33	1.80	1.60	1.47	2.07	1.95	2.51	1.75	-5%	--	55%	32%	-3%	10%	19%	-15%	28%	-30%
Dimethyl-phthalate	0.29	--	--	1.24	2.11	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-butyl-phthalate	1.8	1.5	2.0	1.5	2.2	1.9	1.4	1.44	1.44	1.30	1.83	3%	24%	-8%	25%	-17%	-3%	28%	27%	-10%	41%
Di-n-octylphthalate	--	0.8	--	1.4	3.5	2.0	1.5	1.71	--	--	--	--	--	--	--	--	--	--	--	--	--
Phthalates - Total	16.2	11.9	10.0	13.1	25.5	19.0	13.4	17.39	13.69	10.40	11.46	-29%	-4%	14%	-13%	-55%	-40%	-14%	-34%	-24%	10%
Pesticides (lbs/1000 per acre)																						
Bifenthrin	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dichlobenil	4.22	0.74	0.26	0.67	0.50	0.39	0.26	0.30	0.25	0.24	0.58	-86%	-22%	127%	-14%	16%	47%	125%	94%	-2%	140%

Note: Mass loadings were not calculated for parameters with fewer than 10 percent detected concentrations or only one detected sample in stormwater.

[1] In WY2015, total and dissolved mercury detection limits were lowered by a factor of 1,000 from parts per billion to part per trillion. The WY2012 loadings are based on ppb and may be a factor of 1000 higher than actual loadings.

(yellow) The estimated mass load comparisons to WY2020 are greater than a factor of two of each other (i.e., the percent difference greater than 100%).

(green) The estimated mass load comparisons to WY2020 are less than a factor of two of each other (i.e., the percent difference less than – 75%)

Table 6-2.1 Continued
Pollutant Loading Summary Comparison - WY2010-12 and WY2015-2022

	OF237B - Residential																				
												Percent Difference									
	WY2010	WY2011	WY2012	WY2015	WY2016	WY2017	WY2018	WY2019	WY2020	WY2021	WY2022	WY2010 to WY2022	WY2011 to WY2022	WY2012 to WY2022	WY2015 to WY2022	WY2016 to WY2022	WY2017 to WY2022	WY2018 to WY2022	WY2019 to WY2022	WY2020 to WY2022	WY2021 to WY2022
Conventionals (lbs per acre)																					
TSS	270	494	144	131	209	161	178	105	133	96	117	-57%	-76%	-19%	-10%	-44%	-27%	-34%	11%	-12%	22%
MBAS	0.38	0.65	0.43	0.19	0.41	0.13	0.43	0.34	0.42	0.32	0.40	5%	-38%	-8%	115%	-3%	211%	-6%	19%	-5%	25%
BOD_5	21	24	31	16	52	8	46	20	27	25	26	24%	11%	-17%	60%	-50%	215%	-43%	33%	-1%	3%
Total Phosphorus	0.91	1.40	0.86	0.89	0.89	0.42	0.83	0.66	0.81	0.76	0.73	-20%	-48%	-16%	-18%	-19%	73%	-12%	10%	-11%	-5%
Orthophophorus	0.50	0.37	0.48	0.41	0.44	0.06	0.45	0.39	0.36	0.44	0.44	-11%	19%	-8%	7%	0%	615%	-2%	15%	23%	2%
TN	5.1	7.7	4.5	6.4	36.9	2.1	38.5	35.7	36.8	37.3	38.1	645%	393%	740%	499%	3%	1734%	-1%	7%	3%	2%
Nitrate/Nitrite -Total	36.4	36.7	32.2	37.2	36.8	1.2	38.0	35.0	34.8	37.3	37.4	3%	2%	16%	0%	2%	3122%	-2%	7%	7%	0%
Metals (lbs/1000 per acre)																					
Cu - Total	52	94	61	36	48	35	27	20	29	28	28	-46%	-70%	-54%	-21%	-41%	-19%	3%	39%	-3%	2%
Cu - Dissolved	19	25	25	13	14	11	10	7	11	10	12	-36%	-52%	-53%	-8%	-16%	9%	21%	71%	10%	17%
Zn - Total	276	511	278	216	278	264	174	125	188	162	151	-45%	-70%	-46%	-30%	-46%	-43%	-13%	21%	-20%	-7%
Zn - Dissolved	123	222	126	105	119	147	85	57	79	69	74	-39%	-66%	-41%	-29%	-37%	-49%	-13%	30%	-6%	7%
Cd - Total	1.6	1.5	1.1	0.67	0.61	0.23	0.30	0.15	0.24	0.23	--	--	--	--	--	--	--	--	--	--	--
Cd - Dissolved	1.6	0.8	0.8	0.61	0.25	0.09	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hg - Total[1]	0.585	--	--	0.043	0.046	0.035	0.023	0.060	--	--	--	--	--	--	--	--	--	--	--	--	--
Hg - Dissolved[1]	--	--	--	0.015	0.017	0.012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pb - Total	53	107	52	37	50	28	21	13	19	18	17	-69%	-84%	-68%	-56%	-67%	-42%	-20%	31%	-11%	-8%
Pb - Dissolved	2.1	2.5	2.5	1.4	4.5	0.8	1.0	1.1	1.3	1.0	1.3	-40%	-50%	-48%	-10%	-71%	55%	24%	12%	-2%	32%
LPAHs (lbs/1000 per acre)																					
2-Methylnaphthalene	0.072	0.070	0.225	0.055	0.079	0.031	0.065	0.096	0.096	0.064	0.080	12%	15%	-64%	46%	1%	162%	24%	-16%	-16%	25%
Acenaphthene	0.045	--	--	--	--	--	0.077	--	0.061	0.108	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	0.044	--	--	--	0.056	0.017	0.049	0.031	--	--	--	--	--	--	--	--	--	--	--	--	--
Anthracene	0.041	--	--	--	--	0.016	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluorene	0.049	0.052	0.060	0.051	0.043	0.018	0.045	0.043	--	--	--	--	--	--	--	--	--	--	--	--	--
Naphthalene	0.149	0.136	0.223	0.122	0.174	0.056	0.161	0.147	0.138	--	0.144	--	--	--	--	--	--	--	--	5%	--
Phenanthrene	0.117	0.146	0.137	0.111	0.243	0.155	0.152	0.130	0.120	0.121	0.104	-11%	-28%	-24%	-6%	-57%	-32%	-31%	-20%	-13%	-13%
LPAH - Total	0.364	0.523	0.534	0.501	0.638	0.267	0.510	0.430	0.451	0.475	0.481	32%	-8%	-10%	-4%	-25%	80%	-6%	12%	7%	1%
HPAHs (lbs/1000 per acre)																					
Benzo(a)anthracene	0.052	0.102	0.053	0.062	0.145	0.081	0.078	0.062	0.068	0.051	0.065	25%	-36%	23%	5%	-55%	-20%	-17%	5%	-4%	29%
Benzo(a)pyrene	0.062	0.087	0.053	0.068	0.200	0.112	0.121	0.076	0.076	0.068	0.084	36%	-4%	59%	24%	-58%	-25%	-31%	11%	10%	24%
Benzo(g,h,i)perylene	0.103	0.143	0.053	0.085	0.185	0.131	0.115	0.116	0.124	0.091	0.091	-12%	-36%	72%	8%	-51%	-30%	-21%	-21%	-26%	0%
Benzo(b,k)fluoranthenes	0.155	0.230	0.075	0.118	0.469	0.259	0.285	0.179	0.198	0.178	0.228	48%	-1%	204%	94%	-51%	-12%	-20%	27%	15%	28%
Chrysene	0.090	0.142	0.051	0.073	0.279	0.175	0.140	0.104	0.113	0.092	0.099	10%	-30%	94%	36%	-64%	-43%	-29%	-4%	-12%	7%
Dibenz(a,h)anthracene	--	--	--	0.045	0.063	0.027	0.040	0.033	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluoranthene	0.159	0.233	0.125	0.133	0.373	0.252	0.200	0.169	0.182	0.139	0.171	8%	-26%	38%	29%	-54%	-32%	-14%	1%	-6%	23%
Indeno(1,2,3-c,d)pyrene	0.068	0.091	0.041	0.066	0.159	0.110	0.098	0.084	0.086	0.071	0.084	23%	-8%	105%	27%	-47%	-24%	-15%	0%	-3%	18%
Pyrene	0.181	0.286	0.144	0.150	0.450	0.285	0.224	0.190	0.226	0.148	0.198	9%	-31%	37%	32%	-56%	-31%	-12%	4%	-13%	33%
Retene	--	--	--	--	--	--	--	--	--	--	0.047	--	--	--	--	--	--	--	--	--	--
HPAH - Total	0.793	1.354	0.534	0.800	2.32	1.43	1.30	1.01	1.11	0.87	1.06	34%	-22%	98%	33%	-54%	-26%	-19%	5%	-4%	22%
Phthalates (lbs/1000 per acre)																					
DEHP	9.6	8.4	5.5	6.0	11.5	8.1	5.6	6.5	6.2	5.1	5.7	-40%	-32%	4%	-4%	-50%	-29%	2%	-12%	-8%	13%
Butylbenzyl-phthalate	2.1	--	--	2.25	2.99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Diethyl-phthalate	2.0	--	--	3.33	12.66	0.21	--	4.24	--	--	--	--	--	--	--	--	--	--	--	--	--
Dimethyl-phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-butyl-phthalate	3.2	2.4	3.7	2.4	1.8	1.0	1.6	2.3	2.6	2.6	3.0	-8%	23%	-19%	25%	67%	185%	85%	32%	15%	12%
Di-n-octylphthalate	--	1.2	0.9	1.3	3.6	1.1	--	2.6	--	--	--	--	--	--	--	--	--	--	--	--	--
Phthalates - Total	13.5	14.8	11.2	12.8	26.9	9.7	9.3	12.7	9.9	8.3	9.5	-30%	-36%	-15%	-26%	-65%	-2%	1%	-26%	-4%	13%
Pesticides (lbs/1000 per acre)																					
Bifenthrin	0.45	0.79	1.14	--	--	--	0.00			--	--	--	--	--	--	--	--	--	--	--	--
Dichlobenil	0.45	0.79	1.14	0.31	2.97	0.23	0.28	0.38	0.45	0.40	0.53	19%	-32%	-53%	74%	-82%	132%	89%	41%	17%	33%

Note: Mass loadings were not calculated for parameters with fewer than 10 percent detected concentrations or only one detected sample in stormwater.

[1] In WY2015, total and dissolved mercury detection limits were lowered by a factor of 1,000 from parts per billion to part per trillion. The WY2012 loadings are based on ppb and may be a factor of 1000 higher than actual loadings.

(yellow) *The estimated mass load comparisons to WY2020 are greater than a factor of two of each other (i.e., the percent difference greater than 100%).*

(green) *The estimated mass load comparisons to WY2020 are less than a factor of two of each other (i.e., the percent difference less than – 75%.*

Table 6-2.1 Continued
Pollutant Loading Summary Comparison - WY2010-12 and WY2015-2022

	OF245 - Industrial																				
												Percent Difference									
	WY2010	WY2011	WY2012	WY2015	WY2016	WY2017	WY2018	WY2019	WY2020	WY2021	WY2022	WY2010 to WY2022	WY2011 to WY2022	WY2012 to WY2022	WY2015 to WY2022	WY2016 to WY2022	WY2017 to WY2022	WY2018 to WY2022	WY2019 to WY2022	WY2020 to WY2022	WY2021 to WY2022
Conventionals (lbs per acre)																					
TSS	392	323	181	278	637	462	362	504	247	410	184	-53%	-43%	1%	-34%	-71%	-60%	-49%	-64%	-26%	-55%
MBAS	0.59	0.66	0.77	0.30	0.35	0.57	0.31	0.31	0.48	0.27	0.48	-18%	-27%	-37%	59%	37%	-16%	58%	59%	0%	78%
BOD_5	24	18	13	14	28	35	25	25	25	20	20	-19%	8%	47%	40%	-30%	-44%	-23%	-21%	-22%	-2%
Total Phosphorus	1.22	1.16	0.59	1.67	2.49	2.31	1.24	1.44	1.25	1.08	0.92	-25%	-21%	55%	-45%	-63%	-60%	-26%	-36%	-26%	-15%
Orthophophorus	0.19	0.09	0.11	0.41	0.26	0.57	0.25	0.30	0.25	0.18	0.24	28%	170%	130%	-41%	-8%	-58%	-1%	-18%	-2%	36%
TN	6.9	5.2	2.7	3.6	6.6	7.4	7.0	5.3	5.3	3.7	3.9	-43%	-25%	44%	8%	-41%	-47%	-44%	-26%	-26%	6%
Nitrate/Nitrite -Total	2.4	0.9	0.9	1.0	1.5	1.5	1.9	1.8	1.4	0.8	0.9	-63%	-4%	-6%	-11%	-43%	-43%	-54%	-50%	-37%	5%
Metals (lbs/1000 per acre)																					
Cu - Total	101	118	94	71	181	126	84	110	71	84	60	-40%	-49%	-36%	-15%	-67%	-52%	-28%	-45%	-16%	-29%
Cu - Dissolved	24	27	32	21	41	29	--	26	23.239	18.904	20	-15%	-25%	-36%	-3%	-51%	-30%	--	-22%	-13%	7%
Zn - Total	639	880	734	430	1116	796	694	787	607	556	399	-38%	-55%	-46%	-7%	-64%	-50%	-43%	-49%	-34%	-28%
Zn - Dissolved	300	491	368	181	338	290	324	210	291	176	184	-39%	-62%	-50%	2%	-45%	-36%	-43%	-12%	-37%	5%
Cd - Total	2.2	6.6	2.5	0.96	4.62	2.69	1.22	4.23	1.15	1.31	1.06	-52%	-84%	-57%	11%	-77%	-60%	-13%	-75%	-8%	-19%
Cd - Dissolved	0.8	4.2	1.4	0.36	1.98	1.04	0.49	1.35	0.47	0.44	0.52	-34%	-88%	-64%	46%	-117%	-50%	5%	-62%	10%	17%
Hg - Total[1]	0.247	--	--	0.030	0.067	0.047	0.023	0.030	0.040	0.035	--	--	--	--	--	--	--	--	--	--	--
Hg - Dissolved[1]	--	--	--	0.008	0.016	--	--	0.031	--	--	--	--	--	--	--	--	--	--	--	--	--
Pb - Total	61	69	44	34	106	74	41	50	25	35	18	-70%	-73%	-59%	-45%	-83%	-75%	-55%	-64%	-27%	-47%
Pb - Dissolved	3.5	2.5	2.0	0.9	2.7	1.2	1.2	1.7	1.2	1.1	1.0	-72%	-60%	-50%	5%	-63%	-19%	-14%	-40%	-15%	-6%
LPAHs (lbs/1000 per acre)																					
2-Methylnaphthalene	0.075	0.061	0.045	0.136	0.144	0.182	0.130	0.076	0.058	0.149	0.202	168%	232%	350%	49%	41%	11%	56%	166%	249%	36%
Acenaphthene	0.065	0.064	0.063	0.066	0.189	0.314	0.064	0.062	0.096	0.077	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	0.041	0.034	0.042	0.051	0.096	0.075	0.040	0.047	--	--	--	--	--	--	--	--	--	--	--	--	--
Anthracene	0.033	0.036	0.032	0.044	0.103	0.109	0.049	0.073	0.038	--	--	--	--	--	--	--	--	--	--	--	--
Fluorene	0.066	0.059	0.052	0.076	0.102	0.282	0.051	0.074	0.040	--	0.066	--	--	--	--	--	--	--	--	65%	--
Naphthalene	0.177	0.105	0.098	0.173	0.176	0.260	0.209	0.249	0.140	0.277	0.589	232%	461%	499%	241%	235%	126%	182%	137%	320%	113%
Phenanthrene	0.245	0.138	0.161	0.247	0.403	0.605	0.224	0.264	0.183	0.204	0.173	-29%	26%	8%	-30%	-57%	-71%	-23%	-34%	-5%	-15%
LPAH - Total	0.637	0.436	0.407	0.657	1.139	1.645	0.638	0.768	0.531	0.693	0.981	54%	125%	141%	49%	-14%	-40%	54%	28%	85%	42%
HPAHs (lbs/1000 per acre)																					
Benzo(a)anthracene	0.048	0.042	0.025	0.078	0.153	0.131	0.061	0.069	0.039	0.034	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)pyrene	0.044	0.035	--	0.081	0.212	0.149	0.086	0.095	0.050	0.076	0.047	5%	34%	--	-42%	-78%	-69%	-45%	-51%	-6%	-39%
Benzo(g,h,i)perylene	0.087	0.059	0.050	0.149	0.224	0.205	0.149	0.172	0.089	0.159	0.094	8%	60%	90%	-37%	-58%	-54%	-36%	-45%	6%	-41%
Benzo(b,k)fluoranthenes	0.112	0.080	--	0.137	0.456	0.326	0.208	0.222	0.129	0.171	0.141	27%	77%	--	3%	-69%	-57%	-32%	-36%	10%	-17%
Chrysene	0.092	0.067	0.039	0.166	0.219	0.272	0.113	0.151	0.074	0.118	0.089	-3%	33%	130%	-46%	-59%	-67%	-21%	-41%	21%	-24%
Dibenz(a,h)anthracene	--	--	--	0.052	0.053	0.044	0.030	0.028	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluoranthene	0.203	0.142	0.121	0.168	0.529	0.519	0.257	0.356	0.198	0.249	0.186	-8%	31%	54%	11%	-65%	-64%	-28%	-48%	-6%	-25%
Indeno(1,2,3-c,d)pyrene	0.044	0.031	0.025	0.095	0.147	0.134	0.081	0.158	0.046	0.052	0.043	-3%	38%	72%	-55%	-71%	-68%	-47%	-73%	-7%	-18%
Pyrene	0.242	0.203	0.153	0.344	0.853	0.617	0.372	0.512	0.295	0.470	0.277	15%	36%	81%	-19%	-68%	-55%	-26%	-46%	-6%	-41%
Retene	--	--	--	--	--	--	--	--	--	0.086	0.071	--	--	--	--	--	--	--	--	--	-18%
HPAH - Total	0.906	0.676	0.393	1.269	2.843	2.40	1.36	1.67	0.94	1.35	0.94	3%	39%	138%	-26%	-67%	-61%	-31%	-44%	-1%	-31%
Phthalates (lbs/1000 per acre)																					
DEHP	5.0	4.3	5.4	12.7	26.7	16.7	9.0	10.4	7.6	7.6	8.8	76%	107%	63%	-31%	-67%	-47%	-2%	-15%	16%	15%
Butylbenzyl-phthalate	1.8	--	1.34	2.27	3.33	2.30	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Diethyl-phthalate	1.3	--	--	--	3.96	2.13	--	3.03	--	--	--	--	--	--	--	--	--	--	--	--	--
Dimethyl-phthalate	0.23	--	--	--	1.82	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-butyl-phthalate	2.3	2.1	2.1	2.7	2.3	2.8	1.5	2.5	2.3	5.6	11.8	407%	460%	451%	330%	406%	320%	676%	366%	422%	110%
Di-n-octylphthalate	--	--	--	1.1	2.9	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phthalates - Total	11.1	7.2	6.7	17.3	35.9	21.5	9.7	14.6	9.6	13.1	21.0	89%	191%	212%	21%	-42%	-2%	118%	44%	118%	61%
Pesticides (lbs/1000 per acre)																					
Bifenthrin	0.24	0.14	0.16	--	--	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--
Dichlobenil	0.24	0.14	0.16	0.40	0.46	0.22	0.22	0.33	0.34	0.11	0.20	-14%	44%	27%	-50%	-56%	-6%	-8%	-38%	-41%	81%

Note: Mass loadings were not calculated for parameters with fewer than 10 percent detected concentrations or only one detected sample in stormwater.

[1] In WY2015, total and dissolved mercury detection limits were lowered by a factor of 1,000 from parts per billion to part per trillion. The WY2012 loadings are based on ppb and may be a factor of 1000 higher than actual loadings.

The estimated mass load comparisons to WY2020 are greater than a factor of two of each other (i.e., the percent difference greater than 100%). (yellow)

The estimated mass load comparisons to WY2020 are less than a factor of two of each other (i.e., the percent difference less than – 75%). (green)

Table 6-2.2
Pollutant Loading Summary Comparison - WY2016-WY2022

	OF230 - Commercial													OF237A - Residential												
								Percent Difference													Precent Difference					
	WY2016	WY2017	WY2018	WY2019	WY2020	WY2021	WY2022	WY2016 to WY2022	WY2017 to WY2022	WY2018 to WY2022	WY2019 to WY2022	WY2020 to WY2022	WY2021 to WY2022	WY2016	WY2017	WY2018	WY2019	WY2020	WY2021	WY2022	WY2016 to WY2022	WY2017 to WY2022	WY2018 to WY2022	WY2019 to WY2022	WY2020 to WY2022	WY2021 to WY2022
Conventionals (lbs per acre)																										
TSS	108	150	188	120	146	84	110	2%	-27%	-42%	-8%	-25%	30%	97.7	130.8	118	68	55	145	113	16%	-13%	-4%	66%	108%	-22%
MBAS	0.12	0.25	0.11	0.17	0.21	0.15	0.20	68%	-19%	85%	18%	-3%	33%	0.19	0.22	0.17	0.14	0.17	0.18	0.21	11%	-5%	21%	49%	23%	14%
BOD_5	10.85	12.14	13.63	10.70	12.80	9.49	9.57	-12%	-21%	-30%	-11%	-25%	1%	11.46	10.33	11.69	8.58	9.64	16.37	14.69	28%	42%	26%	71%	52%	-10%
Total Phosphorus	0.43	0.53	0.44	0.39	0.45	0.40	0.45	6%	-14%	4%	15%	1%	13%	0.46	0.41	0.37	0.26	0.31	0.40	0.37	-20%	-10%	0%	45%	21%	-8%
Orthophosphorus	0.16	0.19	0.20	0.19	0.19	0.19	0.22	37%	12%	10%	16%	14%	12%	0.22	0.21	0.18	0.15	0.18	0.17	0.16	-27%	-21%	-10%	6%	-12%	-4%
TN	1.82	2.67	2.48	2.20	3.35	2.30	2.66	46%	-1%	7%	21%	-21%	15%	9.93	9.91	9.82	9.15	9.81	9.37	9.72	-2%	-2%	-1%	6%	-1%	4%
Nitrate/Nitrite -Total	1.31	1.53	1.38	1.42	1.49	1.39	1.54	17%	1%	11%	8%	3%	10%	9.90	9.67	9.40	9.06	9.14	9.35	8.70	-12%	-10%	-7%	-4%	-5%	-7%
Metals (lbs/1000 per acre)																										
Cu - Total	35	38	36	31	35	25	31	-9%	-17%	-13%	2%	-12%	24%	37	31	27	15	20	34	26	-31%	-18%	-6%	68%	29%	-25%
Cu - Dissolved	13	15	13	12	16	11	13	-1%	-13%	5%	14%	-17%	22%	15	11	8	5	11	9	10	-34%	-9%	23%	93%	-11%	8%
Zn - Total	253	279	266	222	252	186	237	-6%	-15%	-11%	6%	-6%	27%	355	247	172	107	134	207	178	-50%	-28%	3%	66%	33%	-14%
Zn - Dissolved	125	144	113	100	124	96	116	-8%	-20%	2%	16%	-7%	21%	220	134	74	50	75	78	90	-59%	-33%	21%	80%	20%	15%
Cd - Total	0.33	0.24	0.31	0.20	0.25	0.19	0.22	-34%	-8%	-30%	10%	-13%	15%	0.88	0.74	0.84	0.53	0.51	0.65	0.58	-34%	-21%	-31%	9%	13%	-11%
Cd - Dissolved	0.13	0.09	0.10	0.09	0.09	0.09	--	--	--	--	--	--	--	0.91	0.09	--	--	--	--	--	--	--	--	--	--	--
Hg - Total[1]	0.023	0.016	0.012	0.024	0.020	0.017	--	--	--	--	--	--	--	0.043	0.027	0.023	0.020	--	--	--	--	--	--	--	--	--
Hg - Dissolved[1]	0.008	0.009	0.012	--	--	--	--	--	--	--	--	--	--	0.014	--	--	--	--	--	--	--	--	--	--	--	--
Pb - Total	35.1	35.7	30.0	25.8	23.2	19.2	25.7	-27%	-28%	-14%	0%	11%	34%	25.2	25.3	22.5	10.8	11.1	25.1	17.6	-30%	-30%	-22%	63%	59%	-30%
Pb - Dissolved	1.23	1.49	1.30	1.27	1.33	1.04	1.73	40%	16%	32%	35%	30%	66%	1.15	0.98	0.88	0.52	0.89	0.75	0.87	-25%	-11%	-2%	67%	-3%	16%
LPAHs (lbs/1000 per acre)																										
2-Methylnaphthalene	0.053	0.046	0.054	0.041	0.040	0.054	0.117	121%	152%	117%	182%	192%	115%	0.063	0.041	0.057	0.519	0.048	0.058	0.056	-11%	36%	-2%	-89%	15%	-5%
Acenaphthene	--	0.021	0.014	--	--	--	--	--	--	--	--	--	--	--	--	0.028	0.047	0.032	0.058	--	--	--	--	--	--	--
Acenaphthylene	0.019	0.022	0.024	0.014	0.020	--	--	--	--	--	--	--	--	0.036	0.027	0.031	0.025	--	0.044	0.044	23%	65%	39%	76%	--	0%
Anthracene	--	0.029	0.023	0.023	0.020	--	0.024	--	--	--	--	0.190	--	--	0.039	0.048	0.028	--	0.038	--	--	--	--	--	--	--
Fluorene	0.027	0.029	0.022	0.026	0.020	--	--	--	--	--	--	--	--	0.032	0.034	0.036	0.025	--	0.038	0.044	36%	27%	20%	74%	--	15%
Naphthalene	0.102	0.077	0.103	0.078	0.070	0.095	0.170	67%	122%	65%	119%	143%	79%	0.116	0.070	0.101	0.029	0.075	0.096	0.093	-20%	32%	-8%	224%	24%	-3%
Phenanthrene	0.150	0.184	0.170	0.093	0.121	0.090	0.154	2%	-17%	-10%	66%	27%	71%	0.158	0.202	0.233	0.072	0.108	0.240	0.178	13%	-12%	-24%	146%	65%	-26%
LPAH - Total	0.334	0.354	0.348	0.246	0.280	0.255	0.413	24%	17%	19%	68%	48%	62%	0.383	0.364	0.440	0.091	0.263	0.475	0.391	2%	7%	-11%	327%	49%	-18%
HPAHs (lbs/1000 per acre)																										
Benzo(a)anthracene	0.091	0.112	0.101	0.041	0.060	0.039	0.061	-33%	-45%	-39%	49%	2%	59%	0.127	0.193	0.181	0.069	0.065	0.149	0.113	-11%	-41%	-37%	64%	75%	-24%
Benzo(a)pyrene	0.120	0.148	0.131	0.066	0.082	0.054	0.077	-35%	-48%	-41%	17%	-6%	44%	0.175	0.277	0.266	0.101	0.086	0.219	0.173	-1%	-37%	-35%	71%	100%	-21%
Benzo(g,h,i)perylene	0.138	0.156	0.118	0.078	0.110	0.073	0.100	-27%	-36%	-15%	29%	-9%	37%	0.168	0.254	0.251	0.111	0.124	0.239	0.300	79%	18%	20%	170%	142%	25%
Benzo(b,k)fluoranthenes	0.303	0.397	0.330	0.156	0.202	0.140	0.100	-67%	-75%	-70%	-36%	-51%	-29%	0.488	0.812	0.662	0.250	0.232	0.601	1.025	110%	26%	55%	310%	342%	71%
Chrysene	0.174	0.228	0.196	0.086	0.130	0.083	0.124	-29%	-45%	-37%	45%	-4%	50%	0.261	0.425	0.343	0.130	0.138	0.307	0.358	37%	-16%	4%	176%	160%	17%
Dibenz(a,h)anthracene	0.034	0.038	0.028	0.017	0.020	--	--	--	--	--	--	--	--	0.052	0.072	0.069	0.031	0.028	0.051	0.212	311%	195%	207%	577%	666%	312%
Fluoranthene	0.214	0.296	0.288	0.131	0.192	0.136	0.207	-3%	-30%	-28%	58%	8%	52%	0.334	0.542	0.510	0.193	0.185	0.509	0.409	23%	-24%	-20%	112%	122%	-20%
Indeno(1,2,3-c,d)pyrene	0.117	0.139	0.099	0.059	0.081	0.054	0.078	-34%	-44%	-22%	31%	-4%	44%	0.162	0.257	0.268	0.107	0.108	0.226	0.321	98%	25%	20%	202%	199%	42%
Pyrene	0.252	0.297	0.287	0.139	0.215	0.131	0.214	-15%	-28%	-25%	54%	0%	63%	0.371	0.487	0.459	0.182	0.198	0.424	0.400	8%	-18%	-13%	119%	102%	-6%
Retene	--	--	--	--	--	0.018	0.027	--	--	--	--	--	48%	--	--	--	--	--	0.055	0.176	--	--	--	--	--	221%
HPAH - Total	1.424	1.790	1.556	0.758	1.070	0.710	1.070	-25%	-40%	-31%	41%	0%	51%	2.053	3.224	2.916	1.101	1.093	2.657	3.245	58%	1%	11%	195%	197%	22%
Phthalates (lbs/1000 per acre)																										
DEHP	7.71	8.75	7.24	4.80	5.99	4.20	4.60	-40%	-47%	-36%	-4%	-23%	9%	9.45	8.91	6.24	3.84	4.76	5.23	5.78	-39%	-35%	-7%	51%	21%	10%
Butylbenzyl-phthalate	1.43	1.54	1.22	--	--	--	--	--	--	--	--	--	--	2.41	2.64	--	--	--	--	--	--	--	--	--	--	--
Diethyl-phthalate	6.83	1.80	--	2.74	1.15	--	1.30	--	--	--	--	0.130	--	3.17	2.22	--	2.92	1.96	--	--	--	--	--	--	--	--
Dimethyl-phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-butyl-phthalate	1.27	1.46	1.10	1.08	1.53	1.17	1.11	-12%	-24%	1%	3%	-27%	-5%	2.24	2.40	2.31	1.70	1.59	1.65	2.26	1%	-6%	-2%	33%	42%	37%
Di-n-octylphthalate	2.34	2.45	2.04	1.21	1.11	--	--	--	--	--	--	--	--	3.66	3.09	2.46	1.87	--	--	--	--	--	--	--	--	--
Phthalates - Total	16.62	12.99	9.60	8.54	8.29	5.62	6.15	-63%	-53%	-36%	-28%	-26%	10%	13.36	10.50	6.60	5.93	5.72	5.71	7.64	-43%	-27%	16%	29%	34%	34%
Pesticides (lbs/1000 per acre)																										
Bifenthrin	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.04	0.07	--	--	--	--	--	97%
Dichlobenil	0.27	0.19	0.27	0.20	0.37	0.36	0.30	10%	56%	10%	51%	-20%	-18%	0.41	0.35	0.33	0.30	0.35	0.37	0.34	-18%	-3%	4%	13%	-4%	-8%

Note: Mass loadings were not calculated for parameters with fewer than 10 percent detected concentrations or only one detected sample in stormwater.

(yellow) The estimated mass load comparisons to WY2020 are greater than a factor of two of each other (i.e., the percent difference greater than 100%).

(green) The estimated mass load comparisons to WY2020 are less than a factor of two of each other (i.e., the percent difference less than – 75%).

Table 6-2.2 Continued
Pollutant Loading Summary Comparison - WY2016-WY2022

OF243 - Industrial

Parameter	WY2016	WY2017	WY2018	WY2019	WY2020	WY2021	WY2022	Percent Difference: WY2016 to WY2022	WY2017 to WY2022	WY2018 to WY2022	WY2019 to WY2022	WY2020 to WY2022	WY2021 to WY2022
Conventionals (lbs per acre)													
TSS	101	366	143	211	70	80	80	-21%	-78%	-44%	-62%	14%	-1%
MBAS	0.16	0.21	0.11	0.11	0.07	0.08	0.12	-27%	-43%	7%	5%	68%	46%
BOD_5	6.17	12.02	9.65	12.29	2.92	8.10	7.36	19%	-39%	-24%	-40%	152%	-9%
Total Phosphorus	1.30	1.94	1.41	2.56	0.41	0.51	0.68	-48%	-65%	-52%	-73%	68%	34%
Orthophosphorus	0.15	0.09	0.09	0.06	0.05	0.07	0.08	-46%	-14%	-16%	37%	49%	14%
TN	1.74	1.95	2.22	2.46	1.51	1.42	1.54	-11%	-21%	-30%	-37%	3%	9%
Nitrate/Nitrite -Total	0.83	0.98	0.60	0.68	0.46	0.47	0.65	-22%	-34%	8%	-5%	41%	38%
Metals (lbs/1000 per acre)													
Cu - Total	58	154	67	78	36	38	39	-32%	-75%	-41%	-50%	8%	3%
Cu - Dissolved	10	16	9	14	6	9	12	14%	-27%	25%	-15%	109%	31%
Zn - Total	219	361	204	217	106	124	133	-39%	-63%	-35%	-39%	26%	7%
Zn - Dissolved	93	80	52	64	34	48	57	-38%	-28%	10%	-11%	67%	20%
Cd - Total	0.98	1.45	1.01	0.75	0.41	0.56	0.62	-37%	-57%	-39%	-17%	50%	10%
Cd - Dissolved	0.48	0.29	0.31	0.24	0.14	0.20	0.21	-57%	-28%	-33%	-15%	45%	3%
Hg - Total[1]	0.026	0.151	0.031	0.074	0.011	0.010	--	--	--	--	--	--	--
Hg - Dissolved[1]	0.006	0.005	--	0.012	--	--	--	--	--	--	--	--	--
Pb - Total	36.7	125.2	51.3	76.1	17.6	27.0	24.8	-33%	-80%	-52%	-67%	41%	-8%
Pb - Dissolved	0.19	0.22	0.30	0.98	0.28	0.56	0.84	330%	278%	175%	-15%	202%	48%
LPAHs (lbs/1000 per acre)													
2-Methylnaphthalene	0.060	0.013	0.023	0.028	0.028	0.027	0.034	-43%	154%	48%	22%	24%	25%
Acenaphthene	0.162	0.026	0.047	0.050	0.081	0.053	0.042	-74%	59%	-11%	-16%	-48%	-20%
Acenaphthylene	0.041	0.033	0.023	0.030	0.011	0.016	0.021	-48%	-35%	-7%	-28%	99%	37%
Anthracene	0.095	0.130	0.098	0.124	0.107	0.086	0.103	8%	-21%	5%	-17%	-4%	19%
Fluorene	0.075	0.036	0.026	0.035	0.015	0.016	0.023	-70%	-36%	-11%	-35%	52%	45%
Naphthalene	0.104	0.027	0.063	0.072	0.054	0.054	0.057	-45%	113%	-8%	-20%	6%	7%
Phenanthrene	0.154	0.099	0.087	0.098	0.064	0.068	0.072	-53%	-27%	-17%	-27%	14%	5%
LPAH - Total	0.631	0.351	0.342	0.409	0.331	0.292	0.333	-47%	-5%	-3%	-19%	1%	14%
HPAHs (lbs/1000 per acre)													
Benzo(a)anthracene	0.085	0.318	0.060	0.041	0.028	0.029	0.032	-63%	-90%	-47%	-22%	15%	9%
Benzo(a)pyrene	0.092	0.352	0.078	0.050	0.031	0.036	0.038	-59%	-89%	-52%	-24%	22%	6%
Benzo(g,h,i)perylene	0.076	0.312	0.073	0.067	0.039	0.038	0.041	-45%	-87%	-44%	-38%	5%	7%
Benzo(b,k)fluoranthenes	0.224	0.772	0.179	0.122	0.076	0.090	0.104	-54%	-87%	-42%	-15%	37%	16%
Chrysene	0.142	0.448	0.101	0.081	0.050	0.054	0.054	-62%	-88%	-46%	-33%	10%	1%
Dibenz(a,h)anthracene	0.021	0.310	0.016	0.008	--	--	--	--	--	--	--	--	--
Fluoranthene	0.223	0.269	0.174	0.162	0.097	0.094	0.094	-58%	-65%	-46%	-42%	-3%	0%
Indeno(1,2,3-c,d)pyrene	0.068	0.342	0.063	0.045	0.031	0.033	0.042	-39%	-88%	-34%	-7%	33%	24%
Pyrene	0.280	0.335	0.180	0.189	0.113	0.091	0.110	-61%	-67%	-39%	-42%	-3%	21%
Retene	--	--	--	--	--	0.016	0.026	--	--	--	--	--	60%
HPAH - Total	1.210	3.457	0.924	0.764	0.472	0.471	0.519	-57%	-85%	-44%	-32%	10%	10%
Phthalates (lbs/1000 per acre)													
DEHP	4.24	7.74	3.28	4.04	1.58	1.12	2.01	-53%	-74%	-39%	-50%	28%	79%
Butylbenzyl-phthalate	0.66	1.05	--	--	--	--	--	--	--	--	--	--	--
Diethyl-phthalate	0.72	0.38	--	0.83	0.63	0.55	1.80	151%	375%	--	118%	187%	228%
Dimethyl-phthalate	0.75	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-butyl-phthalate	0.58	0.95	0.66	0.77	0.47	0.53	0.51	-12%	-47%	-23%	-34%	7%	-5%
Di-n-octylphthalate	0.93	1.58	0.67	1.09	--	--	--	--	--	--	--	--	--
Phthalates - Total	5.11	10.87	3.90	5.93	2.41	1.59	3.98	-22%	-63%	2%	-33%	65%	151%
Pesticides (lbs/1000 per acre)													
Bifenthrin	--	--	--	--	--	--	--	--	--	--	--	--	--
Dichlobenil	0.041	0.042	0.06	0.09	0.07	--	0.05	--	--	--	--	-39%	--

OF254 - Industrial

Parameter	WY2016	WY2017	WY2018	WY2019	WY2020	WY2021	WY2022	Percent Difference: WY2016 to WY2022	WY2017 to WY2022	WY2018 to WY2022	WY2019 to WY2022	WY2020 to WY2022	WY2021 to WY2022
Conventionals (lbs per acre)													
TSS	530	511	647	330	242	338	377	-29%	-26%	-42%	14%	56%	12%
MBAS	0.40	0.63	0.26	0.23	0.34	0.32	0.48	19%	-24%	87%	106%	39%	49%
BOD_5	11.34	26.85	19.99	13.60	13.41	12.21	15.16	34%	-44%	-24%	11%	13%	24%
Total Phosphorus	0.95	1.27	0.97	0.77	0.61	0.67	0.73	-24%	-43%	-25%	-6%	20%	8%
Orthophosphorus	0.17	0.20	0.20	0.11	0.12	0.25	0.13	-22%	-33%	-35%	18%	14%	-48%
TN	2.93	4.18	4.79	2.45	3.09	2.58	2.26	-23%	-46%	-53%	-8%	-27%	-12%
Nitrate/Nitrite -Total	1.29	0.99	0.93	0.63	0.76	0.63	0.70	-46%	-29%	-25%	11%	-7%	10%
Metals (lbs/1000 per acre)													
Cu - Total	132	119	114	78	58	74	99	-25%	-17%	-14%	26%	69%	33%
Cu - Dissolved	19	17	14	12	16	15	16	-15%	-3%	17%	40%	2%	6%
Zn - Total	662	519	528	391	342	386	404	-39%	-22%	-24%	3%	18%	5%
Zn - Dissolved	292	212	182	175	171	167	191	-34%	-10%	5%	10%	12%	14%
Cd - Total	2.81	1.09	1.30	0.92	0.77	0.99	0.84	-70%	-23%	-35%	-9%	9%	-15%
Cd - Dissolved	1.69	0.68	0.62	0.45	0.43	0.38	0.42	-75%	-38%	-31%	-6%	-1%	12%
Hg - Total[1]	0.077	0.051	0.059	0.081	0.024	0.038	--	--	--	--	--	--	--
Hg - Dissolved[1]	0.008	0.014	--	--	--	--	--	--	--	--	--	--	--
Pb - Total	102.7	57.0	65.8	37.2	25.8	35.2	31.9	-69%	-44%	-52%	-14%	24%	-9%
Pb - Dissolved	1.53	0.83	0.95	0.73	0.79	0.60	4.52	195%	447%	374%	518%	473%	649%
LPAHs (lbs/1000 per acre)													
2-Methylnaphthalene	0.093	0.162	0.073	0.189	0.125	0.053	0.136	46%	-16%	85%	-28%	8%	157%
Acenaphthene	0.085	0.052	0.027	0.046	0.068	0.051	0.039	-54%	-25%	43%	-16%	-43%	-24%
Acenaphthylene	0.033	0.060	0.061	0.033	0.027	0.064	0.042	27%	-29%	-31%	29%	55%	-33%
Anthracene	0.067	0.067	0.078	0.059	0.056	0.040	0.049	-26%	-27%	-37%	-17%	-12%	23%
Fluorene	0.078	0.064	0.058	0.091	0.035	0.034	0.044	-44%	-31%	-25%	-52%	26%	27%
Naphthalene	0.220	0.131	0.176	0.160	0.181	0.120	0.177	-20%	35%	1%	10%	-2%	47%
Phenanthrene	0.327	0.291	0.360	0.250	0.204	0.212	0.250	-24%	-14%	-31%	0%	23%	18%
LPAH - Total	0.811	0.664	0.760	0.639	0.571	0.520	0.555	-32%	-16%	-27%	-13%	-3%	7%
HPAHs (lbs/1000 per acre)													
Benzo(a)anthracene	0.141	0.164	0.143	0.088	0.072	0.091	0.115	-19%	-30%	-20%	30%	60%	26%
Benzo(a)pyrene	0.240	0.248	0.231	0.148	0.101	0.188	0.140	-42%	-43%	-39%	-5%	39%	-25%
Benzo(g,h,i)perylene	0.188	0.245	0.193	0.177	0.139	0.185	0.176	-6%	-28%	-9%	0%	27%	-5%
Benzo(b,k)fluoranthenes	0.485	0.409	0.598	0.314	0.251	0.498	0.504	4%	23%	-16%	61%	100%	1%
Chrysene	0.286	0.210	0.411	0.180	0.213	0.561	0.292	2%	39%	-29%	63%	37%	-48%
Dibenz(a,h)anthracene	0.060	0.080	0.055	0.035	0.021	--	0.025	--	--	--	--	18%	--
Fluoranthene	0.461	0.401	0.620	0.385	0.368	0.507	0.451	-2%	12%	-27%	17%	23%	-11%
Indeno(1,2,3-c,d)pyrene	0.122	0.154	0.119	0.099	0.080	0.047	0.116	-5%	-24%	-2%	17%	46%	149%
Pyrene	0.635	0.528	0.774	0.473	0.422	0.544	0.538	-15%	2%	-30%	14%	27%	-1%
Retene	--	--	--	--	--	0.117	0.115	--	--	--	--	--	-2%
HPAH - Total	2.619	2.440	3.144	1.898	1.667	2.636	2.358	-10%	-3%	-25%	24%	41%	-11%
Phthalates (lbs/1000 per acre)													
DEHP	20.14	16.34	14.62	7.52	5.95	7.17	7.65	-62%	-53%	-48%	2%	29%	7%
Butylbenzyl-phthalate	2.06	1.57	--	--	1.74	--	--	--	--	--	--	--	--
Diethyl-phthalate	1.81	1.11	--	--	--	1.49	1.22	-33%	10%	--	--	--	-18%
Dimethyl-phthalate	1.55	0.57	--	--	--	--	--	--	--	--	--	--	--
Di-n-butyl-phthalate	3.31	2.86	2.55	1.82	2.27	2.45	1.83	-45%	-36%	-28%	1%	-19%	-25%
Di-n-octylphthalate	2.85	1.19	1.62	1.10	--	--	--	--	--	--	--	--	--
Phthalates - Total	26.76	20.69	17.80	9.43	8.73	10.24	8.92	-67%	-57%	-50%	-5%	2%	-13%
Pesticides (lbs/1000 per acre)													
Bifenthrin	--	--	--		--	--	--	--	--	--	--	--	--
Dichlobenil	0.26	0.86	--	0.25	0.20	0.11	0.16	-36%	-81%	--	-34%	-17%	50%

Note: Mass loadings were not calculated for parameters with fewer than 10 percent detected concentrations or only one detected sample in stormwater.

