Rethinking Municipal Stormwater Monitoring in Oregon

Submitted to: Oregon Department of Environmental Quality

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Purpose

The project outcome will be a summary report of the goals outlined above. The plan will be used to inform future permit developments based on the assessment of past annual reports and data collection efforts from Phase I permittees.

Goals

1. Summarize current data collection efforts from Phase I permittees; most data is not electronic and there is little understanding of the details of the data that is being collected. Summary will include: protocols being used, collected parameters, level of effort between permittees.
2. Stormwater data analysis to inform permit development: Will determine whether or not DEQ should conduct some basic analysis of the stormwater characterization data. Recommend permit program based on current and proposed data analysis actions.
3. Develop a recommendation for a program for streamlining data collection efforts from Phase 1 Permittees.
4. Recommend a comprehensive stormwater monitoring program/plan/priorities

Achievements

This report provides a succinct summary of the 2015 annual reports from all MS4 Phase 1 permittees. It may be used to inform future permit language and decision making leading to a more standardized and streamlined approach to stromwater management among municipalities in Oregon. DEQ recognizes the substantial contribution made by the permittees in order to better characterize and understand issues with stormwater quality in Oregon.

Methods

Annual reports were reviewed to make assessments about individual stormwater monitoring plans for each of the Phase 1 permittees. Submissions of annual reports are a requirement of the MS4 permit and many reports are electronically accessible to the public. These reports contain detailed information regarding required monitoring methodology, data analysis, and reporting the trends of environmental parameters. Many of the results are presented in graphs, tables, and figures as summary statistics and where appropriate the Permittee reports where parameters exceed their benchmark. For the purposes of this report, the 2015 report from each permittee was used assess the current stormwater monitoring efforts among MS4 Phase 1 permittees.

In addition to the annual reports, Phase 1 permittees submitted their pesticide monitoring data from previous years. No set range of years was required from DEQ during the 2015 data request so the years of sampling were highly variable among permittees. Due to the difficulty in making inferences from pesticide monitoring data across variable years, pesticide data presented here will be used for reference without any statistical testing.

Recommendations

Future Stormwater monitoring

1. Collect high quality data that effective characterize storm-event concentrations. Phase 1 permittees should modify their current data collection efforts to accommodate this goal. That is, provide detailed methodology that is accepted by the current scientific and analytical processes and ensuring the monitoring frequency is sufficient in scope. Monitoring procedures must adhere to standard guidelines distinguished by DEQ.

2. Current data collection efforts are not consistent across permittees. There should be a more standardized approach so that DEQ can more readily conduct statewide analyses with long-term data sets. As the current data has been collected in ways different across permittees, it is difficult to make inferences about the effects of stormwater discharge. It is understandable that different permittees will have different requirements for stormwater monitoring due to population size and land use (e.g. City of Portland vs. Johnson City), however a standardized sampling method across all permittees will yield data that is more attributable to actual storm events rather than site variability.

3. DEQ should modify the requirements for the submission of annual reports. Namely, the reports should be succinct (30 page limit) and provide only the necessary detail for DEQ to ensure that permittees are in compliance with their approved stormwater managing plans. The brevity of this updated style of reports will discourage use of repetitive language, tables, and figures. The style of the report should follow a strict set of guidelines outlined in a “Report requirements” document that follows a style similar to submission to a scientific journal (e.g. formatting & section requirements). With each annual submission, permittees should submit their data in a file that is accessible, readable, and complete. That is, the data should represent all the collection efforts outlined both in the report and their original stormwater management plan. In each report there should be an appendix that outlines how to navigate the submitted data file (tabs, formulas, etc.).

4. Create a statewide, storm water partnership network to identify priorities and facilitate resource sharing.

1. Introduction

DEQ – Oregon Sea Grant Partnership

This project was initiated by a partnership between DEQ and Oregon Sea Grant to investigate the strengths and weaknesses of the State's current MS4 Phase 1 permit program, draw conclusions, and provide essential recommendations for future permit development. Oregon Sea Grant's mission is to serve as a catalyst that promotes discovery, understanding and resilience for Oregon coastal communities and ecosystems. While most urban areas in Oregon are well away from the coastal zone, Oregon Sea Grant recognizes that water quality issues upstream have considerable impacts to coastal ecosystems and seeks to better understand sources of water pollution. Thus the partnership falls well within the mission scope of both entities. Oregon Sea Grant provided assistance by funding a Natural Resource Policy fellow to work with DEQ to explore these issues with municipal stormwater quality programs. The fellow served as a stormwater analyst – assessing the methods, quality assurance protocols, and the results prepared by each Phase 1 permittee in their 2014-2015 annual reports. In addition to analyzing the reports, the fellow provided a set of recommendations to DEQ in order to better inform their permit development program.

