CITY OF PORTLAND
ENVIRONMENTAL SERVICES
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TECHNICAL MEMORANDUM

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DATE: February 01, 2011

SUBJECT: **Basin 19 Stormwater Quality Trend Analyses**
Effectiveness of City Stormwater Source Control Efforts

INTRODUCTION

The City of Portland (City) Bureau of Environmental Services (BES) has been performing long-term stormwater quality data collection at City Outfall 19 (OF 19) since 1995. Stormwater water discharges from OF 19 to the Willamette River are authorized under an Oregon Department of Environmental Quality (DEQ) Phase I National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) Discharge Permit. The MS4 permit, first issued in 1995, requires the City to reduce pollutants in stormwater discharges from its stormwater conveyance systems "to the maximum extent practicable".

Under the MS4 permit, the City has developed and has been implementing a variety of City stormwater management programs within Outfall Basin 19 (Basin 19), as described in this document. The purpose of this memorandum is to evaluate whether these source control programs have been effective and can be demonstrated by long-term concentration trends. In addition to the OF 19 stormwater data, site-specific information, where available, for stormwater discharges into the City's stormwater conveyance system is evaluated to help interpret the results of specific OF 19 sampling events and/or long-term pollutant concentration trends. The site-specific information includes stormwater monitoring required at selected industrial facilities with DEQ-issued NPDES 1200-Z permits or conducted under DEQ's Cleanup Program as part of DEQ's Portland Harbor Cleanup upland site investigations.

Based on the evaluation presented in this memorandum, City stormwater programs have been effective in reducing pollutant concentrations "to the maximum extent practicable" in stormwater discharging from OF 19 over time and data demonstrate significant progress toward meeting water quality goals. Continued implementation of best management

practices (BMPs) under the City's MS4 permit and source control activities under DEQ oversight at upland sites (under DEQ's Cleanup and Water Quality authorities) will promote continued reduction of pollutant concentrations in stormwater.

Memorandum Organization

This memorandum provides the following information:

- *BACKGROUND*. This section provides a general discussion of Basin 19 characteristics, including a description of the stormwater conveyance system, potential pollutant sources within the basin, and programs implemented by the City to manage stormwater discharges within Basin 19 under the City's MS4 permit to prevent pollutants from entering the storm sewer system.
- *BASIN 19 STORMWATER QUALITY TREND ANALYSES.* This section provides a description of the OF 19 stormwater data used in the trend analyses, the statistical methodology used to evaluate the data, and the results of the trend analyses.
- *EVALUATION OF BASIN 19 STORMWATER TRENDS.* This section presents a qualitative discussion regarding the effectiveness of City source control programs to reduce pollutant concentrations over time and highlights specific examples of successes in eliminating or significantly reducing pollutant discharges to the stormwater system.
- *FINDINGS AND CONCLUSIONS.* These sections summarize findings and present conclusions regarding the effectiveness of the City stormwater management programs to reduce pollutant concentrations within Basin 19.

BACKGROUND

Basin Characteristics and Conveyance System Configuration

Basin 19 is located in northwest Portland, as shown on Figure 1, and drains approximately 490 acres; 70 percent of this acreage is Forest Park (~ 339 acres of open space), 28 percent is zoned industrial (~137 acres), and the remaining acreage consists of major transportation (~9 acres). Developed areas in the basin include parking lots, building and operational areas with impervious ground surfaces. Stormwater from this basin discharges to the Willamette River through a 42-inch outfall. Figure 2 provides an overview of the Basin 19 conveyance system. The stormwater conveyance system includes two main lines, which converge at the downstream end of the basin near NW Front Avenue and NW Kittridge Avenue in a stormwater manhole (manhole no. AAP918): a 42-inch diameter line from the northwest along NW Front Avenue (western[1] branch) and a 48-inch diameter line from the south along NW Kittridge Avenue (eastern branch). There are no identified stormwater connections to the conveyance line from adjacent properties between this manhole and the river.

[1] For naming of the branches, the river is assumed to be due north.

Potential Pollutant Sources

There are over 30 industrial properties in Basin 19 (BES, 2000). Information on identified upland properties (i.e., potential pollutant sources) discharging to the City's stormwater conveyance system were inventoried to assess whether known sources may account for the presence or trends of the analytes evaluated in the trend analyses.

Upland properties identified as potential pollutant sources that discharge to the City's stormwater conveyance system include DEQ Cleanup Program sites and facilities permitted by DEQ under the NPDES industrial stormwater discharge (1200-Z) permit program[2]. Although limiting the list of potential sources to those meeting either of these criteria may omit some potential sources (such as sites with unidentified contamination issues, sites that do not require an NPDES permit, or sites that have had spills or that may illicitly discharge pollutants to the stormwater conveyance system), the list is intended to capture the known and likely potential sources based on available information to facilitate interpretation of the long-term Basin 19 stormwater data.

Upland Cleanup Sites

DEQ's Cleanup Program maintains information on sites with known or potential contamination from hazardous substances in the Environmental Cleanup Site Information (ECSI) database. There are 15 sites that are listed in DEQ's database as having or potentially having hazardous releases to the environment in Basin 19. These sites are listed in Table 1. Approximate ECSI site locations are shown on Figure 2.

Basin 19 discharges to the Willamette River near River Mile (RM) 8.2 within a section of the Willamette River designated as the Portland Harbor Superfund Area by the U.S. Environmental Protection Agency (EPA). DEQ and EPA, under a February 2001 Memorandum of Understanding, developed the *Portland Harbor Joint Source Control Strategy* (JSCS), which provides a framework for identifying, evaluating, and controlling sources of contamination to the river. As part of the implementation of the JSCS, DEQ is evaluating and controlling stormwater at ECSI sites through its Cleanup Program.

Ten of the 15 ECSI sites identified within Basin 19 have conducted, initiated, or agreed to conduct stormwater pathway evaluations under DEQ oversight. Some of the sites have received final source control decisions and/or no further action determinations from DEQ. The results of these evaluations will determine whether upland stormwater discharge concentrations require implementation of source control measures in order to protect the Willamette River and prevent recontamination of river sediments. Although review of information for these sites indicates that information gaps related to source evaluation or control remain for some sites, the upland source evaluation/control actions completed constitute major progress toward the goal of identifying and controlling upland sources of pollutants to the Basin 19 stormwater conveyance system.

[2] NPDES 1002-Z permits are issued to industries that discharge stormwater into waters of the State either by direct discharge or discharge through a storm system. Based on federal regulations, NPDES permit coverage is required for industrial facilities with certain types of industrial activities that have the potential to contaminate stormwater.

Table 1 identifies the ECSI site name, contaminants of interest (COI), source control status, and whether a stormwater pathway evaluation has been (or is being) conducted under DEQ oversight at the site. Data from these investigations have not been compiled for use in Basin 19 stormwater trend evaluation. However, information on these properties was inventoried as part of the City's *Stormwater Evaluation Report* (BES, 2010a), and assessment of this information indicates known sources in the basin generally appear to account for the pollutants detected at OF 19. It is assumed that source control measures taken by these uplands under DEQ oversight have reduced and will continue to reduce pollutant discharges to the City's stormwater conveyance system.

Stormwater Discharges

In Basin 19, DEQ has issued NPDES Industrial Stormwater General Permits to industries that discharge stormwater into surface waters via the City's stormwater conveyance system from point sources. The permits require that the facilities develop and implement a *Stormwater Pollution Control Plan* (SWPCP), which includes BMPs, to minimize the amount of pollutants in stormwater runoff.

Five NPDES industrial stormwater 1200-Z permits are currently active for facilities within Basin 19; these facilities are identified in Table 1 and shown on Figure 3. Table 2 identifies properties with current or historic NPDES permits and the time period for which stormwater data are available for these sites.

Stormwater quality monitoring is required for discharges under NPDES 1200-Z permits. Stormwater monitoring results are compared to benchmark concentrations established in the permit, including:

- Copper - 100 micrograms per liter (µg/L);
- Lead - 400 µg/L; and
- Zinc - 600 µg/L.

Discharges in excess of permit benchmarks warrant site response under the terms of the 1200-Z permits. Available NPDES site data are presented in Appendix A to help interpret specific OF 19 sampling events and/or long-term stormwater concentration trends.

Description of City Source Control Programs

The Water Quality Act of 1987 added Section 402(p) to the federal Clean Water Act (CWA) (33 U.S.C. § 1251-1387). This section required the USEPA to establish regulations setting forth NPDES requirements for municipal stormwater discharges. The Phase I Final Rule, published on November 16, 1990 (55 *Fed. Reg*. 47990) requires MS4 permit coverage for stormwater discharges from large municipal separate storm sewer systems located in incorporated places or counties with populations of 100,000 or more. The Phase I regulations (40 CFR 122.26(d)(2)) require regulated municipalities to develop adequate legal

authority, perform source identification, and develop a management program to reduce the discharge of pollutants to the maximum extent practicable using management practices, control technologies, and system design and engineering methods and other such provisions that are appropriate.

DEQ first issued a five-year NPDES MS4 permit to the City in 1995 [3]. The City's implementation of the permit requirements and other related programs have resulted in City stormwater programs geared towards reducing the discharge of pollutants into public waterways including the Willamette River via the City's conveyance systems. The permit also requires the City to assess controls and the effectiveness of its stormwater programs.

As part of its MS4 permit, the City has developed comprehensive stormwater management programs to reduce the discharge of pollutants (i.e., source control) from its stormwater conveyance systems to the maximum extent practicable. City programs or activities applicable to source control within the OF 19 basin include:

1. **Industrial Stormwater Program**. The City has an Intergovernmental Agreement with Oregon DEQ, in effect since 1994, to administer NPDES Industrial Stormwater permits for facilities located within the city limits. City oversight includes review of facility SWPCPs, performing annual inspections to ensure SWPCPs are being followed, providing technical assistance, and referring enforcement to DEQ, where appropriate. The City also identifies and conducts inspections at other facilities to determine if a permit is necessary and/or identify and address sources of pollution in stormwater runoff. Non-stormwater discharges allowed under the MS4 permit are assessed and approved provided appropriate BMPs, if needed, are developed and implemented.
2. **Spill Response and Illicit Discharge Elimination Program**. The City implements an Illicit Discharge Elimination Program (IDEP) to prevent, identify, and control illicit discharges to the City's stormwater systems and surface water. Elements of the program include verification of commercial and industrial connections to the storm system, and dry weather monitoring. The City maintains a 24-hour pollution complaint hotline and provides spill response. The City's Spill Protection and Citizen Response section investigates pollution going to, threatening, or leaving the City's storm sewer system. Staff also inspect and sample discharges from City stormwater outfalls during the dry season from June to September to detect and stop illegal or accidental discharges to City storm sewers.
3. **Development Standards**. The City's comprehensive *Stormwater Management Manual* (SWMM; BES, 2008) outlines the City's stormwater management requirements for new development and redeveloped sites. The manual requires onsite management of both water quantity and quality on both private and public properties. The manual (first adopted in 1999) was last revised in August 2008.

[3] DEQ first issued a five-year NPDES storm water permit for the Portland urban services boundary to the City of Portland, ODOT and other co-permittees on September 7, 1995. At the end of the first five-year cycle, the City and its remaining co-permittees (Multnomah County and the Port of Portland) submitted a permit renewal package to DEQ. The permit was renewed for a second term in March 2004. DEQ subsequently reconsidered the second-term permit and reissued a modified permit in July 2005 with an expiration date of February 28, 2009. Pending permit reissuance for the third term, DEQ has administratively extended the current permit.

4. **Operations and Maintenance**. The City continues to evaluate and improve maintenance practices for City buildings, structures, parks, and streets (street sweeping, stormwater inlet repair and replacement, etc.) to reduce the potential for pollutants to enter the City storm sewer system.
5. **Public Involvement and Education**. The City offers a wide variety of public involvement and education programs on stormwater to residential, commercial, and industrial users and the general public to encourage active participation in pollution reduction activities.
6. **Portland Harbor Superfund Program.** In 2003, the City and DEQ entered into an Intergovernmental Agreement (IGA) to collaborate on the identification and control of upland pollutant sources that drain to the City's stormwater conveyance systems before discharging to the Portland Harbor Study Area (i.e., City of Portland Outfall Project). The objectives of City's outfall investigation work to date have been to identify significant upland sources discharging to the City stormwater conveyance systems and implementing source control measures under the City's and DEQ's respective authorities.

In addition, BES works cooperatively with other City bureaus on watershed and river issues that affect stormwater, such as the North Reach Plan and transportation improvements.

BASIN 19 STORMWATER QUALITY TREND ANALYSES

This section presents the approach used to assess the impact of the City's overall stormwater source control programs, described above, on basin-wide stormwater quality using selected indicator pollutant concentrations.

Available Stormwater Monitoring Data and Usability

Selection of OF 19 for Water Quality Monitoring

In 1994, the City developed an Outfall Prioritization Plan to rank outfalls for investigation relative to each other, based on the potential for pollutant discharges from illicit connections or illegal discharges. The criteria used to prioritize outfalls included:

- IDEP monitoring results and visual observations;
- Land use category;
- Number of NPDES and Industrial Discharge permits; and
- Number of pollution complaints.

OF 19 was ranked by the City as a priority outfall because the basin contains a significant number of industrial properties. In 1995, the City selected OF 19 and began stormwater monitoring to gauge the effectiveness of the City's Industrial Stormwater Program and to

identify potential sources of industrial stormwater pollution within the basin. The City's stormwater source control activities are implemented throughout the area managed under its MS4 permit. Therefore, it is assumed that the results of the Basin 19 trend analyses can be used as a surrogate for likely stormwater quality trends (i.e., representative trend) in other City stormwater basins.

Monitoring Location

Basin 19 monitoring is conducted in a City manhole (manhole no. AAP918) located on the northwest corner of the intersection at NW Front and Kittridge Avenues (see Figure 2). Sampling is performed in the 42-inch storm line downstream of this manhole to represent all piped discharges to the basin. OF 19 is submerged below the river surface at higher river stages. Therefore, stormwater is sampled at an upstream manhole that is not subject to river backup from high river elevation stages.

Stormwater Monitoring

Stormwater quality data within a basin can be variable based on a number of factors (see "*Challenges in Evaluating Stormwater Data*" section below), such as storm type, seasonal trends, land use changes, and changes in industry types. One of the objectives of this evaluation is to determine if any trends can be discerned despite this variability.