The estimated mass load comparisons to WY2020 are greater than a factor of two of each other (i.e., the percent difference greater than 100%). (yellow)

The estimated mass load comparisons to WY2020 are less than a factor of two of each other (i.e., the percent difference less than – 75%). (green)

Table 6-3
Pollutant Loading per Acre - WY2022

Conventionals	OF230 Commercial	OF235 Commercial	OF237A Residential	OF237B Residential	OF243 Industrial	OF245 Industrial	OF254 Industrial
TSS	110	126	113	117	80	184	377
MBAS	0.20	0.32	0.21	0.40	0.12	0.48	0.48
BOD_5	9.6	14.6	14.7	26.2	7.4	19.5	15.2
Total Phosphorus	0.45	0.950	0.37	0.726	0.682	0.917	0.726
Orthophosphorus	0.22	0.59	0.16	0.444	0.079	0.243	0.132
TN	2.7	6.6	9.7	38.1	1.5	3.9	2.3
Nitrate/Nitrite -Total	1.5	4.3	8.7	37.4	0.7	0.9	0.7
Metals (lbs/1000 per acre)							
Cu - Total	31	90	26	28	39	60	99
Cu - Dissolved	13	43	10	12	12	20	16
Zn - Total	237	308	178	151	133	399	404
Zn - Dissolved	116	143	90	74	57	184	191
Cd - Total	0.22	0.46	0.58	--	0.62	1.06	0.84
Cd - Dissolved	--	--	--	--	0.21	0.52	0.42
Hg - Total[1]	--	--	--	--	--	--	--
Hg - Dissolved[1]	--	--	--	--	--	--	--
Pb - Total	25.7	117	18	17	25	18	32
Pb - Dissolved	1.73	20.4	0.9	1.3	0.8	1.0	4.5
LPAHs (lbs/1000 per acre)							
2-Methylnaphthalene	0.117	0.099	0.056	0.080	0.034	0.202	0.136
Acenaphthene	--	--	--	--	0.042	--	0.039
Acenaphthylene	--	--	0.044	--	0.021	--	0.042
Anthracene	0.024	0.085	--	--	0.103	--	0.049
Fluorene	--	--	0.044	--	0.023	0.066	0.044
Naphthalene	0.170	0.113	0.093	0.144	0.057	0.589	0.177
Phenanthrene	0.154	0.155	0.178	0.104	0.072	0.173	0.250
LPAH - Total	0.413	0.453	0.391	0.481	0.333	0.981	0.555
HPAHs (lbs/1000 per acre)							
Benzo(a)anthracene	0.061	0.131	0.113	0.065	0.032	--	0.115
Benzo(a)pyrene	0.077	0.119	0.173	0.084	0.038	0.047	0.140
Benzo(g,h,i)perylene	0.100	0.154	0.300	0.091	0.041	0.094	0.176
Benzo(b,k)fluoranthenes	0.100	0.326	1.025	0.228	0.104	0.141	0.504
Chrysene	0.124	0.199	0.358	0.099	0.054	0.089	0.292
Dibenz(a,h)anthracene	--	--	0.212	--	--	--	0.025
Fluoranthene	0.207	0.294	0.409	0.171	0.094	0.186	0.451
Indeno(1,2,3-c,d)pyrene	0.078	0.101	0.321	0.084	0.042	0.043	0.116
Pyrene	0.214	0.374	0.400	0.198	0.110	0.277	0.538
Retene	0.027	0.077	0.176	0.047	0.026	0.071	0.115
HPAH - Total	1.070	1.680	3.245	1.060	0.519	0.937	2.358
Phthalates (lbs/1000 per acre)							
DEHP	4.60	6.4	5.8	5.7	2.0	8.8	7.6
Butylbenzyl-phthalate	--	3.8	--	--	--	--	--
Diethyl-phthalate	1.30	1.75	--	--	1.80	--	1.2
Dimethyl-phthalate	--	--	--	--	--	--	--
Di-n-butyl-phthalate	1.11	1.8	2.3	3.0	0.5	11.8	1.8
Di-n-octylphthalate	--	--	--	--	--	--	--
Phthalates - Total	6.15	11.5	7.6	9.5	4.0	21.0	8.9
Pesticides (lbs/1000 per acre)							
Bifenthrin	--	--	0.07	--	--	--	--
Dichlobenil	0.296	0.580	0.341	0.530	0.045	0.200	0.163

Note: Mass loadings were not calculated for parameters with fewer than 10 percent detected concentrations or only one detected sample in

Maximum Pollutant Loading per Acre Value

Table 6-4
WY2022 Annual Pollutant Loading

Pounds per Year

	OF230 - Commercial			OF235 - Commercial			OF237A - Residential			OF237B - Residential		
Conventionals	Baseflow	Stormwater	Grand Total	Baseflow	Stormwater	Grand Total	Baseflow	Stormwater	Grand Total	Baseflow	Stormwater	Grand Total
TSS	3,686	57,391	61,078	957	19,543	20,501	18,588	301,242	319,831	24,528	226,410	250,938
MBAS	48.25	63.33	111.60	14.89	36.48	51.37	201	382	583	469	390	860
BOD$_5$	1,229	4,104	5,333	482	1,903	2,385	10,770	30,701	41,471	35,905	20,355	56,260
Total Phosphorus	88	165	253	61	94	155	317	729	1,045	827	733	1,559
Orthophosphorus	79.8	40.9	120.6	57.6	38.5	96.1	366	94	460	839	113	952
TN	755	726	1,481	645	431	1,077	24,759	2,678	27,437	76,193	5,659	81,852
Nitrate/Nitrite -Total	689	167	856	560	136	696	25,513	-949	24,564	77,822	2,404	80,225
Metals												
Cu - Total	3.45	13.99	17.45	1.54	13.11	14.65	5.22	67.41	72.63	8.13	52.35	60.48
Cu - Dissolved	2.20	5.20	7.41	0.98	6.05	7.03	3.37	25.0	28.36	4.41	21.11	25.52
Zn - Total	20.32	111.62	131.90	3.18	47.06	50.24	26.78	474.4	501.2	37.87	286.78	324.64
Zn - Dissolved	9.91	54.47	64.37	2.06	21.33	23.39	20.82	232.3	253.1	29.64	130.31	159.95
Cd - Total	0.022	0.099	0.121	0.026	0.049	0.075	1.241	0.39	1.632	--	--	--
Cd - Dissolved	--	--	--	--	--	--	--	--	--	--	--	--
Hg - Total[1]	--	--	--	--	--	--	0.027	0.04	0.069	--	--	--
Hg - Dissolved[1]	--	--	--	--	--	--	--	--	--	--	--	--
Pb - Total	0.84	13.48	14.32	0.91	18.21	19.11	1.40	48.21	49.60	0.91	34.72	35.63
Pb - Dissolved	0.13	0.84	0.96	0.36	2.97	3.32	0.31	2.14	2.45	0.584	2.16	2.74
LPAHs												
2-Methylnaphthalene	0.005	0.060	0.065	0.003	0.013	0.016	0.053	0.104	0.157	0.096	0.076	0.173
Acenaphthene	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	--	--	--	--	--	0.050	0.073	0.123	--	--	--
Anthracene	0.003	0.010	0.013	0.002	0.012	0.014	--	--	--	--	--	--
Fluorene	--	--	--	--	--	--	0.048	0.075	0.123	--	--	--
Naphthalene	0.011	0.084	0.095	0.004	0.015	0.018	0.068	0.194	0.262	0.167	0.143	0.310
Phenanthrene	0.011	0.075	0.086	0.003	0.022	0.025	0.061	0.441	0.503	0.125	0.099	0.224
LPAH - Total	0.032	0.198	0.230	0.012	0.062	0.074	0.203	0.900	1.103	0.627	0.405	1.032
HPAHs												
Benzo(a)anthracene	0.003	0.031	0.034	0.001	0.020	0.021	0.050	0.270	0.320	0.069	0.071	0.140
Benzo(a)pyrene	0.003	0.040	0.043	0.002	0.018	0.019	0.050	0.439	0.489	0.073	0.107	0.180
Benzo(g,h,i)perylene	0.003	0.053	0.056	0.004	0.021	0.025	0.045	0.801	0.846	0.058	0.138	0.196
Benzo(b,k)fluoranthenes	0.008	0.048	0.056	0.004	0.050	0.053	0.093	2.800	2.893	0.132	0.359	0.490
Chrysene	0.003	0.066	0.069	0.002	0.031	0.032	0.044	0.966	1.010	0.052	0.161	0.213
Dibenz(a,h)anthracene	--	--	--	--	--	--	0.047	0.552	0.599	--	--	--
Fluoranthene	0.006	0.110	0.115	0.002	0.046	0.048	0.050	1.106	1.156	0.077	0.291	0.368
Indeno(1,2,3-c,d)pyrene	0.004	0.039	0.043	0.002	0.014	0.017	0.050	0.858	0.908	0.073	0.106	0.180
Pyrene	0.005	0.114	0.119	0.003	0.058	0.061	0.049	1.080	1.129	0.075	0.349	0.425
Retene	0.002	0.013	0.015	0.001	0.011	0.013	0.027	0.469	0.496	0.063	0.039	0.102
HPAH - Total	0.029	0.567	0.596	0.013	0.261	0.274	0.258	8.903	9.161	0.660	1.616	2.276
Phthalates												
DEHP	0.33	2.23	2.56	0.13	0.91	1.04	4.04	12.28	16.31	4.87	7.46	12.34
Butylbenzyl-phthalate	--	--	--	0.109	0.507	0.616	4.28	1.968	6.251	--	--	--
Diethyl-phthalate	0.41	0.309	0.724	0.08	0.207	0.286	--	--	--	--	--	--
Dimethyl-phthalate	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-butyl-phthalate	0.25	0.37	0.62	0.091	0.21	0.30	3.26	3.12	6.380	4.19	2.19	6.382
Di-n-octylphthalate	--	--	--	--	--	--	4.19	2.18	6.370	--	--	--
Phthalates - Total	0.86	2.56	3.43	0.232	1.64	1.87	3.93	17.65	21.57	11.32	8.98	20.31
Pesticides												
Bifenthrin	--	--	--	--	--	--	0.054	0.14	0.20	--	--	--
Dichlobenil	0.03	0.14	0.17	0.019	0.076	0.095	0.499	0.463	0.962	0.562	0.583	1.145

Note: Mass loadings were not calculated for parameters with fewer than 10 percent detected concentrations or only one detected sample in stormwater.

Table 6-4 Continued
WY2022 Annual Pollutant Loading

	Pounds per Year											
	OF243 - Industrial			OF245 - Industrial			OF254 - Industrial			Overall Total		
Conventionals	Baseflow	Stormwater	Grand Total	Baseflow	Stormwater	Grand Total	Baseflow	Stormwater	Grand Total	Baseflow	Stormwater	Grand Total
TSS	0	4,705	4,705	0	6,982	6,982	0	44,893	44,893	47,760	661,166	708,926
MBAS	0	6.94	6.94	0	18.38	18.38	0	57.14	57.14	734	954	1,688
BOD_5	0	434	434	0	741	741	0	1,804	1,804	48,385	60,042	108,427
Total Phosphorus	0	40	40	0	35	35	0	86	86	1,293	1,881	3,174
Orthophosphorus	0	4.69	4.69	0	9.25	9.25	0	15.75	15.75	1,343	316	1,659
TN	0	91	91	0	148	148	0	269	269	102,353	10,003	112,356
Nitrate/Nitrite -Total	0	38	38	0	33	33	0	83	83	104,583	1,912	106,495
Metals												
Cu - Total	0	2.31	2.31	0	2.29	2.29	0	11.72	11.72	18.35	163.18	181.53
Cu - Dissolved	0	0.69	0.69	0	0.77	0.77	0	1.92	1.92	10.96	60.73	71.70
Zn - Total	0	7.85	7.85	0	15.15	15.15	0	48.03	48.03	88.15	990.88	1079.03
Zn - Dissolved	0	3.38	3.38	0	7.01	7.01	0	22.75	22.75	62.43	471.54	533.97
Cd - Total	0	0.036	0.036	0	0.040	0.040	0.000	0.100	0.100	1.29	0.72	2.00
Cd - Dissolved	0	0.012	0.012	0	0.020	0.020	0.000	0.051	0.051	0.000	0.082	0.08
Hg - Total[1]	0	--	--	0	--	--	0.000	--	--	0.0269	0.0423	0.069
Hg - Dissolved[1]	--	--	--	--	--	--	--	--	--	--	--	--
Pb - Total	0	1.46	1.46	0	0.70	0.70	0	3.79	3.79	4.05	120.56	124.61
Pb - Dissolved	0	0.05	0.05	0	0.04	0.04	0	0.54	0.54	1.38	8.72	10.10
LPAHs												
2-Methylnaphthalene	0	0.002	0.002	0.000	0.008	0.008	0.000	0.016	0.016	0.157	0.280	0.437
Acenaphthene	0	0.002	0.002	--	--	--	0.000	0.005	0.005	0.00	0.007	0.007
Acenaphthylene	0	0.001	0.001	--	--	--	0.000	0.005	0.005	0.050	0.079	0.130
Anthracene	0	0.006	0.006	--	--	--	0.000	0.006	0.006	0.006	0.033	0.039
Fluorene	0	0.001	0.001	0.000	0.003	0.003	0.000	0.005	0.005	0.048	0.084	0.133
Naphthalene	0	0.003	0.003	0.000	0.022	0.022	0.000	0.021	0.021	0.250	0.482	0.732
Phenanthrene	0	0.004	0.004	0.000	0.007	0.007	0.000	0.030	0.030	0.200	0.677	0.878
LPAH - Total	0	0.020	0.020	0.000	0.037	0.037	0.000	0.066	0.066	0.875	1.687	2.562
HPAHs												
Benzo(a)anthracene	0	0.002	0.002	--	--	--	0.000	0.014	0.014	0.124	0.407	0.531
Benzo(a)pyrene	0	0.002	0.002	0.000	0.002	0.002	0.000	0.017	0.017	0.128	0.625	0.753
Benzo(g,h,i)perylene	0	0.002	0.002	0.000	0.004	0.004	0.000	0.021	0.021	0.111	1.039	1.150
Benzo(b,k)fluoranthenes	0	0.006	0.006	0.000	0.005	0.005	0.000	0.060	0.060	0.236	3.328	3.564
Chrysene	0	0.003	0.003	0.000	0.003	0.003	0.000	0.035	0.035	0.102	1.265	1.366
Dibenz(a,h)anthracene	--	--	--	--	--	--	--	0.003	0.003	0.047	0.555	0.602
Fluoranthene	0	0.006	0.006	0.000	0.007	0.007	0.000	0.054	0.054	0.135	1.619	1.753
Indeno(1,2,3-c,d)pyrene	0	0.002	0.002	0.000	0.002	0.002	0.000	0.014	0.014	0.129	1.036	1.165
Pyrene	0	0.006	0.006	0.000	0.011	0.011	0.000	0.064	0.064	0.132	1.683	1.815
Retene	0	0.002	0.002	0.000	0.003	0.003	0.000	0.014	0.014	0.092	0.550	0.643
HPAH - Total	0	0.031	0.031	0.000	0.036	0.036	0.000	0.281	0.281	0.960	11.693	12.653
Phthalates												
DEHP	0	0.12	0.12	0	0.33	0.34	0	0.91	0.91	9.37	24.24	33.61
Butylbenzyl-phthalate	--	--	--	--	--	--	--	--	--	4.39	2.47	6.87
Diethyl-phthalate	0	0.11	0.11	--	--	--	0	0.15	0.15	0.49	0.77	1.26
Dimethyl-phthalate	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-butyl-phthalate	0	0.03	0.03	0	0.45	0.45	0	0.22	0.22	7.79	6.58	14.38
Di-n-octylphthalate	--	--	--	--	--	--	--	--	--	4.19	2.18	6.37
Phthalates - Total	0	0.23	0.23	0	0.80	0.80	0	1.06	1.06	16.35	32.92	49.27
Pesticides												
Bifenthrin	--	--	--	--	--	--	--	--	--	0.05	0.14	0.20
Dichlobenil	--	0.003	0.003	0.000	0.008	0.008	0.000	0.019	0.019	1.11	1.29	2.396

Note: Mass loadings were not calculated for parameters with fewer than 10 percent detected concentrations or only one detected sample in stormwater.

Table 6-4 Continued
WY2022 Annual Pollutant Loading

Percentage of Total Pounds per Year

	OF230 - Commercial			OF235 - Commercial			OF237A - Residential			OF237B - Residential		
Conventionals	Baseflow	Stormwater	Grand Total	Baseflow	Stormwater	Grand Total	Baseflow	Stormwater	Grand Total	Baseflow	Stormwater	Grand Total
TSS	8%	9%	9%	2%	3%	3%	39%	46%	45%	51%	34%	35%
MBAS	7%	7%	7%	2%	4%	3%	27%	40%	35%	64%	41%	51%
BOD$_5$	3%	7%	5%	1%	3%	2%	22%	51%	38%	74%	34%	52%
Total Phosphorus	7%	9%	8%	5%	5%	5%	24%	39%	33%	64%	39%	49%
Orthophosphorus	6%	13%	7%	4%	12%	6%	27%	30%	28%	63%	36%	57%
TN	1%	7%	1%	1%	4%	1%	24%	27%	24%	74%	57%	73%
Nitrate/Nitrite -Total	1%	9%	1%	1%	7%	1%	24%	-50%	23%	74%	126%	75%
Metals												
Cu - Total	19%	9%	10%	8%	8%	8%	28%	41%	40%	44%	32%	33%
Cu - Dissolved	20%	9%	10%	9%	10%	10%	31%	41%	40%	40%	35%	36%
Zn - Total	23%	11%	12%	4%	5%	5%	30%	48%	46%	43%	29%	30%
Zn - Dissolved	16%	12%	12%	3%	5%	4%	33%	49%	47%	47%	28%	30%
Cd - Total	2%	14%	6%	2%	7%	4%	96%	55%	81%	--	--	--
Cd - Dissolved	--	--	--	--	--	--	--	--	--	--	--	--
Hg - Total[1]	--	--	--	--	--	--	100%	100%	100%	--	--	--
Hg - Dissolved[1]	--	--	--	--	--	--	--	--	--	--	--	--
Pb - Total	21%	11%	11%	22%	15%	15%	34%	40%	40%	22%	29%	29%
Pb - Dissolved	9%	10%	10%	26%	34%	33%	23%	25%	24%	42%	25%	27%
LPAHs												
2-Methylnaphthalene	3%	21%	15%	2%	5%	4%	34%	37%	36%	61%	27%	40%
Acenaphthene	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	--	--	--	--	--	100%	92%	95%	--	--	--
Anthracene	59%	30%	33%	41%	35%	36%	--	--	--	--	--	--
Fluorene	--	--	--	--	--	--	100%	89%	93%	--	--	--
Naphthalene	4%	17%	13%	2%	3%	3%	27%	40%	36%	67%	30%	42%
Phenanthrene	5%	11%	10%	2%	3%	3%	31%	65%	57%	62%	15%	26%
LPAH - Total	4%	12%	9%	1%	4%	3%	23%	53%	43%	72%	24%	40%
HPAHs												
Benzo(a)anthracene	3%	8%	6%	1%	5%	4%	41%	66%	60%	56%	18%	26%
Benzo(a)pyrene	3%	6%	6%	1%	3%	3%	39%	70%	65%	57%	17%	24%
Benzo(g,h,i)perylene	3%	5%	5%	4%	2%	2%	41%	77%	74%	53%	13%	17%
Benzo(b,k)fluoranthenes	3%	1%	2%	1%	1%	1%	40%	84%	81%	56%	11%	14%
Chrysene	3%	5%	5%	2%	2%	2%	44%	76%	74%	51%	13%	16%
Dibenz(a,h)anthracene	--	--	--	--	--	--	100%	99%	100%	--	--	--
Fluoranthene	4%	7%	7%	2%	3%	3%	37%	68%	66%	57%	18%	21%
Indeno(1,2,3-c,d)pyrene	3%	4%	4%	2%	1%	1%	38%	83%	78%	57%	10%	15%
Pyrene	4%	7%	7%	2%	3%	3%	37%	64%	62%	57%	21%	23%
Retene	2%	2%	2%	1%	2%	2%	29%	85%	77%	68%	7%	16%
HPAH - Total	3%	5%	5%	1%	2%	2%	27%	76%	72%	69%	14%	18%
Phthalates												
DEHP	4%	9%	8%	1%	4%	3%	43%	51%	49%	52%	31%	37%
Butylbenzyl-phthalate	--	--	--	2%	20%	9%	98%	80%	91%	--	--	--
Diethyl-phthalate	3%	6%	4%	16%	27%	23%	--	--	--	--	--	--
Dimethyl-phthalate	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-butyl-phthalate	3%	6%	4%	1%	3%	2%	42%	47%	44%	54%	33%	44%
Di-n-octylphthalate	--	--	--	--	--	--	100%	100%	100%	--	--	--
Phthalates - Total	5%	8%	7%	1%	5%	4%	24%	54%	44%	69%	27%	41%
Pesticides												
Bifenthrin	--	--	--	--	--	--	100%	100%	100%	--	--	--
Dichlobenil	3%	10%	7%	2%	6%	4%	45%	36%	40%	51%	45%	48%

Highlighted cells are the highest loadings values for baseflow, stormwater and total.

Note: Mass loadings were not calculated for parameters with fewer than 10 percent detected concentrations or only one detected sample in stormwater.

Table 6-4 Continued
WY2022 Annual Pollutant Loading

Percentage of Total Pounds per Year

	OF243 - Industrial			OF245 - Industrial			OF254 - Industrial			Overall Total		
Conventionals	Baseflow	Stormwater	Grand Total	Baseflow	Stormwater	Grand Total	Baseflow	Stormwater	Grand Total	Baseflow	Stormwater	Grand Total
TSS	0%	1%	1%	0%	1%	1%	0%	7%	6%	7%	93%	100%
MBAS	0%	1%	0%	0%	2%	1%	0%	6%	3%	43%	57%	100%
BOD_5	0%	1%	0%	0%	1%	1%	0%	3%	2%	45%	55%	100%
Total Phosphorus	0%	2%	1%	0%	2%	1%	0%	5%	3%	41%	59%	100%
Orthophosphorus	0%	1%	0%	0%	3%	1%	0%	5%	1%	81%	19%	100%
TN	0%	1%	0%	0%	1%	0%	0%	3%	0%	91%	9%	100%
Nitrate/Nitrite -Total	0%	2%	0%	0%	2%	0%	0%	4%	0%	98%	2%	100%
Metals												
Cu - Total	0%	1%	1%	0%	1%	1%	0%	7%	6%	10%	90%	100%
Cu - Dissolved	0%	1%	1%	0%	1%	1%	0%	3%	3%	15%	85%	100%
Zn - Total	0%	1%	1%	0%	2%	1%	0%	5%	4%	8%	92%	100%
Zn - Dissolved	0%	1%	1%	0%	1%	1%	0%	5%	4%	12%	88%	100%
Cd - Total	0%	5%	2%	0%	6%	2%	0%	14%	5%	64%	36%	100%
Cd - Dissolved	0%	15%	15%	0%	24%	24%	0%	61%	61%	0%	100%	100%
Hg - Total[1]	--	--	--	--	--	--	--	--	--	39%	61%	100%
Hg - Dissolved[1]	--	--	--	--	--	--	--	--	--	--	--	--
Pb - Total	0%	1%	1%	0%	1%	1%	0%	3%	3%	3%	97%	100%
Pb - Dissolved	0%	1%	0%	0%	0%	0%	0%	6%	5%	14%	86%	100%
LPAHs												
2-Methylnaphthalene	0%	1%	0%	0%	3%	2%	0%	6%	4%	36%	64%	100%
Acenaphthene	0%	35%	35%	--	--	--	0%	65%	65%	0%	100%	100%
Acenaphthylene	0%	2%	1%	--	--	--	0%	6%	4%	39%	61%	100%
Anthracene	0%	18%	16%	--	--	--	0%	17%	15%	15%	85%	100%
Fluorene	0%	2%	1%	0%	3%	2%	0%	6%	4%	37%	63%	100%
Naphthalene	0%	1%	0%	0%	5%	3%	0%	4%	3%	34%	66%	100%
Phenanthrene	0%	1%	0%	0%	1%	1%	0%	4%	3%	23%	77%	100%
LPAH - Total	0%	1%	1%	0%	2%	1%	0%	4%	3%	34%	66%	100%
HPAHs												
Benzo(a)anthracene	0%	0%	0%	--	--	--	0%	3%	3%	23%	77%	100%
Benzo(a)pyrene	0%	0%	0%	0%	0%	0%	0%	3%	2%	17%	83%	100%
Benzo(g,h,i)perylene	0%	0%	0%	0%	0%	0%	0%	2%	2%	10%	90%	100%
Benzo(b,k)fluoranthenes	0%	0%	0%	0%	0%	0%	0%	2%	2%	7%	93%	100%
Chrysene	0%	0%	0%	0%	0%	0%	0%	3%	3%	7%	93%	100%
Dibenz(a,h)anthracene	--	--	--	--	--	--	0%	1%	0%	8%	92%	100%
Fluoranthene	0%	0%	0%	0%	0%	0%	0%	3%	3%	8%	92%	100%
Indeno(1,2,3-c,d)pyrene	0%	0%	0%	0%	0%	0%	0%	1%	1%	11%	89%	100%
Pyrene	0%	0%	0%	0%	1%	1%	0%	4%	4%	7%	93%	100%
Retene	0%	0%	0%	0%	0%	0%	0%	2%	2%	14%	86%	100%
HPAH - Total	0%	0%	0%	0%	0%	0%	0%	2%	2%	8%	92%	100%
Phthalates												
DEHP	0%	0%	0%	0%	1%	1%	0%	4%	3%	28%	72%	100%
Butylbenzyl-phthalate	--	--	--	--	--	--	--	--	--	64%	36%	100%
Diethyl-phthalate	0%	14%	8%	--	--	--	0%	19%	12%	39%	61%	100%
Dimethyl-phthalate	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-butyl-phthalate	0%	0%	0%	0%	7%	3%	0%	3%	2%	54%	46%	100%
Di-n-octylphthalate	--	--	--	--	--	--	--	--	--	66%	34%	100%
Phthalates - Total	0%	1%	0%	0%	2%	2%	0%	3%	2%	33%	67%	100%
Pesticides												
Bifenthrin	--	--	--	--	--	--	--	--	--	27%	73%	100%
Dichlobenil	0%	0%	0%	0%	1%	0%	0%	2%	1%	46%	54%	100%

Highlighted cells are the highest loadings values for baseflow, stormwater and total.

Note: Mass loadings were not calculated for parameters with fewer than 10 percent detected concentrations or only one detected sample in stormwater.

Table 6-5
Percent of Annual Loading Rates by Outfall

Stormwater Outfalls		Phenanthrene			Pyrene			Dibenz(ah)anthracene			Bis(2-ethylhexyl)phthalate			Volume, ac-ft/yr	% of Total Volume
		Contaminant Load in Kg/Year	% of Total SW Load	% of Total Load	Contaminant Load in Kg/Year	% of Total SW Load	% of Total Load	Contaminant Load in Kg/Year	% of Total SW Load	% of Total Load	Contaminant Load in Kg/Year	% of Total SW Load	% of Total Load		
OF237A	SW	0.200	49.0%	9.1%	0.490	57.5%	13.5%	0.250	90.7%	91.6%	5.57	35.6%	23.3%	3,032	14.7%
	BF	0.028	6.8%	1.3%	0.022	2.6%	0.6%	0.021	7.7%	7.8%	1.83	11.7%	7.7%	3,970	19.2%
OF237B[2]	SW	0.045	11.0%	2.0%	0.159	18.6%	4.4%	0.000	0.0%	0.0%	3.39	21.7%	14.2%	2,626	12.7%
	BF	0.057	13.9%	2.6%	0.034	4.0%	0.9%	0.000	0.0%	0.0%	2.21	14.1%	9.3%	9,218	44.6%
OF230	SW	0.034	8.3%	1.5%	0.052	6.1%	1.4%	0.000	0.0%	0.0%	1.01	6.5%	4.2%	614	3.0%
	BF	0.005	1.2%	0.2%	0.002	0.3%	0.1%	0.000	0.0%	0.0%	0.15	1.0%	0.6%	255	1.2%
OF235	SW	0.010	2.5%	0.5%	0.026	3.1%	0.7%	0.000	0.0%	0.0%	0.41	2.6%	1.7%	297	1.4%
	BF	0.001	0.3%	0.1%	0.001	0.1%	0.0%	0.000	0.0%	0.0%	0.06	0.4%	0.2%	178	0.9%
OF245[2]		0.003	0.7%	0.1%	0.005	0.6%	0.1%	0.000	0.0%	0.0%	0.15	1.0%	0.6%	125	0.6%
OF243[2]		0.002	0.5%	0.1%	0.003	0.3%	0.1%	0.000	0.0%	0.0%	0.05	0.3%	0.2%	63	0.3%
OF254		0.013	3.3%	0.6%	0.029	3.4%	0.8%	0.001	0.5%	0.5%	0.41	2.6%	1.7%	312	1.5%
All Other SW Outfalls[1]		0.010	2.4%	0.5%	0.029	3.4%	0.8%	0.003	1.1%	1.1%	0.38	2.4%	1.6%	72	0.3%
BF Total		**0.09**	**22%**	**4%**	**0.06**	**7%**	**2%**	**0.021**	**8%**	**8%**	**4.25**	**27%**	**18%**	**13,620**	**66%**
SW Total		**0.32**	**78%**	**14%**	**0.79**	**93%**	**22%**	**0.255**	**92%**	**93%**	**11.38**	**73%**	**48%**	**7,069**	**34%**
Loading values for SW Outfalls and Other Sources (Total Loadings) were based on the WASP2006 Model Update														**Total 2022 Volume**	
Total Outfall Loadings		**0.41**		**18.6%**	**0.85**		**23.5%**	**0.28**		**101.0%**	**15.63**		**65.5%**	**20,689**	**ac-ft/yr**
Total Loadings		**2.19**		**100.0%**	**3.62**		**100.0%**	**0.273**		**100.0%**	**23.86**		**100.0%**		

1-Loading values for SW Outfalls and Other Sources (Total Loadings) were based on the WASP2006 Model Update

2-As the concentrations of stormwater and baseflow converge and where baseflow accounts for >65 of the discharge, the largest contribution of mass loadings is estimated from baseflow. This is seen for a few constituents with less than 25 percent detections and/or less than five detected results that generate estimated mass loads with a high degree of uncertainty, even though mass loads may still be calculated using one-half the detection limit for that non-detected value