Stormwater quality in Oregon's municipalities

Contaminant and pollutant loading in stormwater runoff significantly degrades the conditions of surface water in the State of Oregon (Kennedy & Jenks 2009). During storm events, numerous pollutants including sediment, nutrients, bacteria, motor oil, metals, and pesticides are washed into storm sewer systems for diffuse sources such as neighborhoods, construction sites, industrial facilities, parking lots, commercial areas, and landfills. Given the diffuse nature of the pollution sources – stormwater is difficult to manage. Environmental managers among municipal and state agencies have coordinated efforts to reduce contaminant loading into surface waters of the State through a combination of Best Management Practices and stormwater quality monitoring. This coordinated effort revolves around the National Pollution Discharge Elimination System (NPDES) permit program and is regulated by the Clean Water Act. The NPDES Stormwater Program regulates discharges from municipal stormwater sewer systems (MS4s) through the issuance of a Phase I (for populations > 100,000) or Phase II (populations <100,000) permits. Essentially each municipality is permitted to discharge pollutants into waters of the State provided they monitor discharges effectively and implement Best Management Practices (BMPs) that aim to reduce pollution. These BMPs are intended to lower pollution in stormwater to levels that do not exceed current EPA benchmarks for each contaminant.

Currently there are 7 Phase 1 permittees in Oregon: Portland Group (City of Portland and Port of Portland), City of Eugene, City of Salem, Multnomah County, Gresham Group (Cities of Gresham and Fairview), Clackamas County Group (13 municipalities as co-permittees), and Clean Water Services. Each permittee is charged with implementing a stormwater monitoring program under their own Quality Assurance Project Plan (QAPP) with the intent to detect the status and trends of water quality conditions and develop BMPs to reduce stormwater pollution within their jurisdictions. Reducing pollutant loads in stormwater flows to prevent harm to aquatic ecosystems is a common goal of both state and municipal agencies – however it also the goal of numerous other stakeholders including: environmental groups, development companies, and also Oregonians whose lifestyles and livelihoods are often dependent on the quality of nearby water bodies.

A considerable amount of stormwater-related monitoring is currently being conducted among Phase 1 Permittees but it is not being coordinated or compiled to answer regional questions. Currently only residents within a particular MS4 conveyance system may know how their municipality is contributing to stormwater runoff. Questions such as whether or not the quality of stormwater runoff is improving within the Willamette River Valley, where ~70% of Oregonians reside, are not being answered by DEQ or Phase 1 Permittees. Thus, a *collaborative*, comprehensive regional strategy is needed for the Willamette River Valley (where all Phase 1 Permit holders reside) to provide an unbiased assessment of whether stormwater management actions are resulting in genuine progress towards water and habitat quality targets.

This report is meant to serve as a central document for prescribing a new vision for stormwater management in Oregon. Specifically, it details the limited scope of monitoring among only individual Phase 1 permittees and suggests a strategy to develop a regional monitoring plan that will be a massive collaboration between DEQ, Phase 1 Permittees, and other stakeholders who aim to reduce pollutant loading in stormwater runoff. DEQ's mission is to be a leader in restoring, maintaining, and enhancing the quality of Oregon's air, land, and water. Yet DEQ will need to play a more central role in ensuring improvements to water quality through stormwater runoff within water bodies of the State – beyond issuing permits and assessing compliance.

The major theme of this report is to rethink stormwater management in Oregon. In keeping with this theme it will be necessary to invite all stakeholders to the table to discuss a bold new strategy to change how stormwater is managed in order to reduce runoff of pollutants into waters of the State. Municipal stormwater management will need to be reshaped in order to better understand:

- How pollutants in stormwater are affecting aquatic ecosystems within the Willamette River Valley at a both local and regional scales.
- Where are pollutants coming from and how they can be effectively reduced?
- The most sensible approach to monitoring – so that trends can be determined and provide meaningful data for adapting sampling procedures.