OF 19 has been sampled over 80 times representing approximately 50 wet or dry weather[4] sampling events collected between February 1995 and February 2010. Sampling was performed at least three times per fiscal year (FY; July 1 – June 30), with the exception of FY 1996-97, when no samples were collected. The data set includes 11 dry weather events; dry weather sampling events typically included a 24-hour time-weighted composite sample collected at 10-minute intervals as well as a grab sample collected at the beginning of the composite monitoring period. In Basin 19, the only known sources of dry weather flow are from Forest Park streams and infiltration of groundwater into the storm pipes. Dry weather monitoring was discontinued in July 1998. Wet weather (i.e., stormwater) sampling is ongoing.

Wet weather sampling protocols have varied over time and have included grab and composite samples collected during first flush conditions as well as flow-activated, time - weighted composites intended to represent the remainder of the storm, and flow-weighted composites representing the full storm hydrograph. Wet weather compositing protocols varied between events until the second event (i.e., December 1999) of FY 1999-00, when the protocol was changed to be consistent with other monitoring sites being used to meet the MS4 permit requirements. From this point to the present, stormwater sample collection changed to one flow-weighted composite sample collected over the duration of the storm. Appendix B provides a more detailed summary of OF 19 monitoring protocols.

Typically, stormwater samples have been analyzed for pollutants commonly found in stormwater [total suspended solids (TSS), total dissolved solids (TDS), hardness, *e. coli*,

[4] "Dry weather event" is defined as non-stormwater flows from various sources including, but not limited to: diverted stream flow; groundwater infiltration; approved or permitted discharges (e.g., remediated groundwater, structure dewatering); non-contact cooling water; etc.

phosphorus, nitrogen, oil and grease) and seven metals (arsenic, cadmium, chromium, copper, lead, silver, zinc]. Beginning in FY 2006-07, the City's Portland Harbor Superfund Program requested that additional parameters be analyzed to support the objectives of the IGA with DEQ [e.g., polycyclic aromatic hydrocarbons (PAHs) added in 2006, polychlorinated biphenyls (PCBs) added in 2007, pesticides added in 2009].

Laboratory data sheets are not provided in this report. OF 19 stormwater data have been previously submitted to DEQ in the Annual Compliance Reports (BES et al., 1996 through 2010) required by the City's NPDES MS4 Discharge Permit. Stormwater data collected under the direction of the City's Portland Harbor Superfund Group was submitted to DEQ in the *Stormwater Evaluation Report* (BES, 2010a).

Data Used in Trend Analyses

The stormwater trend analyses presented in this report focus on a limited number of pollutants: copper, lead, and zinc. These pollutants were selected because long-term stormwater data are available for these parameters and they are monitored at upland facilities with NPDES Industrial Stormwater permits. The data set used in the statistical evaluation, described below, represents a sample size of 33 samples for each pollutant (copper, lead, zinc) and is comprised of data from three sampling events per stormwater (i.e., wet) season over 11 stormwater seasons (1999/2000 through 2009/2010). Only data collected since December 1999 (second wet weather sampling event) using standardized sampling techniques (e.g., one flow-weighted composite sample collected over the duration of the storm) were evaluated to assess trends. Data collected before December 1999, while of acceptable quality, were excluded from the trend analyses because sampling protocols were significantly different and would introduce uncertainty in the analyses. Data used in the trend analyses is summarized in Appendix C. Concentrations reported by the laboratory as not detected were plotted and included in the analyses at the method reporting limit (MRL).

Trend Analyses Methodology

A statistical regression model was used to assess whether concentration trends could be identified in the OF 19 stormwater quality monitoring data. The trend analysis employs a regression methodology called quantile regression. Quantile regression attempts to model quantiles (such as the median, 25th percentile, etc.) of a response variable (e.g., concentration of a pollutant) as a function of predictor variables (e.g., time). The method is semiparametric in that there is no parametric distribution (e.g., normal) assumed for the error term in the model. This method has an advantage over ordinary least squares regression because it allows fitting regression models for any quantile and it is more robust with respect to outliers than standard linear regression. Just as the median is used as a robust estimate of central tendency for data with outliers, a quantile regression model for the median (or other quantile) can be used as a robust alternative to standard ordinary least squares regression models (Cade, et. al., 2003).

Quantile regression models were fit to total and dissolved copper, lead, and zinc data for three quantiles: the median, the 20th and the 80th percentiles. These three quantiles were chosen to represent an "average" concentration, the lower tail and the upper tail, respectively, of the distribution of the analyte.

Trend Analyses Results

Plots illustrating OF 19 stormwater concentrations over time (1995 -2010) are presented for copper, lead, and zinc in Figures 4 through 7, respectively. The plots are useful for:

- Presenting the variability of concentrations (i.e., range of concentration values) between individual stormwater sampling events over time.
- Presenting the results of dry weather flow sampling.
- Providing context of the stormwater concentrations for individual OF 19 sampling events and long-term concentration trends against EPA's chronic National Recommended Water Quality Criteria (NRWQC)[5] and DEQ NPDES 1200-Z benchmark concentrations for each pollutant.
- Identifying potentially anomalous data points that may be associated with discharges to the conveyance system or activities within the basin conveyance system.
- Depicting the estimated stormwater concentration trend lines for 1999-2010 data, based on the results of the statistical regression model for three quantiles: the median, the 20th and the 80th percentiles.

The estimated trend coefficients (i.e., slope of estimated trend line) for the quantile regression models and the confidence intervals on those trends are summarized in Figure 7.

Copper

Figure 4 presents a plot of the OF 19 copper concentrations over time (1995 to 2010) and the results of the quantile regression analyses performed on data collected between December 1999 and February 2010. Copper was generally detected at low concentrations in dry weather flow samples, indicating copper detected in the OF 19 samples is associated with stormwater discharges from upland sources.

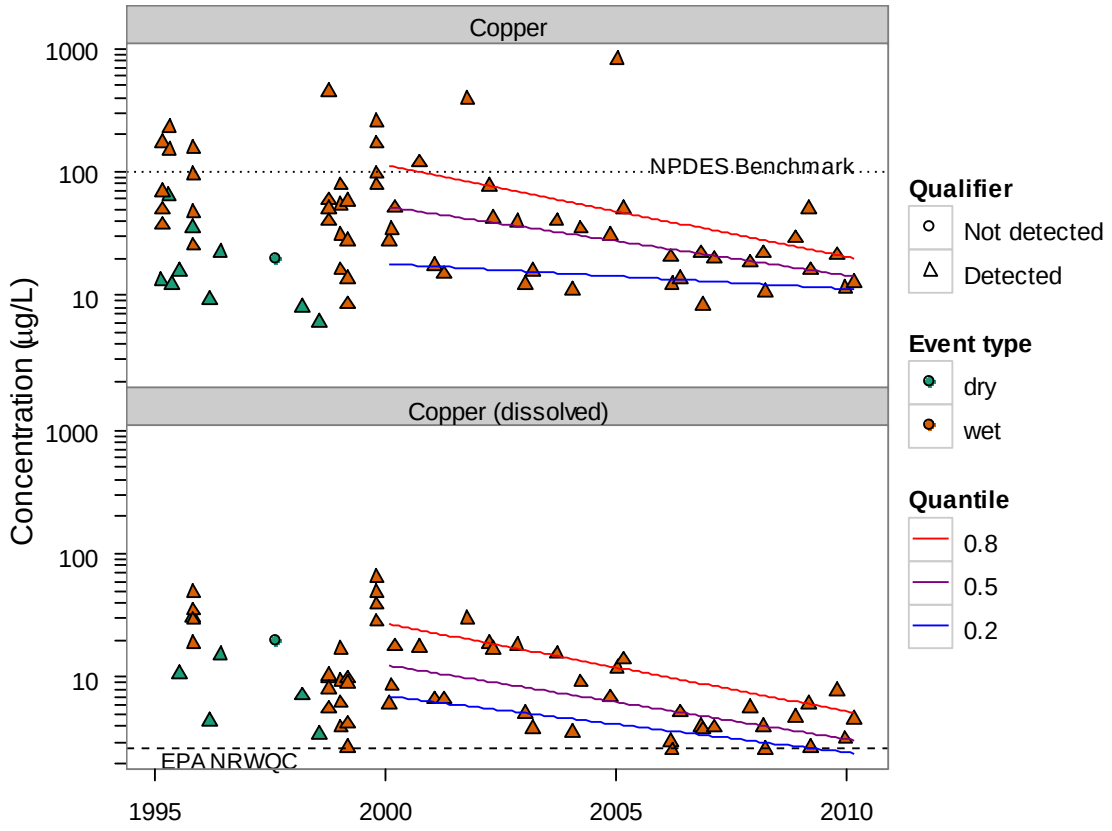
Copper concentrations at current and historic NPDES 1200Z permitted facilities are plotted and presented in Appendix A. Comparison of facility permit data to the basin-wide data indicates that early source control actions (pre-2000) resulted in concentration reductions to levels generally below permit benchmark values at upland sites and decreased

[5] NRWQC are used in this memorandum as screening level values to assess whether stormwater concentrations from upland pollutant sources may pose a potential threat to the Willamette River, consistent with the Portland Harbor JSCS (DEQ and EPA; 2005). NRWQC standards are intended to protect surface water quality and are expressed as dissolved metal concentrations in the water column and are not intended to be applied to stormwater. It should be noted that both total and dissolved metal concentrations detected in OF 19 stormwater samples are conservatively compared to the NRWQC concentration. The JSCS identified copper, lead, and zinc as hardness dependent metals and adjusted the NRWQC concentrations to the estimated hardness (25 mg/l of $CaCO_3$) of the Willamette River.

concentrations at the outfall. Elevated copper concentrations detected in some site permit monitoring data may help explain some of the higher measured outfall concentrations. Other elevated outfall concentrations may be the result of basin activities; for example, one anomalous total copper concentration (January 6, 2005) is likely the result of documented stormwater system cleaning activities within the basin. This sample was collected at the same time (January 4 - 6, 2005) contaminated stormwater solids were being removed from catch basins and stormwater lines at the Calbag facility (CEC, 2005).

The quantile regression results for both copper and dissolved copper indicate that concentrations are decreasing over time. As shown on Figure 7, all of the estimated trends for copper are decreasing (i.e., negative) and the trends for each quantile are significantly different from zero (i.e., the upper limit of the confidence interval for each quantile is less than zero; see Figure 7). The decreases in the median concentrations for copper and dissolved copper were 12 percent and 13 percent per year, respectively. The higher quantiles appear to be decreasing somewhat faster than the lower quantiles. The trend in the 80th percentile for copper is about a 16 percent decrease per year while the trend for the 20th percentile is about a 5 percent decrease per year. The dissolved copper results are more consistent across quantiles with decreasing trends of 15 percent per year for the 80th percentile and 10 percent per year for the 20th percentile.

Figure 4: OF 19 Copper Concentrations and Trend Analysis Results



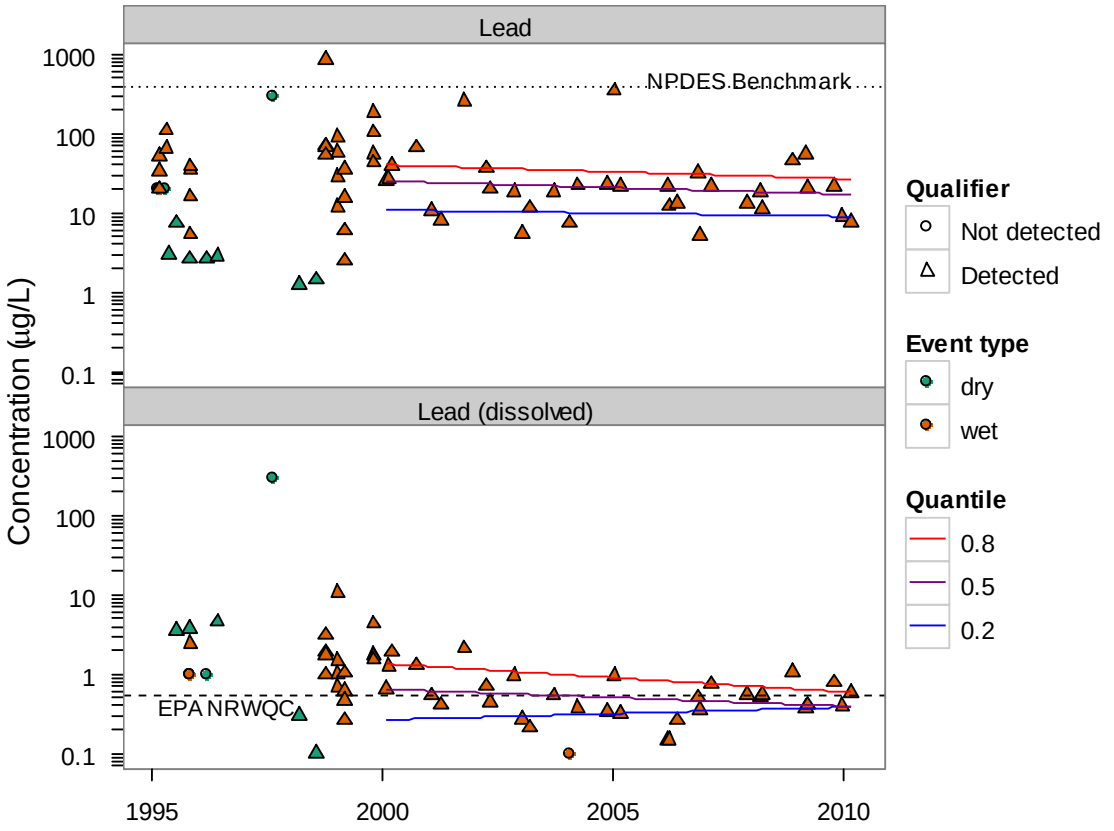
Lead

Figure 5 presents a plot of the OF 19 lead concentrations over time (1995 to 2010) and the results of the quantile regression analyses performed on data collected between December 1999 and February 2010. Lead was generally detected at low concentrations in dry weather flow samples, indicating lead detected in the OF 19 samples is associated with stormwater discharges from upland sources.

Lead concentrations at current and historic NPDES 1200Z permitted facilities are plotted and presented in Appendix A. Similar to copper, these plots indicate that early source control actions (pre-2000) resulted in concentration reductions to levels generally below permit benchmark values at upland sites and decreased concentrations at the outfall. Elevated lead concentrations detected in some site permit monitoring data may help explain some of the higher measured outfall concentrations. Other elevated outfall concentrations may be the result of basin activities; for example, the total lead concentration in the January 2005 sample is likely elevated due to stormwater system cleaning activities at and adjacent to the Calbag facility (see above).