SW - Stormwater

BF- Baseflow

FIGURES

This page is intentionally left blank

Figure 1-1
Thea Foss Post-Remediation Source Control Strategy

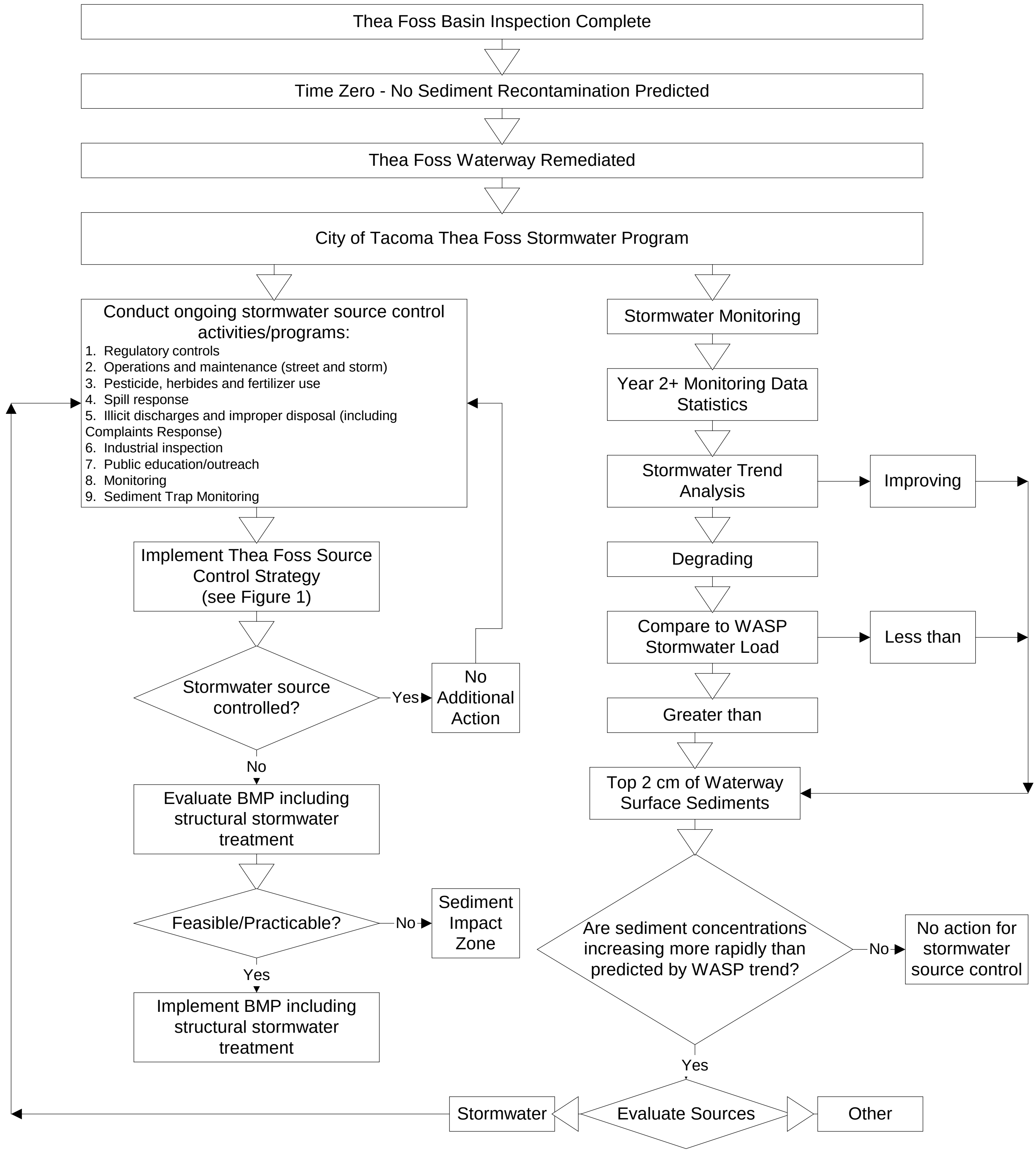
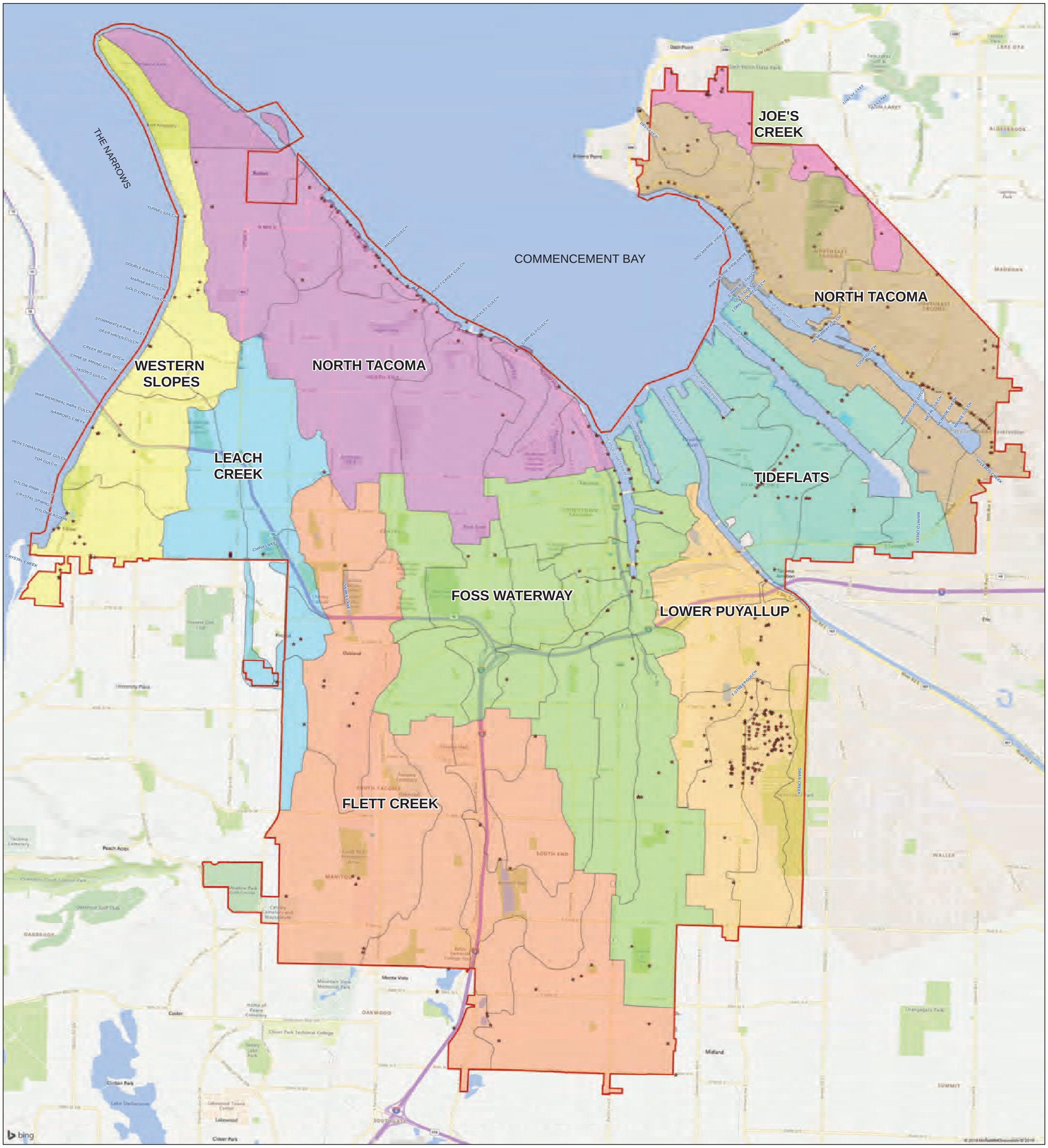


Figure 1-1 Source Control Strategy

Figure 1-2
City of Tacoma Watersheds



WATERSHEDS

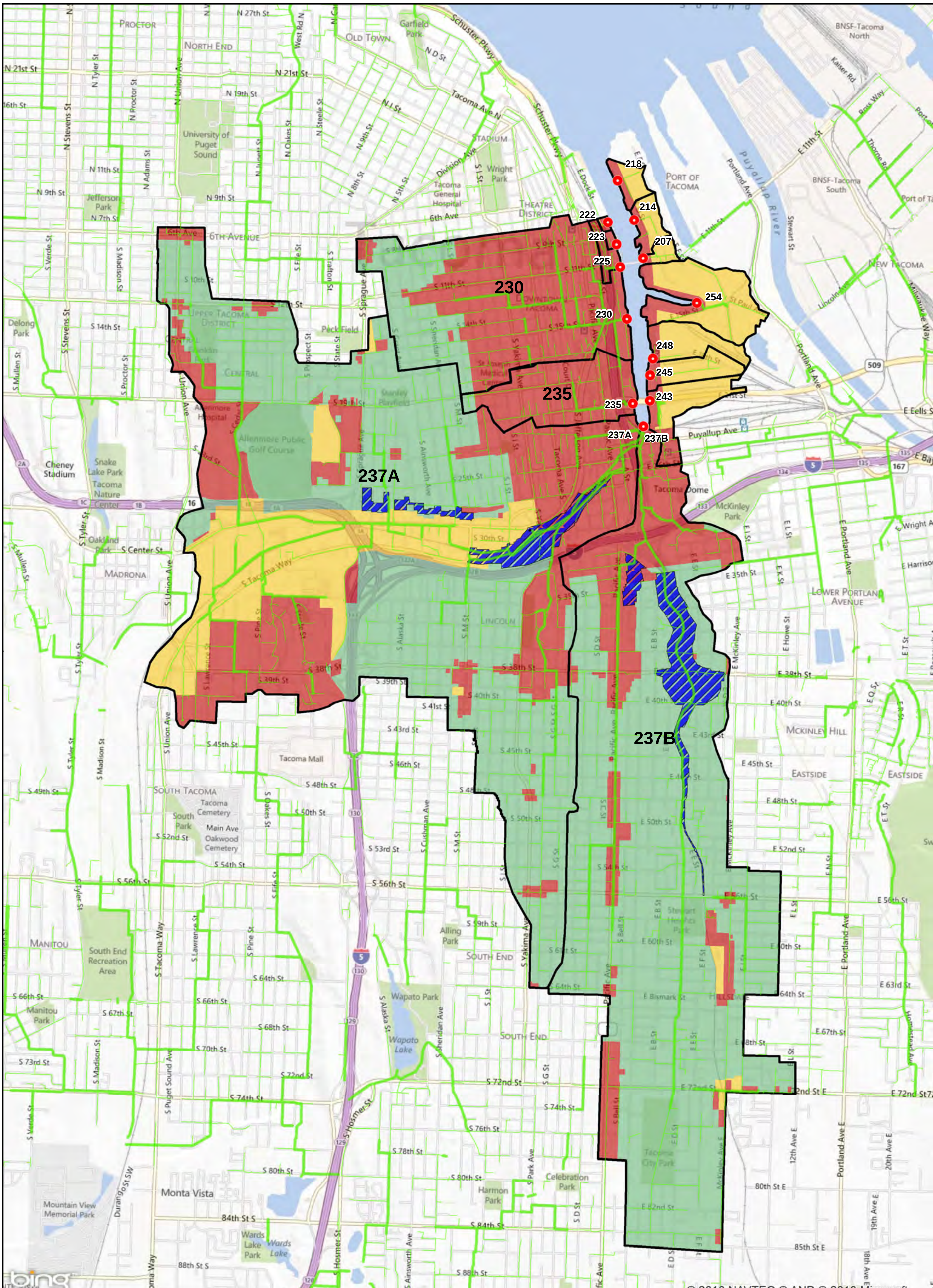
WESTERN SLOPES	LOWER PUYALLUP	FLETT CREEK
TIDEFLATS	LEACH CREEK	TACOMA CITY LIMITS
NORTH TACOMA	JOE'S CREEK	OUTFALLS
NE TACOMA	FOSS WATERWAY	SUB-BASINS

N

0 0.375 0.75 1.5 2.25 Miles

Map Date: 9/30/2019
Source: Science and Engineering Division
Environmental Services Department
City of Tacoma
326 East D Street, Tacoma WA 98421
(253) 591-5588

Figure 1-3
Thea Foss Basins Land Use and Outfall Locations



Legend

STORM LINES
TRUNKLINES 24" AND LARGER
OUTFALLS

Map Date: February 22, 2013
Source: Environmental Services Division, Public Works Department City of Tacoma

Center for Urban Waters
326 East D Street, Tacoma WA 98421
(253) 591-5588

N

0 1,000 2,000 4,000 Feet

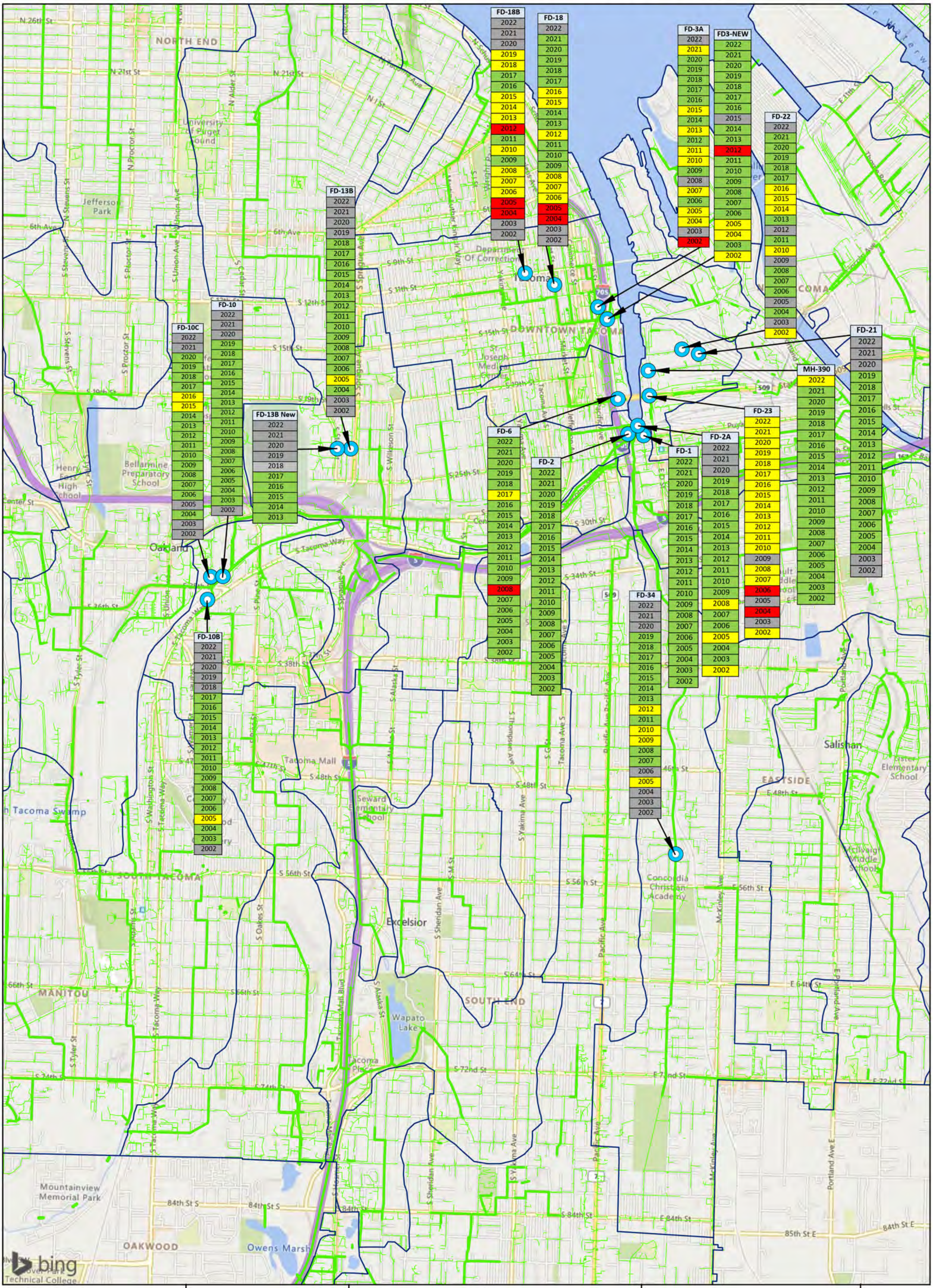
Land Use

OPEN SPACE
INDUSTRIAL
COMMERCIAL
RESIDENTIAL

Tacoma

Datarequest/MHenley/Thea Foss Monitoring Program Figure 2-1c - Van Pelt

Figure 2-1.1
Sediment Trap Results - Mercury



Legend

- SAMPLE SITE LOCATIONS
- STORM LINES
- TRUNKLINES 24" AND LARGER
- STORMWATER SUB-BASINS

Map Date: January 4, 2023
Source: Science and Engineering Division, Environmental Services Department City of Tacoma

Environmental Services/ Science & Engineering
326 East D Street, Tacoma WA 98421
(253) 591-5588

N

0 1,000 2,000 4,000 Feet

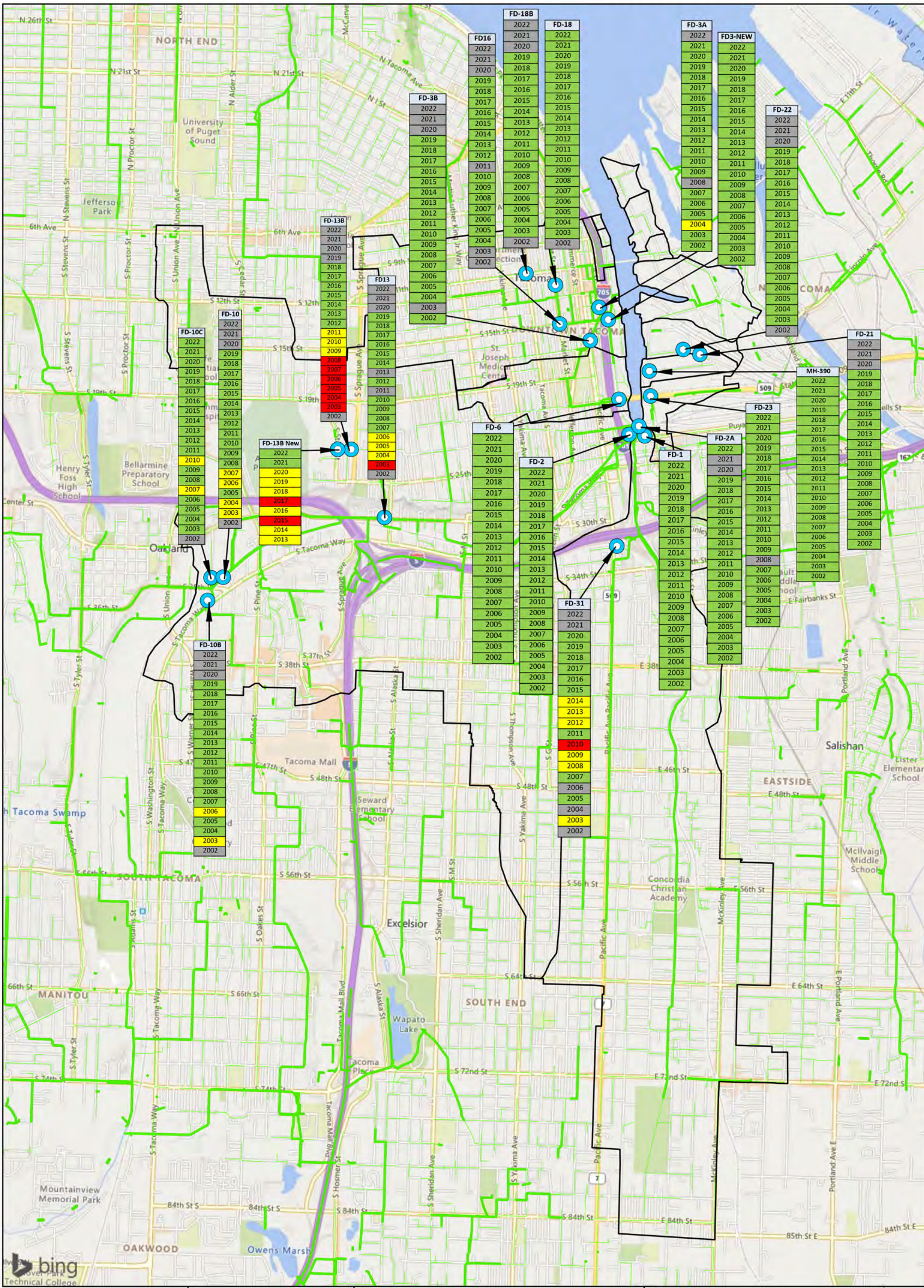
Symbol Level Key

- NO ANALYSIS
- SMALL LEVELS - <.20 mg/Kg
- MEDIUM LEVELS - .20 - .70 mg/Kg
- LARGE LEVELS - >.70 mg/Kg

Tacoma

R:\Projects\2023\P0004_SedimentTrapResultFigureUpdatesForFossReport

Figure 2-1.2
Sediment Trap Results - PAHs



Legend

- SAMPLE SITE LOCATIONS
- STORM LINES
- TRUNKLINES 24" AND LARGER
- STORMWATER SUB-BASINS

Map Date: January 4, 2023
Source: Science and Engineering Division, Environmental Services Department City of Tacoma

Environmental Services/ Science & Engineering
326 East D Street, Tacoma WA 98421
(253) 591-5588

N

0 1,000 2,000 4,000 Feet

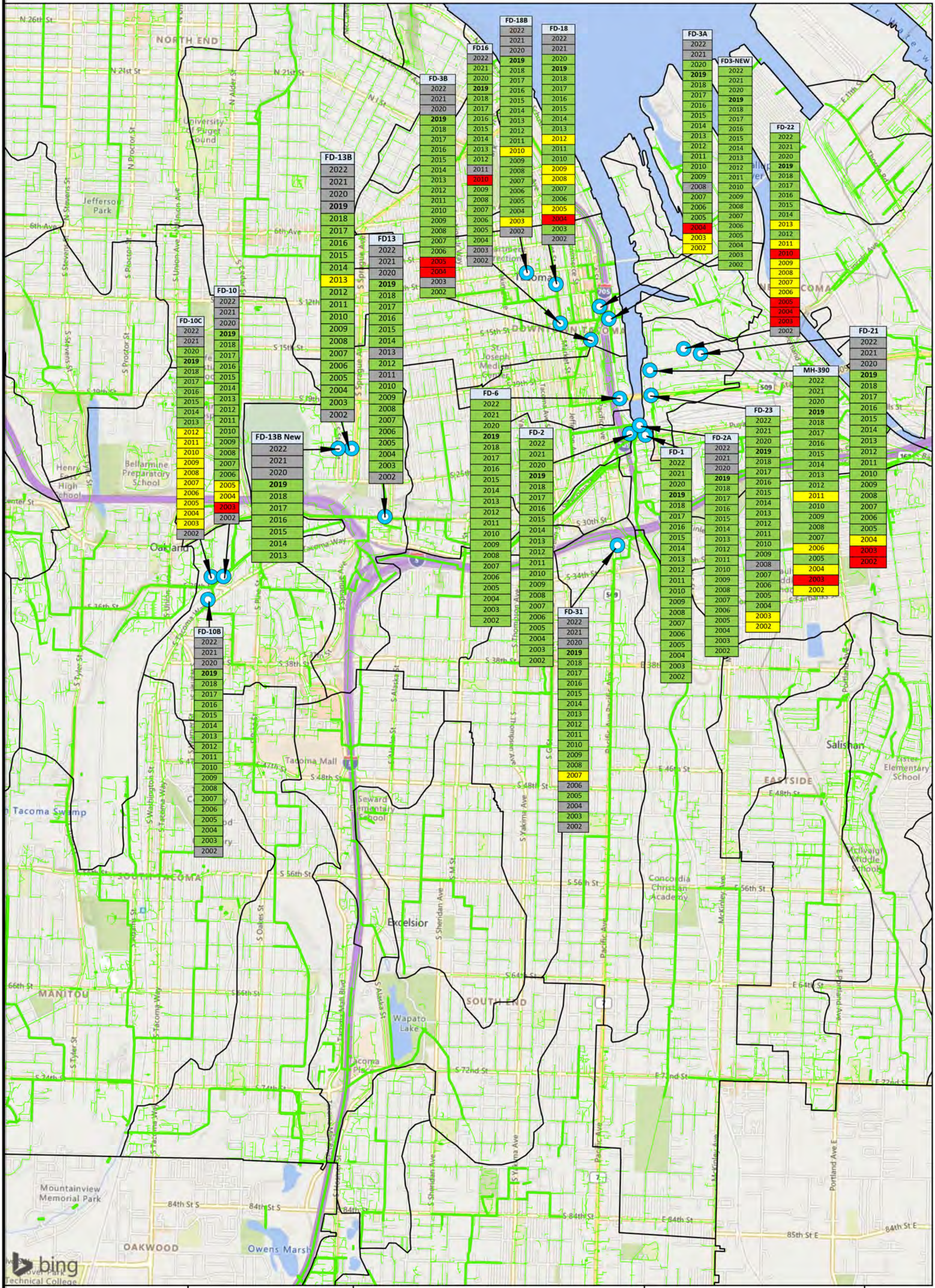
Symbol Level Key

- NO ANALYSIS
- SMALL LEVELS - < 164,000 ug/Kg
- MEDIUM LEVELS - 164,000 - 300,000 ug/Kg
- LARGE LEVELS - > 300,000 ug/Kg

Tacoma

R:\Projects\2023\P0004_SedimentTrapResultFigureUpdatesForFossReport

Figure 2-1.3
Sediment Trap Results - Phthalates



Legend

- SAMPLE SITE LOCATIONS
- STORM LINES
- TRUNKLINES 24" AND LARGER
- STORMWATER SUB-BASINS

Map Date: January 4, 2023
Source: Science and Engineering Division, Environmental Services Department City of Tacoma

Environmental Services/ Science & Engineering
326 East D Street, Tacoma WA 98421
(253) 591-5588

N

0 1,000 2,000 4,000 Feet

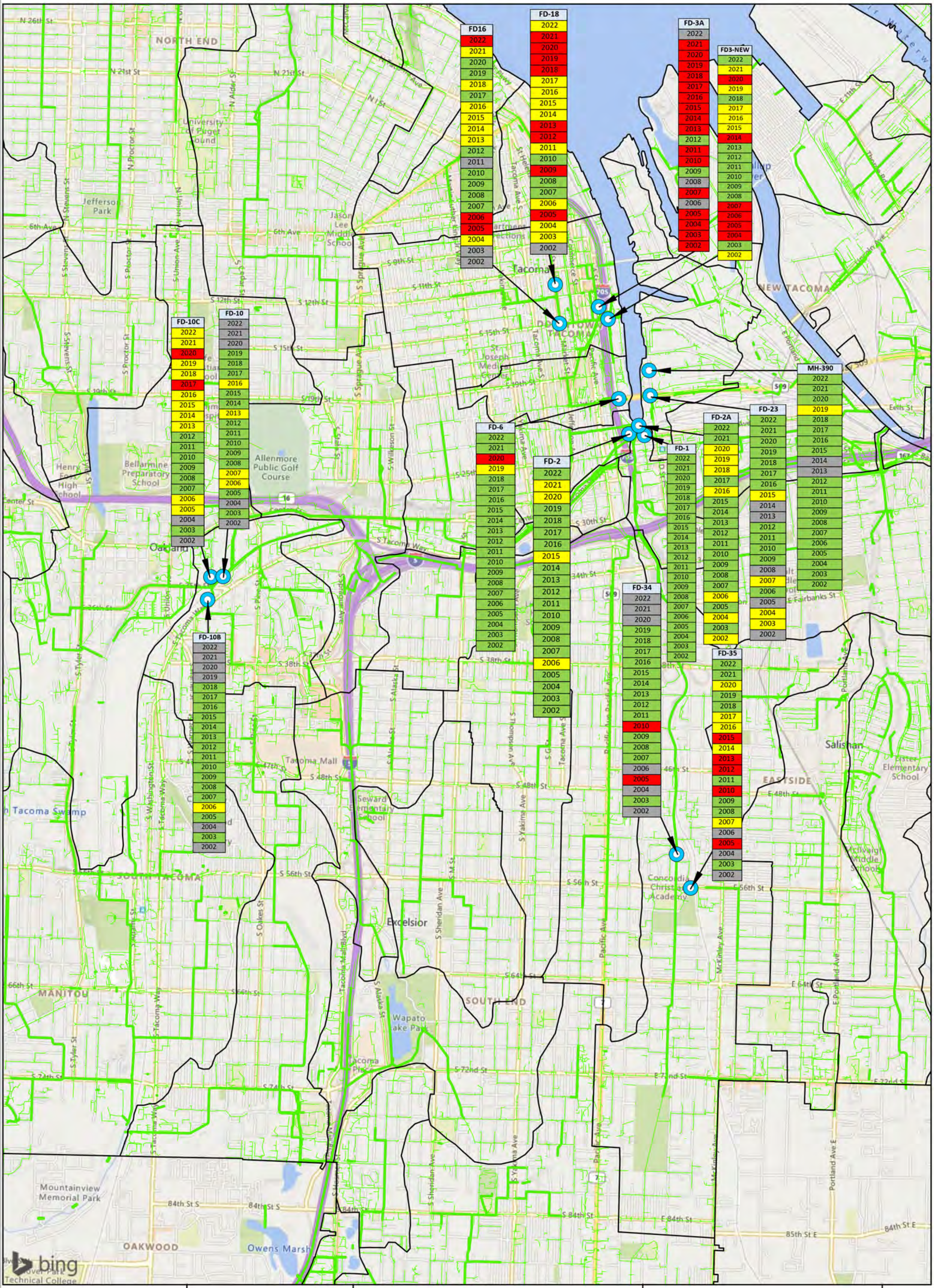
Symbol Level Key

- NO ANALYSIS
- SMALL LEVELS - < 50,000 ug/Kg
- MEDIUM LEVELS - 50,000 - 100,000 ug/Kg
- LARGE LEVELS - > 100,000 ug/Kg

Tacoma

R:\Projects\2023\P0004_SedimentTrapResultFigureUpdatesForFossReport

Figure 2-1.4
Sediment Trap Results - PCBs



Legend

- SAMPLE SITE LOCATIONS
- STORM LINES
- TRUNKLINES 24" AND LARGER
- STORMWATER SUB-BASINS

Map Date: January 4, 2023
Source: Science and Engineering Division, Environmental Services Department City of Tacoma

Environmental Services/ Science & Engineering
326 East D Street, Tacoma WA 98421
(253) 591-5588

N

0 1,000 2,000 4,000 Feet

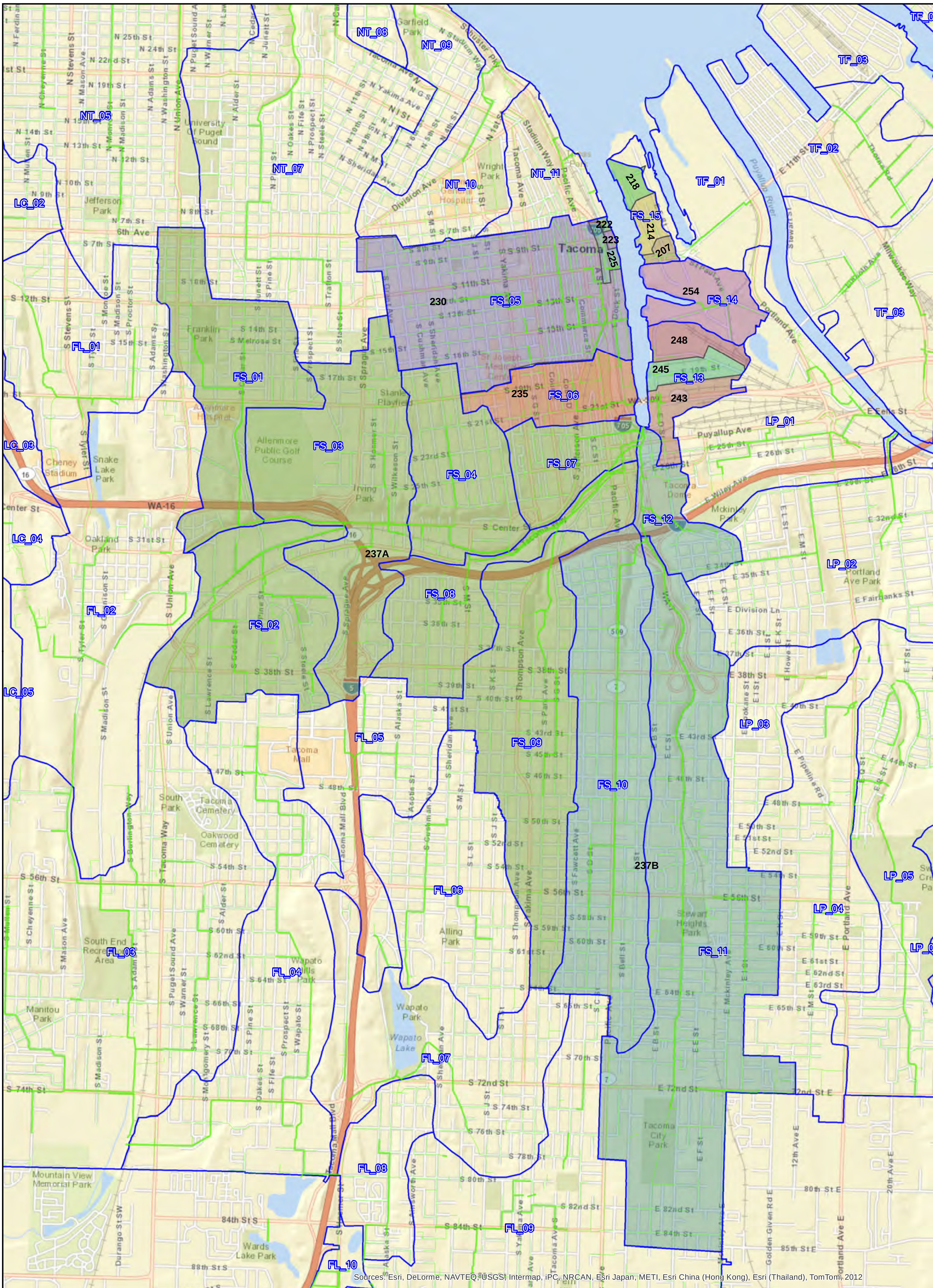
Symbol Level Key

- NO ANALYSIS
- SMALL LEVELS - < 120 ug/Kg
- MEDIUM LEVELS - 120 - 400 ug/Kg
- LARGE LEVELS - > 400 ug/Kg

Tacoma

R:\Projects\2023\P0004_SedimentTrapResultFigureUpdatesForFossReport

Figure 2-2
Stormwater Sub-Basins In the Thea Foss Basin



Legend

STORM LINES

TRUNKLINES 24" AND LARGER

Map Date: February 22, 2013
Source: Environmental Services Division, Public Works Department City of Tacoma

Center for Urban Waters
326 East D Street, Tacoma WA 98421
(253) 591-5588

N

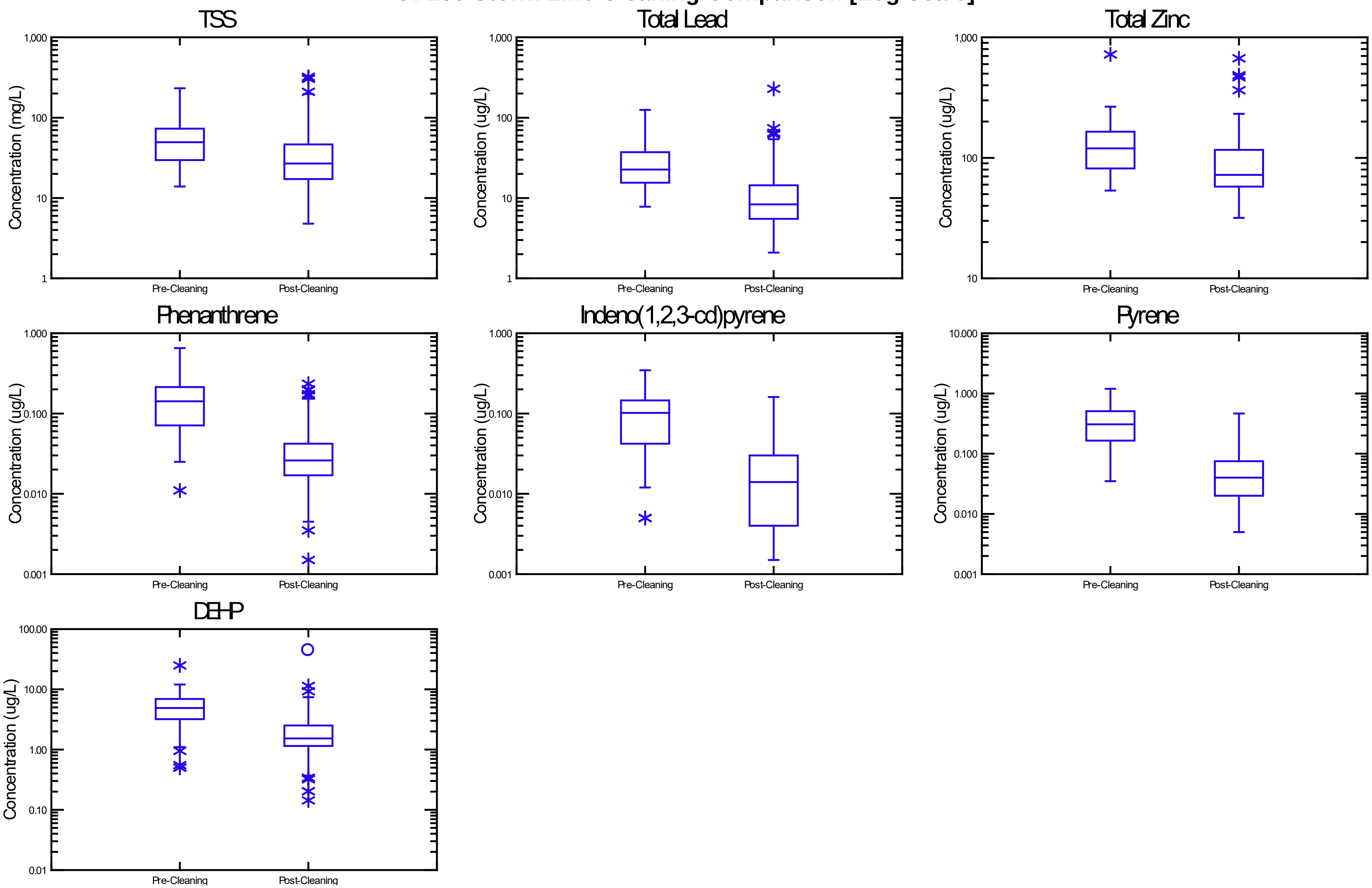
0 1,000 2,000 4,000 Feet

STORM SUB-BASINS

Tacoma

Datarequest/MHenley/Thea Foss Monitoring Program Figure 2-1c - Van Pelt

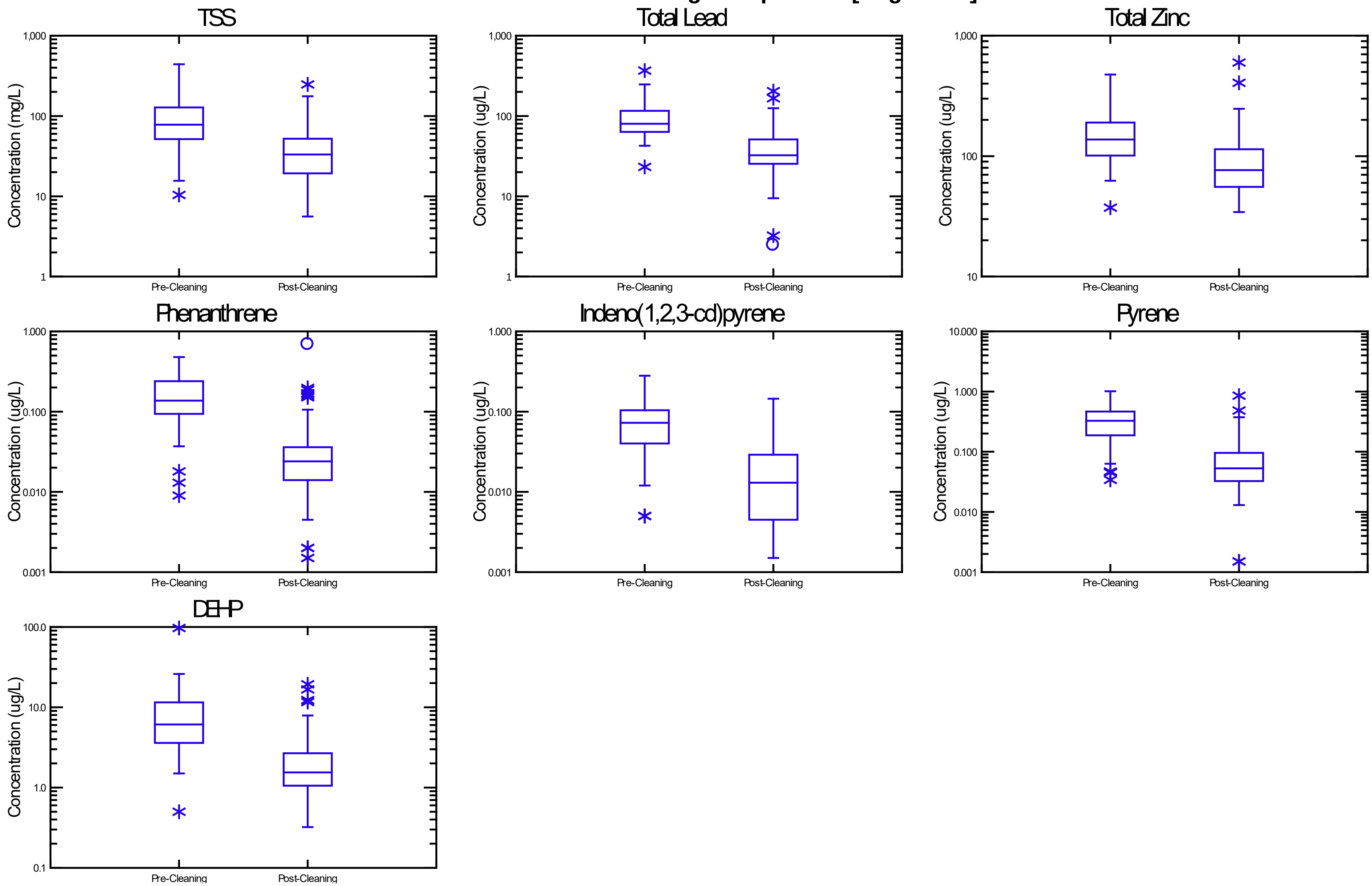
Figure 2-3.1
OF230 Storm Line Cleaning Comparison [Log Scale]



— Median   * Moderate Outlier   ○ Extreme Outlier

Notes: ^ Extreme outliers exceeding maximum y-scale with result posted.
Tukey Box boundaries display the interquartile range (IQR) of the distribution ranging from the first quartile to the third. The central 50% of data is within the box boundaries. The whiskers represent the remaining data minus the outliers. The moderate outlier value is greater than the third quartile plus 1.5*IQR or less than the first quartile minus 1.5*IQR. The extreme outlier value is greater than the third quartile plus 3.0*IQR or less than the first quartile minus 3.0*IQR.