The New MS4 Phase 1 Monitoring Program Vision

The Oregon Department of Environmental Quality (DEQ) is developing a stronger vision of stormwater quality monitoring going forward into the next MS4 NPDES permit cycle. The goal of this project is to develop a monitoring program that streamlines coordinated methods among MS4 Phase 1 permittees yielding a system of reporting that will result in better characterization of stormwater quality statewide. Paramount to this vision is the concept of a central repository of municipal stormwater quality data – where data may be accessed by fellow permittees, researchers, DEQ analysts, and other stakeholders. This stormwater data will be reviewed by DEQ to inform permit development and compliance with permit conditions. DEQ recognizes the amount of work and resources that permittees put into stormwater quality monitoring.

A large part of this vision is to provide constructive and collaborative feedback on data collection and annual reporting of stormwater quality. Stormwater quality monitoring on a regional scale will allow DEQ to analyze changing trends across permittee jurisdictions which comprise a significant portion of stormwater inputs to the Willamette River Basin. Collectively, trends analyzes in the Willamette River Basin will direct best management practices (BMPs) in order to reduce transmission of contaminants from stormwater into receiving surface waters. While this is a primary focus of current MS4 Phase 1 NPDES permits, the regional trends will help contribute to a larger collaborative framework that may direct future stormwater program developments.

Current Gaps

- DEQ does not have a central data repository in place.
- Stormwater quality monitoring data is collected and analyzed by the individual permittee, not DEQ
- There is little to know collective knowledge or use of the municipal stormwater quality data.
- Current data submittals are not reviewed or approved

Future Directions

- DEQ will require electronic data submittal by permittees in a standard format that will easily allow for data analyses in order to interpret trends.
- While permittees will collect, enter, and analyze the data collected within their jurisdictions, DEQ will interpret regional trends submitted by all permittees.
- DEQ and MS4 Phase 1 permittees will develop a collaborative approach to stormwater monitoring, which will result in more strategic stormwater management aimed at addressing the effectiveness of Best Management Practices (BMPs) and monitoring efforts.
- DEQ will initiate the formation of a stormwater working group or task force which will be comprised of agencies (state and federal), municipalities, and other stormwater stakeholders. This working group will draft and administer a central Quality Assurance Project Plan (QAPP) in which all members agree to a stringent set of guidelines and expectations for stormwater monitoring.

2. Rethinking Stormwater Management in Oregon

After reviewing the 2014-2015 annual stormwater reports from each Phase 1 Permittee (Section 4) it is evident that a comprehensive approach to stormwater management is needed. A simple overall assessment of stormwater management in Oregon is that individual Phase 1 Permittees have been left to develop their own monitoring programs without much collaboration or involvement with DEQ. Phase 1 Permittees are required to provide an electronic copy of their report on their websites presumably for public access. However a number of these reporting styles would be incredibly difficult for the public to understand or interpret. The permittees need to interpret their results in a fashion that is discernible to the lay audience. Their citizens are the ones paying stormwater fees in order to fund these monitoring and Best Management Programs and an exorbitant amount of money is budgeted for these programs every year. If these programs are to be transparent they should be presented in a way that is much less convoluted.

A number of permittees have organized through membership with the Oregon Association of Clean Water Agencies (ORACWA), a private non-profit organization with interests in improving water quality in Oregon. In the past there has been correspondence between DEQ and ORACWA, however this has not proven fruitful in unifying all parties under a central stormwater vision. The common goals of stormwater management should be shared inclusively by all stakeholders. Thus, the number one recommendation of this report is to develop a working group comprised of stormwater quality stakeholders in Oregon. Given the geographic proximity of most Phase 1 permittees perhaps it makes the most sense to focus the stakeholder group on issues affecting stormwater quality within the Willamette River Valley. The remainder of this section will focus on ideas for reforming the stormwater management process in Oregon. Many of these concepts are based on successful programs in other state programs such as Washington and Maryland, where larger ecosystems (i.e. the Chesapeake Bay and the Puget Sound, respectively) are central to regional stormwater management efforts.