The quantile regression results for both lead and dissolved lead indicate that the concentrations of lead in OF 19 stormwater are likely decreasing at a slow rate (i.e., concentration have been relatively steady over the time period evaluated). For dissolved lead, the 80th percentile has a significantly decreasing trend of approximately 8 percent per year. As shown on Figure 7, the estimated trends for lead are generally decreasing with the exception the 20th percentile for dissolved lead which indicates a slight increase (i.e., positive trend) of less than 5 percent per year. However, the trends for the 20th percentile and the median quantile are not considered statistically significant (i.e., different than zero) because the confidence intervals bracket zero (see Figure 7). Overall, five of the six estimated trends for lead are decreasing which indicate that the data support the conclusion that lead concentrations are decreasing slightly over the period of the analysis. The dissolved lead concentrations may indicate that concentrations may be narrowing more than decreasing across the board. The lead results may show only a slight decrease, because the use of leaded gasoline was phased out before OF 19 stormwater monitoring was initiated, due to the federal regulations implemented between 1973 and 1996.

Figure 5: OF 19 Lead Concentrations and Trend Analysis Results



Zinc

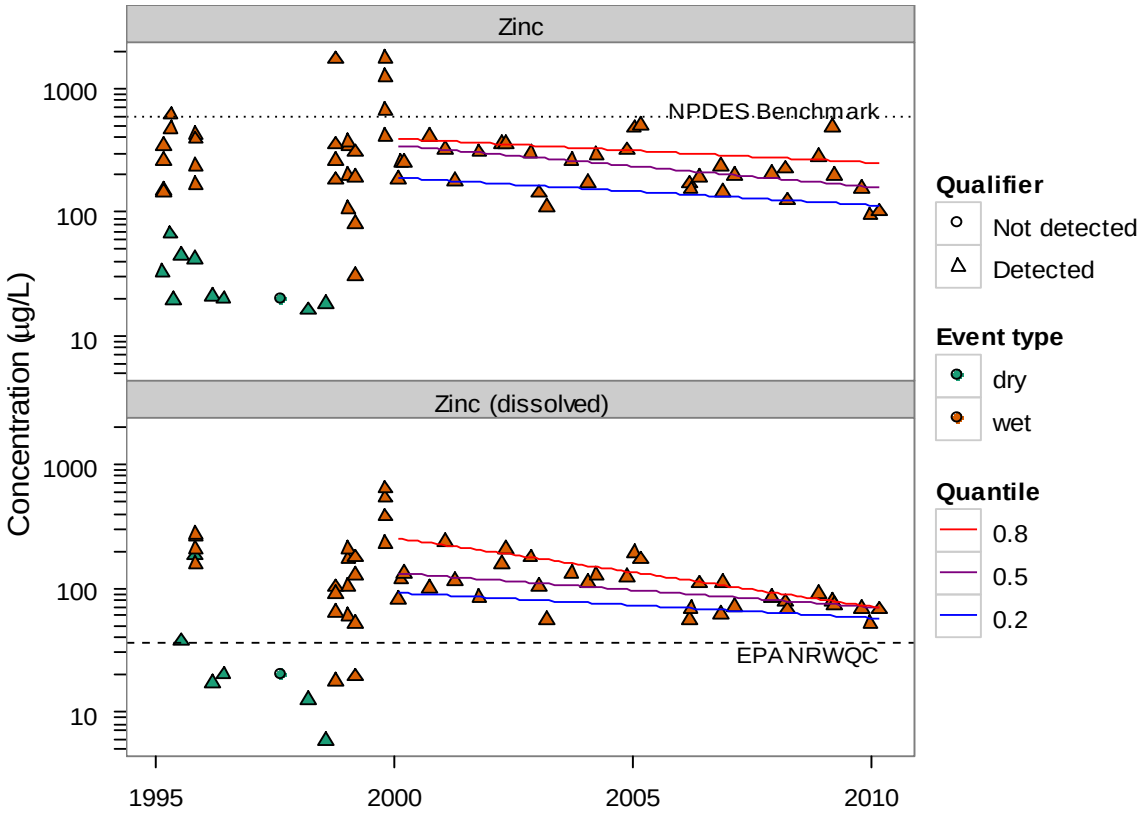
Figure 6 presents a plot of the OF 19 zinc concentrations over time (1995 to 2010) and the results of the quantile regression analyses performed on data collected between December 1999 and February 2010. Zinc was generally detected at low concentrations in dry weather flow samples, indicating lead detected in the OF 19 samples is associated with stormwater discharges are from upland sources.

Zinc concentrations at current and historic NPDES 1200Z permitted facilities are plotted and presented in Appendix A. Similar to copper and lead, these plots indicate that early source control actions resulted in concentration reductions to levels generally below permit benchmark values at upland sites and decreased concentrations at the outfall. Elevated zinc concentrations detected in some site permit monitoring data may help explain some of the higher measured outfall concentrations. Other elevated outfall concentrations may be the result of basin activities; for example, the elevated total zinc concentration in the January 2005 sample is likely related to the concurrent Calbag stormwater system cleaning activities (see above).

The quantile regression results for both zinc and dissolved zinc indicate that the concentrations of zinc in OF 19 stormwater are decreasing over time. As shown on Figure 6, all zinc and dissolved zinc quantiles have decreasing estimated trends. Five of the six trends are significantly different from a zero trend with the only exception being the 80th

percentile for total zinc (see Figure 7). The magnitude of the trends ranged from a decrease of 4 percent per year for the 80th percentile of total zinc to 12 percent per year for the 80th percentile of dissolved zinc.

Figure 6: OF 19 Zinc Concentrations and Trend Analysis Results



Summary

The estimated annual stormwater concentrations reductions presented in the previous subsections are based on a linear regression analysis. The analyses demonstrate that copper and zinc, and (to a lesser extent) lead concentrations have decreased over the past 10 years. The linear quantile regression model is a good fit to the data used in the model and there is no serious evidence of lack of fit for any of the analytes. As with any statistical model, estimated rates of change and confidence intervals for these rates involve an assumption that the model is correct. For this model, we are assuming that the quantiles of the analyte distribution are changing linearly over time. Concentration reductions were likely greater (i.e., steeper) in earlier years of source control and tapered off in later years, as suggested by the copper data (see Figure 4). Appropriate cautions and additional analyses should be considered before projecting potential concentration reductions into the future since industries are permitted to discharge at higher concentrations (i.e., benchmarks) than water quality criteria.

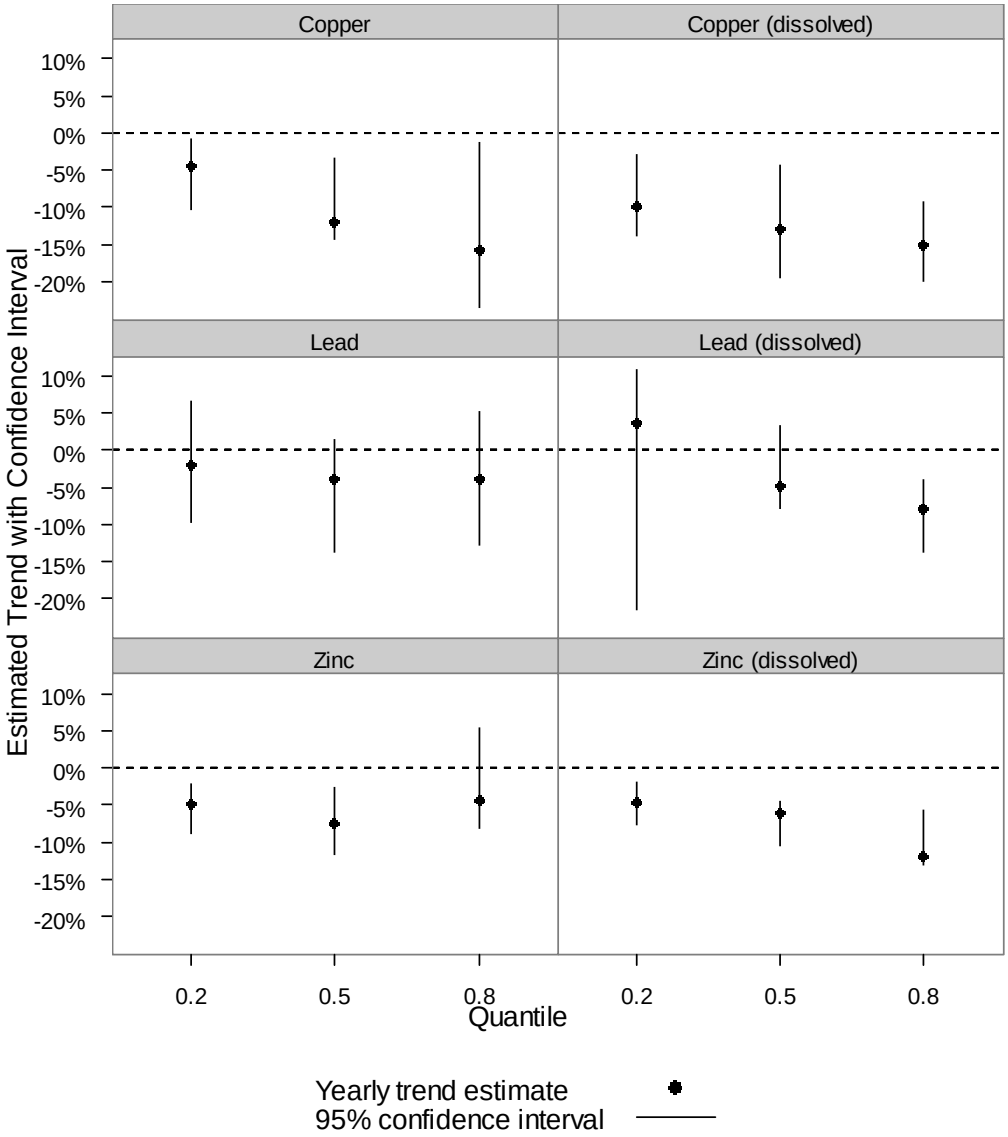
Appendix A also presents concentration plots for Outfall 19 over time for total and dissolved arsenic, chromium, silver and total suspended solids. While a quantile regression analyses was not performed on these data, these plots show similar patterns to those for

copper, lead, and zinc. The plots for arsenic, chromium, and silver also indicate that early upland source control actions (pre-2000) likely resulted in the significant concentration reductions at the outfall.

The following general observations were made, based on the concentration plots presented in Figures 4 through 7:

- In general, the figures display expected patterns with higher concentrations and concentration reductions noted in the early years of the monitoring data. Concentration reductions were likely highest in the earlier years due to the implementation of the City's NPDES MS4 permit and as facilities (i.e., pollutant sources) were identified and source control activities implemented (e.g., permits, BMPs, technical assistance).
- Concentrations of the selected pollutants in stormwater have decreased overtime and have been generally below NPDES-1200Z benchmark concentrations over the past 10 years.
- The variability in stormwater concentrations appears to have decreased over time due to one or more of the following:
    - Implementation of BMPs by facilities discharging to the City's stormwater conveyance system under NPDES permits.
    - Improved upland site practices to prevent non-stormwater discharges and/or spills).
    - Implementation of BMPs by the City under the MS4 permit in City rights-of-way.
    - Improved consistency in stormwater sampling protocols.
- Dissolved concentrations appear to be approaching the chronic NRWQC concentrations.

Figure 7: Estimated annual trends and confidence intervals for the OF 19 metals data.



EVALUATION OF BASIN 19 STORMWATER TRENDS

This section considers the results of the stormwater quality trends analyses in light of some of the challenges in evaluating stormwater data, site-specific source control activities, and site-specific NPDES stormwater monitoring data. This additional information is presented to help interpret the results and significance of the long-term pollutant concentration trends.

Challenges in Evaluating Stormwater Data

A number of challenges in evaluating basin scale stormwater data make it difficult to determine source control effectiveness. These include:

1. **Inherent Variability of Stormwater**. Stormwater quality is influenced by a number of physical factors, including the antecedent dry period, rainfall intensity, rainfall duration, runoff surface characteristics such as slope and permeability, and seasonal and spatial fluctuations in pollutant source locations. Because samples collected over a rainy season will reflect a variety of storm conditions, and the spatial distribution of pollutant sources is not fixed, stormwater data typically includes a high degree of variability.

   The inherent variability of stormwater concentrations contributes uncertainty to the stormwater trends analyses (i.e., the uncertainty represented by the confidence intervals). For example, lead concentrations (see Figure 5) in OF 19 stormwater vary over several orders of magnitude and the estimated trends have large confidence intervals (see Figure 7). However, the long-term period of the trend analysis (11 years), the sample size (n = 33), and the magnitude of the estimated trends all contribute to our ability to identify trends in the data. Thus, our ability to detect trends has not been overly affected by stormwater variability.

2. **Changes in Activities within a Basin**. On a longer-term basis, companies (i.e., industrial base), facility operations, and/or traffic patterns change, which can affect the types of pollutants transported by stormwater runoff. Trends in stormwater concentrations could be related to source control efforts at sites or related to the type of facilities operating within a basin at the time of sampling. Shorter-term activities, such as seasonal operational changes, spills or occasional vehicle washing, can also affect stormwater concentrations and reduce our ability to detect trends in stormwater quality.

3. **Pollutant Contributions from Numerous Sources**. City conveyance systems typically receive stormwater from both public rights-of-way and numerous facilities with varying physical characteristics (impermeable surface area, slope, etc); land uses (industrial, commercial, open space, etc.) and activities (parking, fueling, plating, storage, etc.). Currently, there is no model to quantitatively determine how individual site pollutant contributions (i.e., upstream point source network) impact the measured basin scale concentrations (i.e., downstream concentrations in the stormwater conveyance system).

4. **Limited Stormwater Data at NPDES-Permitted Sites**. Correlating overall stormwater changes at the basin level with changes occurring at the site level (see Appendix A for examples) is difficult. NPDES-permitted facilities are required to collect a limited number of grab samples per year (two per year until 2006 and four per year after 2006) for analysis of total lead, copper, zinc, TSS, total oil & grease, and pH. The challenges in correlating this site monitoring data to basin-wide stormwater data include:

   - Grab sample results can be highly variable depending on the relationship of the source to the sampling location, how stormwater runs off a site, and the timing of the sample collection. For example, samples collected at the start of a storm, after a period of no rain when pollutants have accumulated on exposed surfaces (often referred to as first flush samples), might have higher concentrations. On the other hand, if the site has clean pavement close to the sampling point and contaminated soils far from the sampling point, the highest concentrations in stormwater might be expected later in the storm hydrograph. Grab samples may or may not be representative of overall stormwater quality discharging into the City's stormwater system.