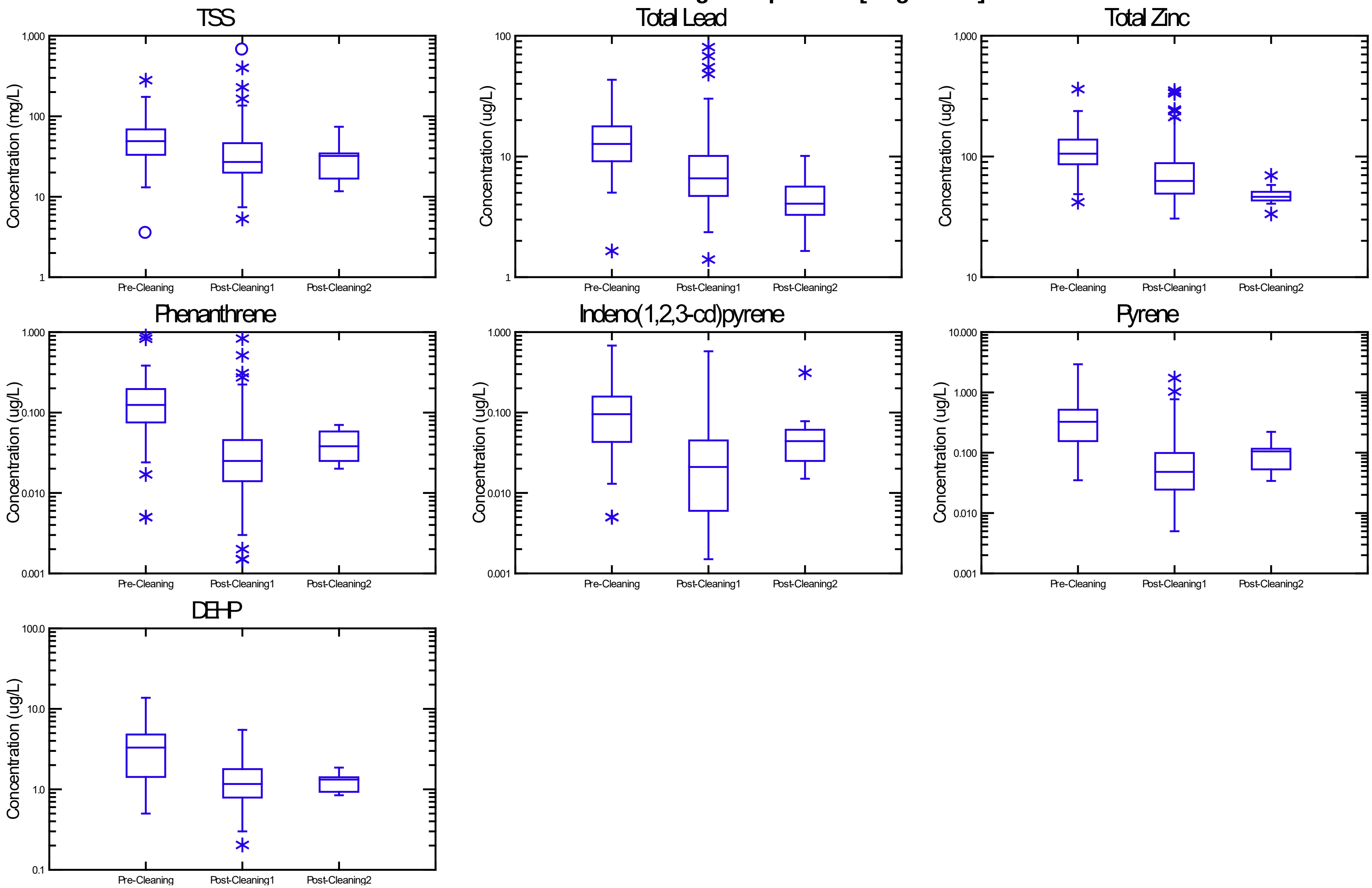
Figure 2-3.2
OF235 Storm Line Cleaning Comparison [Log Scale]



— Median * Moderate Outlier O Extreme Outlier

Notes: ^ Extreme outliers exceeding maximum y-scale with result posted.
Tukey Box boundaries display the interquartile range (IQR) of the distribution ranging from the first quartile to the third. The central 50% of data is within the box boundaries. The whiskers represent the remaining data minus the outliers. The moderate outlier value is greater than the third quartile plus 1.5*IQR or less than the first quartile minus 1.5*IQR. The extreme outlier value is greater than the third quartile plus 3.0*IQR or less than the first quartile minus 3.0*IQR.

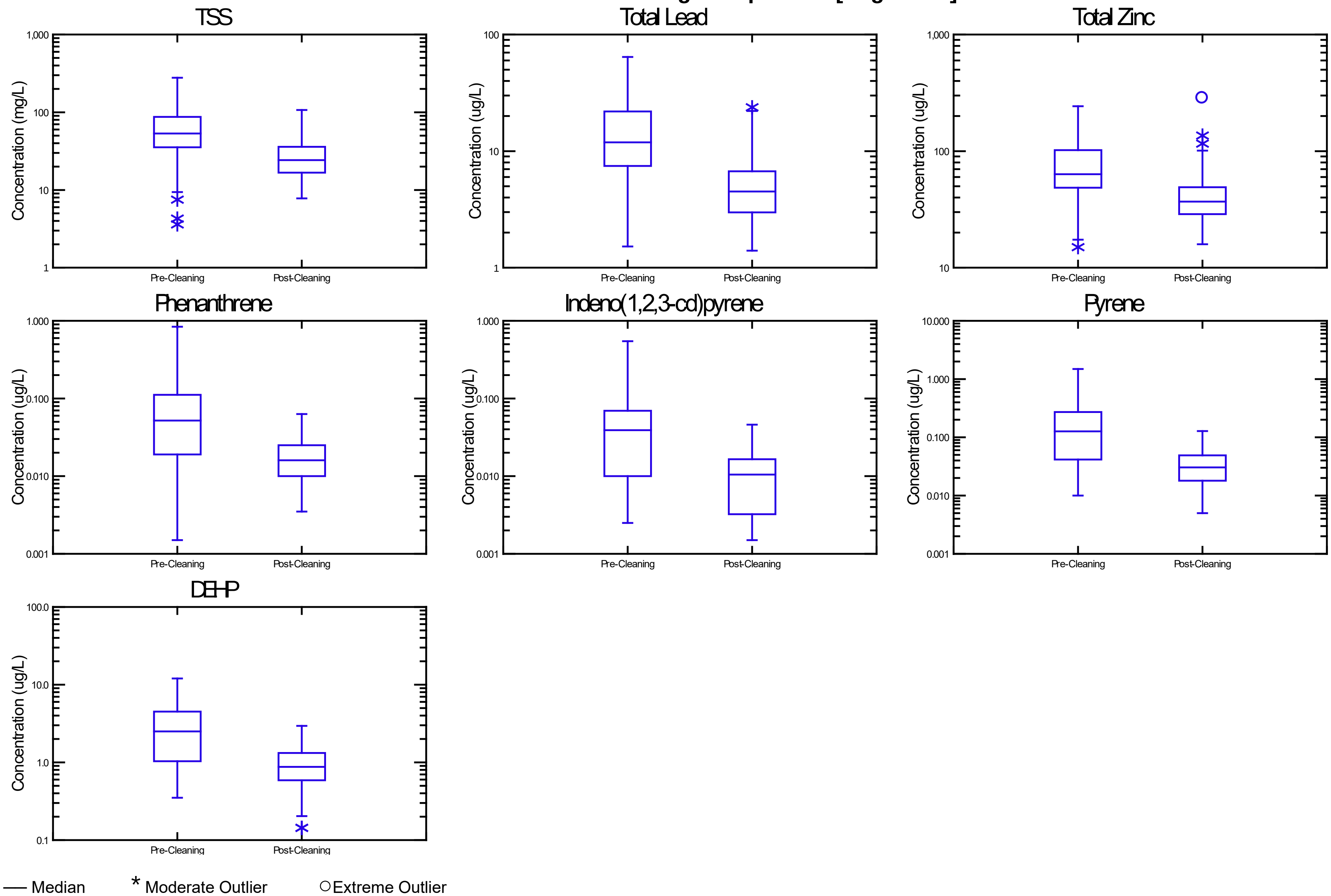
Figure 2-3.3
OF237A Storm Line Cleaning Comparison [Log Scale]



— Median * Moderate Outlier ○ Extreme Outlier

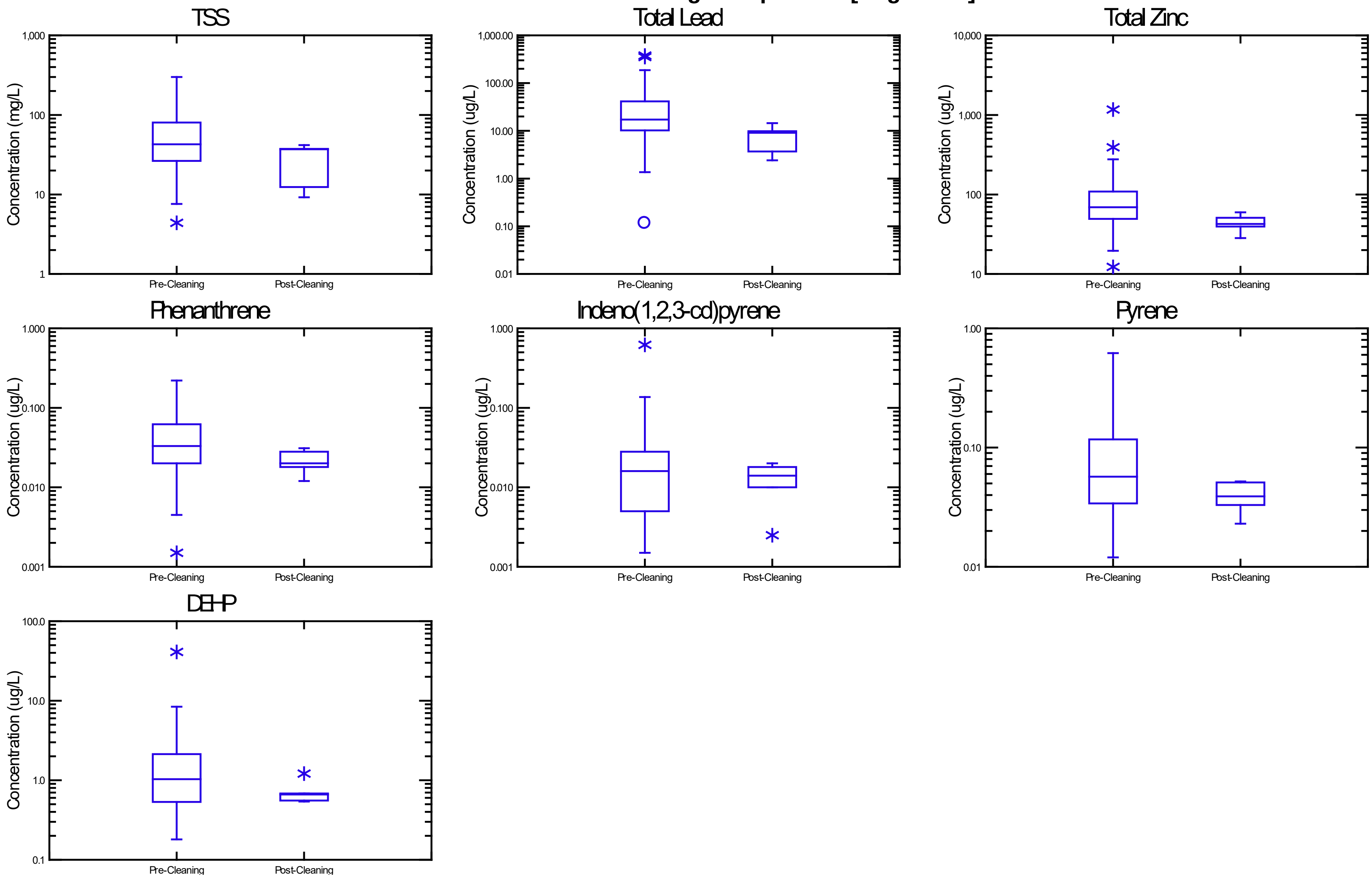
Notes: ^ Extreme outliers exceeding maximum y-scale with result posted.
Tukey Box boundaries display the interquartile range (IQR) of the distribution ranging from the first quartile to the third. The central 50% of data is within the box boundaries. The whiskers represent the remaining data minus the outliers. The moderate outlier value is greater than the third quartile plus 1.5*IQR or less than the first quartile minus 1.5*IQR. The extreme outlier value is greater than the third quartile plus 3.0*IQR or less than the first quartile minus 3.0*IQR.

Figure 2-3.4
OF237B Storm Line Cleaning Comparison [Log Scale]



Notes: ^ Extreme outliers exceeding maximum y-scale with result posted.
Tukey Box boundaries display the interquartile range (IQR) of the distribution ranging from the first quartile to the third. The central 50% of data is within the box boundaries. The whiskers represent the remaining data minus the outliers. The moderate outlier value is greater than the third quartile plus 1.5*IQR or less than the first quartile minus 1.5*IQR. The extreme outlier value is greater than the third quartile plus 3.0*IQR or less than the first quartile minus 3.0*IQR.

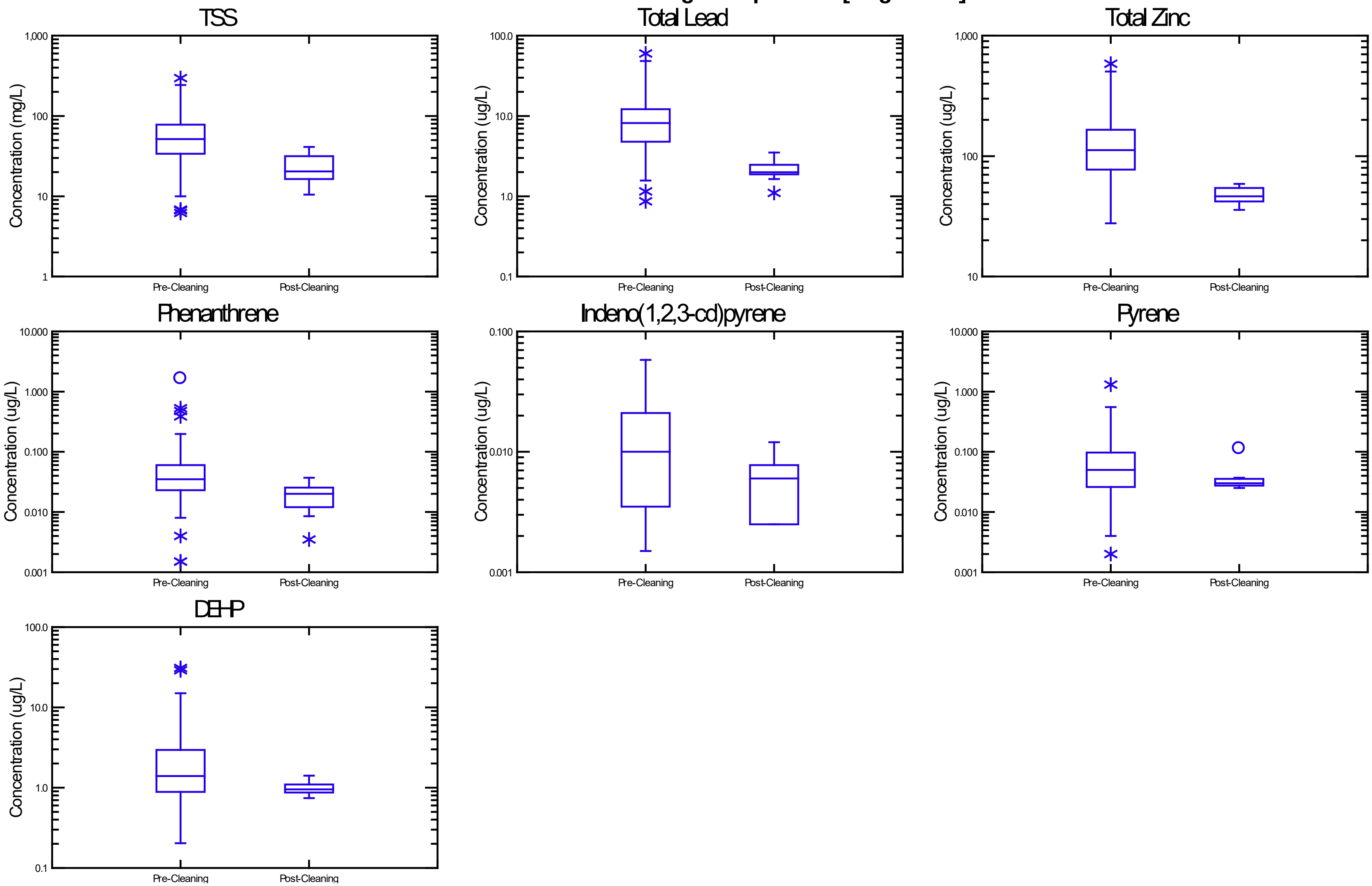
Figure 2-3.5
OF243 Storm Line Cleaning Comparison [Log Scale]



— Median * Moderate Outlier ○ Extreme Outlier

Notes: ^ Extreme outliers exceeding maximum y-scale with result posted.
Tukey Box boundaries display the interquartile range (IQR) of the distribution ranging from the first quartile to the third. The central 50% of data is within the box boundaries. The whiskers represent the remaining data minus the outliers. The moderate outlier value is greater than the third quartile plus 1.5*IQR or less than the first quartile minus 1.5*IQR. The extreme outlier value is greater than the third quartile plus 3.0*IQR or less than the first quartile minus 3.0*IQR.

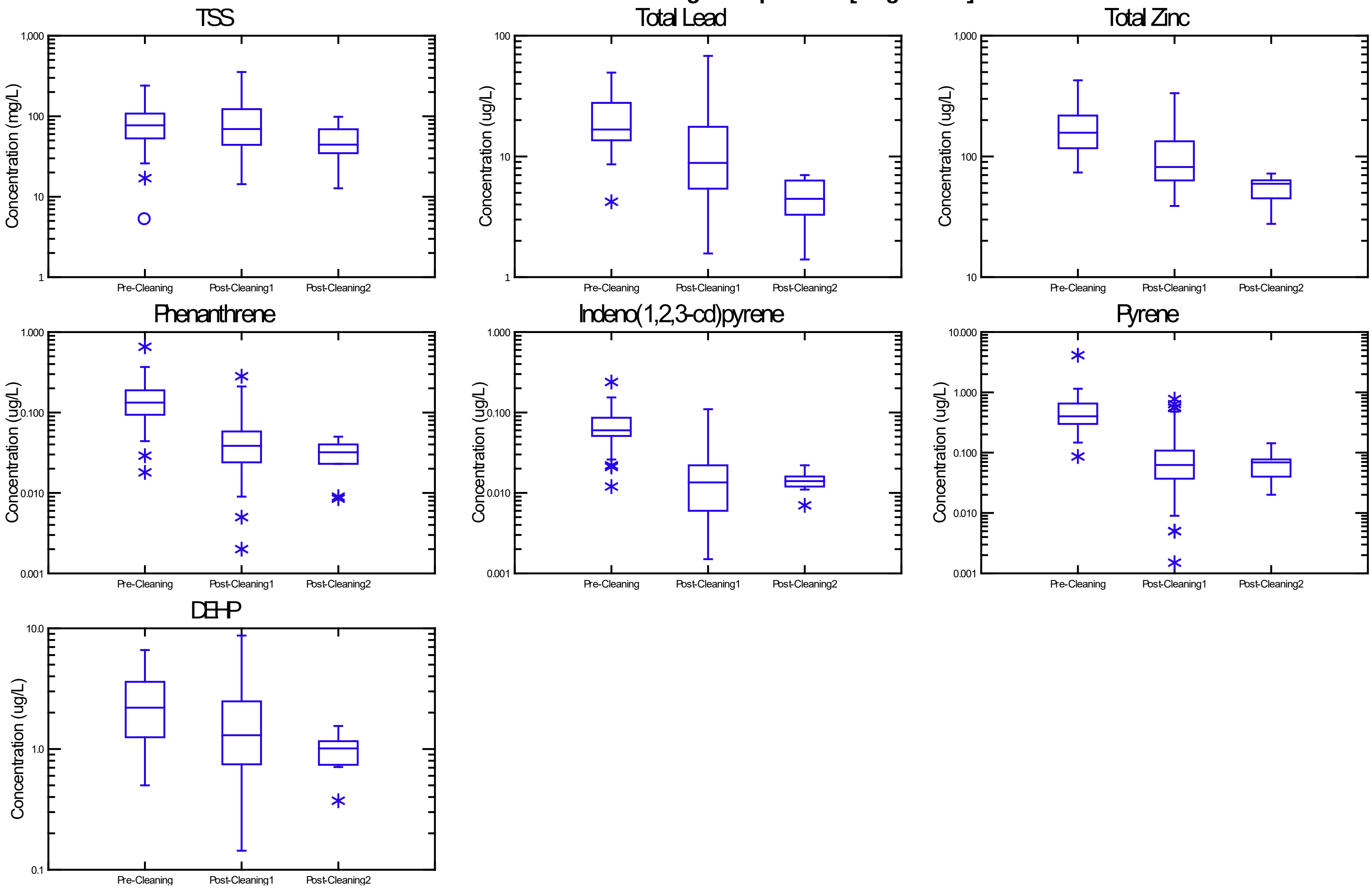
Figure 2-3.6
OF245 Storm Line Cleaning Comparison [Log Scale]



— Median * Moderate Outlier ○ Extreme Outlier

Notes: ^ Extreme outliers exceeding maximum y-scale with result posted.
Tukey Box boundaries display the interquartile range (IQR) of the distribution ranging from the first quartile to the third. The central 50% of data is within the box boundaries. The whiskers represent the remaining data minus the outliers. The moderate outlier value is greater than the third quartile plus 1.5*IQR or less than the first quartile minus 1.5*IQR. The extreme outlier value is greater than the third quartile plus 3.0*IQR or less than the first quartile minus 3.0*IQR.

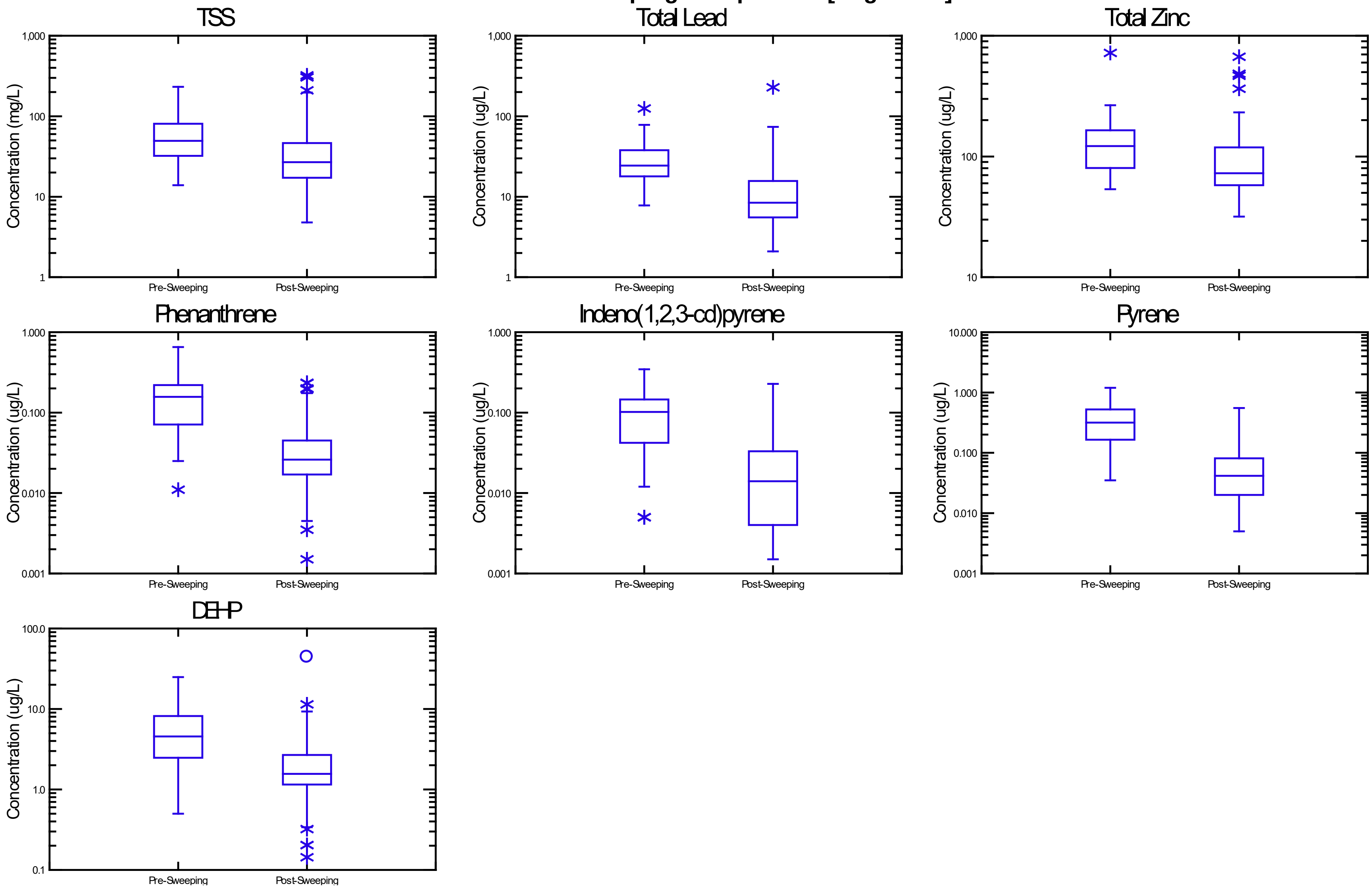
Figure 2-3.7
OF254 Storm Line Cleaning Comparison [Log Scale]



— Median   * Moderate Outlier   O Extreme Outlier

Notes: ^ Extreme outliers exceeding maximum y-scale with result posted.
Tukey Box boundaries display the interquartile range (IQR) of the distribution ranging from the first quartile to the third. The central 50% of data is within the box boundaries. The whiskers represent the remaining data minus the outliers. The moderate outlier value is greater than the third quartile plus 1.5*IQR or less than the first quartile minus 1.5*IQR. The extreme outlier value is greater than the third quartile plus 3.0*IQR or less than the first quartile minus 3.0*IQR.

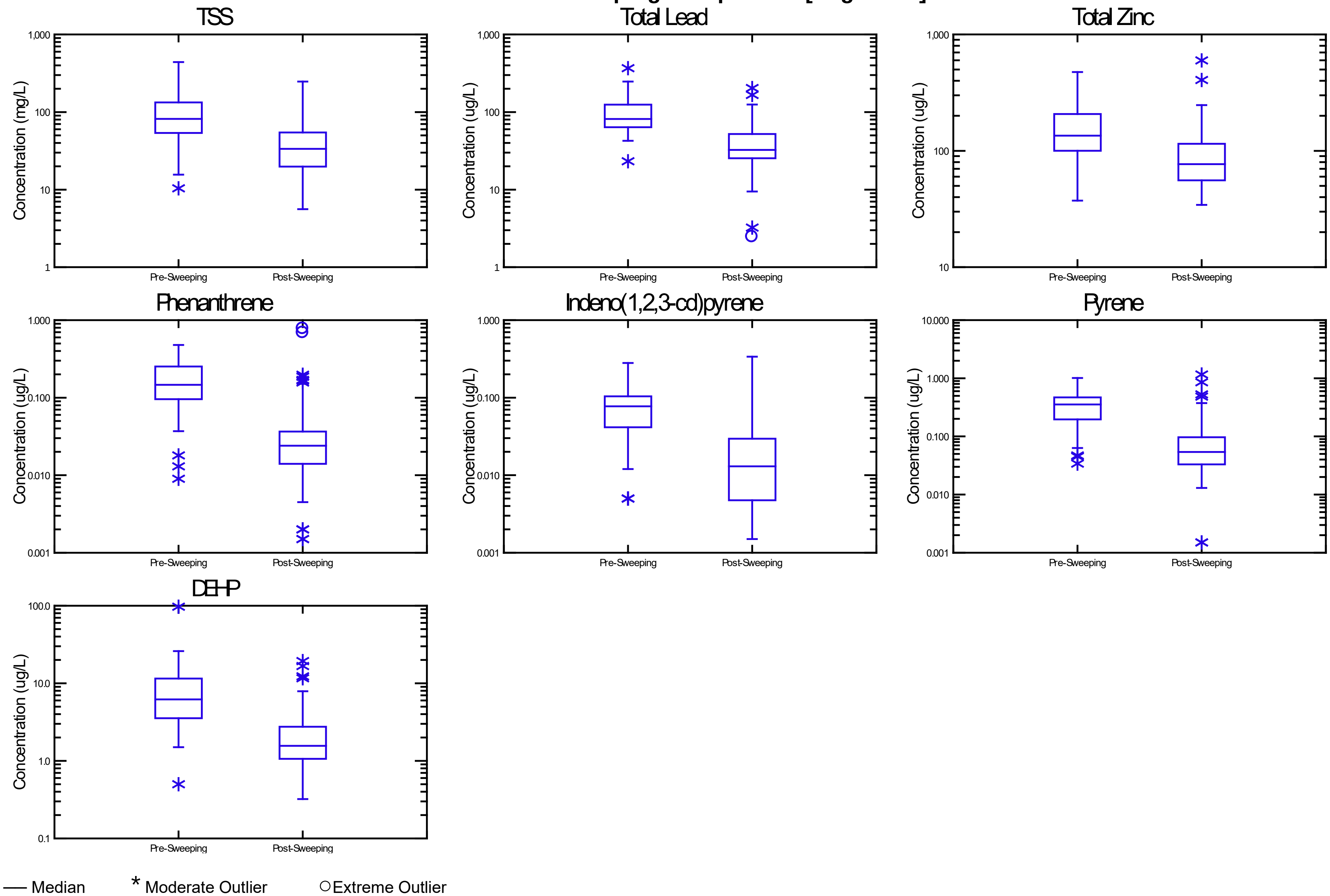
Figure 2-4.1
OF230 Street Sweeping Comparison [Log Scale]



— Median   * Moderate Outlier   ○ Extreme Outlier

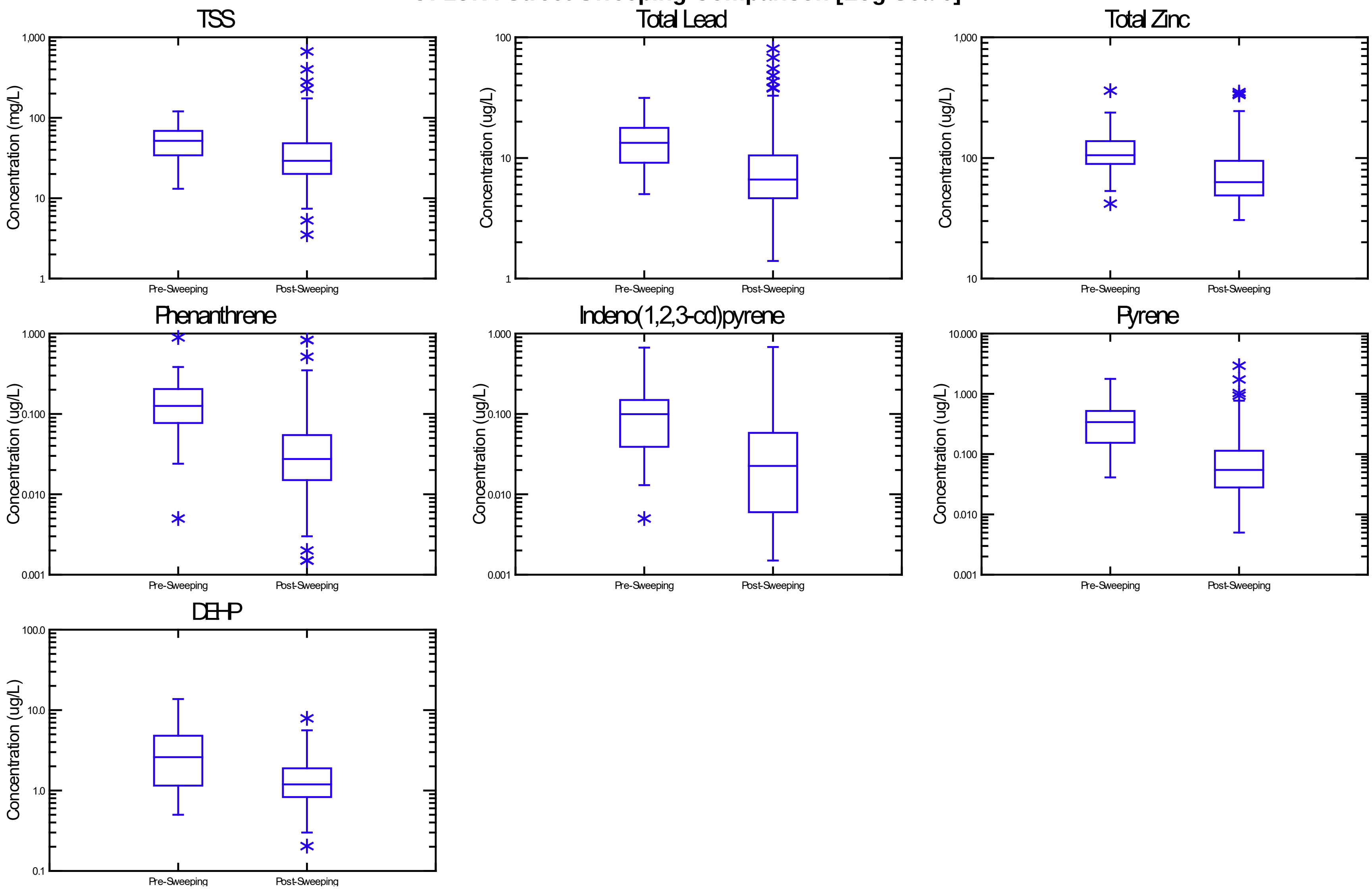
Notes: ^ Extreme outliers exceeding maximum y-scale with result posted.
Tukey Box boundaries display the interquartile range (IQR) of the distribution ranging from the first quartile to the third. The central 50% of data is within the box boundaries. The whiskers represent the remaining data minus the outliers. The moderate outlier value is greater than the third quartile plus 1.5*IQR or less than the first quartile minus 1.5*IQR. The extreme outlier value is greater than the third quartile plus 3.0*IQR or less than the first quartile minus 3.0*IQR.

Figure 2-4.2
OF235 Street Sweeping Comparison [Log Scale]



Notes: ^ Extreme outliers exceeding maximum y-scale with result posted.
Tukey Box boundaries display the interquartile range (IQR) of the distribution ranging from the first quartile to the third. The central 50% of data is within the box boundaries. The whiskers represent the remaining data minus the outliers. The moderate outlier value is greater than the third quartile plus 1.5*IQR or less than the first quartile minus 1.5*IQR. The extreme outlier value is greater than the third quartile plus 3.0*IQR or less than the first quartile minus 3.0*IQR.