A. Developing a Stormwater Working Group for the Willamette River Region

Over 70% of Oregonians live within the Willamette River Valley and it follows that all Phase 1 permittee jurisdictions are also within the region. As stated earlier, there is no shared vision for improving stormwater quality at the regional scale. Instead efforts have been focused only on the individual bearing the NPDES permit. Washington and other states have moved away from the individual monitoring model to a new regionally-focused paradigm. Of course permittees are still required to monitor stormwater within their individual jurisdictions, but they also contribute to a regional understanding of stormwater quality issues. Currently, Washington phase I and II permittees organized as co-permittees under 3 permit regions, these include: the Puget Sound, the Lower Columbia River watershed, and Eastern Washington. Monitoring procedures have been standardized following guidelines outlined by the Washington Department of Ecology (Ecology). They then contribute to a fund for regional monitoring that is administered by Ecology. Although Ecology coordinates regional monitoring efforts, the decision of what and where to monitor is decided by their Stormwater Work Group (SWG). The SWG‘s goal is to identify priorities, a starting point, and next steps primarily to support stormwater management efforts. The SWG meets regularly to determine roles and responsibilities in their regional monitoring program.

Oregon should consider following a similar trajectory when building their stormwater program. Ecology (2007) determined that surface water and stormwater runoff in urban and rural areas is the primary, unaddressed transporters of toxic, nutrient, and pathogen pollutants to surface and groundwater resources throughout the Puget Sound basin and is recognized a one of the primary causes of habitat degradation in small streams due to alterations in flow volumes, timing, and duration. It is likely that stormwater runoff in urban and rural areas of Oregon also contribute to considerable degradation to water and habitat quality in the Willamette River Valley. The types and severity of threats likely vary in different places, but the entire region faces challenges from a growing human population and a conversion of natural to developed lands. A coordinated ecosystem approach much like those conducted in the Puget Sound would allow both DEQ and Phase 1 communities to more effectively address the ubiquitous nature and diffuse sources of pollutants that runoff into freshwater sources.

The development of a Stormwater Working Group could follow these central tenets:

1. A strong scientific foundation that incorporates specific, testable hypotheses related to reducing the impact of stormwater throughout the Willamette River Valley.

2. Adaptive management practices are employed to ensure that the relevance of scientific results of monitoring and used to inform management and permit development.

3. All strategies are inclusive and transparent. A comprehensive, regional stormwater assessment and monitoring program will be developed cooperatively for the Willamette River Valley.

The first steps will be to discuss strategies between all parties involved and this list may grow beyond Phase 1 Permittees and DEQ as there are other players in the Willamette River Valley who have interests in improving stormwater quality. These may include other local, state, and federal agencies, environmental groups, tribes, landowners, and development companies. This will have to be decided by the proposed members of the Stormwater Working Group, but the processes should be inclusive to save in time and resources as well as to avoid overlapping study designs.

B. Shifting to a standard set of monitoring procedures

Currently, MS4 Phase 1 permittees develop their own set of monitoring procedures in Stormwater Management Plans (SWMPs) that are reviewed and approved by DEQ. While this approach has been informative to the individual permittee for stormwater issues within their jurisdictions the procedures are limited in scope. A coordinated regional sampling regimen would be the ideal approach in determining issues with stormwater quality within the Willamette River Valley. At a minimum, a set of standardized stormwater monitoring procedures should be required by DEQ in order to make meaningful comparisons across the jurisdictions of permittees. DEQ should develop a set of required procedures for each permittee to use in their monitoring programs based on the latest science and adaptive management procedures that have proven successful in other states. This may require permittees to refine their scale and focus for their individual stormwater monitoring so that they can contribute to a larger scale vision of coordinated stormwater management. The Stormwater Working Group should agree on a standardized QAPP that will be followed by all permittees.

DEQ should require a specific style for reports that minimizes excessive reporting of raw data tables and repeated text. Ecology currently requires Phase 1 permittees to answer a set of specific questions and provided electronic data in the form of an excel file. Although DEQ has no central repository of data in place requiring a certain format for excel files will make data analyses much easier in the future. The size of data files collected each year should not be too large that they cannot be simply emailed along with report submission. DEQ may then acknowledge receipt of both and keep track of all submitted documents on their central server. Analyses and interpretation of monitoring data should still be conduced by the individual permittees to inform their monitoring and BMP programs. However electronic data submission (which is technically already required in the current NPDES permit) will allow DEQ to draw additional conclusions.