- The limited number (two) of grab samples per year before 2006 introduces significant uncertainty into conclusions regarding historical site stormwater quality. Because grab sample concentrations can vary greatly, a large number of samples may be needed to adequately capture the range of potential concentrations and allow estimation of the true mean concentration within a defined confidence interval. While the collection of a larger number of grab samples typically improves the "representativeness" of a data set, at permitted sites changing operations and/or BMP implementation to reduce pollutant loading complicates the collection and development of statistical stormwater descriptions (e.g., mean, geomean) at individual sites.

- Sites operating under NPDES 1200-Z permits are required to compare stormwater monitoring results to established benchmark concentrations and to implement response actions if discharge concentrations exceed these values. In general, actions are generally implemented to reduce concentrations to benchmark values. Sites discharging near benchmark concentrations may mask the effectiveness of basin-wide stormwater source control activities. Benchmark concentrations are significantly higher than water quality criteria or Portland Harbor Screening Level Values (SLVs) defined in the JSCS (DEQ/EPA, 2005).

- The limited NPDES 1200-Z permit analyte list for required monitoring limits the ability to interpret and understand the water quality trends at sites and how they affect overall stormwater discharging from basin. For example, if a non-NPDES analyte such as cadmium significantly increases in the basin during one period, it is not possible to determine if the source is one or many sites, if the increase is a result of when the sample was collected (e.g., seasonal effects), or if there was a spill that affected the results.

5. **Limited Stormwater Pathway Evaluation Data at DEQ Cleanup Sites**. Sites are identified in DEQ's ECSI database because they have had a release of one or more site pollutants that DEQ believed posed a potential risk to human health or the environment. Therefore for the purposes of this report these sites are considered as potential current or historical sources of pollutants to the City's storm system. The analyte list for upland Portland Harbor site stormwater pathway evaluations includes a comprehensive list of metals, PAHs, PCBs, phthalates, and other constituents. However, a limited number of stormwater sampling events are typically required for stormwater pathway evaluations, and insufficient data are available to establish concentration trends at these sites. Although there are 15 ECSI sites in the basin, stormwater pathway evaluation data are not available for all these sites, either because a site completion decision was made by DEQ before they started requiring stormwater pathway evaluations, the site is inactive, or (for active sites) sampling results are still pending. Stormwater pathway evaluations have been completed or are in progress for 10 of the ECSI sites in Basin 19. Data from these investigations (where available) were not compiled for this report. However, it is assumed that source control measures taken at these upland sites under DEQ oversight have reduced and will continue to reduce pollutant discharges to the City's conveyance systems.

6. **Background Stormwater Quality**. Stormwater quality as noted above is influenced by a variety of factors. Some constituents (e.g., metals) measured in stormwater are naturally occurring (i.e., natural background) and may be present either due to erosion or leaching from exposed surface soils. Other constituents (e.g., petroleum hydrocarbons, metals, organic pollutants) measured in stormwater are the result of human activities (i.e., anthropogenic) such as vehicular traffic (exhaust, tire wear, brake pads, belt wear, fuel leaks, fluid leaks, etc.). Natural or anthropogenic background stormwater concentrations have not been defined by DEQ or EPA.

While these challenges introduce uncertainty into the long-term stormwater quality trend analyses, the long-term stormwater data set collected in Basin 19, in conjunction with information on source control activities and site stormwater data, is adequate to demonstrate the general trends in stormwater quality are likely attributable to upland source control efforts.

Stormwater Program Effectiveness Evaluation

The results of the trend analyses indicate that Basin 19 stormwater pollutant concentrations have decreased over time. These concentration reductions are attributed to site-specific source control actions required and implemented under NPDES permits, actions required under the City's Industrial Stormwater Program authority, upland site stormwater improvements required by the SWMM for sites undergoing redevelopment, and the successful implementation and adaptive management of City-wide stormwater programs under the MS4 permit. As such, reductions are expected to continue into the future (although if any of the numerous NPDES-permitted industrial facilities in the basin increase their discharge of metals up to the 1200-Z permit benchmark concentrations, these permitted discharges may mask further overall reductions in loading to the system). Examples of site-specific source control activities and BES successes in reducing pollutant discharges to the City's stormwater conveyance system are presented in the following sections.

Source Controls Activities

The City has been collecting information on industrial facilities that discharge to the City's stormwater conveyance systems since the mid-1990s. Actions, such as BMPs, implemented at upland facilities under either NPDES or City Code authority within Basin 19 to reduce the discharge of pollutants to the City's conveyance system are briefly summarized below:

- **Requiring appropriate BMPs**. The City's Industrial Stormwater Program administers the NPDES Industrial Stormwater General Permits issued by the DEQ for facilities located within the City of Portland. The City conducts annual inspections to assess compliance with the permit and to ensure that SWPCPs are complete, accurate and followed. Samples of stormwater runoff are taken by the permitted facility and compared with benchmarks in the permit. If benchmarks are exceeded, the facility is required to assess the SWPCP and ensure it is being followed and to implement additional measures to meet benchmark values.

- **Providing technical assistance.** The City provides technical assistance to facilities on minimizing the exposure of industrial activities to stormwater as well as on implementing spill prevention and control measures. This approach is an iterative process that is intended to improve stormwater runoff quality over time.
- **Eliminating prohibited non-stormwater discharges.** The City requires that prohibited non-stormwater discharges or illicit discharges to the City's stormwater conveyance system be terminated, as they are identified**.**
- **Ensuring adequate spill prevention and response measures.**

These efforts provide improvements in stormwater runoff from industrial properties over time. In addition, the removal of illicit discharges and improvements in spill prevention and response are likely reducing peak discharge concentrations in stormwater runoff. These efforts should continue to provide improvements with time as additional properties are inspected and permitted sites implement additional BMPs as necessary.

BES Successes/Adaptive Management

Specific examples of BES successes in reducing pollutant discharges to the Basin 19 conveyance system through implementation of City-wide stormwater management requirements or programs are presented below.

- **Eliminated Silver Source Discharge.** In 2000, the City's Illicit Discharge Elimination Program (IDEP) identified an illicit wastewater connection to the onsite stormwater system from a photo processor (Color Magic), located at the Mt. Hood Chemical Property (ECSI #1328). The City required the site to reroute the connection to the sanitary sewer in 2000. Concentrations of silver, a common pollutant associated with photo processing, were generally between 1 and 500 µg/L at OF 19 before 2000 but dropped significantly (not detected ($\leq$0.1) and 0.3 µg/L) after this wastewater was rerouted to sanitary (See plots in Appendix A).
- **Abandonment of Stormwater Lines**. Lines at and in the vicinity of the PGE-Forest Park property, a site with known PCB contamination, were abandoned by the City to prevent off-site migration in 2007.
- **Redevelopment under the SWMM**. Two properties, Penske Truck Leasing and Greenway Recycling, were redeveloped in accordance with the SWMM in 2007, which required stormwater treatment before discharging to the City's system.
- **Paving/redevelopment to prevent soil erosion**. The redevelopment of the Schnitzer Kittridge Distribution Center property (performed prior to the SWMM) and repaving of the Calbag Metals property (action did not trigger the SWMM) were intended to prevent the historic pollutants present in site soils from being eroded and transported to the Willamette River.

FINDINGS

This section summarizes the findings presented in this technical memorandum.

- Stormwater concentration reductions in Basin 19 are attributed to the implementation of stormwater programs under the MS4 permit.
- Concentrations of the pollutants monitored under the City's NPDES MS4 permit are decreasing as measured at the end of Basin 19, and are approaching surface water NRWQC (See Figures 4 – 7). However, NPDES 1200-Z permitted facilities discharging near benchmark concentrations may mask the effectiveness of ongoing basin-wide stormwater source control activities. Benchmark concentrations are significantly higher than water quality criteria.
- BMPs implemented under programs developed in response to the City's MS4 permit and City Code requirements for stormwater treatment and/or management at new development and redevelopment sites are expected to result in additional control of pollutant sources and subsequent reductions in pollutant discharge concentrations to Basin 19 and other City's stormwater systems.
- Stormwater pollutant concentrations at individual industrial properties within Basin 19 are likely to decrease into the future as a result of redevelopment under the SWMM, implementation of current NPDES 1200-Z permits, and potential changes to DEQ's NPDES 1200-Z permit requirements. Ongoing inspections, technical assistance, monitoring and BMP activities at permitted facilities within the basin are likely to ensure pollutant discharges to the City's stormwater system are maintained at concentrations below benchmark values.
- Known and potential sources of pollutants to the Willamette River, within Basin 19 and within other City stormwater basins that discharge within the Portland Harbor Study Area, have been or currently are being evaluated under DEQ's Cleanup Program to determine if stormwater source control measures are required to meet the objectives of the Portland Harbor JSCS. Actions implemented under this program should reduce the discharge of a broad range of stormwater pollutants (e.g., PCBs, PAHs, metals, pesticides) to the Basin 19 and other City conveyance systems.

CONCLUSION

The City concludes that its stormwater management programs (Industrial Stormwater Program, MS4 permit implementation, etc.) have been effective in reducing pollutant discharges to City stormwater conveyance systems. Continued implementation of City programs and enforcement of City Code requirements for stormwater management at new development and redeveloped sites are expected to result in additional control of pollutant sources and subsequent reductions in pollutant discharges to City-wide stormwater systems.

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Tables

Figures

Appendices

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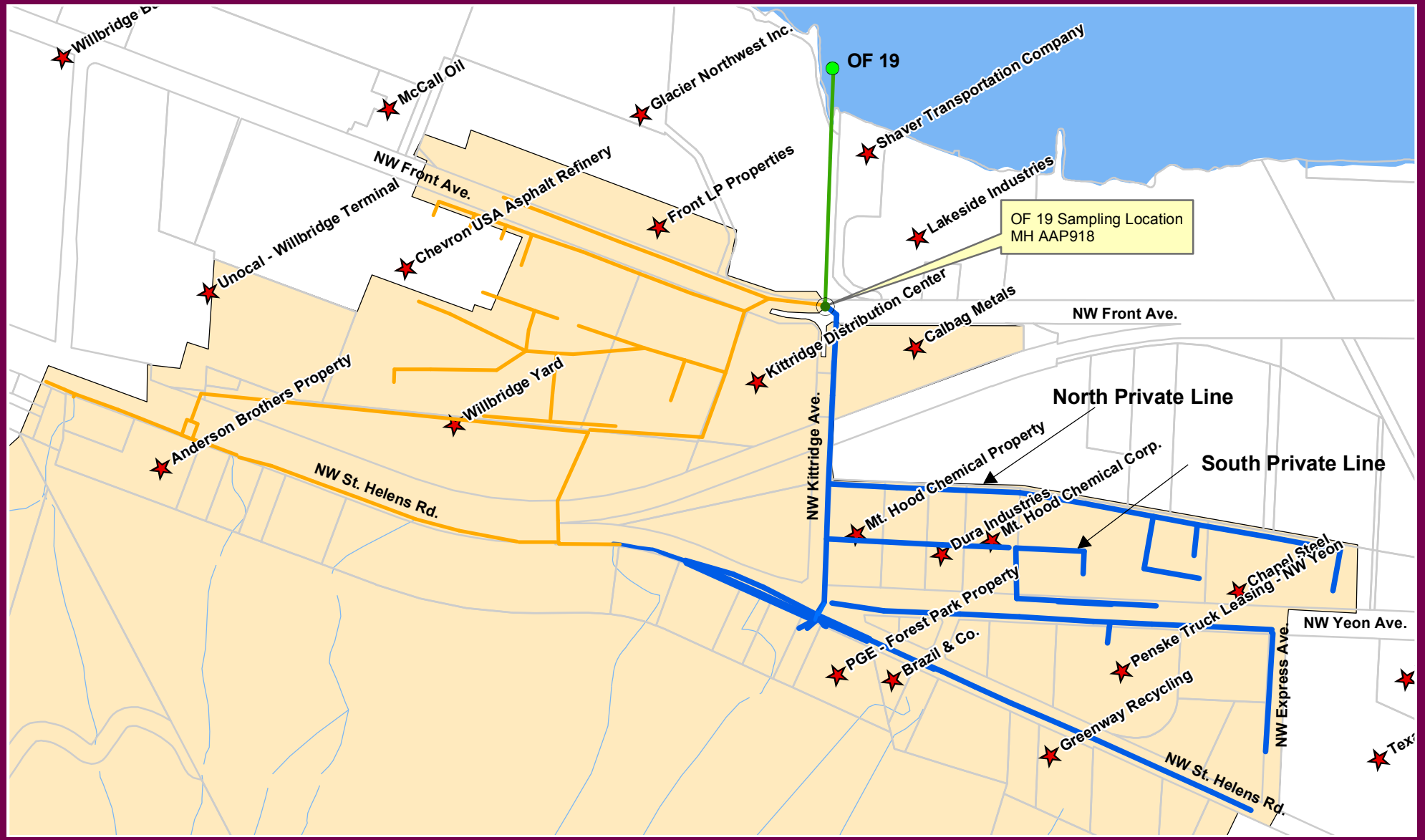
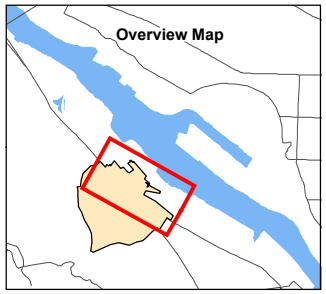