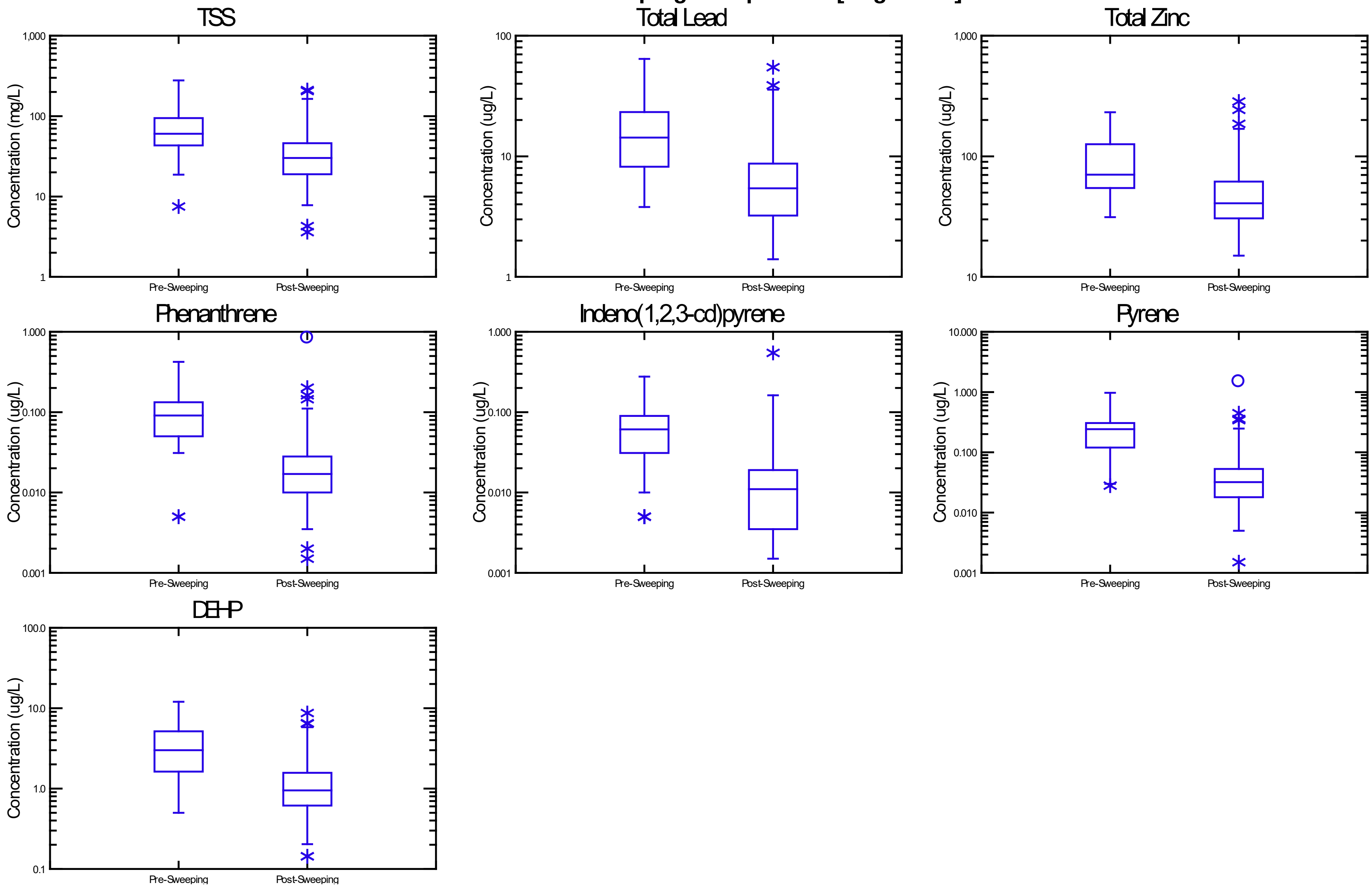
Figure 2-4.3
OF237A Street Sweeping Comparison [Log Scale]



— Median   * Moderate Outlier   ○ Extreme Outlier

Notes: ^ Extreme outliers exceeding maximum y-scale with result posted.
Tukey Box boundaries display the interquartile range (IQR) of the distribution ranging from the first quartile to the third. The central 50% of data is within the box boundaries. The whiskers represent the remaining data minus the outliers. The moderate outlier value is greater than the third quartile plus 1.5*IQR or less than the first quartile minus 1.5*IQR. The extreme outlier value is greater than the third quartile plus 3.0*IQR or less than the first quartile minus 3.0*IQR.

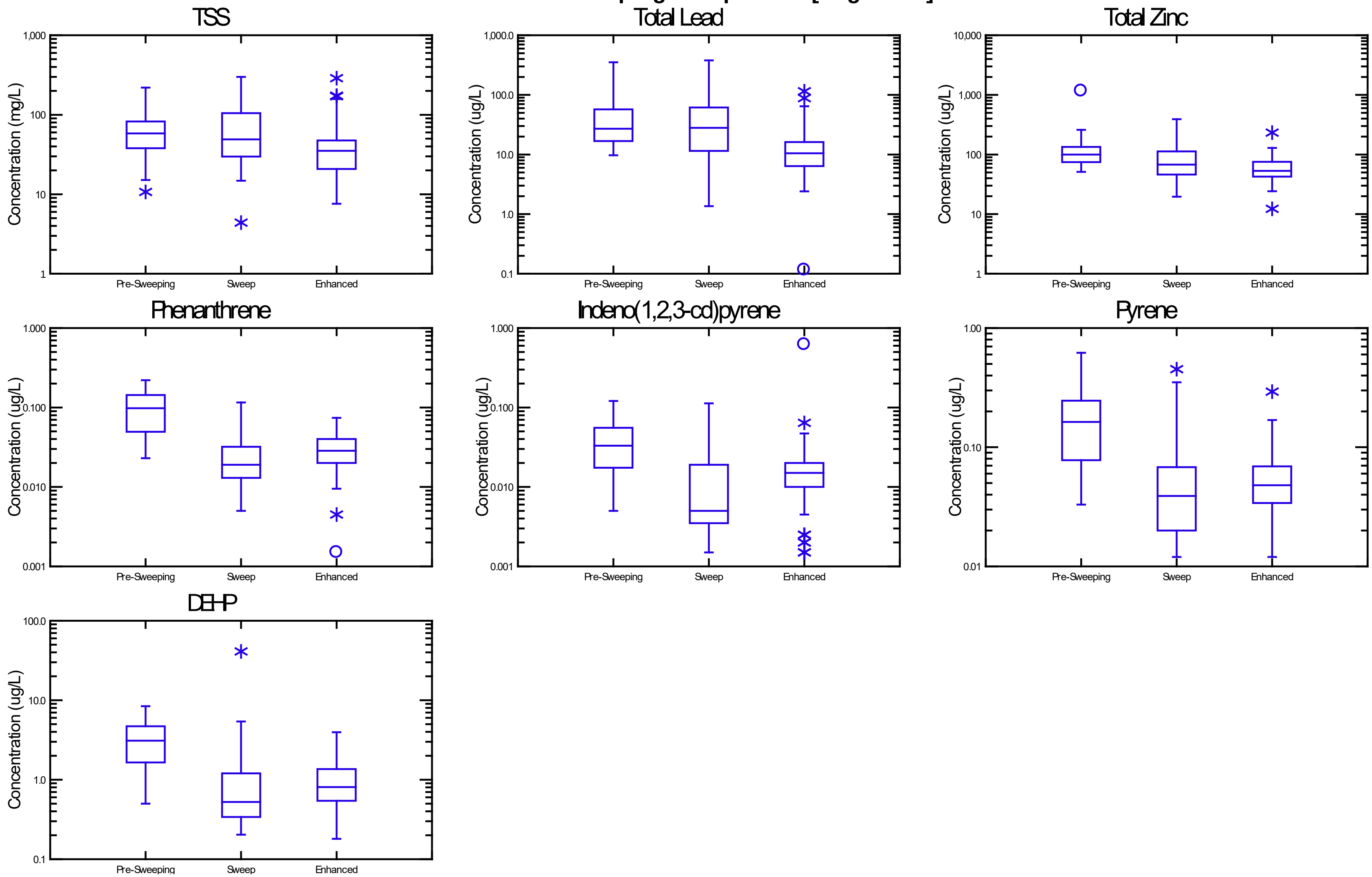
Figure 2-4.4
OF237B Street Sweeping Comparison [Log Scale]



— Median   * Moderate Outlier   O Extreme Outlier

Notes: ^ Extreme outliers exceeding maximum y-scale with result posted.
Tukey Box boundaries display the interquartile range (IQR) of the distribution ranging from the first quartile to the third. The central 50% of data is within the box boundaries. The whiskers represent the remaining data minus the outliers. The moderate outlier value is greater than the third quartile plus 1.5*IQR or less than the first quartile minus 1.5*IQR. The extreme outlier value is greater than the third quartile plus 3.0*IQR or less than the first quartile minus 3.0*IQR.

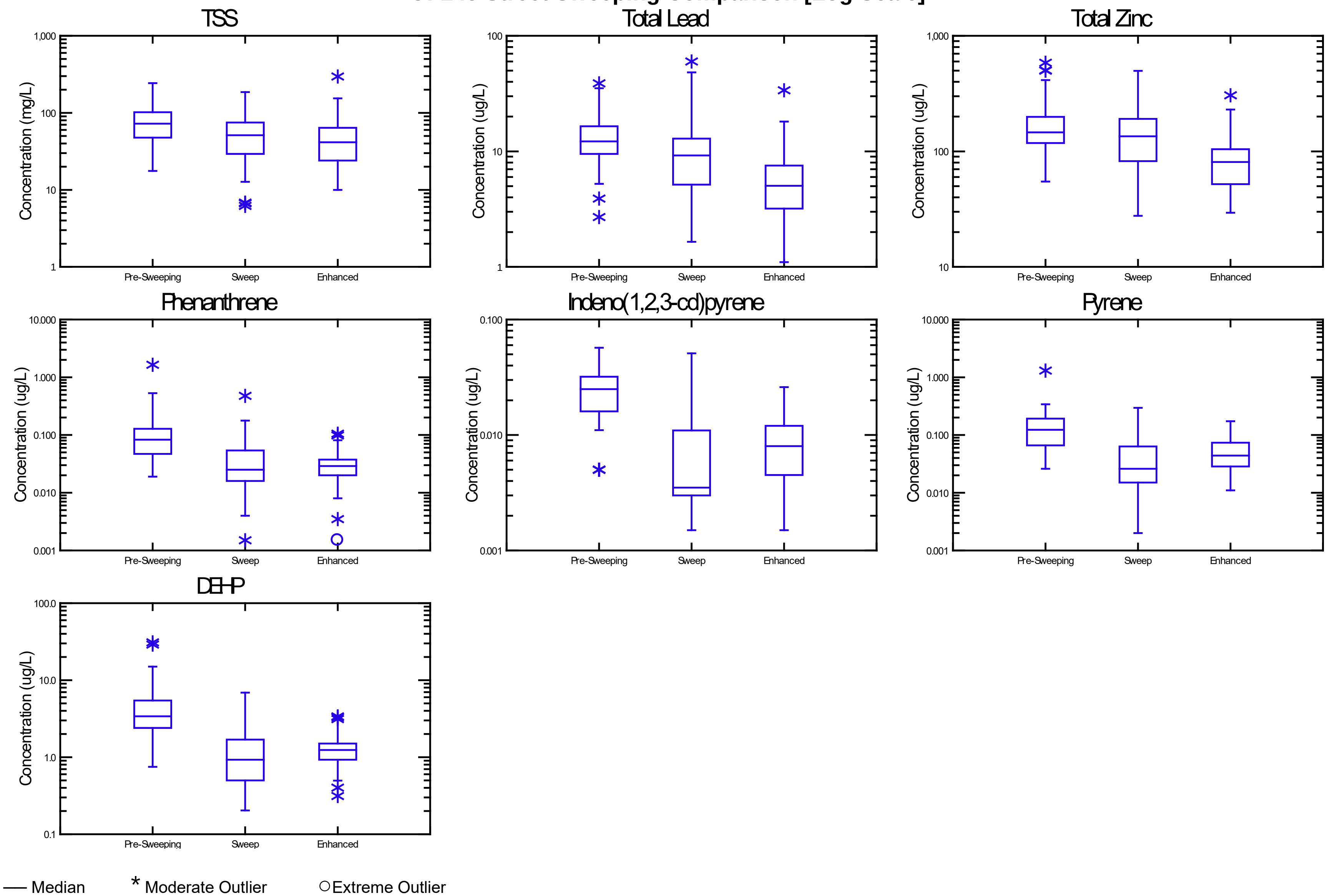
Figure 2-4.5
OF243 Street Sweeping Comparison [Log Scale]



— Median * Moderate Outlier O Extreme Outlier

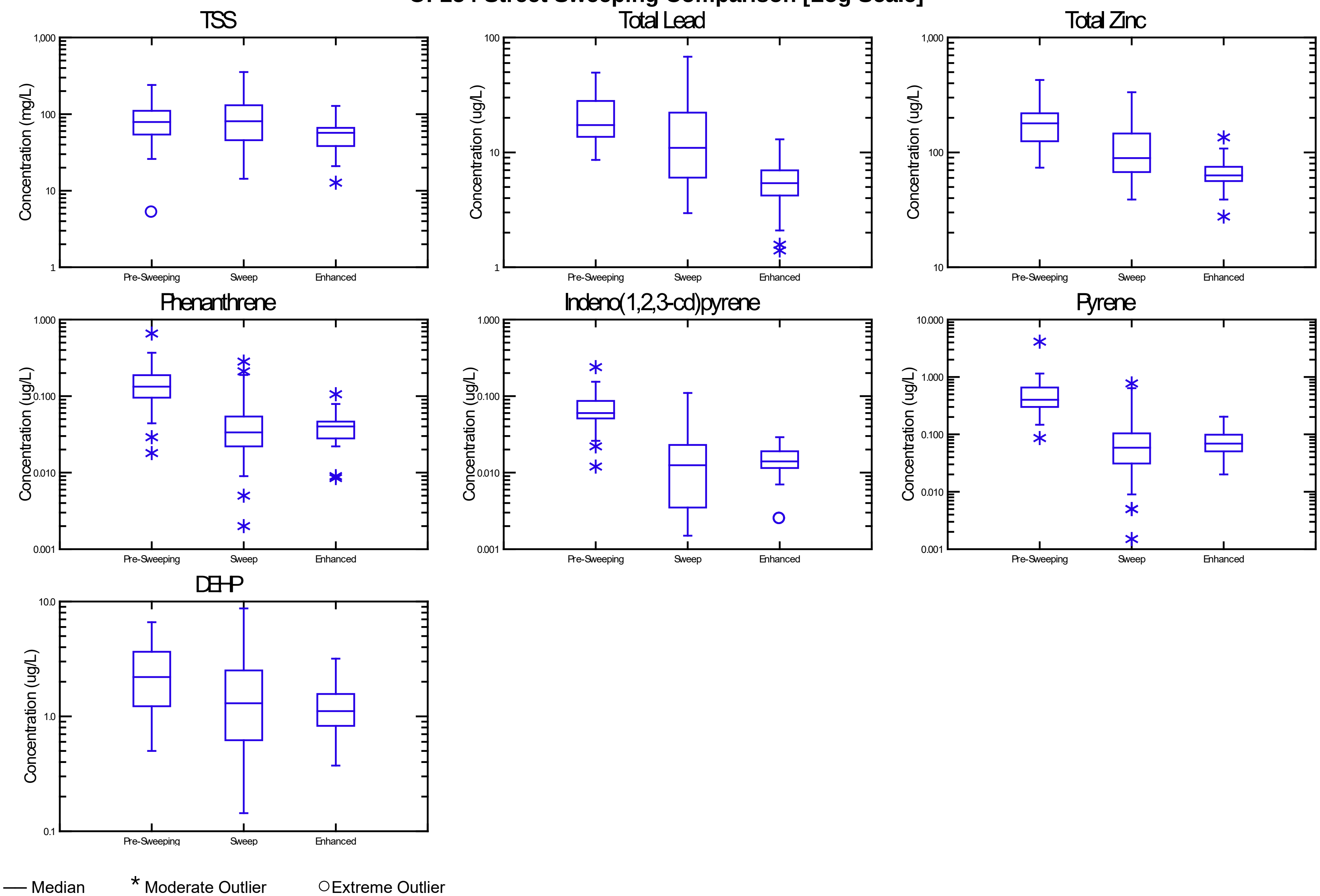
Notes: ^ Extreme outliers exceeding maximum y-scale with result posted.
Tukey Box boundaries display the interquartile range (IQR) of the distribution ranging from the first quartile to the third. The central 50% of data is within the box boundaries. The whiskers represent the remaining data minus the outliers. The moderate outlier value is greater than the third quartile plus 1.5*IQR or less than the first quartile minus 1.5*IQR. The extreme outlier value is greater than the third quartile plus 3.0*IQR or less than the first quartile minus 3.0*IQR.

Figure 2-4.6
OF245 Street Sweeping Comparison [Log Scale]



Notes: ^ Extreme outliers exceeding maximum y-scale with result posted.
Tukey Box boundaries display the interquartile range (IQR) of the distribution ranging from the first quartile to the third. The central 50% of data is within the box boundaries. The whiskers represent the remaining data minus the outliers. The moderate outlier value is greater than the third quartile plus 1.5*IQR or less than the first quartile minus 1.5*IQR. The extreme outlier value is greater than the third quartile plus 3.0*IQR or less than the first quartile minus 3.0*IQR.

Figure 2-4.7
OF254 Street Sweeping Comparison [Log Scale]



Notes: ^ Extreme outliers exceeding maximum y-scale with result posted.
Tukey Box boundaries display the interquartile range (IQR) of the distribution ranging from the first quartile to the third. The central 50% of data is within the box boundaries. The whiskers represent the remaining data minus the outliers. The moderate outlier value is greater than the third quartile plus 1.5*IQR or less than the first quartile minus 1.5*IQR. The extreme outlier value is greater than the third quartile plus 3.0*IQR or less than the first quartile minus 3.0*IQR.

Figure 3-1
Daily Rainfall - Monthly Averages WY2002-2022

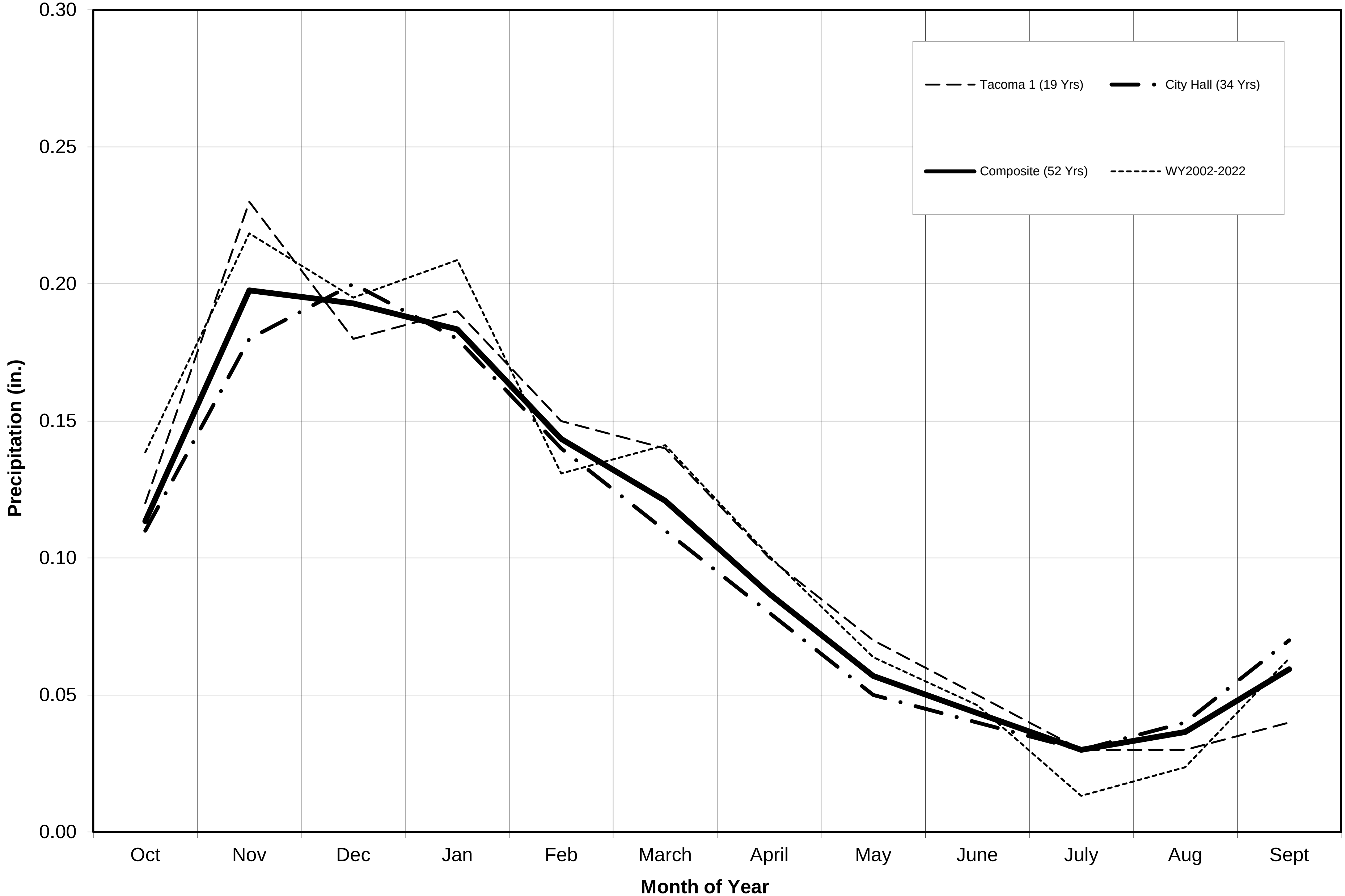
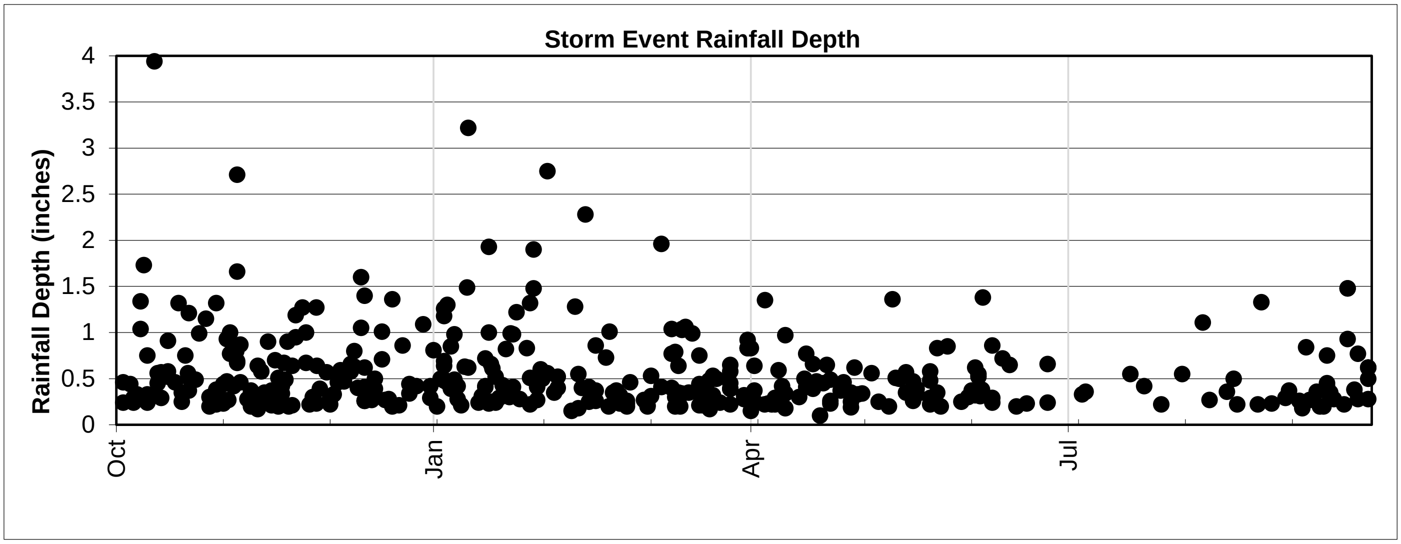
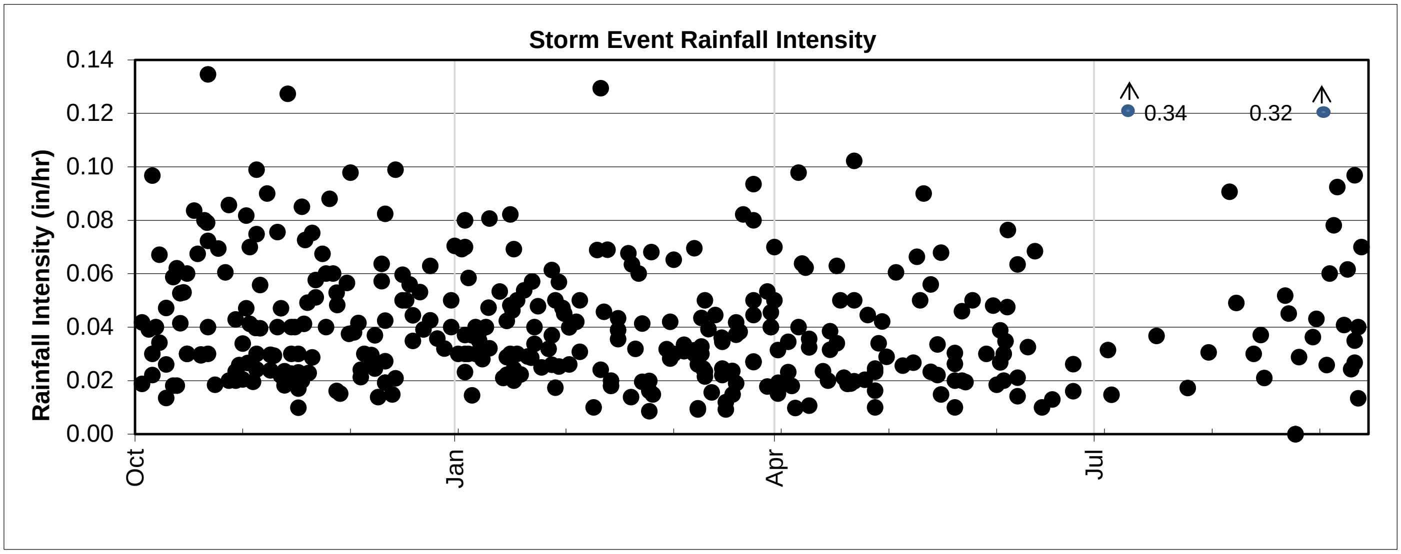


Figure 3-1

Figure 3-2.1
Storm Event Hydrologic Parameters, October 2001 - September 2022





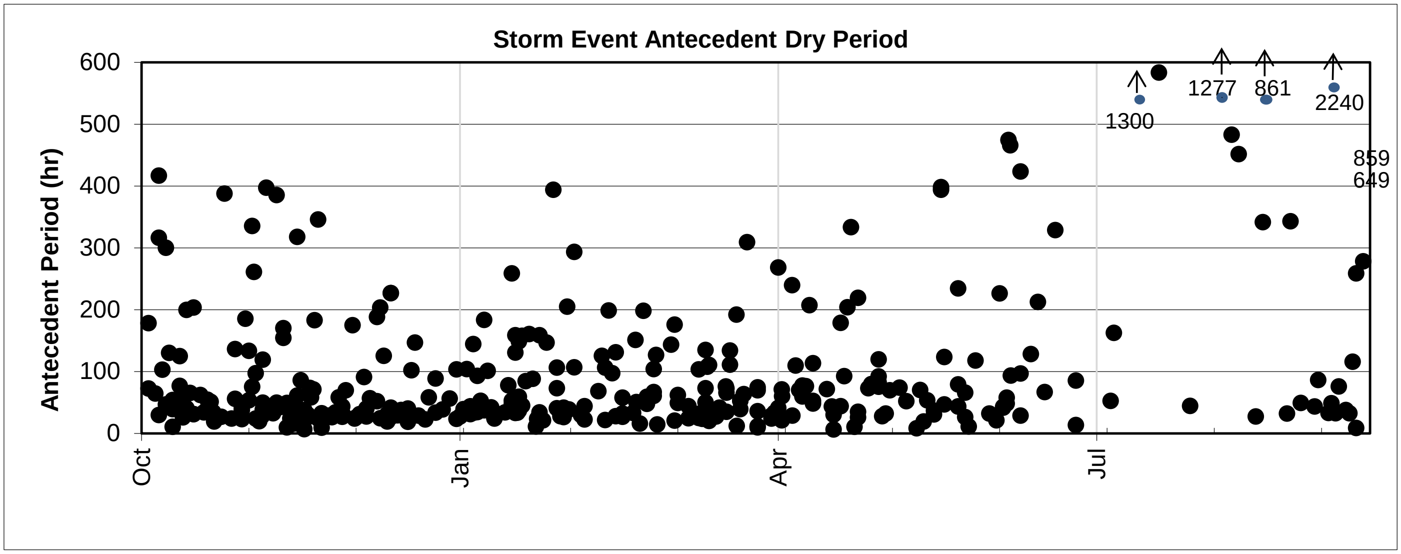
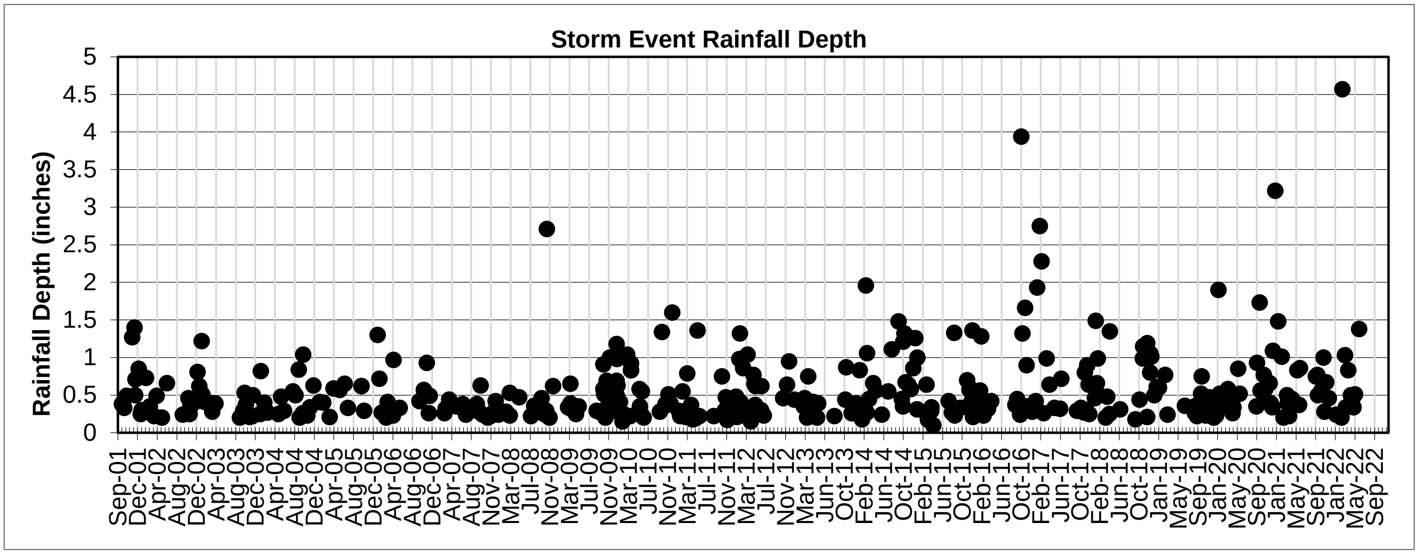
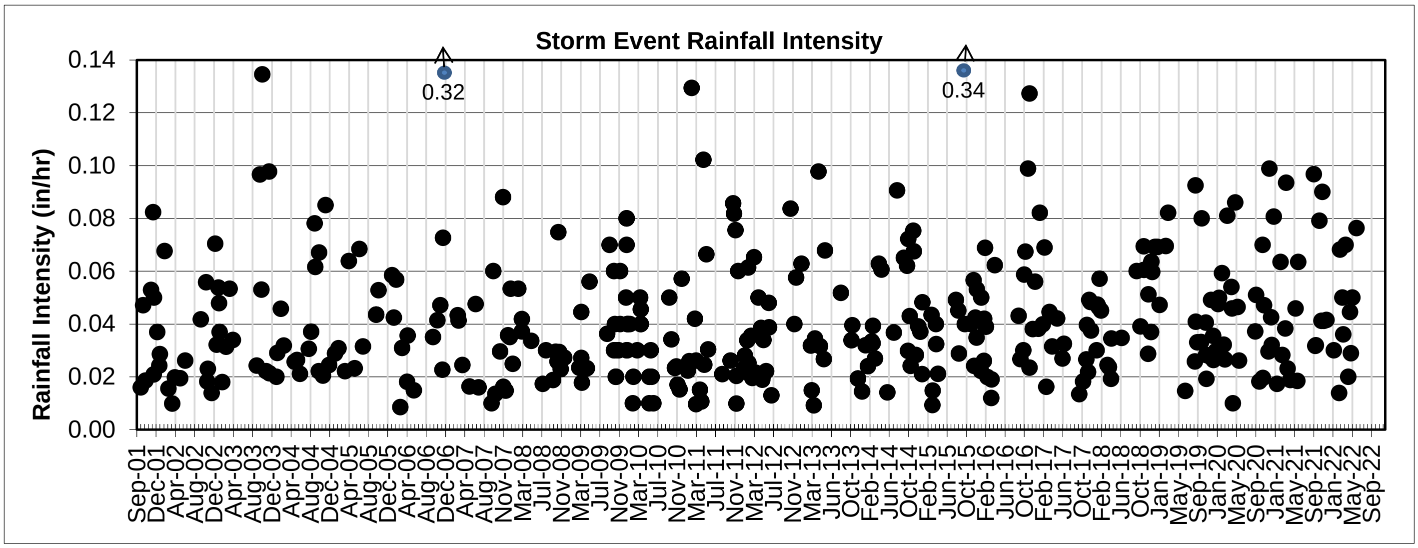


Figure 3-2.2
Storm Event Hydrologic Parameters, October 2001 - September 2022





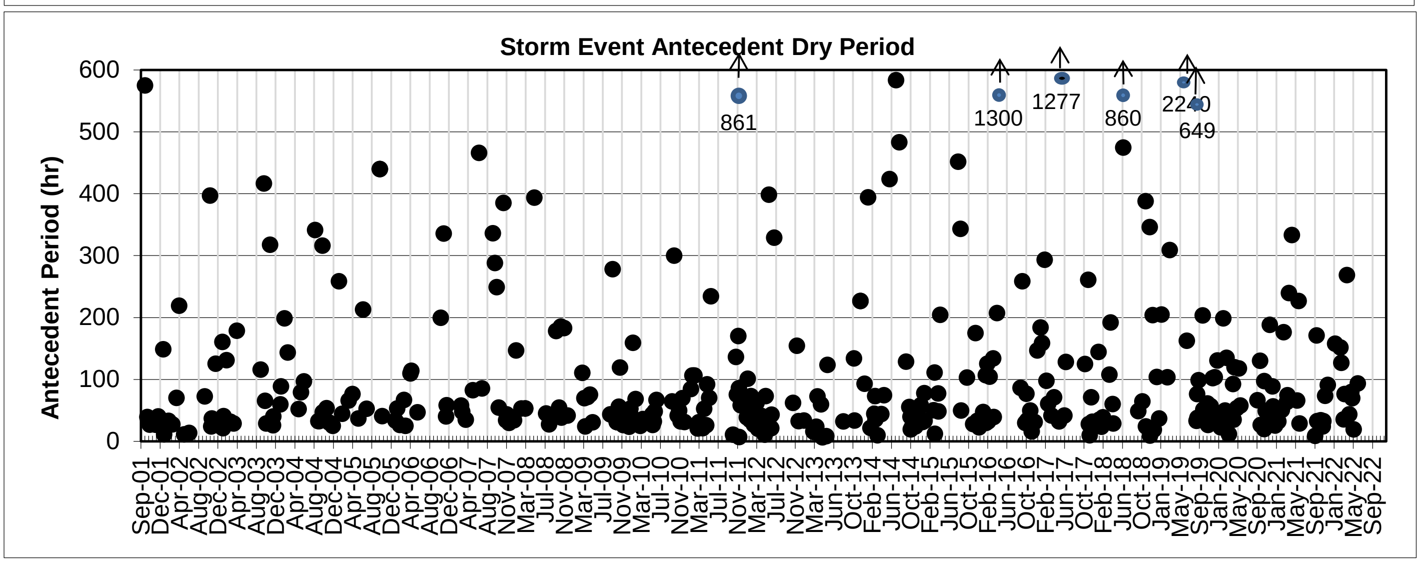
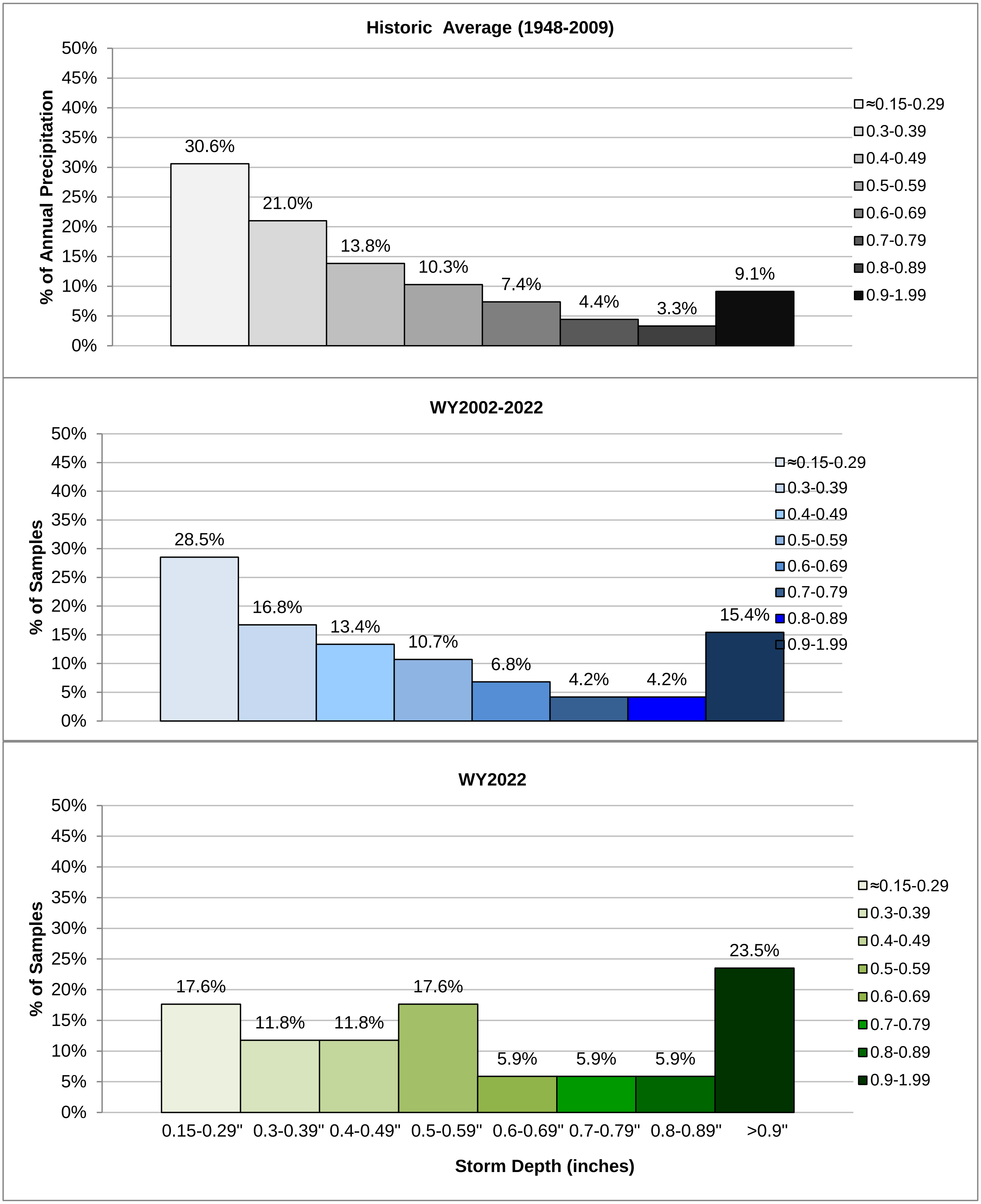
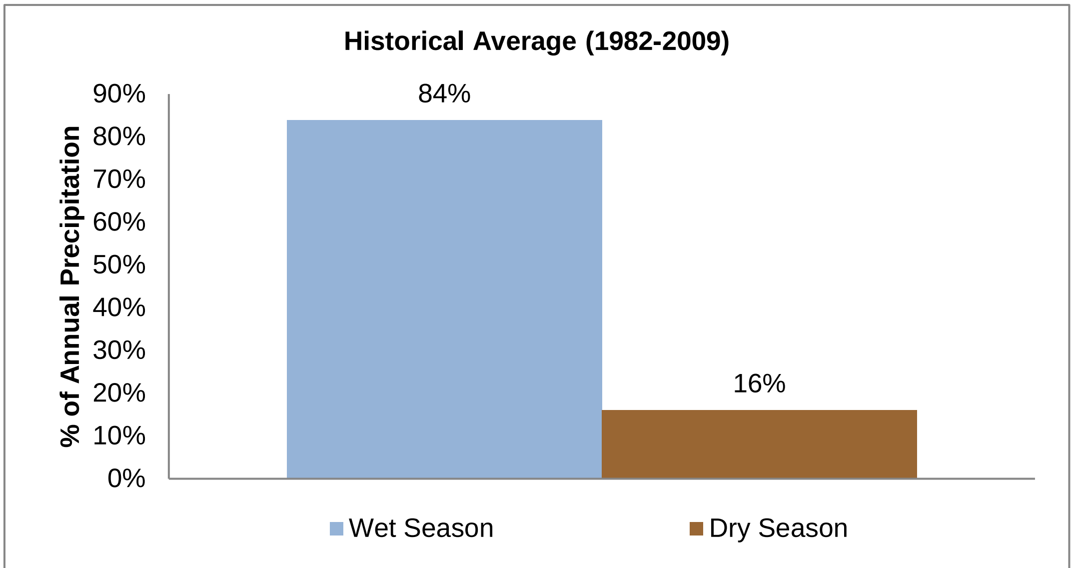


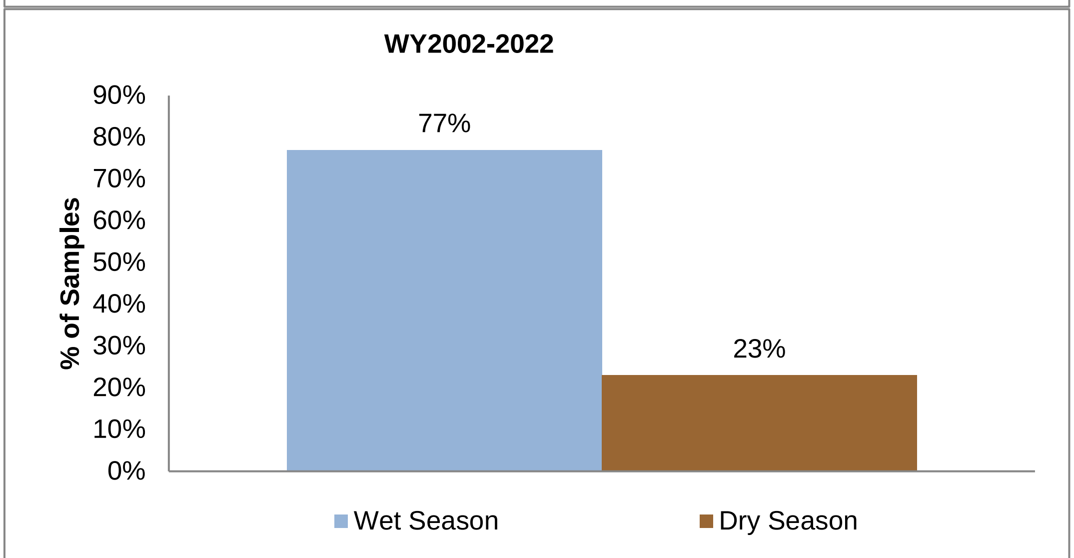
Figure 3-3
Representativeness of Sampled Storm Sizes



Note: Data for 237A is from the original 237A site through WY2011. The 237A New sampling site data was used for WY2012 and later.