3. Emphasize Status and Trends Monitoring

A. Incorporating Status and Trends Monitoring

A critical component of regional monitoring of stormwater quality for the Willamette River Valley is the development and implementation of status and trends monitoring. In this section, a proposed framework is outlined for review by DEQ and the Phase 1 permittees for the development of a status and trends monitoring strategy. Status and trends are defined as long-term (e.g. >5 years) regional monitoring focused on biological communities and water quality in small streams in order to improve the understanding of whether stormwater management practices are improving habitat and receiving water body conditions throughout the Willamette Valley. Each component of the Study design and Experimental Framework section will have a "*Collaborators*" bullet that will list proposed monitoring entities.

B. Study design and Experimental Framework

Instream Monitoring – This type of monitoring is already conducted among most Phase 1 permittees. Small streams are assessed for total suspended solids (TSS), conductivity, pH, temperature, and other parameters that contribute to the physical conditions of the stream. However, it may be beneficial to add in assessments of habitat complexity (i.e. log jams, riffles, etc.) to contribute to a wider knowledge of stream conditions at each sample site. If collaborators are already monitoring these types of conditions it would be beneficial to merge efforts so that there is no overlap or repeated monitoring procedures. A useful assessment of stream integrity integrates both abiotic and biotic conditions in order to better adapt BMPs. While this may be trivial, it may be important to decide on a single term for this type of monitoring as instream monitoring may also be referred to ambient monitoring.

Collaborators: Local municipalities, ODEQ, ODFW, USGS, Universities and other parties that collect ambient water data in Oregon water bodies within the greater Willamette Valley region.

Biological Monitoring - Historically, the impacts of urban stormwater runoff on receiving waters have been assessed through direct comparison of water quality to standards or guidelines. However, biological monitoring must be incorporated in the study design order to truly understand the cumulative impacts of urbanization on stream condition (NRC 2009). Other state programs (e.g. Ecology) consider the monitoring of macroinvertebrate and fish communities in the receiving bodies of urban runoff areas a critical aspect of their status and trends monitoring program. Biological communities are likely affected by more than just stormwater management practices, therefore a monitoring program involving other management entities will greatly improve our understanding of long-term trends. Currently, most phase 1 permittees conduct some form of biological monitoring however all should have an agreed upon metric for assessing the quality of macroinvertebrate communities. A list of potential collaborators below will integrate data on water quality, land use types, geologic and geomorphic conditions, and other factors that contribute to the integrity and health of biological communities.

Collaborators: Local municipalities, ODEQ, ODFW, USGS, Universities and other parties that collect biological data in Oregon water bodies within the greater Willamette Valley region.

Stormwater (outfall) Monitoring – These monitoring procedures in particular need to be redefined by DEQ and the proposed Stormwater Working Group. To begin with stormwater quality data is highly variable by nature. That is, a terrible number of factors will contribute to the total variation in particular samples (e.g. storm intensity, timing of the sample, and land use categories). There are also several methods for collecting stormwater samples (i.e. grab, composite). Permittees have considerably variable styles of reporting these results, where some may interpret the findings while others simply present data in raw form. If the goal of stormwater monitoring is to inform BMPs to improve the conditions of stormwater quality a standard set of procedures must be reached. Further, some municipalities have opted to sample their UIC manholes as a substitute for stormwater outfalls into receiving bodies of surface water. While sampling UIC manholes may be important for groundwater quality, should it be considered a replacement for stormwater that is being spilled into surface waters? This is a major issue that DEQ and the proposed Stormwater Working Group must decide.

Collaborators: Local municipalities, ODEQ, Universities and other parties that are interested in stormwater outfall monitoring in Oregon water bodies within the greater Willamette Valley region.