Legend

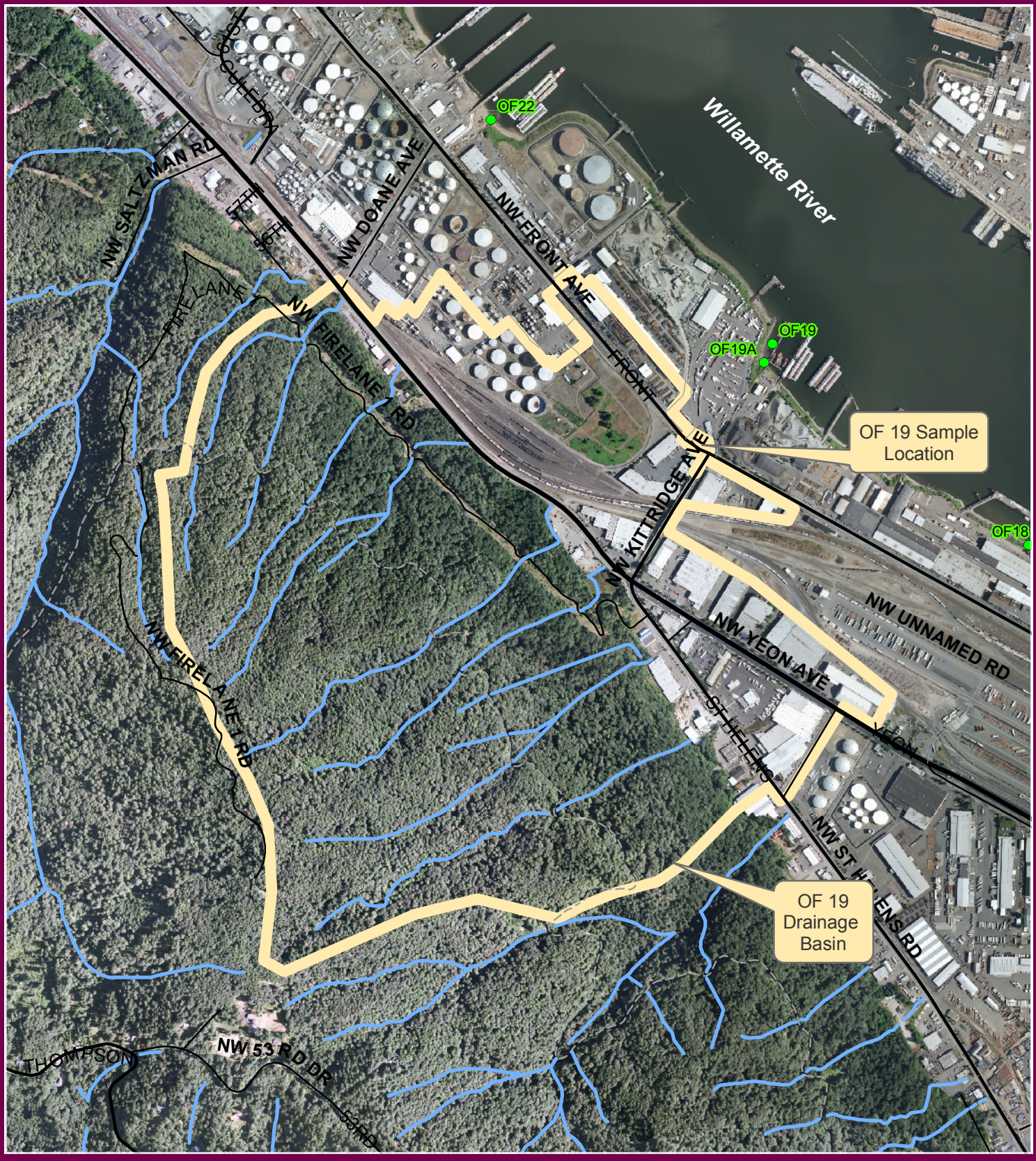
- Basin 19
- To Outfall 19
- Eastern Branch
- Western Branch
- Taxlots
- DEQ Environmental Cleanup Sites
- City Outfall
- Manhole

0 250 500 1,000 Feet

N E S W

Figure 2
Basin 19 Conveyance System Overview

Source: City of Portland BES	Environmental Services City of Portland 1120 SW Fifth Avenue, Room 1000 Portland Oregon, 97204-1912
File Name: s:\GIS\Sara\of19\Basin19_Fig2.mxd	**Program Manager:** Rod Struck Portland Harbor Superfund
Sheet No. 1 OF 1	**Date Printed:** 01/27/11 **Prepared by:** Sara Gardner



Legend

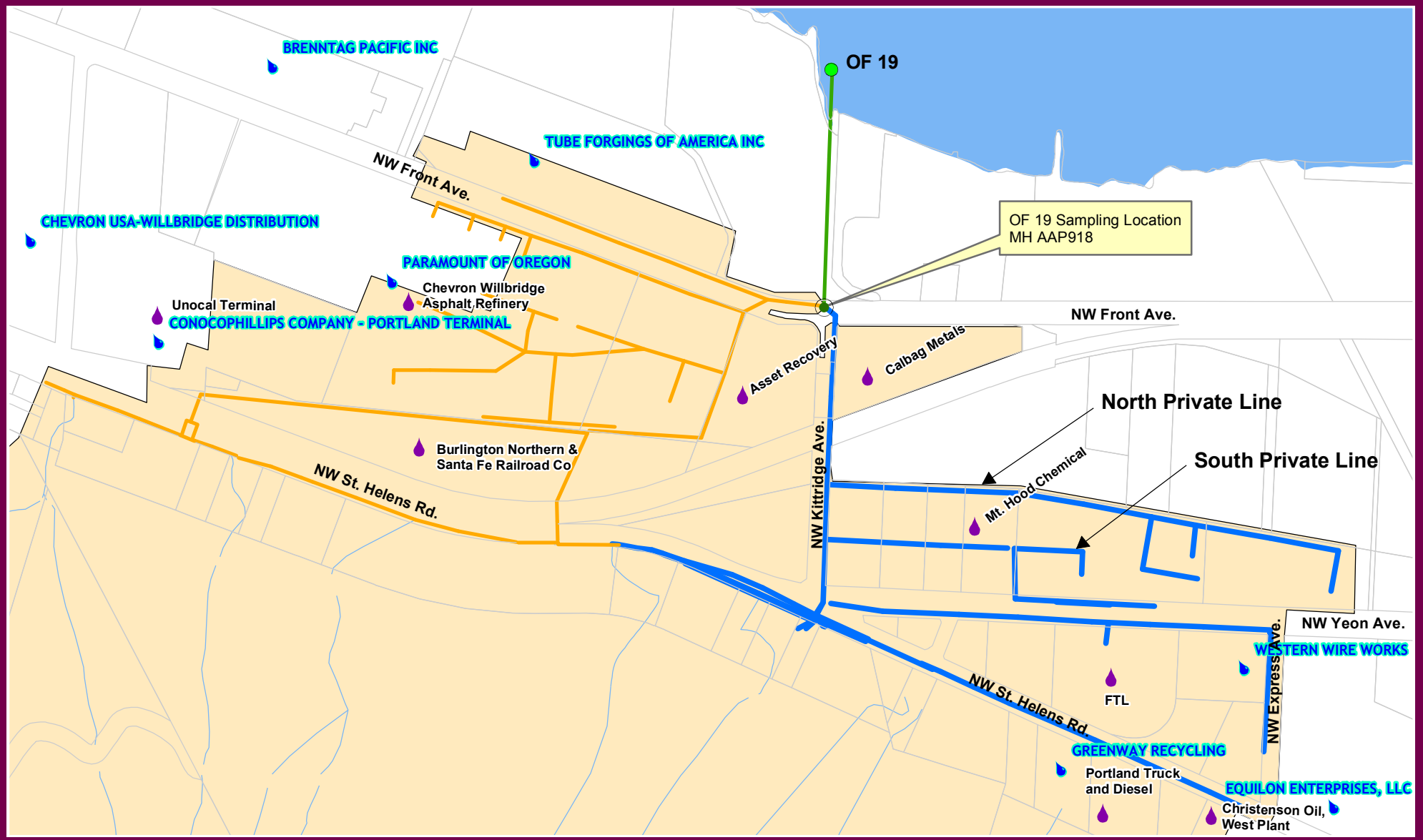
- Basin 19
- Streams
- City Outfall

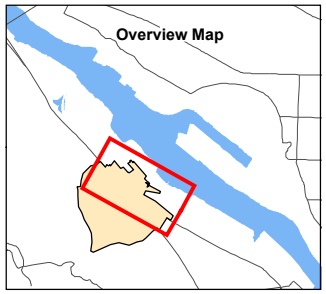
0 500 1,000 2,000 Feet

N W E S

Figure 1
Basin 19 Location

Source: City of Portland BES	Environmental Services City of Portland 1120 SW Fifth Avenue, Room 1000 Portland Oregon, 97204 - 1912
File Name: s:\GIS\Sara\of19\Basin19_Fig1.mxd	**Program Manager:** Rod Struck Portland Harbor Superfund
Sheet No. 1 OF 1	**Date Printed:** 01/25/11 **Prepared by:** Sara Gardner





Legend

- Basin 19
- To Outfall 19
- Eastern Branch
- Western Branch
- Taxlots
- City Outfall
- Manhole
- Current NPDES Stormwater Permits
- Historical NPDES Stormwater Permits

0 250 500 1,000 Feet

N E S W

Figure 3
Basin 19
Stormwater Permits

Source: City of Portland BES	Environmental Services City of Portland 1120 SW Fifth Avenue, Room 1000 Portland Oregon, 97204-1912
File Name: s:\GIS\Sara\of19\Basin19_Fig3.mxd	**Program Manager:** Rod Struck Portland Harbor Superfund
Sheet No. 1 OF 1	**Date Printed:** 01/27/11 **Prepared by:** Sara Gardner

Table 1. Outfall Basin 19: Summary of Upland Site Sources

City Outfall Basin	Information on Potential Upland Sources (DEQ Cleanup Sites and NPDES 1200Z Permit Sites)					
	Potential Upland Sources	**DEQ Cleanup (ECSI) Site**	**NPDES 1200Z Permitted Site [1]**	**Site Contaminants of Interest [2]**	**DEQ Cleanup Program Status [3]**	**Site Stormwater Pathway Evaluated Under DEQ Oversight?**
OF 19	Anderson Brothers Property (ECSI #970)	X		VOCs, PAHs, TPH, metals	NFA and SCD issued	Yes
	Brazil & Co. (ECSI #1026)	X		PCBs	Inactive	No
	Calbag Metals (ECSI #2454)	X		Cadmium, lead, mercury, zinc, PCBs, phthalates	NFA, SCD issued [7]	Yes
	Chapel Steel (ECSI #4920)	X		Aluminum, antimony, lead, nickel, zinc, PAHs, PCBs, BEHP	Inactive	No
	Dura Industries (ECSI #111)	X		Cadmium, chromium, lead	Inactive	No
	Front LP Properties (Tube Forgings of America) (ECSI	X	X	Metals [arsenic, chromium, copper, zinc],[6] PAHs, PCBs, VOCs, SVOCs, phthalates, TPH	Active	In process
	Greenway Recycling (ECSI #4655)	X	X	VOCs, TPH, PCBs, arsenic, chromium, copper, zinc	NFA issued	Yes
	Mt. Hood Chemical Corp (ECSI #81)	X		Methylene chloride (VOCs)	Active	In process
	Mt. Hood Chemical Property (ECSI #1328)	X		VOCs	NFA issued	No
	Paramount of Oregon (Chevron USA Asphalt) (ECSI #1281)	X	X	VOCs, PAHs, TPH, metals [arsenic, chromium, copper, zinc] [4]	SCD issued	In process
	Penske Truck Leasing - NW Yeon (ECSI #5055)	X		TPH, PAHs, VOCs, SVOCs, metals	NFA issued	Yes
	PGE – Forest Park Property (ECSI #2406)	X		PCBs	NFA issued	Yes
	Schnitzer Kittridge Distribution Center (ECSI #2442)	X		Cadmium, lead, mercury, zinc, PCBs, VOCs, TPH	NFA issued	No
	Western Wire Works		X	(Site not listed in Table 4.4-4 of Draft RI Report)	N/A	N/A
	Willbridge Terminal - Unocal/Conoco/Phillips (ECSI #1549/177) [4]	X	X [5]	Metals [arsenic, chromium, copper, zinc][6], PAHs, pesticides/herbicides, phthalates, VOCs, TPH	Active	In process
	Willbridge Rail Yard / BNSF (ECSI #3395)	X		TPH	Active	In process

Notes:

N/A = not applicable.

[1] See Section 4 and Table 4-3 of *Stormwater Evlalution Report (BES, 2010)*. Identification of analytes for further evaluation is based on a statistical analyses conducted by the City to determine the significance of detected concentrations relative to other basins discharging to Portland Harbor. Analytes shown in italics are permitted under the NPDES 1200Z industrial stormwater permit program.

[1] Except as noted, reference for NPDES 1200Z permit holders is *BES Industrial Stormwater, Portland Harbor Permits – Sorted by Outfall, Report Date: 10/23/09*. NPDES 1200Z permits allow discharges of permitted analytes up to the designated benchmark concentrations. NPDES 1200Z permit analytes and benchmarks include copper (100 ug/L), lead (400 ug/L), and zinc (600 ug/L).

[2] Contaminants of interest (COI) for DEQ ECSI sites identified in Table 4.4-4 of the *Portland Harbor RI/FS Remedial investigation Report Draft* (Integral Consulting and others, 2009). The listing of "TPH" as a COI implies that PAHs are COIs because TPH consists of PAHs in addition to other compounds.

[3] NFA = No Further Action determination issued by DEQ. SCD = Source Control Decision by DEQ. Pending = site has agreed to work with DEQ under the cleanup program, but cleanup activities have not yet been initiated. N/A = not applicable because site is not an ECSI site (or no ECSI sites in basin).

[4] ECSI #1549 encompasses a number of discrete DEQ Cleanup sites. The site COIs listed for these individual cleanup sites include the site COIs for the larger site (ECSI #1549).

[5] Permit issued to ConocoPhillips Company - Portland Terminal

[6] Metals COIs for this site not listed individually [or this metal not listed] in Table 4.4-4, but selected metals COIs are identified in Panels 10.2-9A - 10.2-12C of the *Portland Harbor RI/FS Remedial investigation Report Draft* (Integral Consulting and others, 2009).

[7] DEQ reopened the SCD in 2010.

Table 2: Current[1] and Historic NPDES Permits in Basin 19.