Figure 3-4
Representativeness of Seasonal Sampling Distribution





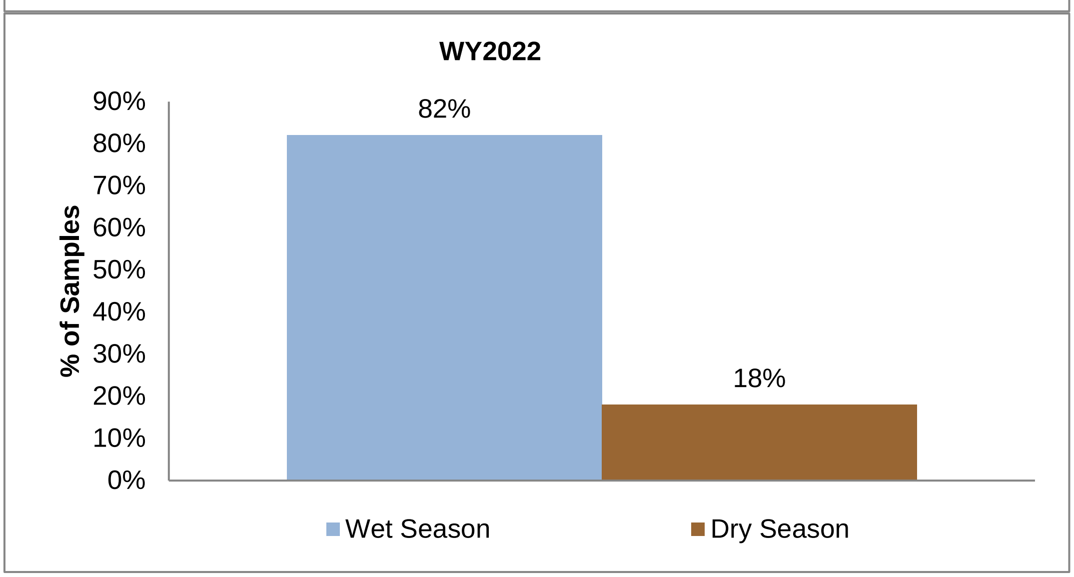
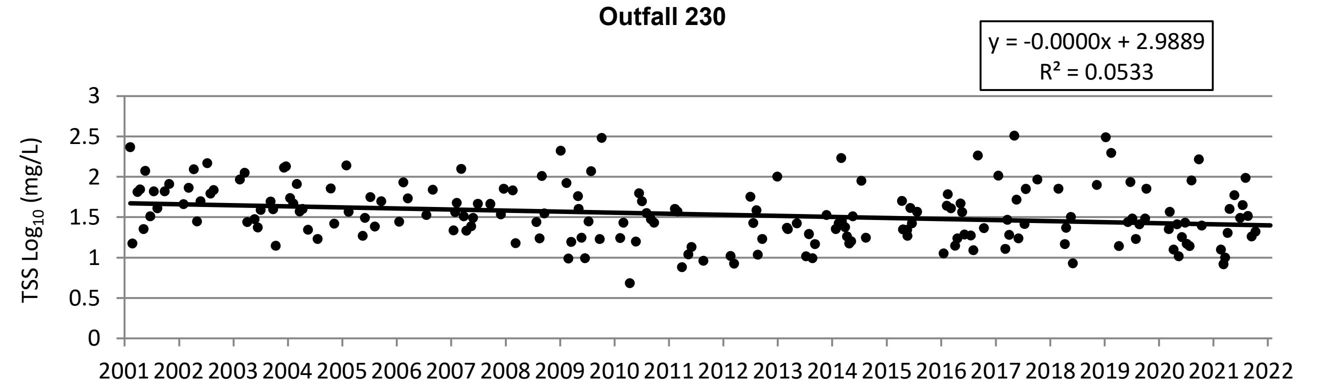
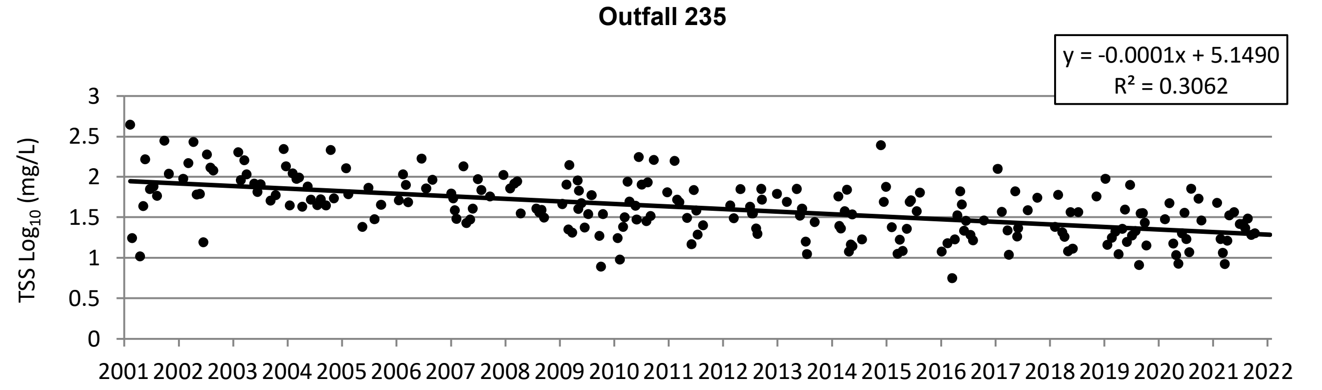


Figure 3-5.1
Linear Regression Analysis of Stormwater Time Trends
Time Series for Total Suspended Solids (TSS)
September 2001 - September 2022

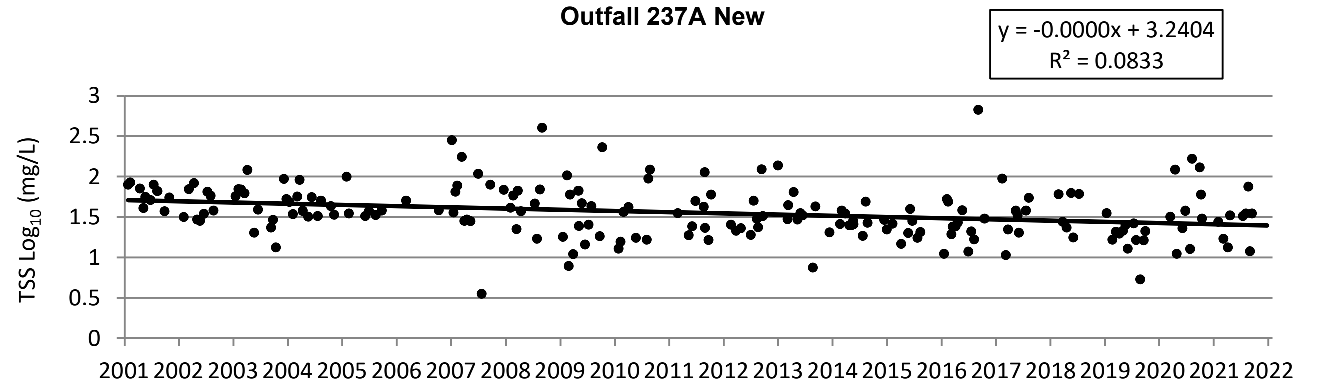
Outfall 230



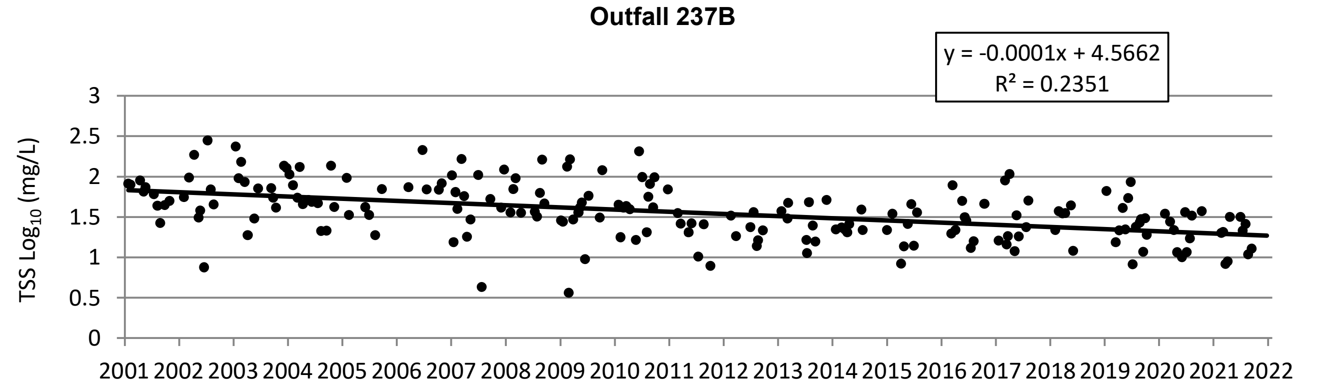
Outfall 235



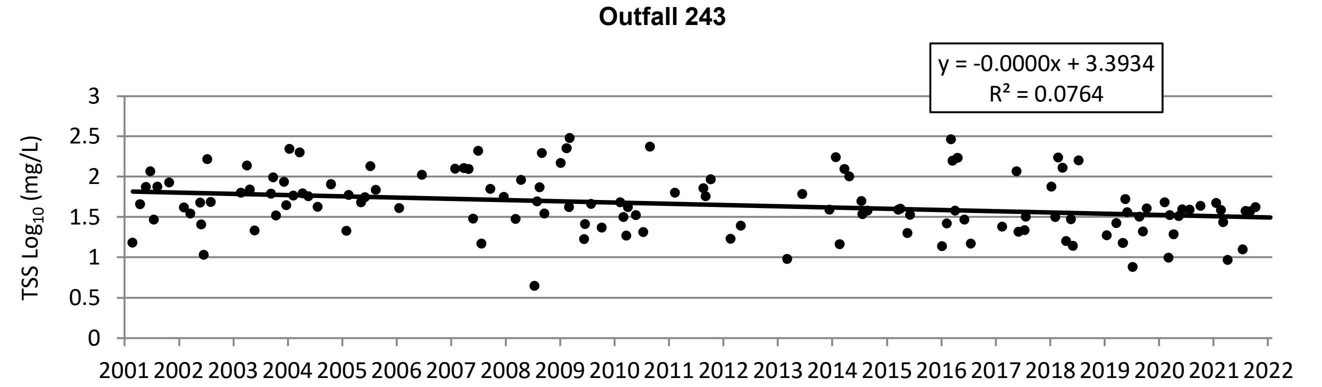
Outfall 237A New



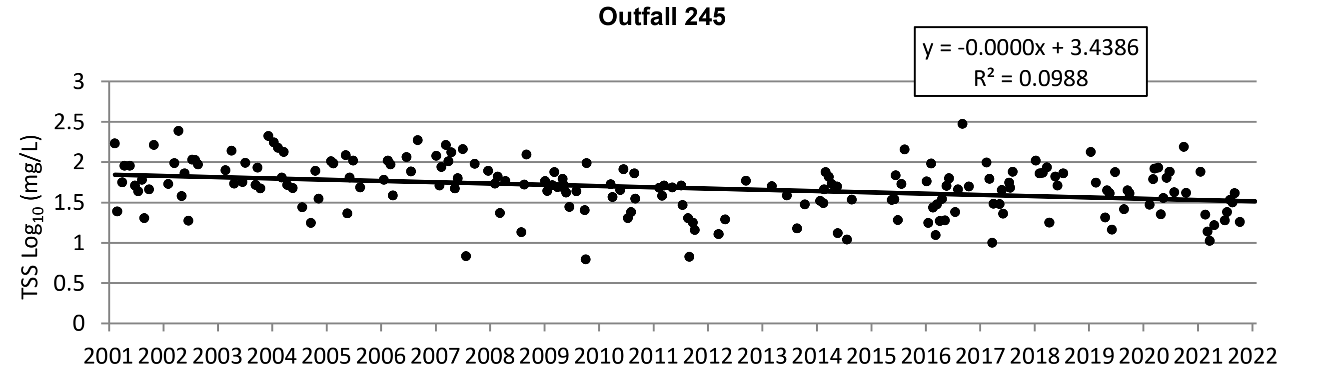
Outfall 237B



Outfall 243



Outfall 245



Outfall 254

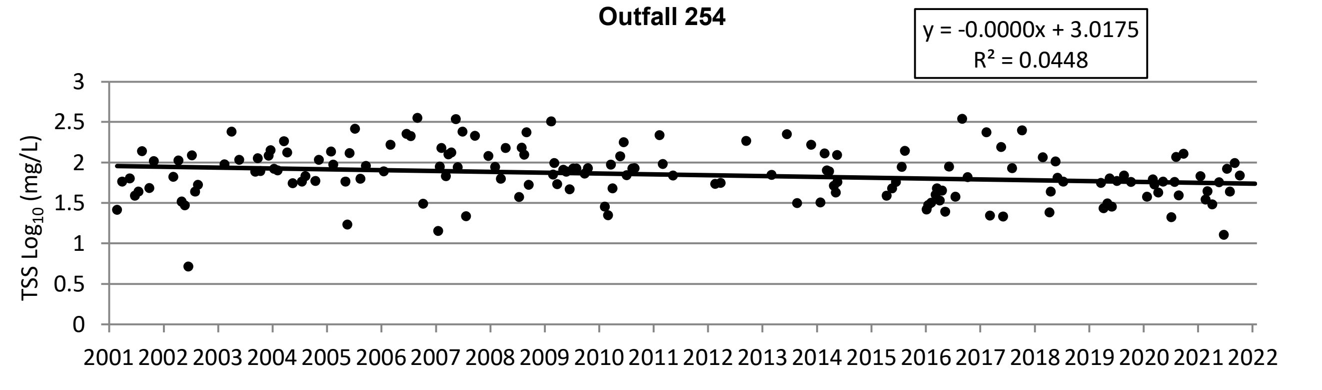
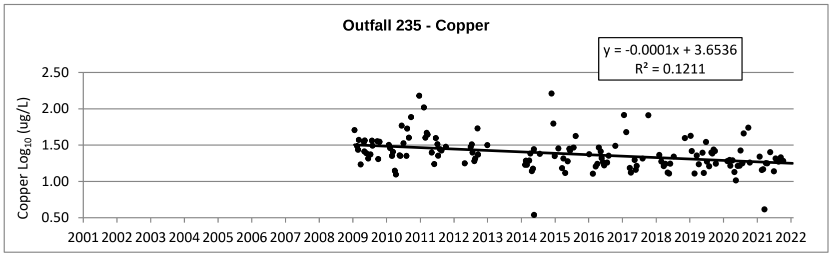
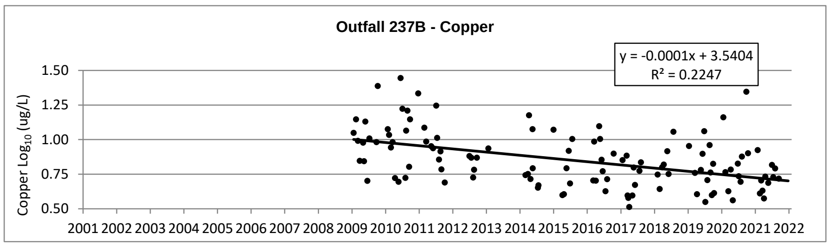


Figure 3-5.2
Linear Regression Analysis of Stormwater Time Trends
Time Series for Copper
September 2001 - September 2022





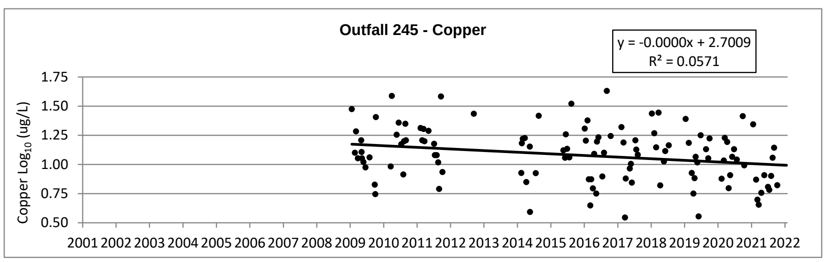


Figure 3-5.3
Linear Regression Analysis of Stormwater Time Trends
Time Series for Total Lead
September 2001 - September 2022

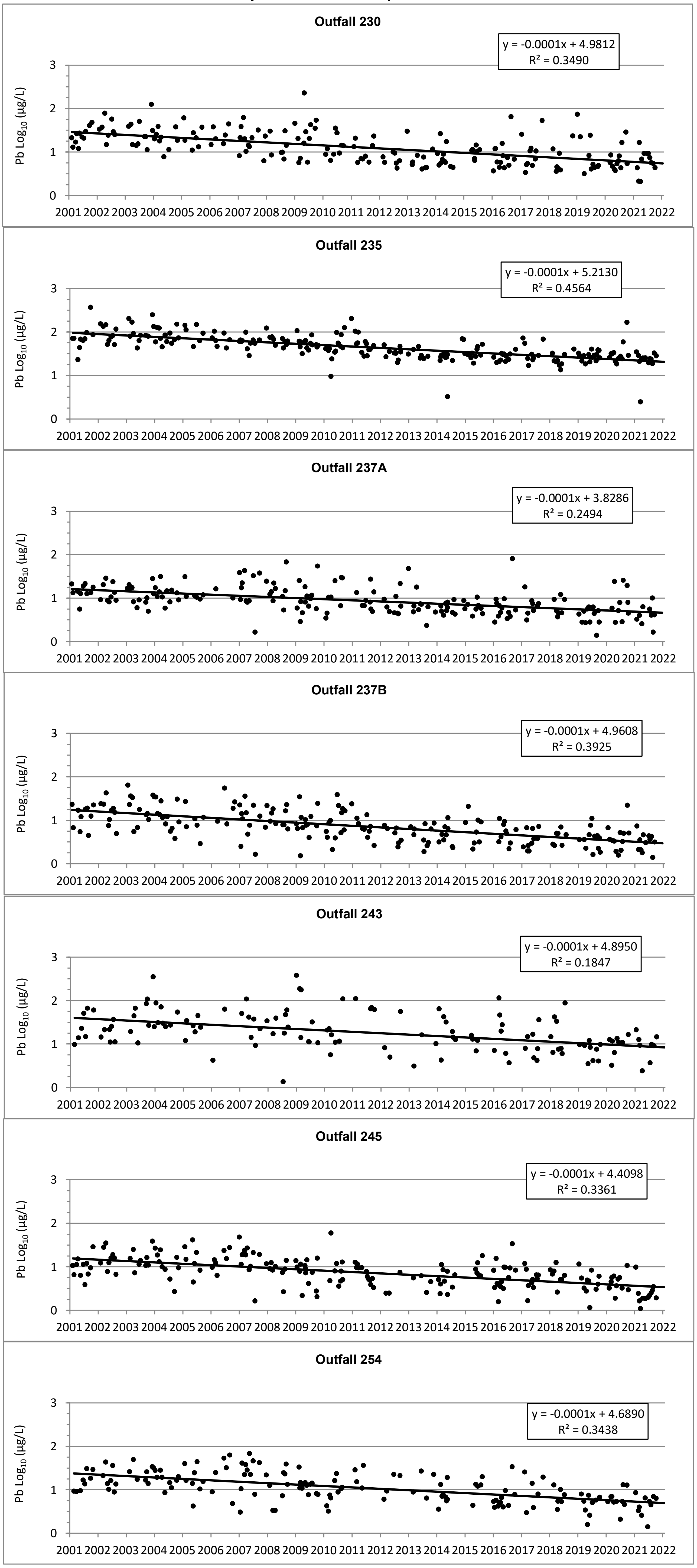


Figure 3-5.4
Linear Regression Analysis of Stormwater Time Trends
Time Series for Total Zinc
September 2001 - September 2022

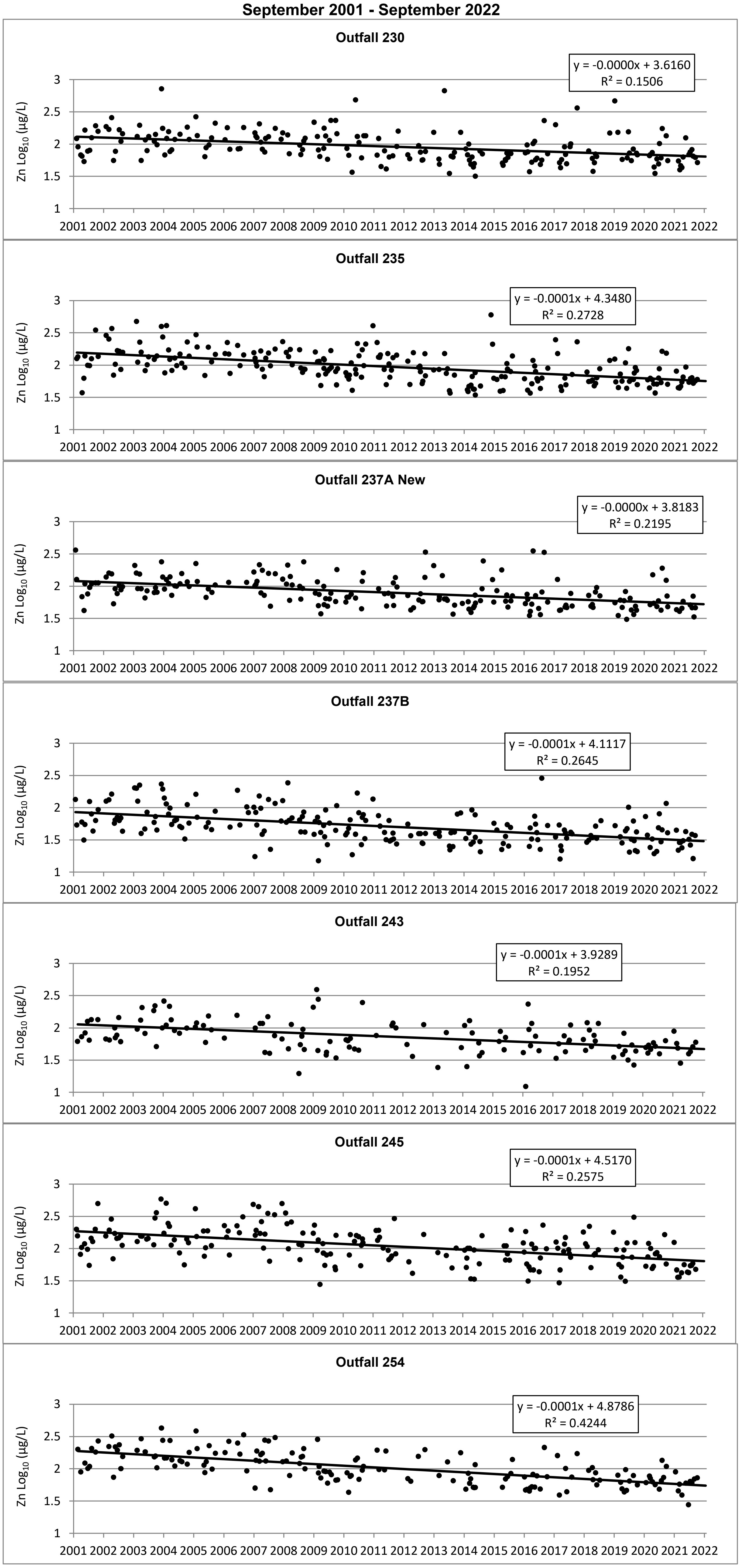


Figure 3-5.5
Linear Regression Analysis of Stormwater Time Trends
Time Series for Phenanthrene
September 2001 - September 2022

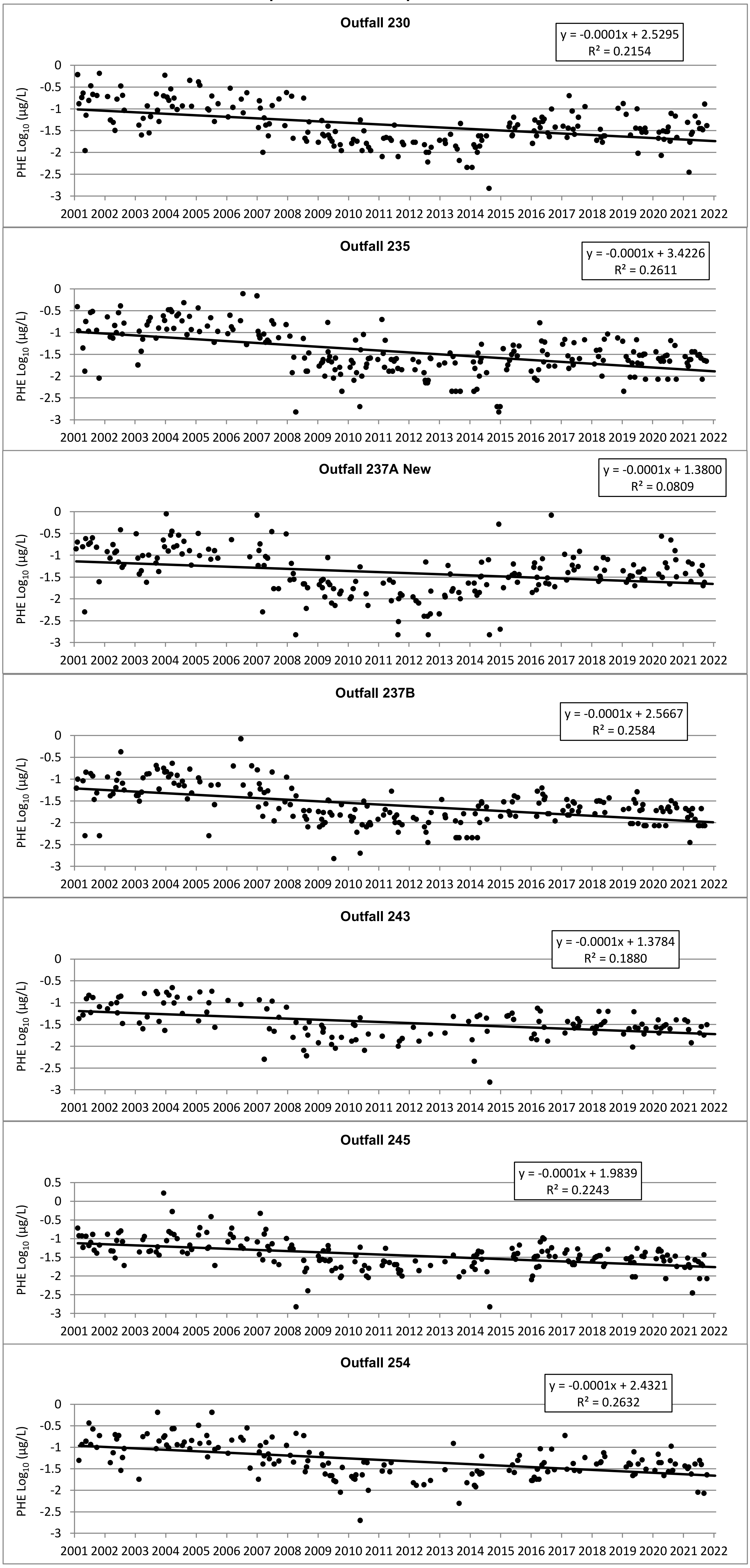
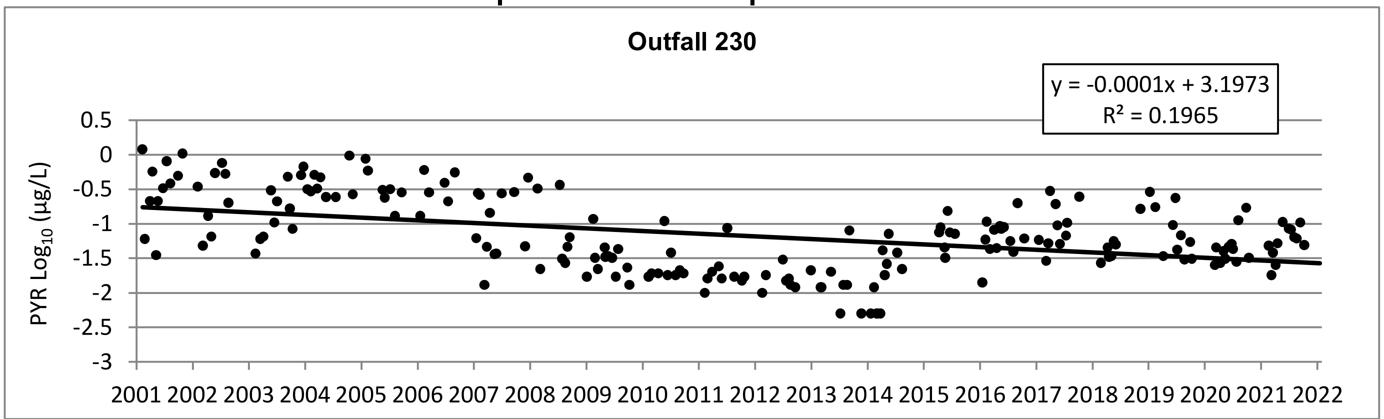
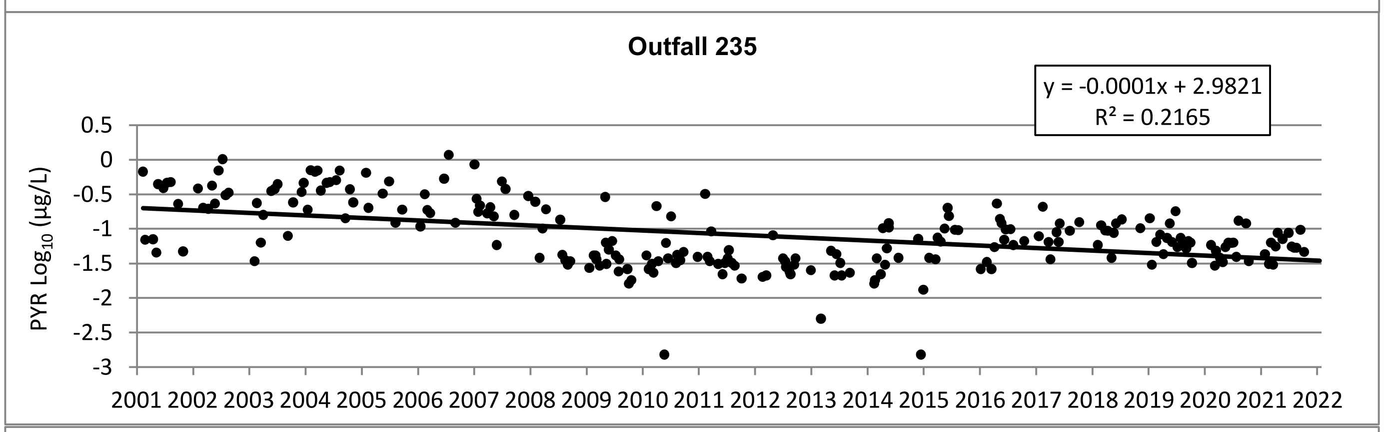
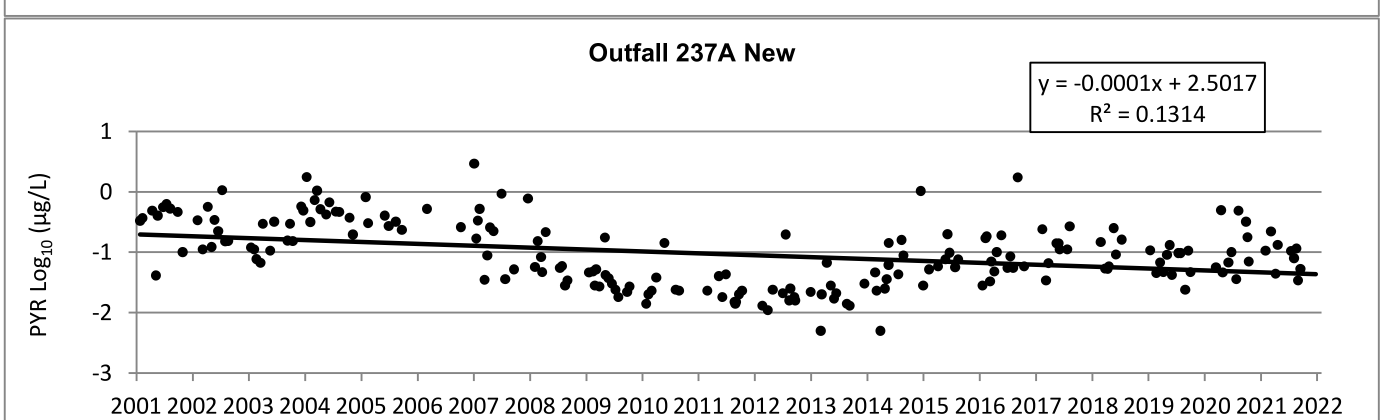
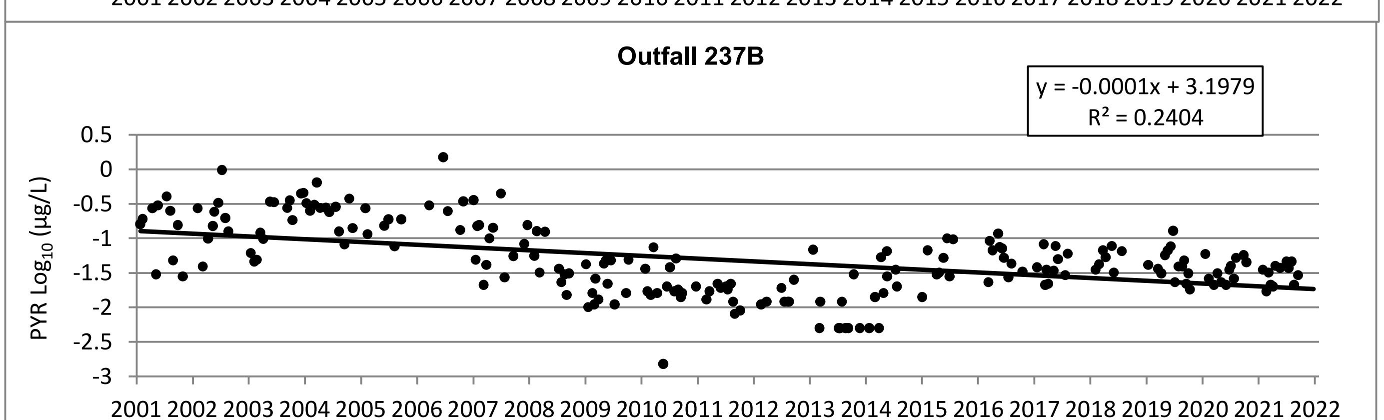