Pesticides Monitoring – Monitoring for pesticides seems to be one of the more contested procedures by permittees, as several have asked DEQ to reduce monitoring efforts in this area. Currently, permittees may reduce monitoring efforts for pesticides if they have not consistently detected a particular analyte. This should be one of the easier analytes to inform BMPs to reduce pesticide loading in surface waters as these compounds can only enter the environment through human activities. Again, collaboration may be the best course of action to assist in this area. Often pesticides are used on agricultural fields well outside of the permittees MS4 conveyance system, but will still be detected in ambient water samples. A broader suite of sampling among other collaborators may elucidate the diffuse sources so that actions may be taken to mitigate the pesticide loading. DEQ is home to the Pesticide Stewardship Partnership program in which members could play a central role within the Stormwater Working Group to seek out proper sampling procedures and actions to reduce pesticides from entering surface waters.

Collaborators: Local municipalities, ODEQ, Pesticide Stewardship Partnership program.

Mercury Monitoring – The mercury monitoring program was imitated during the current permit cycle and permittees were asked to sample for mercury as a supplement to their routine sampling procedures. This sampling yielded little interpreted results or discussion and subsequently many permittees have called for its elimination. However, continued mercury sampling may be a question for the Stormwater Working Group to see if mercury pollution in stormwater is a concern for parts of the Willamette River Valley.

Collaborators: Local municipalities, ODEQ, Universities, ODFW, USFWS, USGS.

Other Monitoring – A number of permittees have sampling procedures that are unique to their permit such monitoring of Structural BMPs or geomorphic condition of their respective jurisdictions. While these may be monitoring efforts that are important for the individual permittee it should be decided by the Stormwater Working Group if there could be use in establishing additional monitoring within their permit areas to better inform the regional monitoring efforts.

Collaborators: Local municipalities, ODEQ, Pesticide Stewardship Partnership program.

In summary, the current individual monitoring efforts as categorized above may be useful in deciding a mutual approach to status and trends monitoring in the Willamette River Valley region. If a stormwater working group is established they could decide on how to best monitor stormwater quality both within their jurisdictions and for the region. Unless a regional scale monitoring effort is achieved it will be difficult to understand the status and trends of pollutants in stormwwater – as there may be unexplored contributing factors outside of permittee jurisdictions. It will also be important to invite other stakeholders to join the stormwater working group to build a network of active members who routinely contribute to this project. The alternative is the current Phase 1 permit program that has failed to achieve a central vision for improving stormwater quality in the region. Some permittees have achieved successes in reducing the loading of some parameters but cannot explain or resolve the parameters with frequent detections or that may be a sign of degraded water quality. A unified effort is essential to really understanding the driving forces behind stormwater pollution.

4. Summary of Phase 1 Permittee 2014-2015 Annual Reports

This section provides a succinct review of each Phase 1 Permittee's Annual Reports with respect to the monitoring procedures, data analyses, and reporting/interpretation of results. Each permittee is required to interpret their monitoring data and provide DEQ with explanations. At the end of each review there is a commentary section that provides notes and criticism. Each section is organized exactly how the Permittee presented their respective summaries of their findings.

Monitoring procedures are summarized for each permittee in Table B-1 Environmental Monitoring of their permit. Table B-1 for the City of Portland is provided below as a sample of how these procedures are outlined in the permit. Special conditions are provided in a summary below the table.

Table B-1 Environmental Monitoring

Monitoring Type	**Monitoring Location(s)**	**Monitoring Frequency**	**Pollutant Parameter Analyte(s)**
Instream Monitoring	Sixteen (16) sites; probabilistically selected; city-wide	Four (4) events/year	Field; Conventional; Metals; Nutrients
Continuous Instream Monitoring	Three (3) continuous monitoring stations	Ongoing	Temperature and Flow
Stormwater Monitoring	Fifteen (15) sites; probabilistically selected; city-wide	Three (3) events/year	Field; Conventional; Metals; Nutrients; Pesticides
Stormwater Monitoring- Pesticide	Fifteen (15) sites; probabilistically selected; city-wide	Three (3) events/permit term	Pesticides
Stormwater Monitoring- Mercury	Two (2) sites	Two (2) events/year; one summer event and one winter event	Mercury
Macro-invertebrate Monitoring	Sixteen (16) sites; probabilistically selected; city-wide	One (1) event/year	N/A

Special Conditions:

1) The monitoring frequency reflects the required number of sample events per monitoring location.