Address	Company	Permit Type and Time Period			Available Stormwater Data Period	Notes
		Type	Issue Date[2]	Expiration Date[3]		
4927 NW Front	Acme Trading	1200-R	5/12/1992	9/30/1996	5/1993 - 3/2003	Began as Acme Trading. Calbag assumed operations in late 1995 and the sale was final in 1996. Calbag subleased the warehouse at the north end of the property to O'Neil Transfer in '98. Also subleased to NW Fleet Services in '03. Currently site has Fast Fab in southern part of site & Pacific Power Vac in the northern part.
		1200-Z	10/17/1997	6/30/2002		
	CalBag Metals	1200-Z	10/1/2002	6/30/2007		
		Permit terminated 5/7/2003				
4444 NW Yeon	Mt Hood Chemical	1200-H	5/11/1992	9/30/1996	3/1995 - 2/2008	1200-H set to expire 9/30/96. Gap between 1200-H and 1200-Z (96-98)1200-H was extended by DEQ until 1200-Z took effect. Moved to new site, N.O.T. filed 3/6/2009. New tenant is Benson Industries, NEC 6/21/2010.
		1200-Z	1/8/1998	6/30/2002		
		1200-Z	10/29/2002	6/30/2007		
		1200-Z	9/25/2007	6/30/2012		
		Permit terminated 3/6/2009				
4285 NW Yeon	ABF	1200-T	2/22/1993	9/30/1996	1/1996 - 4/2000	ABF began at 4285 NW Yeon and then moved between 9/13/00 and 1/3/01.
		1200-Z	10/21/1997	6/30/2002*		
		*Permit transferred from ABF to FTL 1/2/2001				
	FTL	1200-Z	1/2/2001	6/30/2002*	3/2001 - 6/2005	FTL moved locations to 4285 NW Yeon between 9/13/00 and 1/3/01.
		1200-Z	10/8/2002*	6/30/2007**		The 4285 NW Yeon site was vacant ~10/31/2005.
		* Permit transferred from FTL to ABF 1/2/2001				Site was redeveloped ~2007 for operation by Penske Truck. Permit not required. Most stormwater retained and infiltrated on site.
		** Permit terminated 10/13/2006				
4025 NW Express	Western WireWorks	1200-Z	4/17/1998	6/30/2002	11/1998 - 4/2009	Began operations on site in 1965.
		1200-Z	10/29/2002	6/30/2007		
		1200-Z	9/25/2007	6/30/2012		
3865 NW St Helens	Christenson Oil, West Plant	1200-H	4/26/1996	9/30/1996	No data for part of site that drains to OF19, sheet flow to street CBs	West Plant houses offices & storage no on-site CBs. Stormwater exposure from transfer of materials via trucks, loading docks.
		1200-Z	10/23/1997	6/30/2002		
		1200-Z	10/9/2002	6/30/2007		
4135 NW St Helens	Greenway Recycling	1200-Z	1/23/2006	6/30/2007	2/2007-2/2010	Began site operations ~2002 w/o permits to connect or discharge to storm or sanitary sewers.
		1200-Z	9/25/2007	6/30/2012		

Address	Company	Permit Type and Time Period			Available Stormwater Data Period	Notes
		Type	Issue Date[2]	Expiration Date[3]		
5528 NW Doane	Unocal Terminal	INDV 100005	11/19/1984	10/31/1989	No Data	Unocal began operations ~1950. "Oily Stormwater" discharge was covered by Individual permits.
		INDV 100910	5/28/1992	5/31/1997	6/1997 - 12/1997	Only OWS #001 discharge to OF 19. 1200-T was operating concurrently. City recommended on 3/28/95 that all storm permits on the site be replaced with 1300-J permit.
		1200-T	10/23/1992	9/30/96*	6/1995 - 4/1997	* No record of 1200-T being renewed/extended. 1200-T terminated by DEQ 6/17/98 with Tosco operating on site & not Unocal.
	Tosco Corporation	1300-J	12/24/1997	12/31/1999	7/1997- 1/2003	Only OWS #001 discharge to OF 19. 1300-J was used to 'replace' all other stormwater permits, general & individual.
		1300-J	2/28/2000	12/31/2004**		** Name changed and renewed permit as 1300-J to Conoco-Phillips 1/23/03.
	ConocoPhillips – Portland Terminal	1300-J	1/23/2003	12/31/2004	1/2003 - 12/2007	Only OWS #001 discharges to OF 19. Permit transferred/Name Changed 1/23/03 to Conoco-Phillips. 1300-J Permit replaced with 1200-Z by DEQ.
		1300-J	12/31/2004	6/30/2007		
		1200-Z	12/7/2007	6/30/2012	12/2007 - 5/2009	
5814 NW Doane	Burlington Northern & Santa Fe Railroad Co	1200-Z	11/22/1999	6/30/2002	No Data	Only sheet flow from site to street, no exposures & no activites. City recommended permit be terminated.
		1200-Z	9/30/2002	6/30/2007*		
		*Permit terminated 2/24/2005.				
5200 NW Front	Tube Forgings of America	1200-L	10/7/1992	9/30/1996	#2: 3/1995 - 12/2004, 11/2007 - 4/2009 #3: 11/1995 - 12/2004, 11/2007 - 4/2009	Only sample points #2 & #3 discharge to OF 19. Gap in data due to monitoring waivers granted in 2005.
		1200-Z	11/5/1997	6/30/2002		
		1200-Z	10/10/2002	6/30/2007		
		1200Z	09/25/07	6/30/12		
5501 NW Front	Chevron Willbridge Asphalt Refinery	100-J	12/15/1985	12/15/1990	No Data	Non-contact cooling water permit only kept for emergency use, no 100-J process discharge since it was issued.
		100-J	12/20/1990	12/31/1995		
		1200-H	8/25/1992	9/30/1996	3/1995 - 8/1997	Stormwater outfall from valve box at outlet from OWS; V-39, drains the Guilds Lake Tank Farm through vacant land that has active stormwater inlets, and drains to OF19.
		1200-Z	10/17/1997	6/30/2002	11/1997 - 1/2005	* Name changed to Paramount of Oregon on 3/1/05. Not changed on permit until renewal.
		1200-Z	10/1/2002	6/30/2007*		

Address	Company	Permit Type and Time Period			Available Stormwater Data Period	Notes
		Type	Issue Date[2]	Expiration Date[3]		
	Paramount Petroleum	1200-Z	9/25/2007	6/30/2012**	3/2005 - 5/2009	**Named Changed from Paramount of Oregon to Paramount Petroleum Corp. 7/30/2009 on permit.
4959 NW Front	Asset Recovery	1200-R	8/21/1992	9/30/1996	Data available from 6/22/93–6/15/95 for both smpl. pts.	Site located across NW Kittridge from Acme/Calbag site, both sites operated under MMI. Shared BMPs & inspected together by ISW Section. Facility closed down Spring 1996.
4015 NW St Helens	American Transport	1200-Z	2/28/2001	6/30/2002	No Data , no samples taken	Started operations on site ~4/1998, permitted 2/28/01. Permit terminated as of 6/6/02, OOB
	Portland Truck & Diesel	1200-Z	8/23/2003	6/30/2007*	No Data, no samples taken	Started operations on site ~5/2003, permitted 8/22/2003. Permit terminated as of 6/9/2004 – NEC. OOB before 6/2009.
		* Permit terminated 6/9/04, NEC issued				

Notes:
[1] Current permits are indicated in **bold**.
[2] General stormwater permits first issued by DEQ in early 1990s (exact date dependent on industrial sector).
[3] Expiration date listed on general permit: DEQ generally gave admistrative extention of permit until new general permit issued.

Abbreviations:
BMPs – Best management practices.
ISW – Industrial Stormwater Section (of the City's Bureau of Environmental Services)
N.O.T - Notice of Termination for an issued permit, stoppage of permit coverage for a site.
NEC - No Exposure Certification form issued by ODEQ for sites that do not exposure stormwater to the industrial activites that may be occurring on the site.
OOB - Out of Business - a site that no longer is in operation - may be vacant or closed.
OWS – Oil-Water Separator.

Appendix A
Basin 19 and NPDES Permitted Facility Stormwater Data

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Appendix A

Basin 19 and NPDES Permitted Facility Stormwater Data

This appendix presents plots of stormwater quality data from OF 19 and individual NPDES permitted facilities. These plots are presented side-by-side to assist in the interpretation of OF 19 sampling data and long-term stormwater concentration trends.

OF19 Plots. OF 19 data plots are presented at the top of the following pages. These plots are the same as the trend analyses plots presented and discussed in the main body of the report. The dashed line shown on the plots represents the National Recommended Water Quality Criteria[1] (NRWQC) concentrations.

NPDES Facility Plots. The plots on the bottom of the following pages depict available stormwater quality data from individual NPDES permitted sites. The dotted line represents the NPDES permit benchmark concentration. The blue lines in the facility plots are locally weighted regression lines[2] which are intended to visually aid in evaluating the overall concentration pattern for individually permitted sites.

[1] NRWQC are used in this memorandum as screening level values to assess whether stormwater concentrations from upland pollutant sources may pose a potential threat to the Willamette River, consistent with the Portland Harbor JSCS (DEQ and EPA; 2005). NRWQC standards are intended to protect surface water quality and are expressed as dissolved metal concentrations in the water column and are not intended to be applied to stormwater.

[2] W. S. Cleveland, E. Grosse and W. M. Shyu (1992) Local regression models. Chapter 8 of *Statistical Models in S*eds J.M. Chambers and T.J. Hastie, Wadsworth & Brooks/Cole.

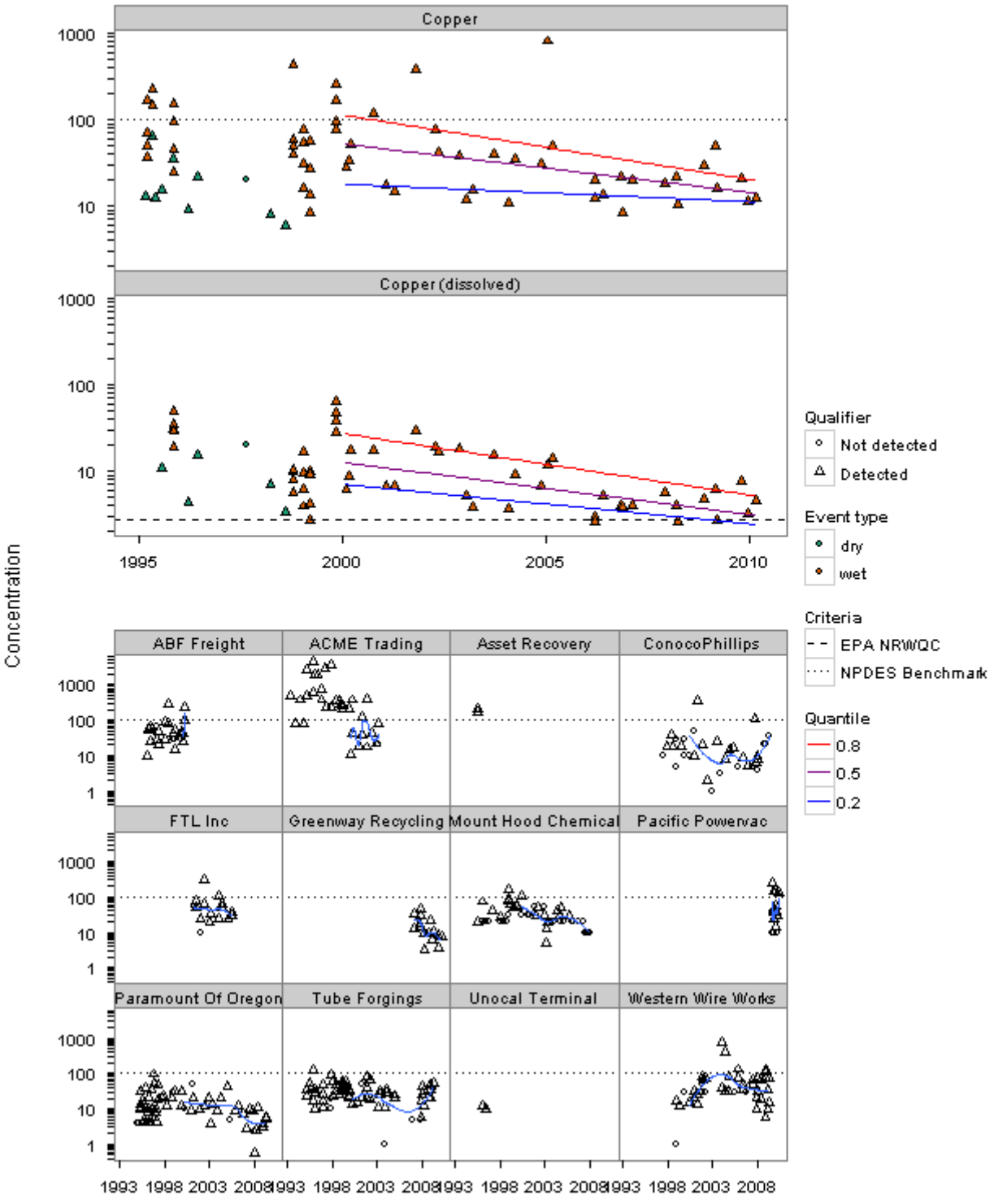

Figure A-1. Basin 19 Stormwater Data – Copper.