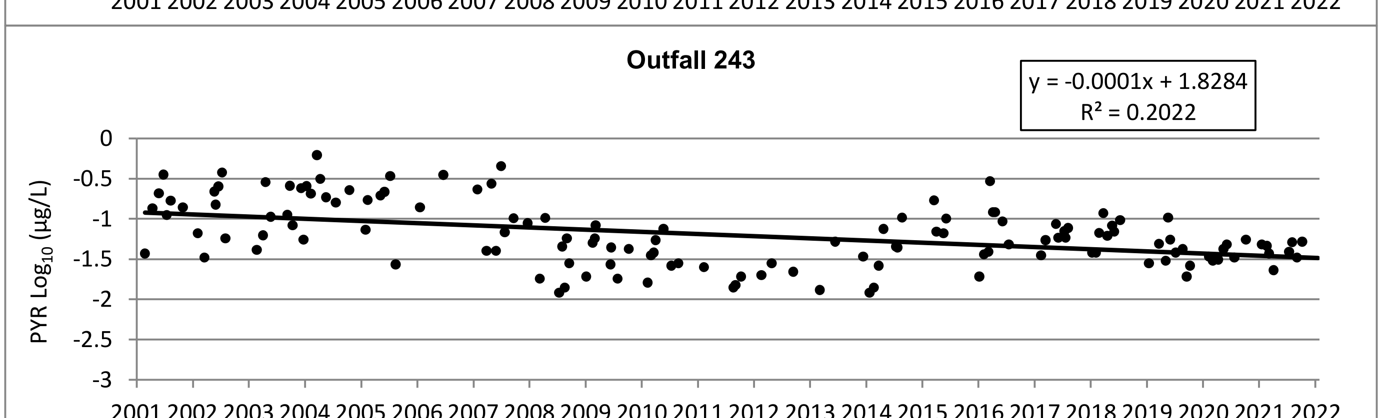
Figure 3-5.6
Linear Regression Analysis of Stormwater Time Trends
Time Series for Pyrene
September 2001 - September 2022

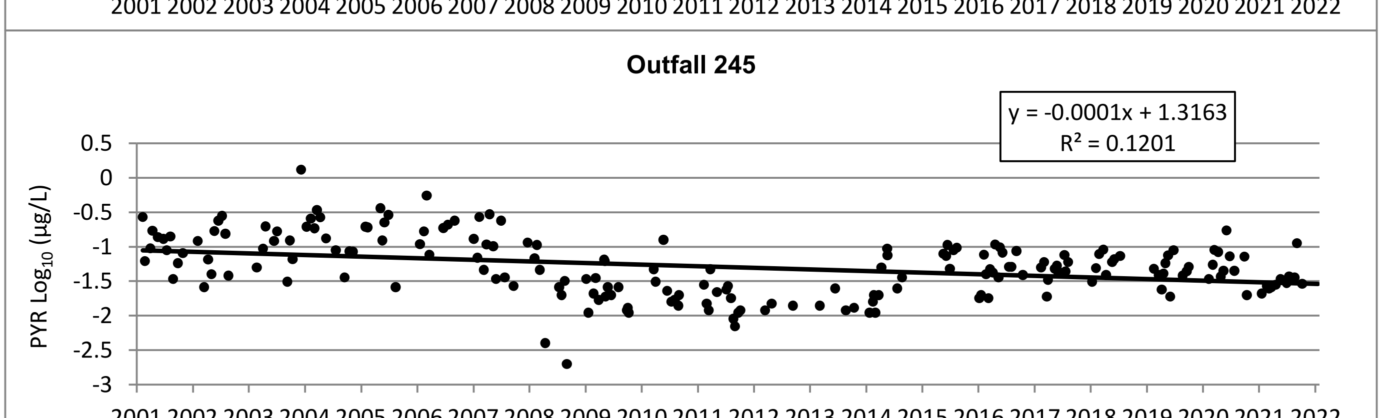












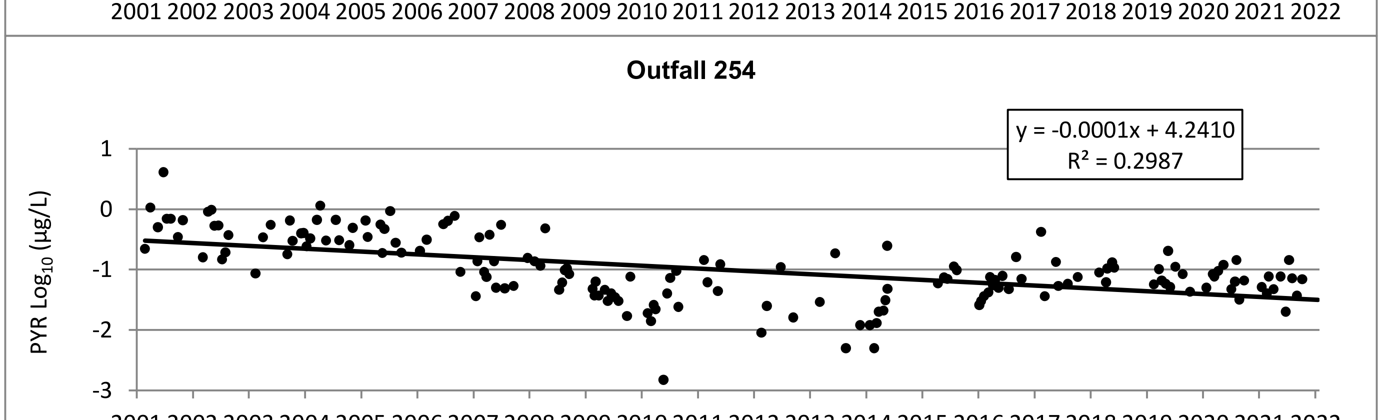


Figure 3-5.7
Linear Regression Analysis of Stormwater Time Trends
Time Series for Indeno(1,2,3-c,d)pyrene
September 2001 - September 2022

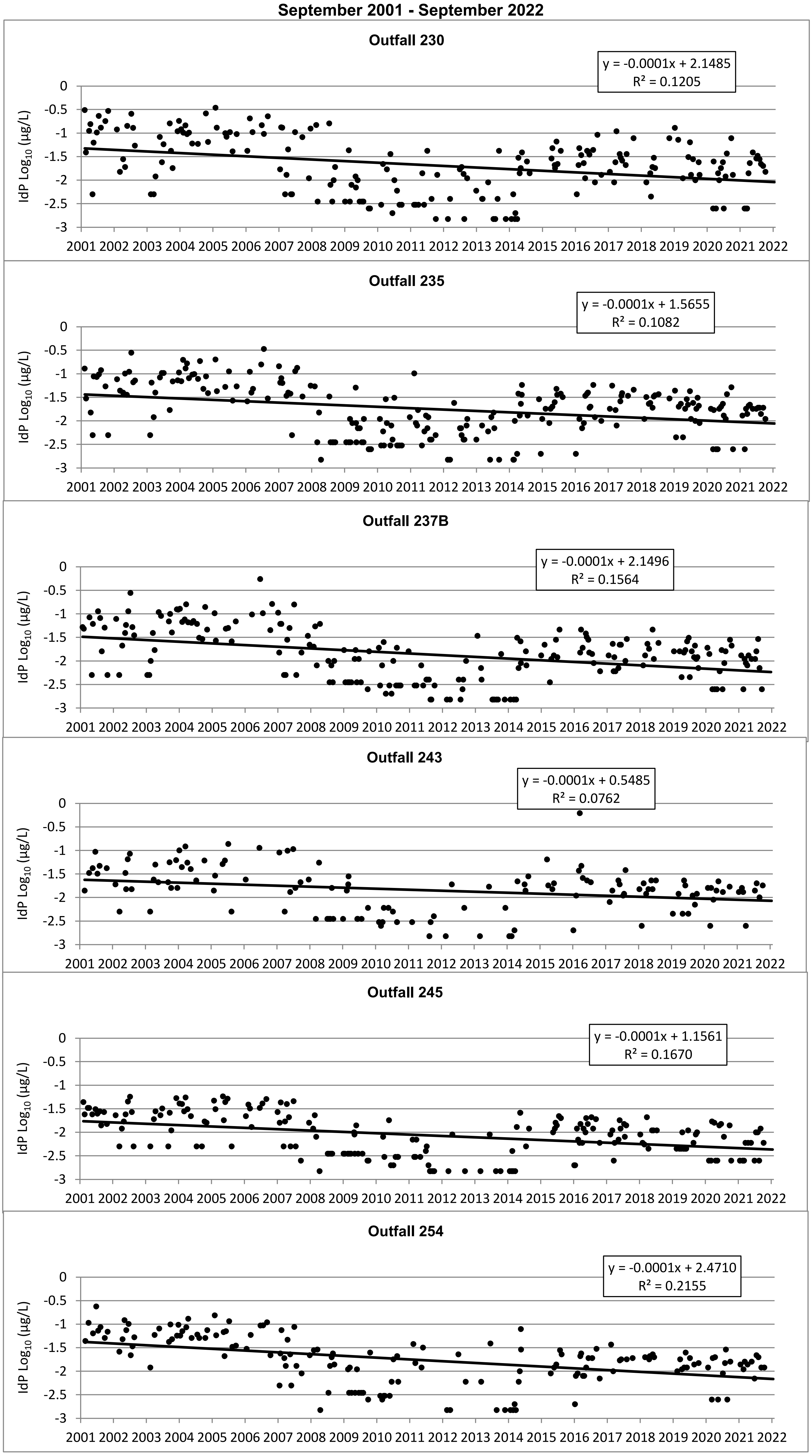


Figure 3-5.8
Linear Regression Analysis of Stormwater Time Trends
Time Series for Bis(2-ethylhexyl)phthalate (DEHP)
September 2001 - September 2022

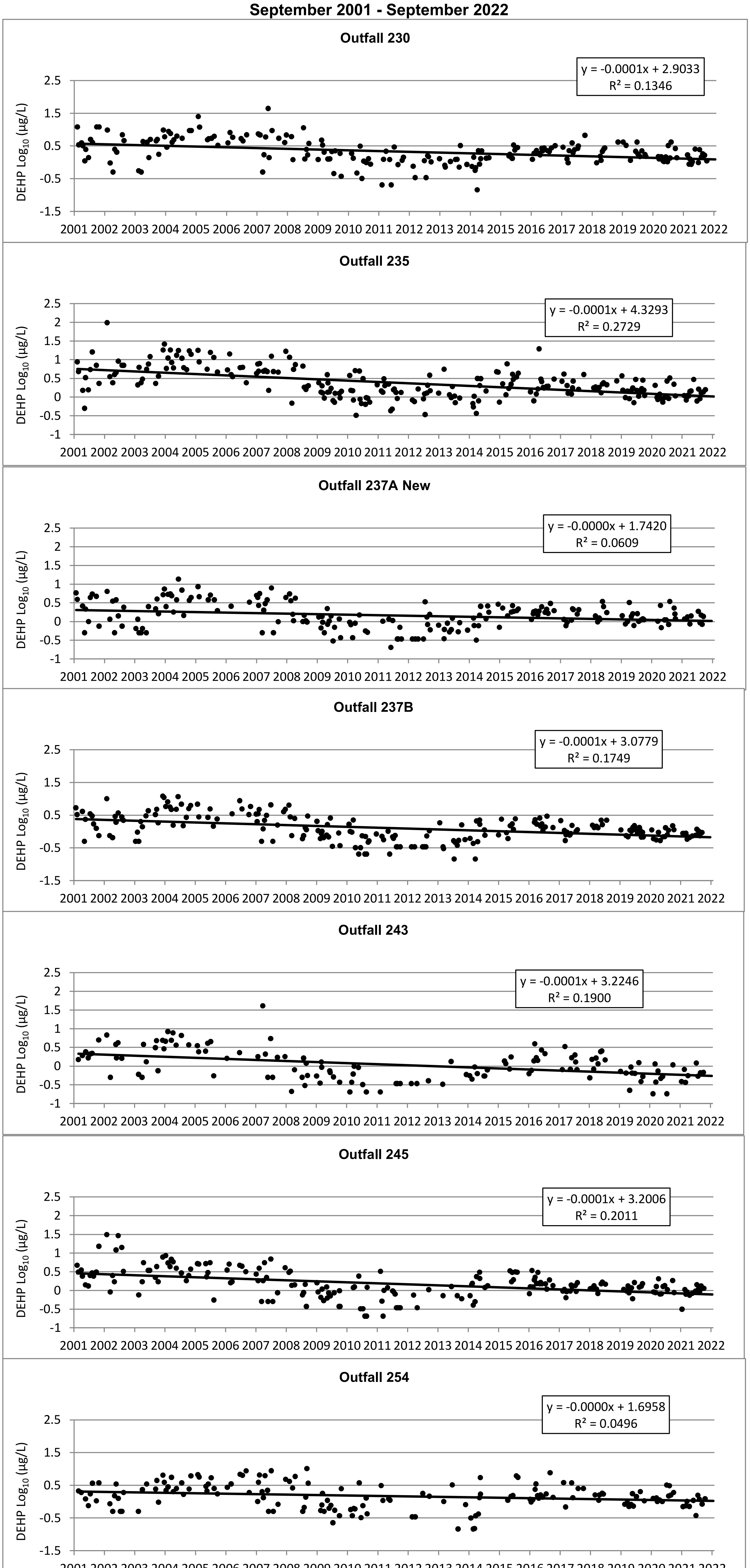
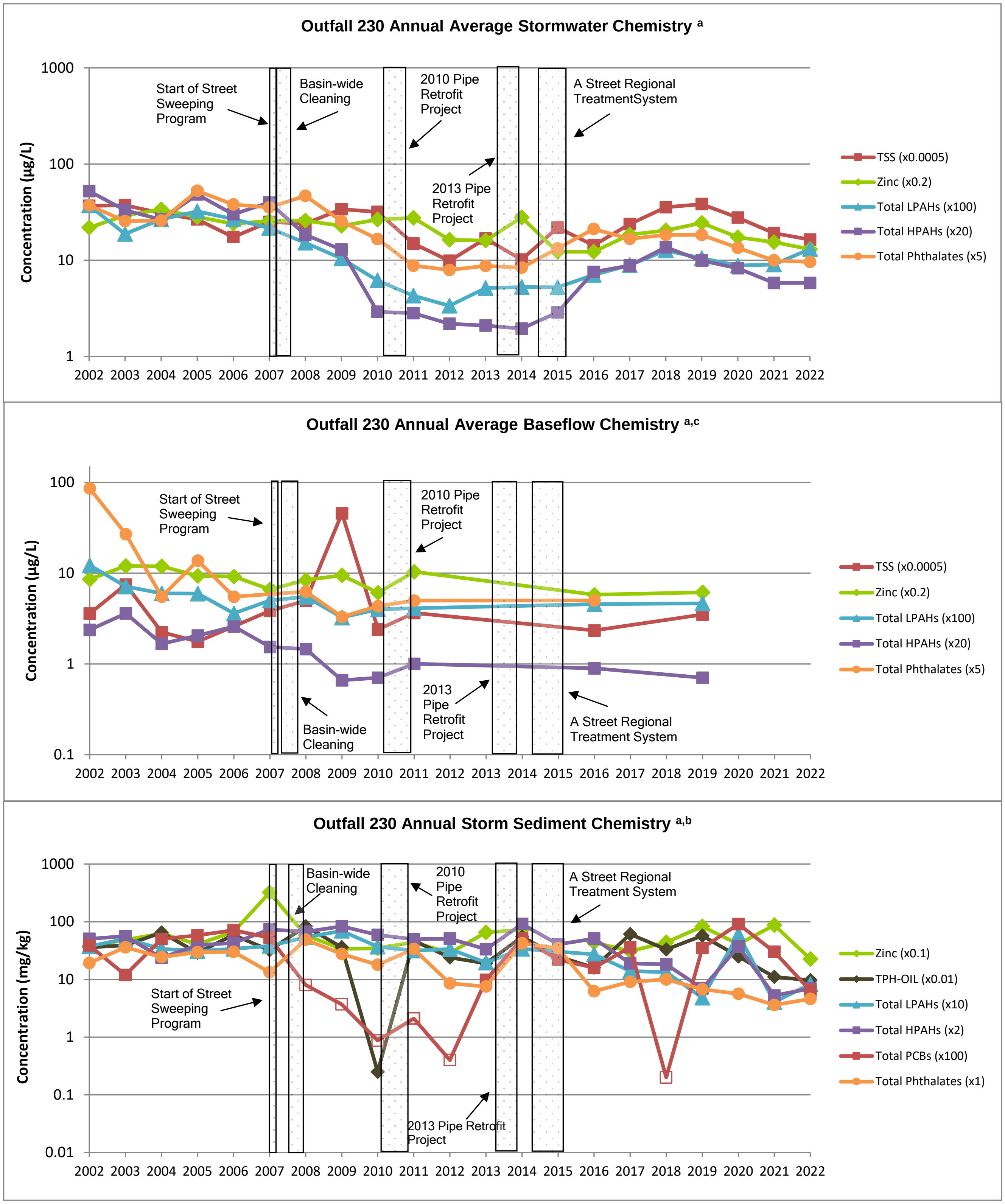


Figure 5-1.1
Analysis of Monitoring Trends in Stormwater, Baseflow, and Storm Sediment
OF230



Notes:

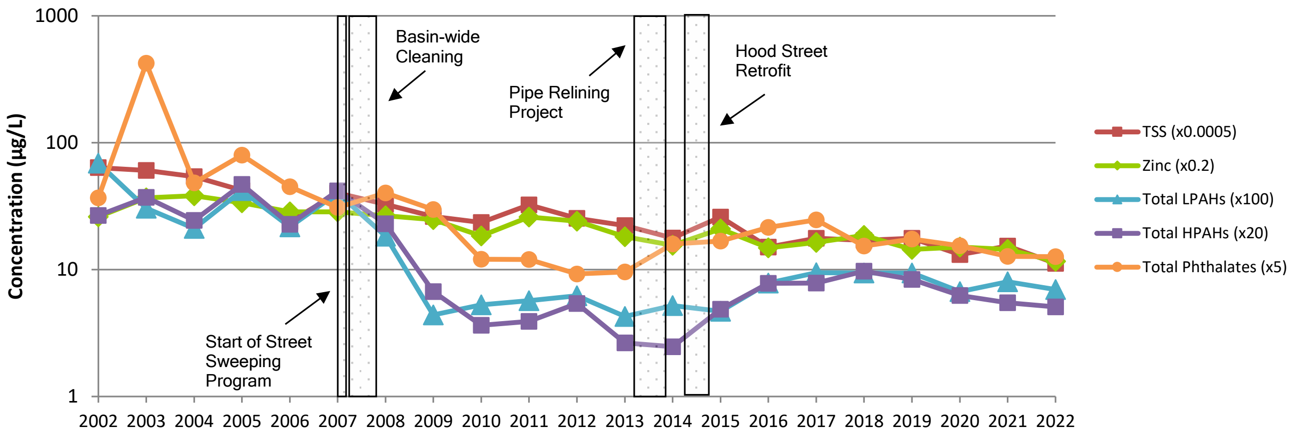
[a] Results shown are a product of chemistry data and an analyte-specific multiplier in order to display results on a common scale

[b] Open symbols denote censored data; highest detection limit posted as value

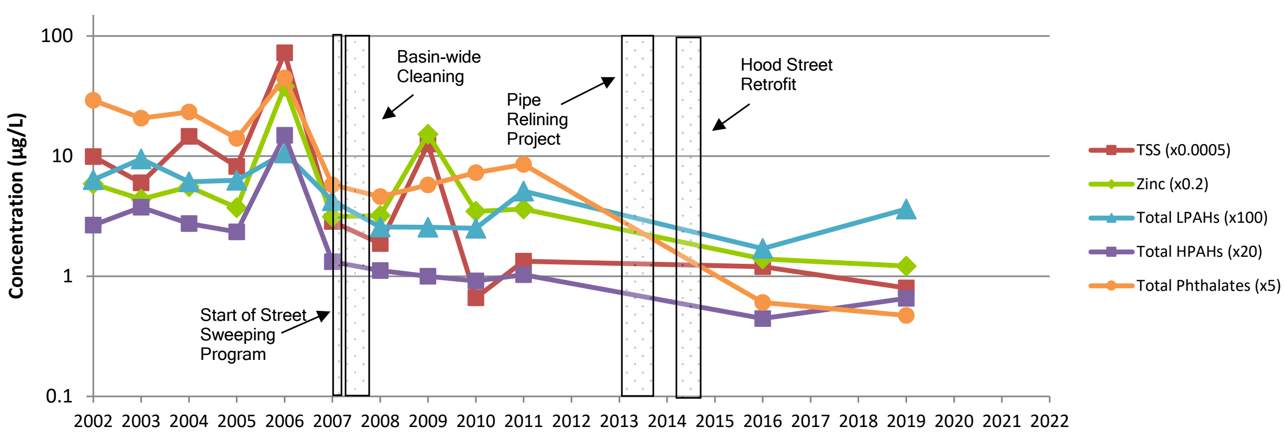
[c] Baseflow sampling was discontinued after WY2011.

Figure 5-1.2
Analysis of Monitoring Trends in Stormwater, Baseflow, and Storm Sediment
OF235

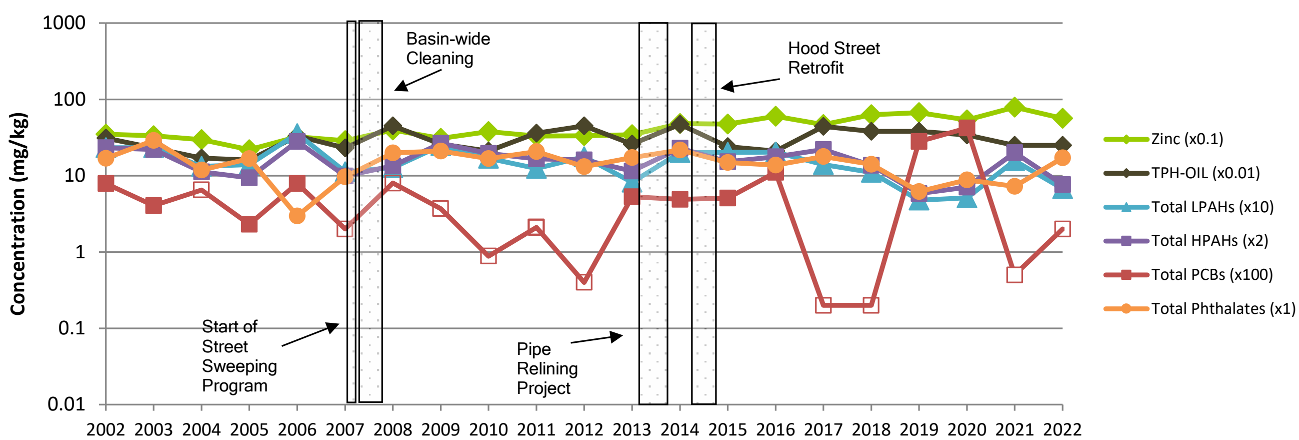
Outfall 235 Annual Average Stormwater Chemistry [a]



Outfall 235 Annual Average Baseflow Chemistry [a,c]



Outfall 235 Annual Storm Sediment Chemistry [a,b]



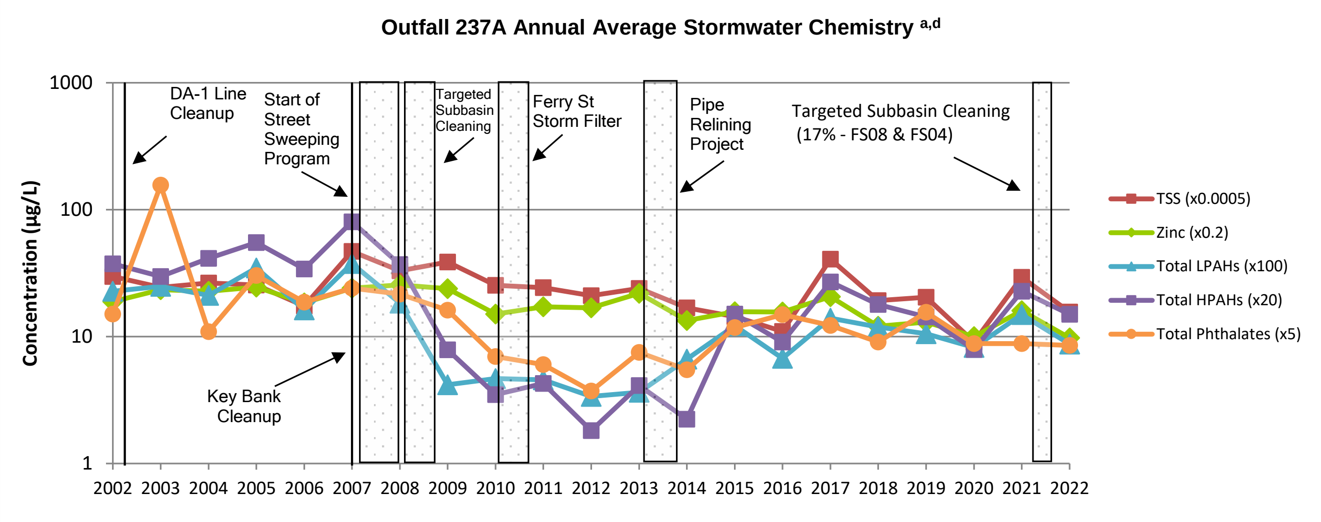
Notes:

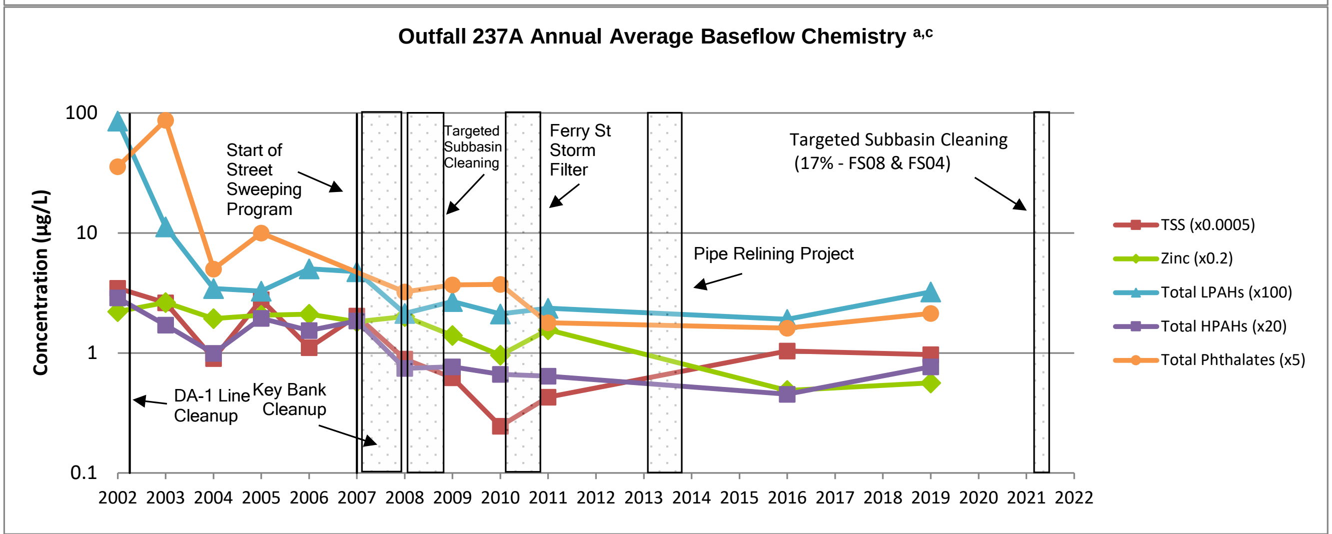
[a] Results shown are a product of chemistry data and an analyte-specific multiplier in order to display results on a common scale

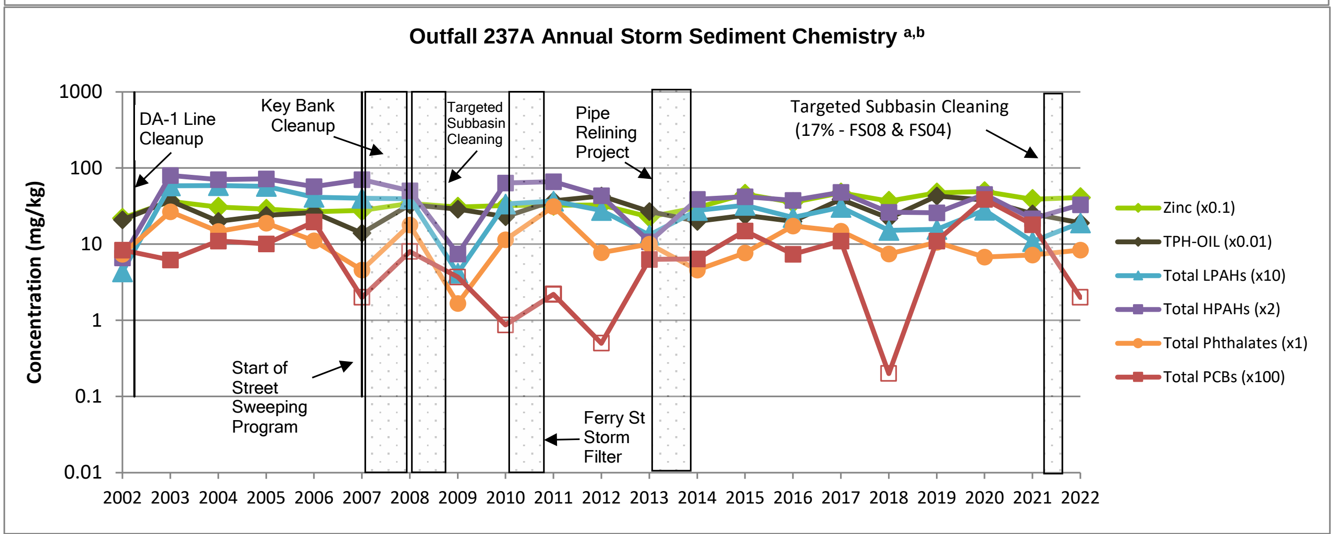
[b] Open symbols denote censored data; highest detection limit posted as value

[c] Baseflow sampling was discontinued after WY2011.

Figure 5-1.3
Analysis of Monitoring Trends in Stormwater, Baseflow, and Storm Sediment
OF237A







Notes:

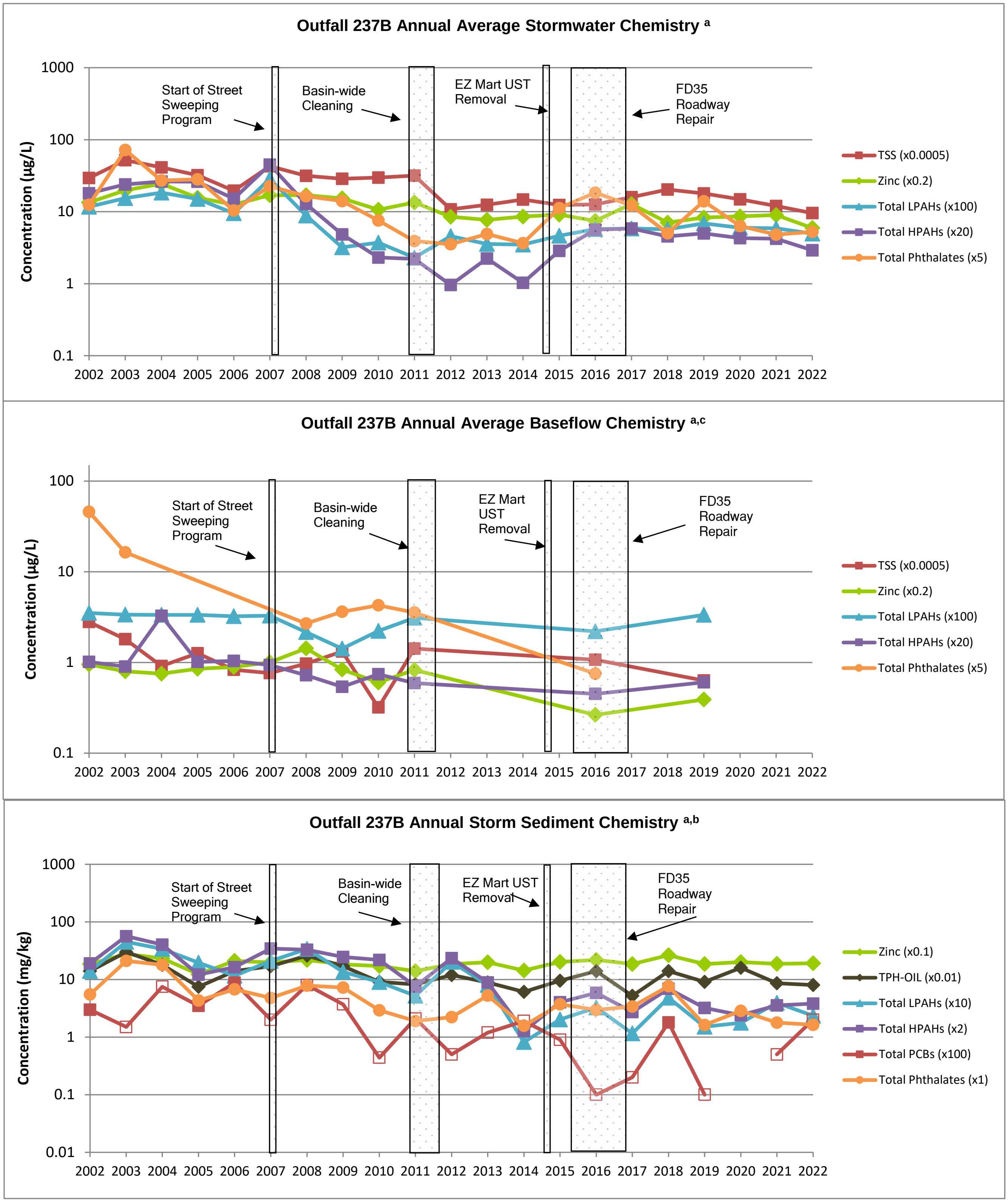
[a] Results shown are a product of chemistry data and an analyte-specific multiplier in order to display results on a common scale

[b] Open symbols denote censored data; highest detection limit posted as value

[c] Baseflow sampling was discontinued after WY2011.

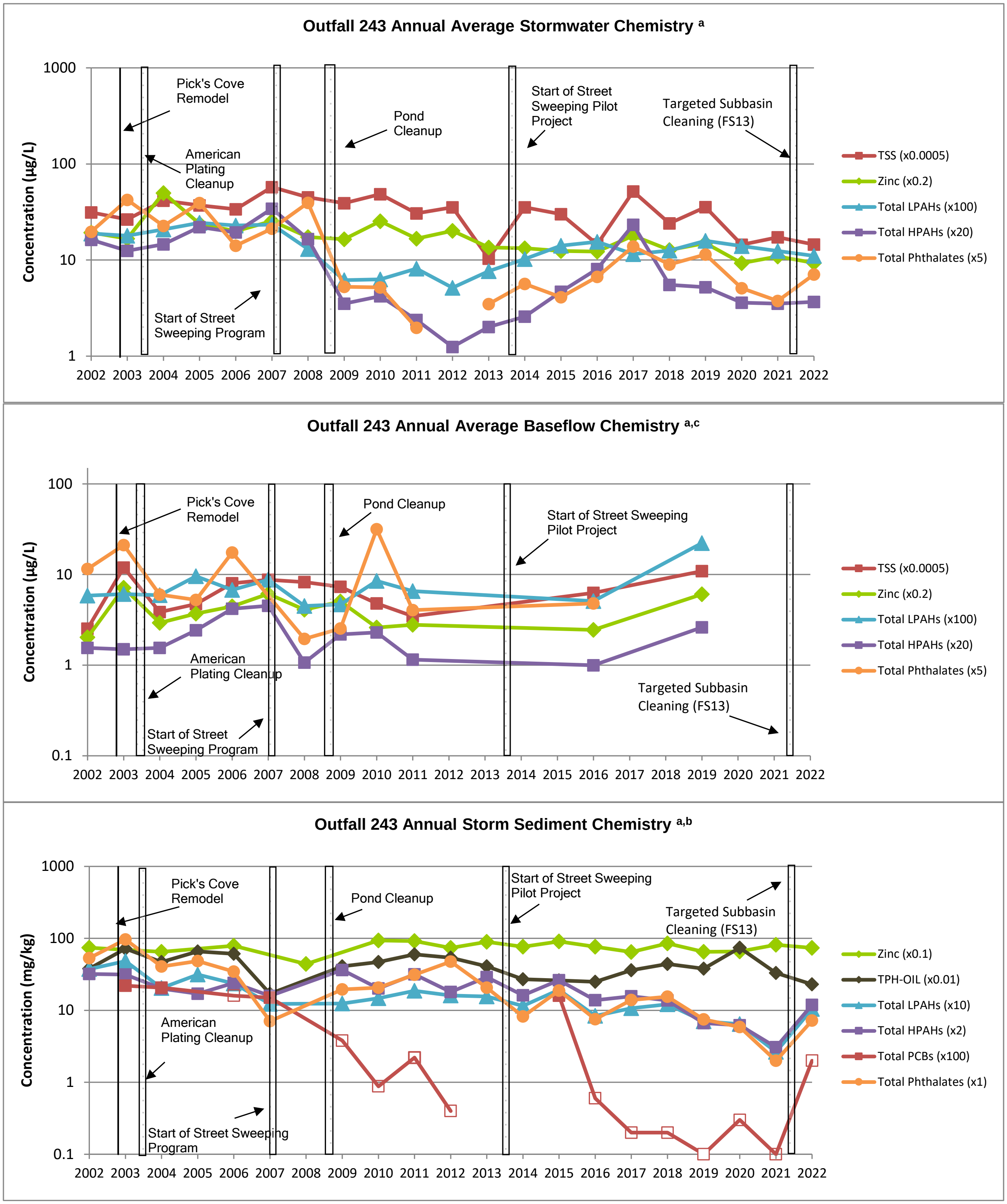
[d] 237A data Includes data from the old 237A site for events prior collected prior to 2/26/06. Events after 2/26/06 were from the 237A New site.

Figure 5-1.4
Analysis of Monitoring Trends in Stormwater, Baseflow, and Storm Sediment
OF237B



Notes:
[a] Results shown are a product of chemistry data and an analyte-specific multiplier in order to display results on a common scale
[b] Open symbols denote censored data; highest detection limit posted as value
[c] Baseflow sampling was discontinued after WY2011.