2) Additional pesticide pollutant parameters that must be considered for purposes of stormwater monitoring – pesticide include any pesticides currently used by the co-permittees within their jurisdictional areas and the following: Insecticides: Bifenthrin, Cypermethrin or Permethrin, Imidacloprid, Fipronil, Malathion, Carbaryl, Herbicides: Triclopyr, 2, 4-D, Glyphosate & degradate (AMPA), Trifluaralin, Pendimethalin, and Fungicides: Chlorothalonil, Propiconazole, Myclobutanil.

3) The Macroinvertebrate monitoring must follow a generally accepted macroinvertebrate monitoring methodology (e.g., DEQ Benthic Macroinvertebrate Protocol for Wadeable Rivers and Streams). The methodology must be documented in the monitoring plan.

4) BOD5 are only required to be monitored in streams with an established TMDL.

5) Monitoring and analysis for mercury and methyl mercury must be conducted in accordance with DEQ's December 23, 2010 "Mercury Monitoring Requirements for Willamette Basin Permittees" memo. After two years of monitoring the co-permittee may request in writing to the Department that the mercury and methyl mercury monitoring be eliminated. The monitoring may be eliminated only after written approval by the Department. EPA Method 1669 ultra clean sampling protocol must be used to collect samples. Monitoring for total and dissolved mercury must be performed according to USEPA method 1631E with a quantitation limit of 0.5 ng/L. Monitoring for total and dissolved methyl mercury must be performed according to USEPA method 1630 with a quantitation limit of 0.05 ng/L.

Pollutant parameter(s) identified in each analyte category in Table B-1 are as follows:

Field	Conventional	Nutrients	Metals (Total Recoverable & Dissolved)
Dissolved Oxygen	Escherichia coli (E.coli)	Nitrate (NO_3)	Copper
pH	Hardness	Ammonia Nitrogen (NH_3-N)	Lead
Temperature	Total Organic Carbon (TOC)	Total Phosphorous (TP)	Zinc
Conductivity	Total Suspended Solids (TSS)	Ortho-Phosphorous (O-PO_4)	Pesticides
		Mercury (Total & Dissolved)	2,4-D
		Mercury & Methyl Mercury	Pentachlorophenol

A. City of Portland

Monitoring Locations

Site ID	Location	Stream Name	Watershed
AWB	NE Airport Way Bridge B	Columbia Slough	Columbia Slough
SJB	St. John's Landfill Bridge	Columbia Slough	Columbia Slough
M2	1900 SE Millport Road	Johnson Creek	Johnson Creek
JC-6	SE 158th Ave. Bridge	Johnson Creek	Johnson Creek
FC-8	4916 SW 56th Avenue	Fanno Creek	Fanno Creek
TC-4	10750 SW Boones Ferry Road	Tryon Creek	Tryon Creek
TC-5	SW 26th Way and Barbur Boulevard	Tryon Creek	Tryon Creek
TC-6	9323 SW Lancaster Road	Tryon Creek	Tryon Creek
WR-BM	Morrison Street Bridge – RM 12.7	Willamette River	Willamette River
WR-CM	St. John's Railroad Bridge – RM 6.8	Willamette River	Willamette River
WR-FM	Waverly Country Club – RM 17.9	Willamette River	Willamette River

Instream Monitoring

- Most streams met most of the standards or guidance values most of the time, except for bacteria and phosphorus in Fanno Creek, bacteria in the Tualatin River tributaries, and dissolved copper in the Willamette River tributaries.

- Bacteria concentrations in the urbanized smaller tributaries met the single sample standard between 60 and 80 percent of the time. The mainstem Willamette River and the Columbia Slough met the single sample standard for 92 and 97 percent of the samples, respectively.

- Attainment of the dissolved copper guidance value ranged from 53 percent in the Willamette River tributaries to 100 percent in the Willamette River and Tualatin River tributaries.

- The Columbia Slough and Johnson Creek met their respective TSS guidance values (established to meet the toxics TMDL) in 74 and 84 percent of samples, respectively. All other streams met the TSS guidance values in 77 to 93 percent of samples.