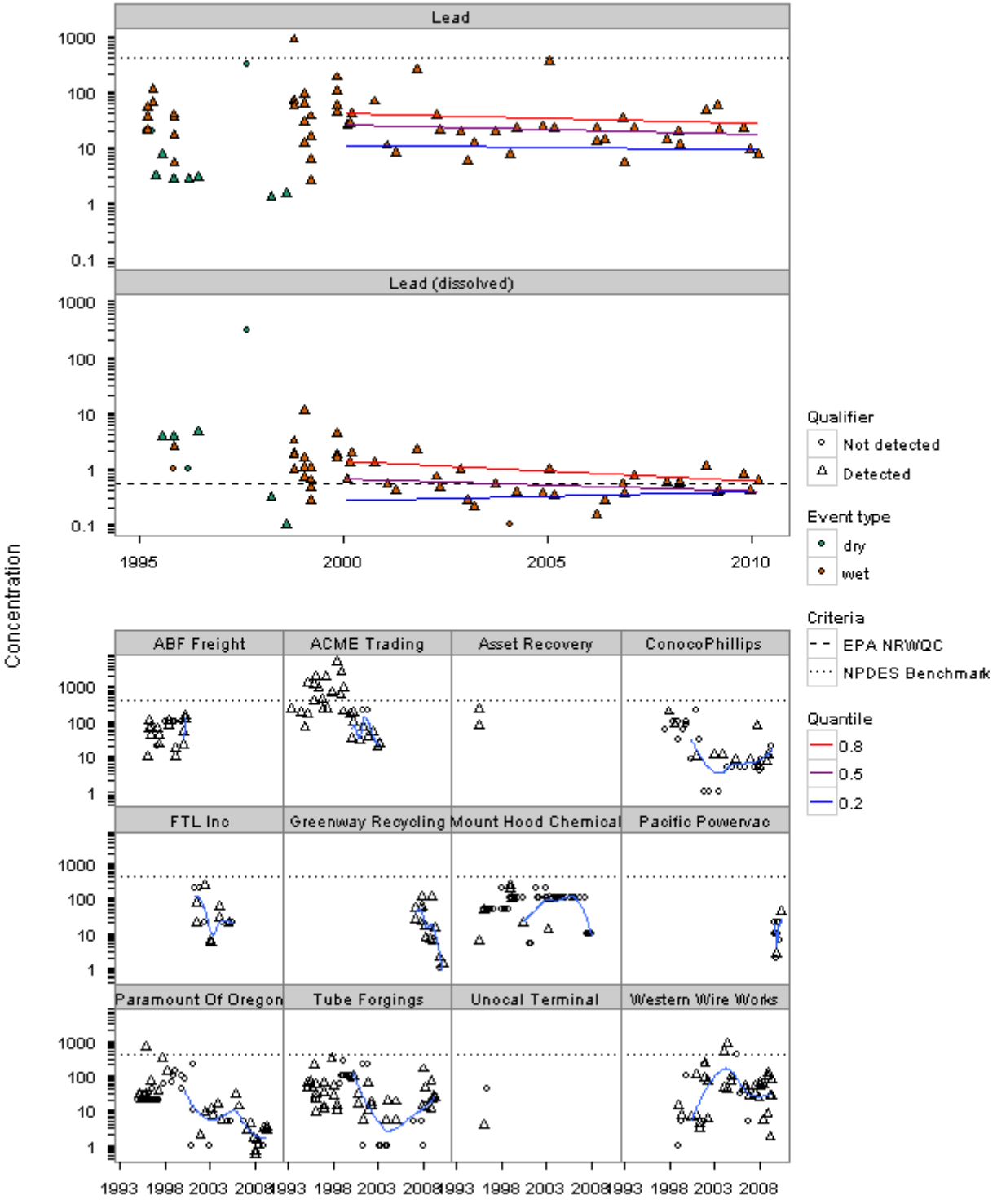

Figure A-2. Basin 19 Stormwater Data – Lead.

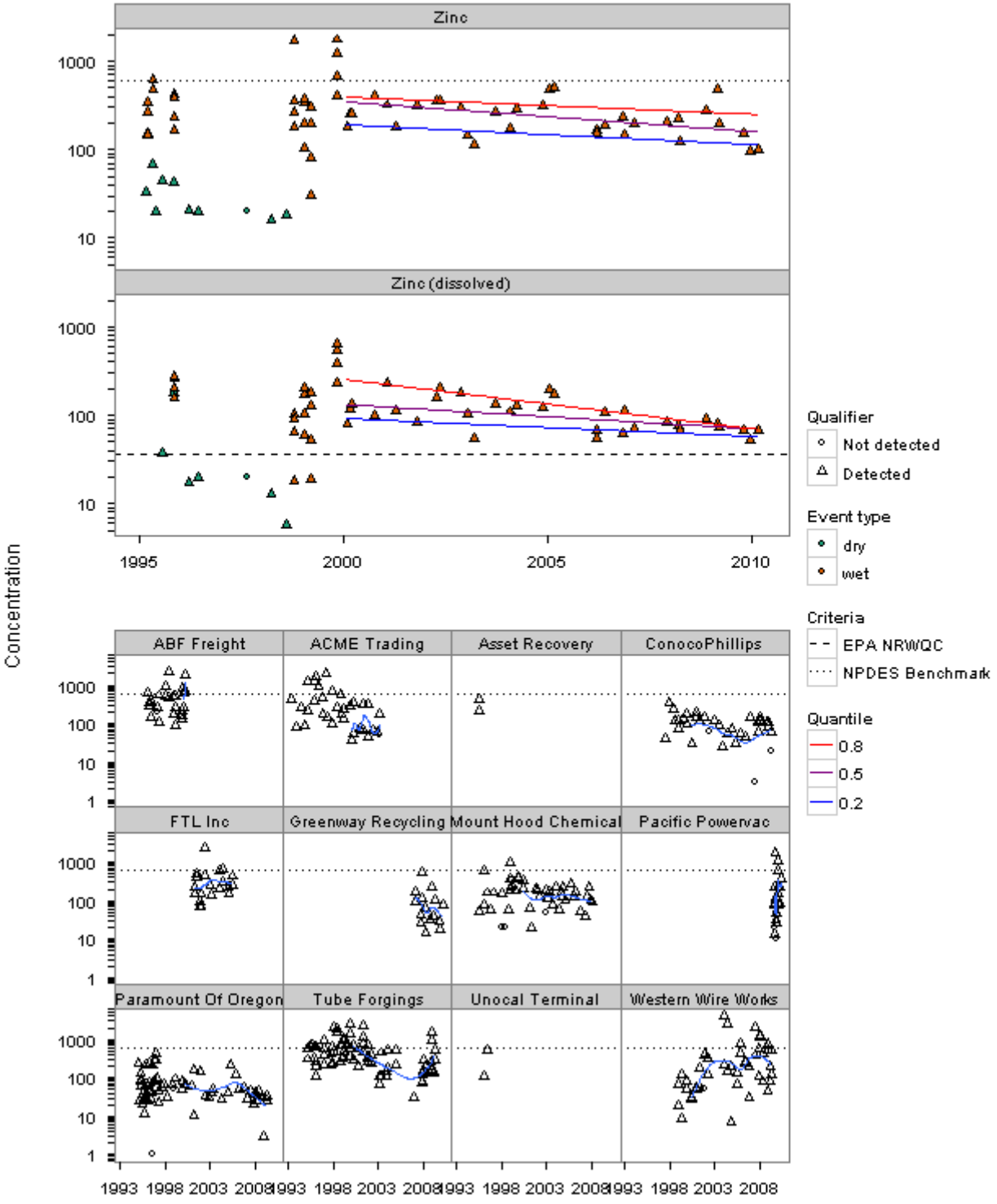

Figure A-3. Basin 19 Stormwater Data – Zinc.

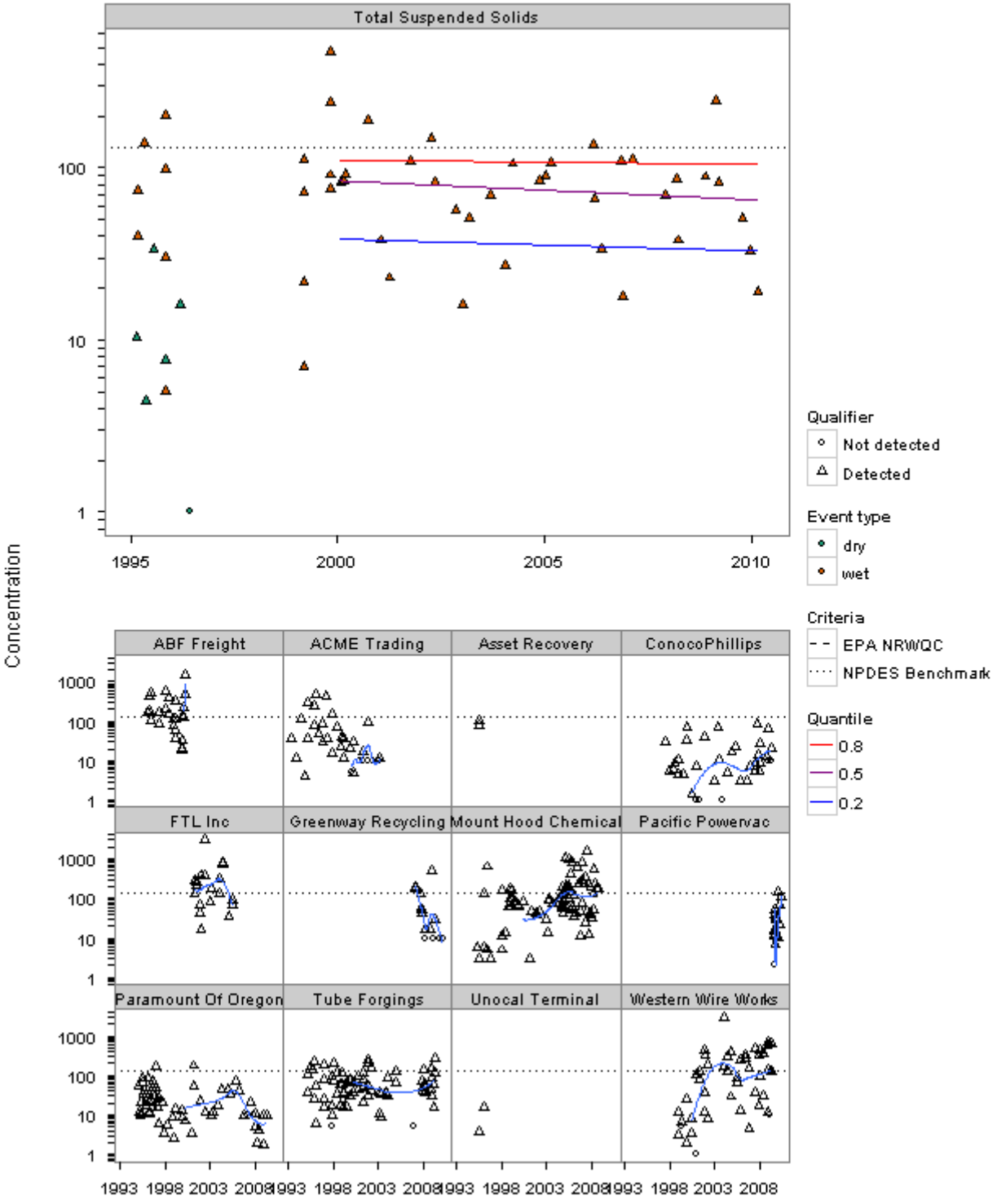

Figure A-4. Basin 19 Stormwater Data – Total Suspended Solids.

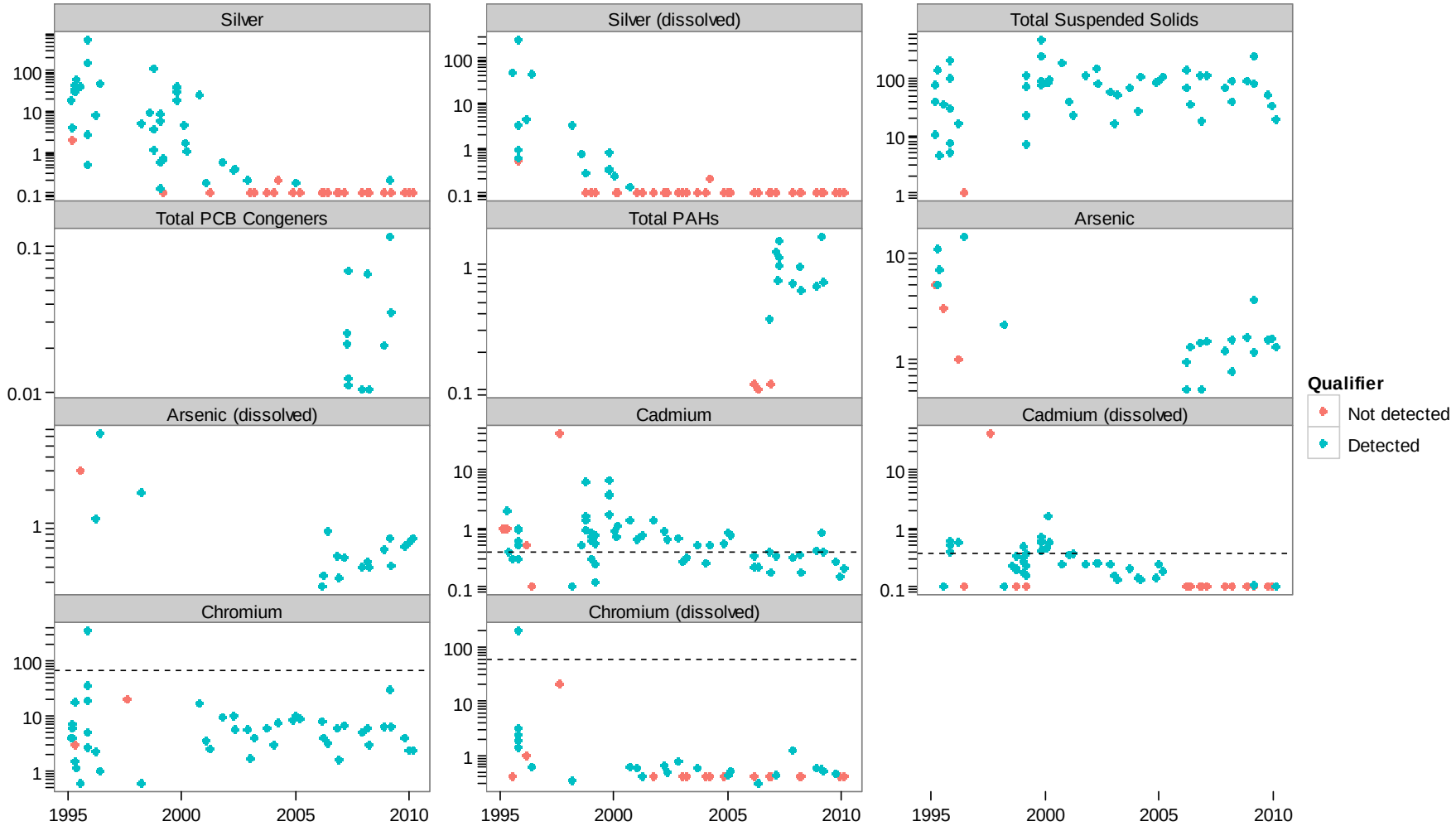

Figure A-5. Basin 19 Stormwater Data – Additional Pollutants.

Appendix B
OF 19 Stormwater Data Collection

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Appendix B

OF 19 Stormwater Data Collection

Introduction

This appendix summarizes the 1999-2010 collection of stormwater data from City of Portland Outfall Basin 19 (Basin 19). This appendix is intended to provide background, technical details, and supporting information regarding the data used to analyze long-term concentration trends presented in this report.