Figure 5-1.5
Analysis of Monitoring Trends in Stormwater, Baseflow, and Storm Sediment
OF243



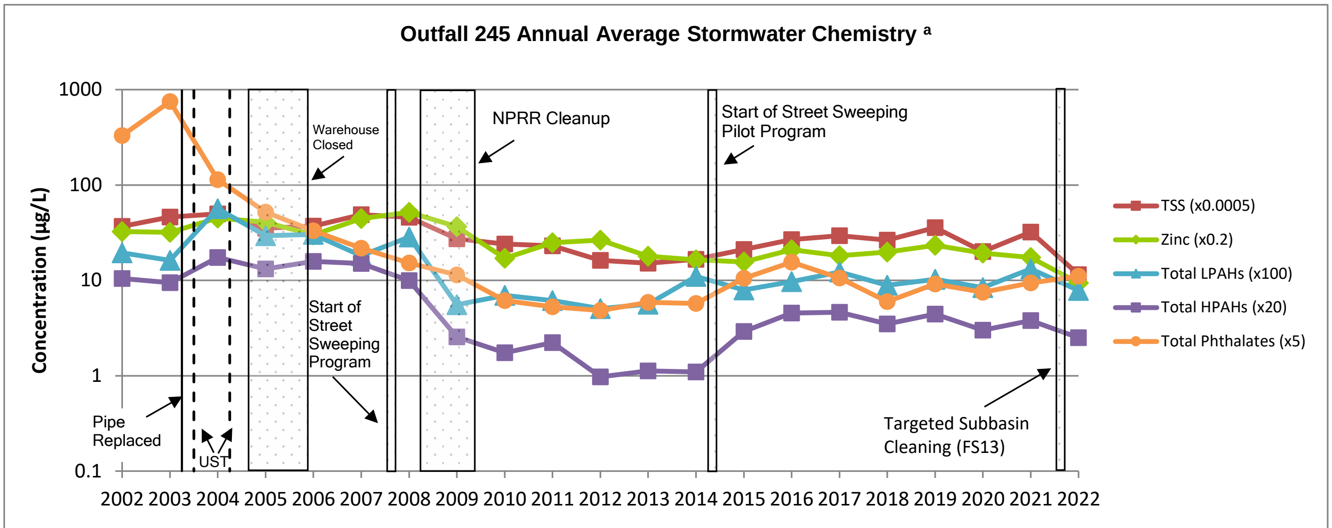
Notes:

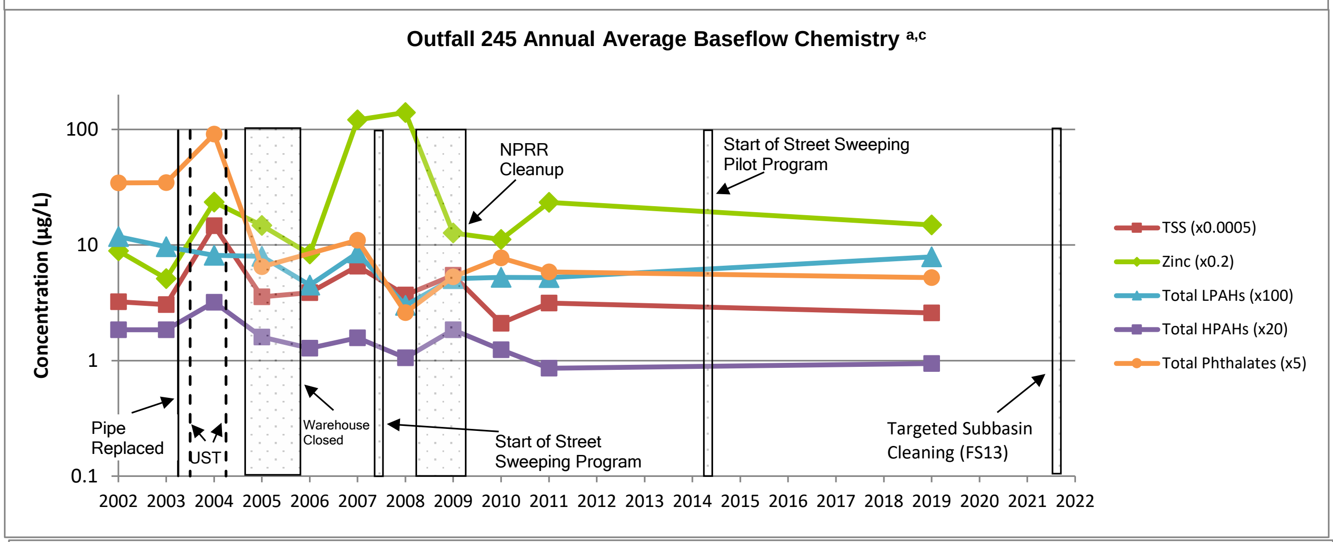
[a] Results shown are a product of chemistry data and an analyte-specific multiplier in order to display results on a common scale

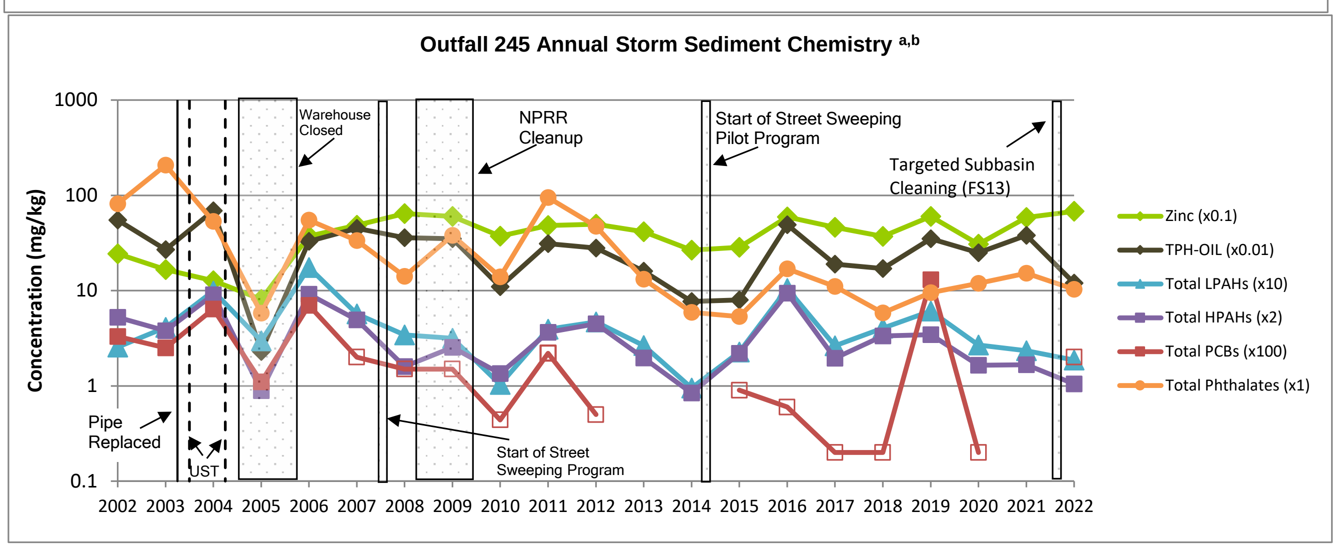
[b] Open symbols denote censored data; highest detection limit posted as value

[c] Baseflow sampling was discontinued after WY2011.

Figure 5-1.6
Analysis of Monitoring Trends in Stormwater, Baseflow, and Storm Sediment
OF245







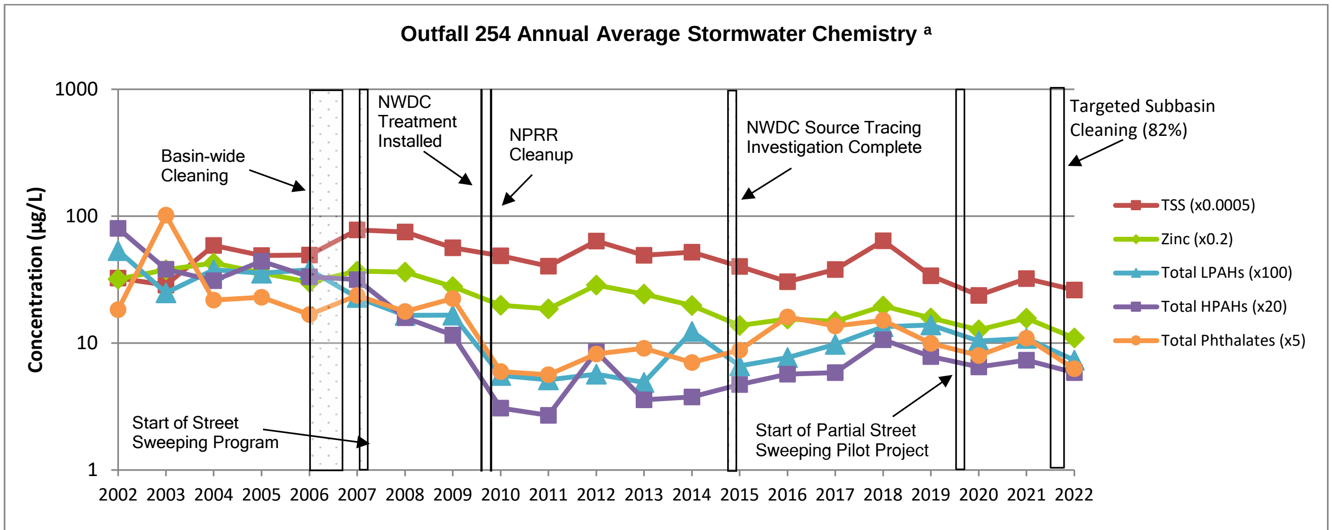
Notes:

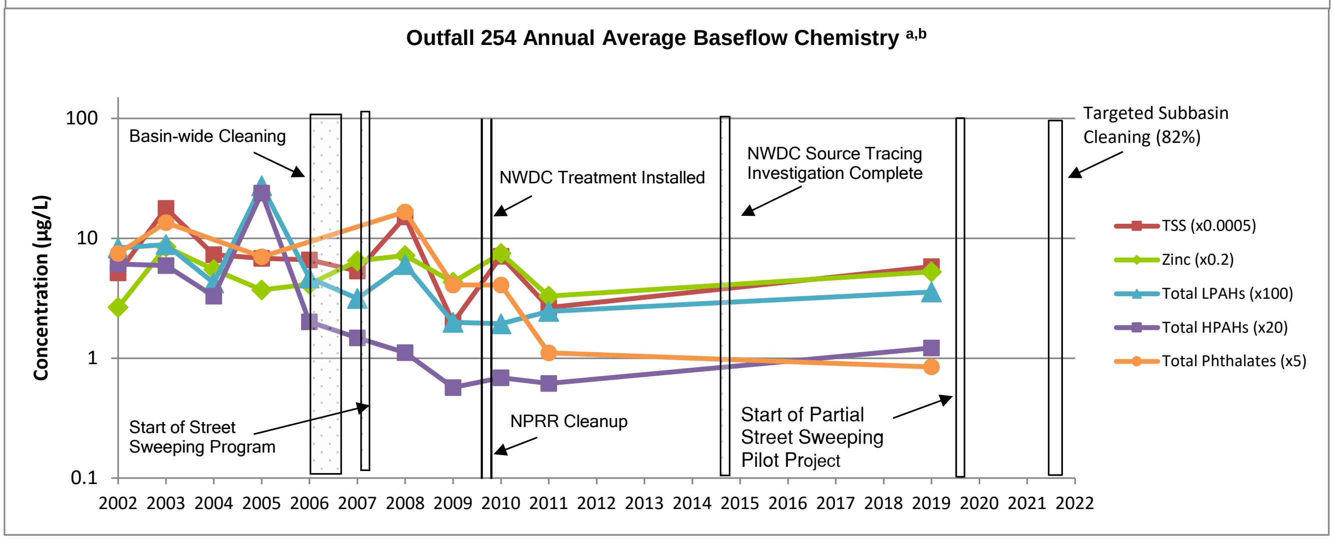
[a] Results shown are a product of chemistry data and an analyte-specific multiplier in order to display results on a common scale

[b] Open symbols denote censored data; highest detection limit posted as value

[c] Baseflow sampling was discontinued after WY2011.

Figure 5-1.7
Analysis of Monitoring Trends in Stormwater and Baseflow, and Storm Sediment
OF254





Notes:

[a] Results shown are a product of chemistry data and an analyte-specific multiplier in order to display results on a common scale

[b] Baseflow sampling was discontinued after WY2011.

Figure 5-2.1
Analysis of Monitoring Trends in Storm Sediment in OF230

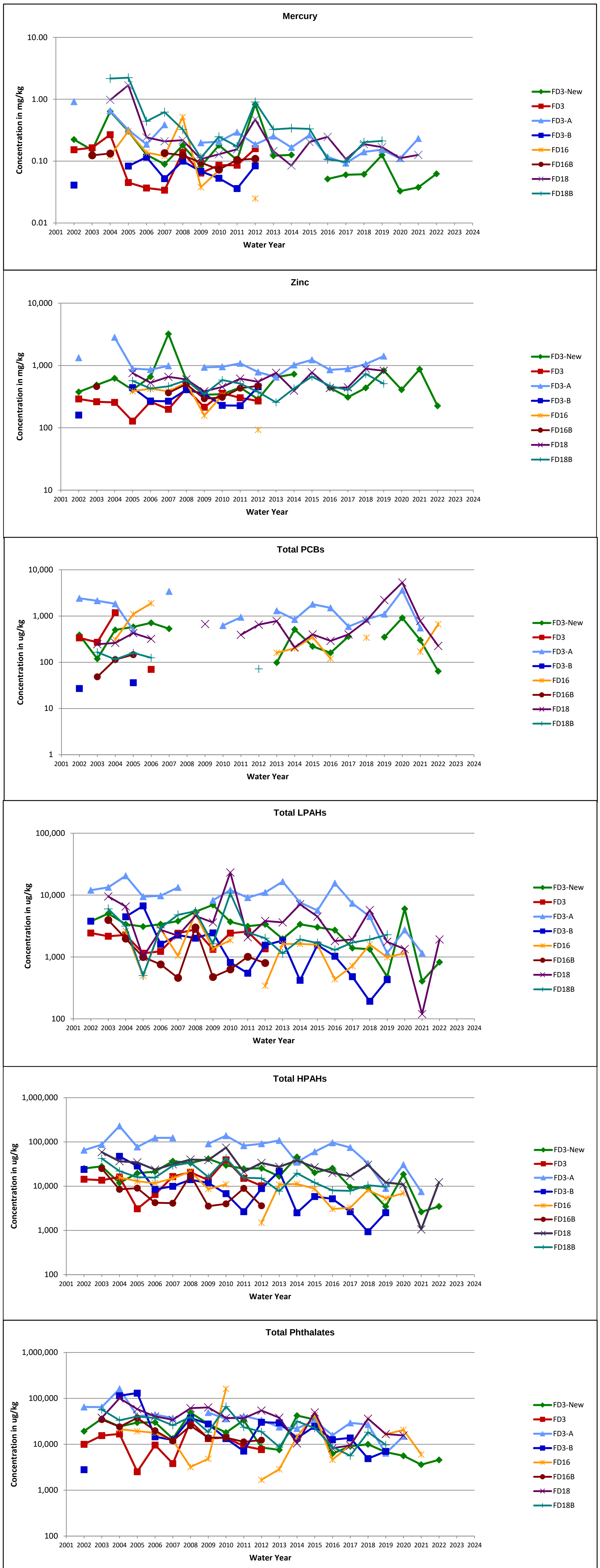


Figure 5-2.2
Analysis of Monitoring Trends in Storm Sediment in OF235

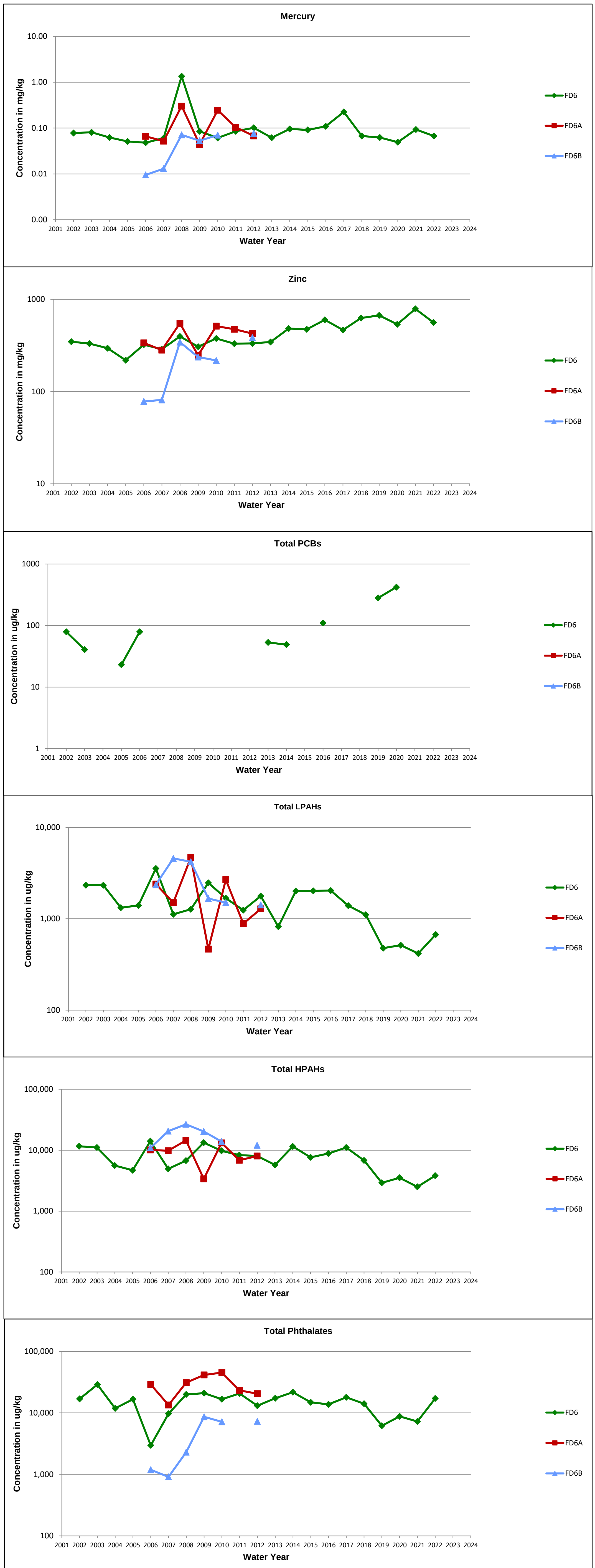
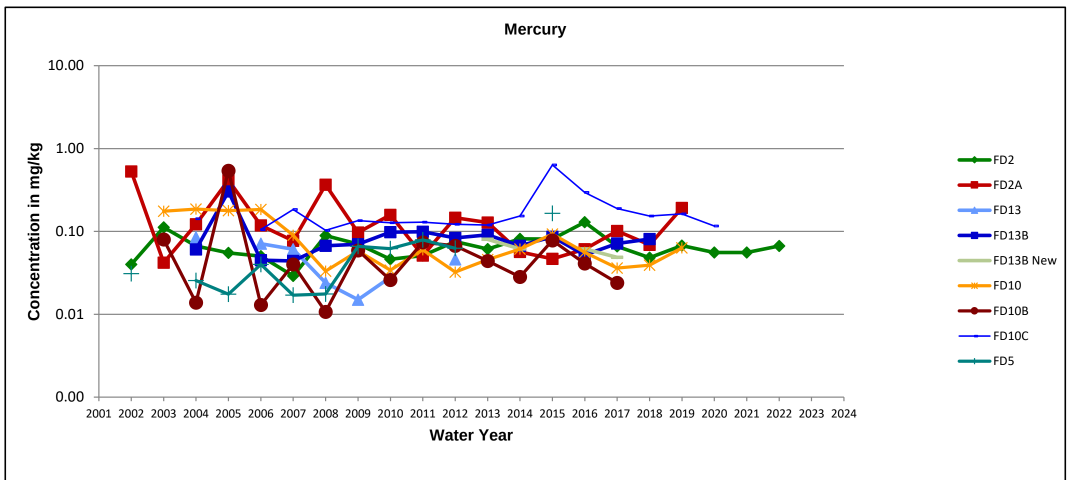
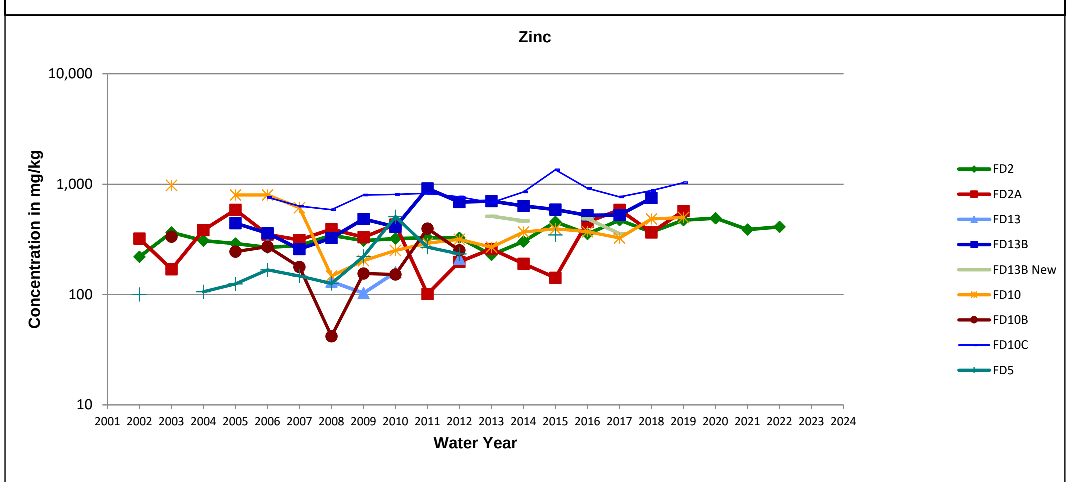
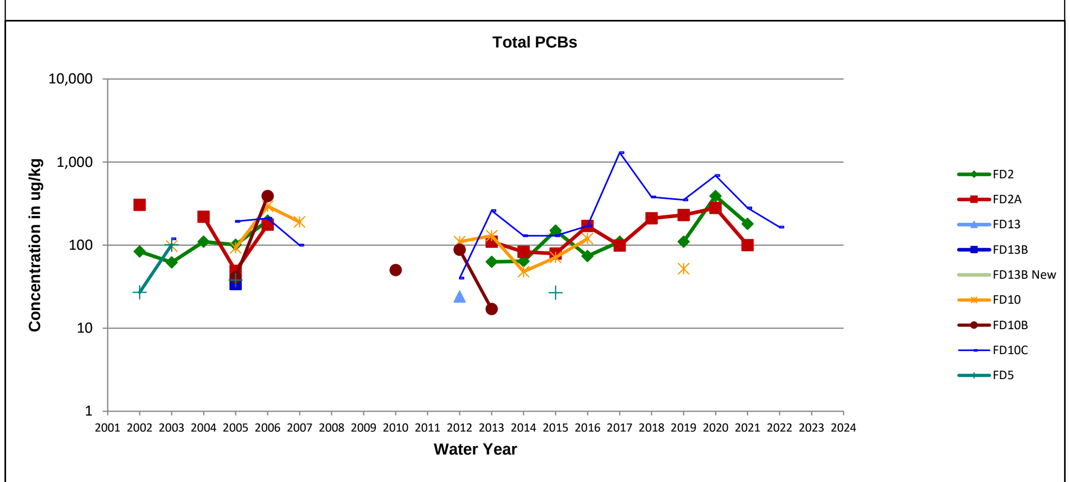
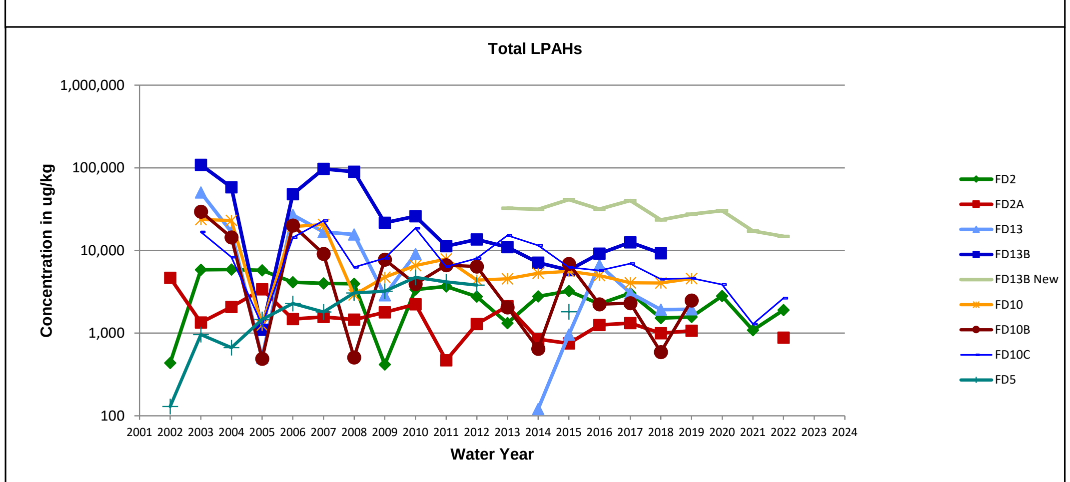


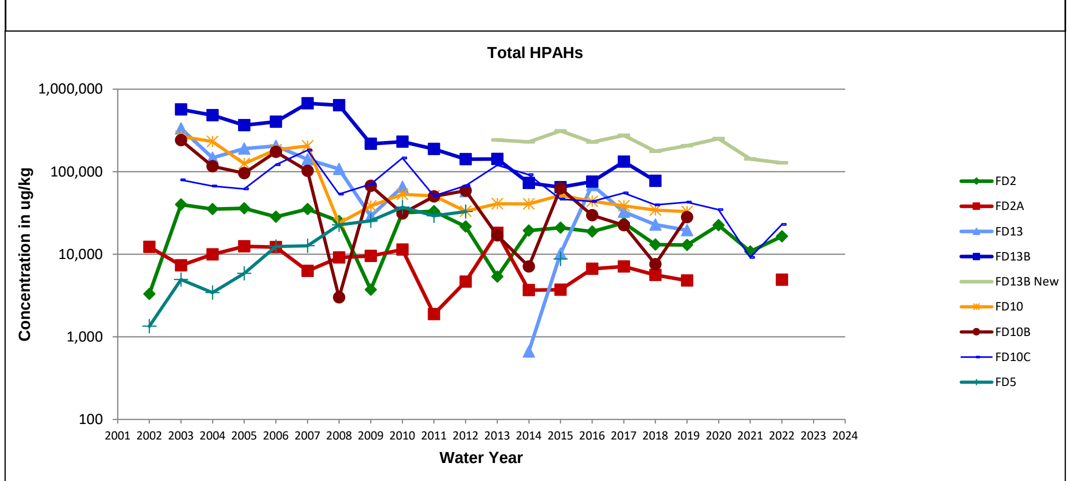
Figure 5-2.3
Analysis of Monitoring Trends in Storm Sediment in OF237A











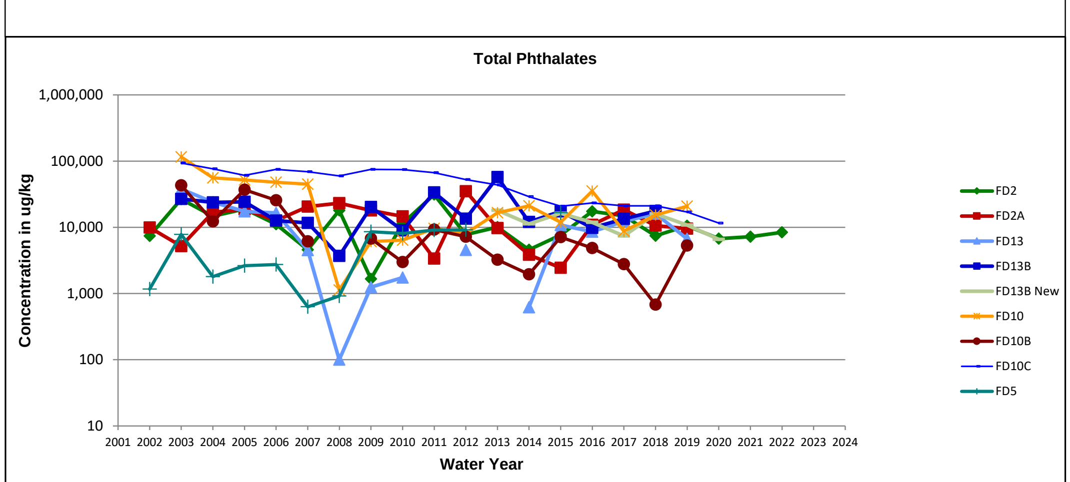


Figure 5-2.4
Analysis of Monitoring Trends in Storm Sediment in OF237B

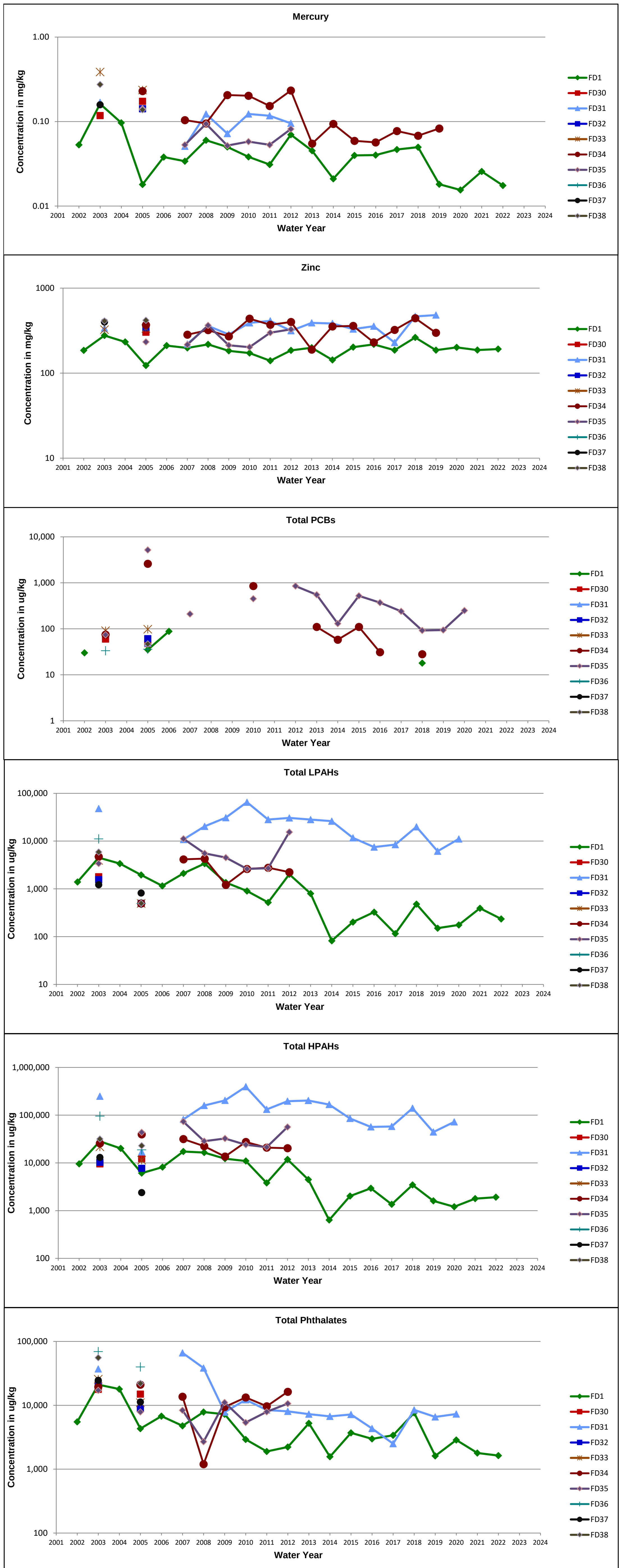
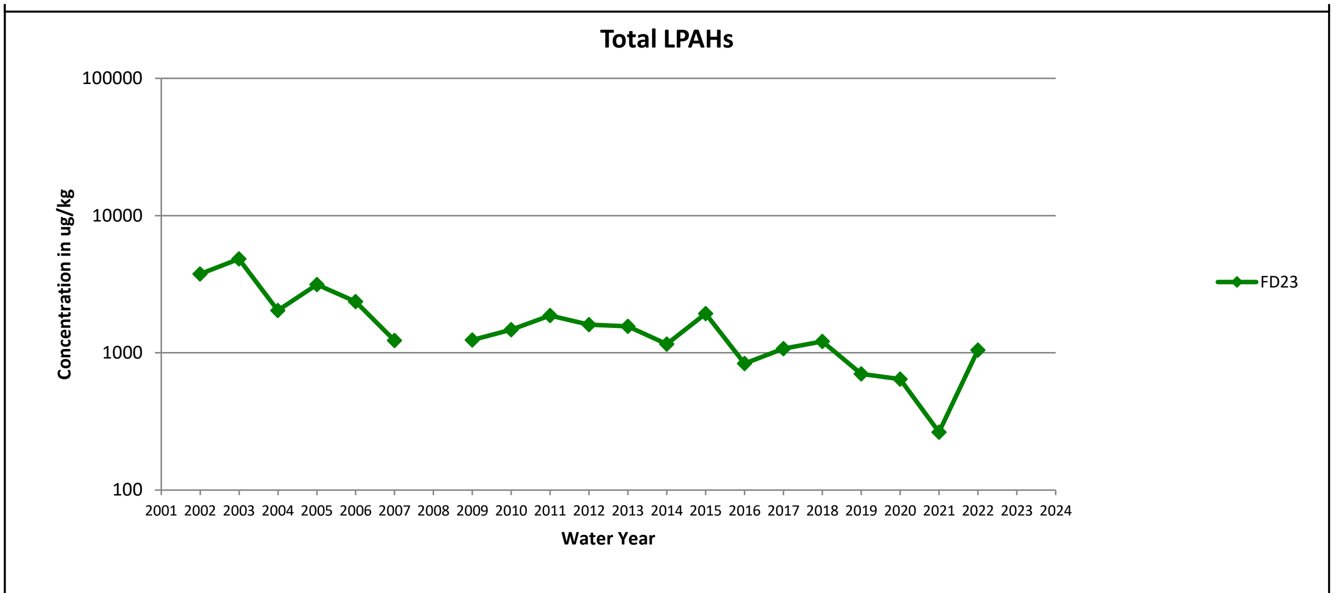
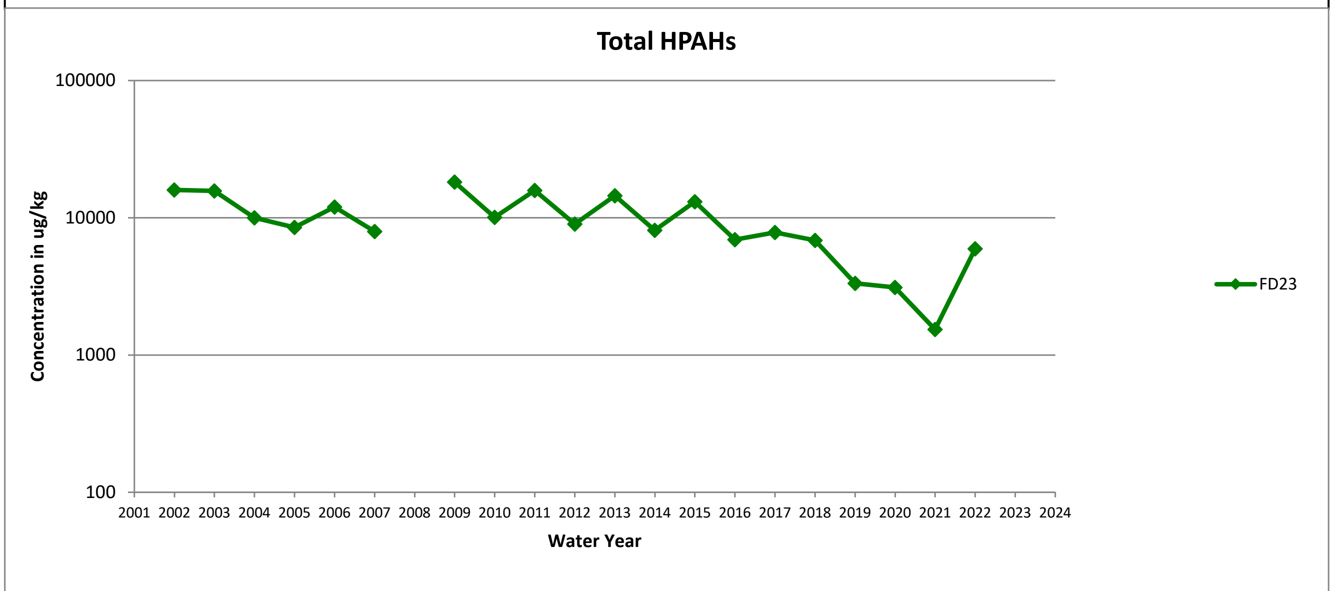


Figure 5-2.5
Analysis of Monitoring Trends in Storm Sediment
OF-243





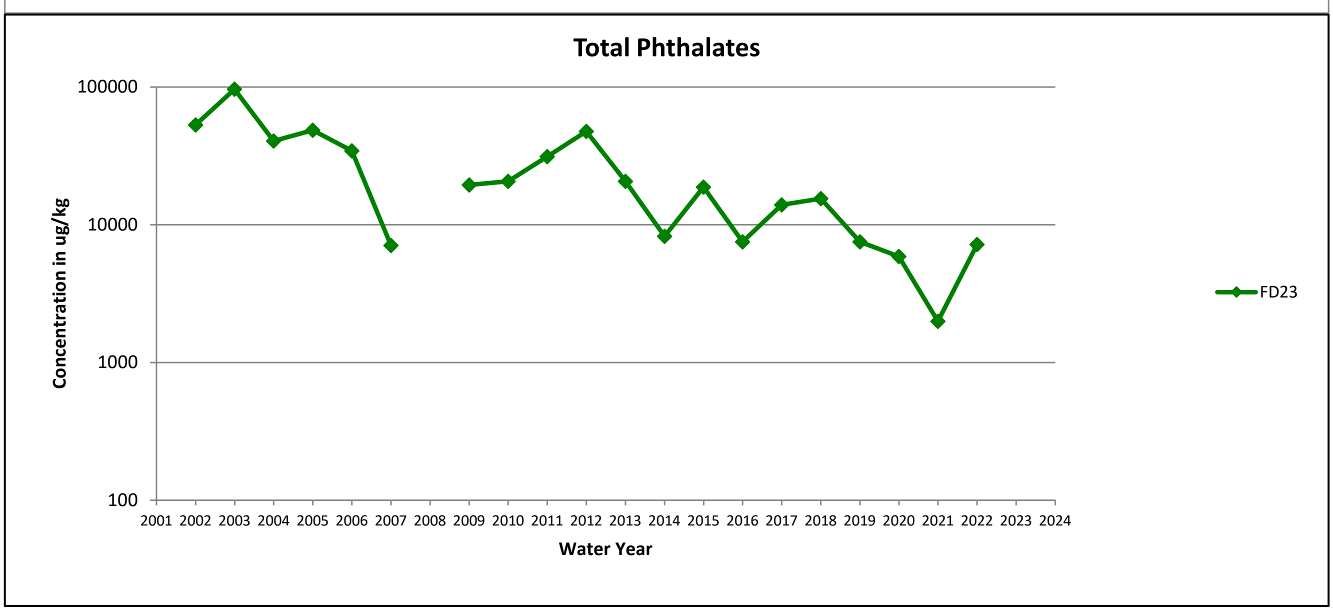


Figure 5-2.6
Analysis of Monitoring Trends in Storm Sediment in OF245