Characteristics of the stormwater data set are listed below:

- The sample population includes grab and composite samples collected from Outfall (OF 19).
- Analytical stormwater discharge data was collected near the end of the conveyance system and is therefore assumed to be representative of "basin" conditions.
- Analytical results have a lower concentration bound of zero (i.e., no negative values).
- Analytical results are censored (i.e., some concentration data are reported as below analytical laboratory method reporting limits (MRLs)).
- Data collected by different sampling methods (i.e., grab sampling and flow-weighted composite sampling) were used in the trend analyses.

City Stormwater Data

Stormwater discharges from the City's stormwater outfall system are authorized and regulated under the City's NPDES Municipal Separate Storm Sewer System (MS4) Discharge Permit (Permit #101314), issued jointly to the City, Multnomah County, and the Port. Stormwater from Basin 19 has been monitored during at least three storm events per year starting in fiscal year (FY) 1997/1998 to generate a long-term effectiveness measure of the City's Industrial Stormwater Program. Starting in FY 2006/2007, the list of constituents analyzed in samples collected at OF 19 was expanded to meet the objectives of both the MS4 program and the City of Portland Outfall Project. The OF 19 MS4 monitoring data have previously been reported to DEQ in the City's Annual MS4 permit reports (http://www.portlandonline.com/bes/index.cfm?c=50289). Data and additional documentation for the OF 19 MS4 monitoring are provided in Appendix B of the *Stormwater Evaluation Report* (BES, 2010a).

OF 19 has been sampled for these programs 80 times representing approximate 50 wet or dry weather sampling events between February 1995 and January 2010. Sampling has occurred at least three times per fiscal year, with the exception of FY 1996-97, when no sampling was performed, for reasons unknown. Of the 38 total sampling events, there have been 11 dry weather and 27 wet weather events. Dry weather sampling events typically included a 24-hour time-weighted composite sample collected at 10-minute intervals as well as a grab sample

collected at the beginning of the composite monitoring period. Dry weather monitoring was discontinued following the last dry weather event on July 29, 1998.

Wet weather sampling protocols have varied and have included grab and composite samples collected during first flush conditions as well as flow-activated, time-weighted composites intended to represent the remainder of the storm, and flow-weighted composites representing the full storm hydrograph. It is important to note that wet weather compositing schemes varied between events until the second event of FY 1999-00. From this point to the present, stormwater sample collection changed from multiple flow-activated time-weighted composites per event to one flow-weighted composite sample collected over the duration of the storm. Some wet weather composites in the data set represent discrete portions of storm events while others reflect the entire event, and the earlier events were not flow-weighted. Table B-1 summarizes the sample type and chemical analyses for the City data used in this report.

Table B-1. Basin 19 Stormwater Quality Trend Analyses Data Source

Outfall Basin	Data Collection Program	Sample Type(s)	Analytes	References
City Outfall Basin				
OF 19	City of Portland NPDES Municipal Separate Storm Sewer System (MS4) Discharge Permit Monitoring Program January 2000 – February 2010	Stormwater – flow-weighted composite	Metals (arsenic, cadmium, chromium, *copper*, *lead*, silver, *zinc*), PAHs (added in 2006), SVOCs, PCB congeners (added in 2007), pesticides (added in 2009), TSS(1)	Appendix B of *Stormwater Evaluation Report* (BES, 2010a)

Note:

Analytes in italics are reported in both total and dissolved (filtered) concentrations. Unless in italics, analytes are reported in total concentrations only.

(1) In addition to the analytes listed, the City MS4 samples from OF 19 were also tested for ammonia-nitrogen, nitrate-nitrogen, orthophosphate phosphorus, total dissolved solids, total phosphorus, total solids, and hardness.

Appendix C
Data Used In Trend Analyses

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Appendix C: OF19 Data Used in Trend Analyses

Sample Date	Analyte	Result (ug/L)	Qualifier
01/31/00	Lead	25.2	Detected
02/22/00	Lead	26.8	Detected
03/13/00	Lead	40.1	Detected
09/30/00	Lead	66.2	Detected
01/19/01	Lead	10.7	Detected
04/06/01	Lead	8.09	Detected
10/10/01	Lead	254	Detected
04/05/02	Lead	36.9	Detected
05/05/02	Lead	20.1	Detected
11/07/02	Lead	18.7	Detected
01/11/03	Lead	5.47	Detected
03/12/03	Lead	11.6	Detected
09/16/03	Lead	18.7	Detected
01/23/04	Lead	7.42	Detected
03/24/04	Lead	22.3	Detected
11/15/04	Lead	22.7	Detected
01/06/05	Lead	347	Detected
03/01/05	Lead	21.5	Detected
03/08/06	Lead	21.4	Detected
03/16/06	Lead	12.3	Detected
05/23/06	Lead	13.4	Detected
11/02/06	Lead	31.7	Detected
11/19/06	Lead	5.2	Detected
02/14/07	Lead	22	Detected
11/27/07	Lead	13.3	Detected
03/08/08	Lead	18.4	Detected
03/26/08	Lead	11.3	Detected
11/20/08	Lead	45.9	Detected
02/24/09	Lead	55	Detected
03/14/09	Lead	20.2	Detected
10/14/09	Lead	21.6	Detected
12/15/09	Lead	9.02	Detected
02/23/10	Lead	7.58	Detected

Appendix C: OF19 Data Used in Trend Analyses

Sample Date	Analyte	Result (ug/L)	Qualifier
01/31/00	Lead (dissolved)	0.66	Detected
02/22/00	Lead (dissolved)	1.26	Detected
03/13/00	Lead (dissolved)	1.91	Detected
09/30/00	Lead (dissolved)	1.28	Detected
01/19/01	Lead (dissolved)	0.54	Detected
04/06/01	Lead (dissolved)	0.41	Detected
10/10/01	Lead (dissolved)	2.13	Detected
04/05/02	Lead (dissolved)	0.71	Detected
05/05/02	Lead (dissolved)	0.45	Detected
11/07/02	Lead (dissolved)	0.96	Detected
01/11/03	Lead (dissolved)	0.27	Detected
03/12/03	Lead (dissolved)	0.21	Detected
09/16/03	Lead (dissolved)	0.54	Detected
01/23/04	Lead (dissolved)	0.1	Not detected
03/24/04	Lead (dissolved)	0.37	Detected
11/15/04	Lead (dissolved)	0.34	Detected
01/06/05	Lead (dissolved)	0.97	Detected
03/01/05	Lead (dissolved)	0.32	Detected
03/08/06	Lead (dissolved)	0.15	Detected
03/16/06	Lead (dissolved)	0.15	Detected
05/23/06	Lead (dissolved)	0.26	Detected
11/02/06	Lead (dissolved)	0.51	Detected
11/19/06	Lead (dissolved)	0.36	Detected
02/14/07	Lead (dissolved)	0.74	Detected
11/27/07	Lead (dissolved)	0.56	Detected
03/08/08	Lead (dissolved)	0.51	Detected
03/26/08	Lead (dissolved)	0.56	Detected
11/20/08	Lead (dissolved)	1.07	Detected
02/24/09	Lead (dissolved)	0.37	Detected
03/14/09	Lead (dissolved)	0.41	Detected
10/14/09	Lead (dissolved)	0.78	Detected
12/15/09	Lead (dissolved)	0.39	Detected
02/23/10	Lead (dissolved)	0.59	Detected

Appendix C: OF19 Data Used in Trend Analyses

Sample Date	Analyte	Result (ug/L)	Qualifier
01/31/00	Copper	27.7	Detected
02/22/00	Copper	34.1	Detected
03/13/00	Copper	51.1	Detected
09/30/00	Copper	118	Detected
01/19/01	Copper	17.5	Detected
04/06/01	Copper	14.8	Detected
10/10/01	Copper	386	Detected
04/05/02	Copper	77	Detected
05/05/02	Copper	41.6	Detected
11/07/02	Copper	39	Detected
01/11/03	Copper	12.1	Detected
03/12/03	Copper	15.5	Detected
09/16/03	Copper	39.7	Detected
01/23/04	Copper	11	Detected
03/24/04	Copper	34.6	Detected
11/15/04	Copper	30.7	Detected
01/06/05	Copper	812	Detected
03/01/05	Copper	50.4	Detected
03/08/06	Copper	20.3	Detected
03/16/06	Copper	12.2	Detected
05/23/06	Copper	13.5	Detected
11/02/06	Copper	22	Detected
11/19/06	Copper	8.34	Detected
02/14/07	Copper	19.7	Detected
11/27/07	Copper	18.2	Detected
03/08/08	Copper	21.8	Detected
03/26/08	Copper	10.6	Detected
11/20/08	Copper	29	Detected
02/24/09	Copper	49.5	Detected
03/14/09	Copper	16	Detected
10/14/09	Copper	21.1	Detected
12/15/09	Copper	11.3	Detected
02/23/10	Copper	12.6	Detected

Appendix C: OF19 Data Used in Trend Analyses

Sample Date	Analyte	Result (ug/L)	Qualifier
01/31/00	Copper (dissolved)	6.08	Detected
02/22/00	Copper (dissolved)	8.52	Detected
03/13/00	Copper (dissolved)	17.7	Detected
09/30/00	Copper (dissolved)	17.6	Detected
01/19/01	Copper (dissolved)	6.6	Detected
04/06/01	Copper (dissolved)	6.64	Detected
10/10/01	Copper (dissolved)	29.3	Detected
04/05/02	Copper (dissolved)	18.8	Detected
05/05/02	Copper (dissolved)	16.9	Detected
11/07/02	Copper (dissolved)	18.1	Detected
01/11/03	Copper (dissolved)	5.12	Detected
03/12/03	Copper (dissolved)	3.84	Detected
09/16/03	Copper (dissolved)	15.5	Detected
01/23/04	Copper (dissolved)	3.59	Detected
03/24/04	Copper (dissolved)	9.12	Detected
11/15/04	Copper (dissolved)	6.81	Detected
01/06/05	Copper (dissolved)	11.9	Detected
03/01/05	Copper (dissolved)	13.9	Detected
03/08/06	Copper (dissolved)	2.99	Detected
03/16/06	Copper (dissolved)	2.55	Detected
05/23/06	Copper (dissolved)	5.2	Detected
11/02/06	Copper (dissolved)	4.01	Detected
11/19/06	Copper (dissolved)	3.74	Detected
02/14/07	Copper (dissolved)	3.91	Detected
11/27/07	Copper (dissolved)	5.64	Detected
03/08/08	Copper (dissolved)	3.96	Detected
03/26/08	Copper (dissolved)	2.61	Detected
11/20/08	Copper (dissolved)	4.73	Detected
02/24/09	Copper (dissolved)	6.08	Detected
03/14/09	Copper (dissolved)	2.67	Detected
10/14/09	Copper (dissolved)	7.79	Detected
12/15/09	Copper (dissolved)	3.17	Detected
02/23/10	Copper (dissolved)	4.58	Detected

Appendix C: OF19 Data Used in Trend Analyses

Sample Date	Analyte	Result (ug/L)	Qualifier
01/31/00	Zinc	184	Detected
02/22/00	Zinc	255	Detected
03/13/00	Zinc	252	Detected
09/30/00	Zinc	410	Detected
01/19/01	Zinc	321	Detected
04/06/01	Zinc	179	Detected
10/10/01	Zinc	308	Detected
04/05/02	Zinc	357	Detected
05/05/02	Zinc	355	Detected
11/07/02	Zinc	302	Detected
01/11/03	Zinc	143	Detected
03/12/03	Zinc	111	Detected
09/16/03	Zinc	261	Detected
01/23/04	Zinc	173	Detected
03/24/04	Zinc	290	Detected
11/15/04	Zinc	317	Detected
01/06/05	Zinc	478	Detected
03/01/05	Zinc	501	Detected
03/08/06	Zinc	169	Detected
03/16/06	Zinc	153	Detected
05/23/06	Zinc	190	Detected
11/02/06	Zinc	237	Detected
11/19/06	Zinc	146	Detected
02/14/07	Zinc	199	Detected
11/27/07	Zinc	206	Detected
03/08/08	Zinc	223	Detected
03/26/08	Zinc	125	Detected
11/20/08	Zinc	282	Detected
02/24/09	Zinc	486	Detected
03/14/09	Zinc	197	Detected
10/14/09	Zinc	155	Detected
12/15/09	Zinc	94	Detected
02/23/10	Zinc	101	Detected

Appendix C: OF19 Data Used in Trend Analyses

Sample Date	Analyte	Result (ug/L)	Qualifier
01/31/00	Zinc (dissolved)	81.3	Detected
02/22/00	Zinc (dissolved)	116	Detected
03/13/00	Zinc (dissolved)	131	Detected
09/30/00	Zinc (dissolved)	100	Detected
01/19/01	Zinc (dissolved)	235	Detected
04/06/01	Zinc (dissolved)	114	Detected
10/10/01	Zinc (dissolved)	84.6	Detected
04/05/02	Zinc (dissolved)	156	Detected
05/05/02	Zinc (dissolved)	207	Detected
11/07/02	Zinc (dissolved)	177	Detected
01/11/03	Zinc (dissolved)	104	Detected
03/12/03	Zinc (dissolved)	55	Detected
09/16/03	Zinc (dissolved)	133	Detected
01/23/04	Zinc (dissolved)	110	Detected
03/24/04	Zinc (dissolved)	128	Detected
11/15/04	Zinc (dissolved)	124	Detected
01/06/05	Zinc (dissolved)	193	Detected
03/01/05	Zinc (dissolved)	171	Detected
03/08/06	Zinc (dissolved)	55.3	Detected
03/16/06	Zinc (dissolved)	68.7	Detected
05/23/06	Zinc (dissolved)	109	Detected
11/02/06	Zinc (dissolved)	62.1	Detected
11/19/06	Zinc (dissolved)	111	Detected
02/14/07	Zinc (dissolved)	70.1	Detected
11/27/07	Zinc (dissolved)	84.6	Detected
03/08/08	Zinc (dissolved)	77.2	Detected
03/26/08	Zinc (dissolved)	67.3	Detected
11/20/08	Zinc (dissolved)	89.2	Detected
02/24/09	Zinc (dissolved)	78.6	Detected
03/14/09	Zinc (dissolved)	73.9	Detected
10/14/09	Zinc (dissolved)	67.7	Detected
12/15/09	Zinc (dissolved)	51.6	Detected
02/23/10	Zinc (dissolved)	67.2	Detected