- The Columbia Slough, Fanno Creek, and Tualatin River tributaries met their respective phosphorus TMDL concentrations across all locations ranging between 59 and 80 percent of samples. This is consistent with previous years. Using the Columbia Slough TMDL as guidance, other streams showed attainment of 87 percent and greater for phosphorus.

Continuous Monitoring

Location	Parameter	Period of record
Columbia Slough – RM 0.25 Gauge #14211820	Gauge height, Discharge, Stream velocity	10/01/1989 – to date 10/01/1989 – to date
Fanno Creek at 56th Ave. – RM 11.9 Gauge #14206900	Gauge height, Discharge	10/01/1990 – to date 10/01/1990 – to date
Johnson Creek at Sycamore – RM 10.2 Gauge #14211500	Gauge height, Discharge, Temperature	07/01/1940 – to date 10/01/2001 – to date 04/28/1998 – to date

Johnson Creek at Milwaukie – RM 0.7 Gauge #14211550	Gauge height, Discharge, Temperature	04/22/1989 – to date 04/22/1989 – to date 05/07/1998 – to date 11/10/2004 – to date
Kelly Creek at 159th Dr. – RM 0.0 Gauge #14211499	Gauge height, Discharge, Temperature	03/11/2000 – to date 01/29/2000 – to date 07/27/2010 – to date
Tryon Creek near Lake Oswego – RM 1.0 Gauge #14211315	Gauge height, Discharge	08/03/2001 – to date 08/02/2001 – to date
Willamette River at Morrison Bridge – RM 12.8 Gauge #14211720	Gauge height, Discharge, Temperature Turbidity, Specific conductivity, Stream velocity, Dissolved oxygen, pH, Chlorophyll, Sensor depth, Cyanobacteria, Nitrate (in situ)	10/11/1987 – to date 10/01/1972 – to date 02/09/1972 – to date 01/22/2009 – to date

- The maximum discharges in Fanno Creek and Johnson Creek were higher than last fiscal year, and both occurred on March 15 in 2015. The minimum discharges in the streams occurred in the summer months.

- Temperature maximums occurred in late June in Johnson Creek and the Willamette River due to low river levels and very high ambient temperatures. Small streams typically respond more quickly to high ambient temperature and solar radiation, and therefore can exhibit temperature maximums earlier in the year than large streams.

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- The summer temperature at JC-1 is mainly driven by conditions in the Crystal Springs Creek system, rather than the Johnson Creek mainstem. While the summer water temperature at JC-1 is often cooler than at JC-2 (as noted in the table above), there are three large unshaded inline ponds in Crystal Springs that can be a source of thermal loading during very hot days, which can result in higher temperatures at JC-1 than at JC-2. Since the removal in 2013 of one inline pond located at Westmoreland Park, it appears that a warming increase during very hot days in the summer is closer to 1°C compared to the 3°+ C increase prior to the removal of the pond.

- The temperature maximum in both Johnson Creek and the Willamette River exceeded the respective biological criteria temperatures.

- Chlorophyll a readings in the Willamette River were occasionally above the water quality criterion between July 1 and September 1 when flows are typically below 15,000 cfs. These exceedances are attributed to a combination of slow-moving water and hot weather.

Stormwater Monitoring

Site ID	**Watershed**	**Predominant land use**	**Location**	**Dates of previous data collection**
OF19	Willamette River	Forest Park and Industrial	NW Front and Kittridge Avenues	2000–2011[1]
M1	Columbia Slough	Mixed	NE 122nd Avenue at the Columbia Slough	1991-2011

R1	Fanno Creek	Residential	Fanno Creek at SW 56th Street	1991-2001
R2	Columbia Slough	Residential	NE 141st Avenue and Sandy Boulevard	

- A total of 91 samples at 30 locations (16 at locations with greater than 1,000 average vehicle daily trips [ADT] and 14 at locations with less than 1,000 ADT) were collected during three storm events. At one location, four storm samples were collected. Because the stormwater that was sampled discharges to City sumps, not surface water, reference to surface water standards or guidance values is solely for comparison purposes.

- The median concentrations of dissolved copper in both traffic categories were slightly above the guidance value, and the 90th percentile concentrations in both traffic categories were above the guidance value.

- The total phosphorus and TSS median concentrations were slightly below the guidance values for both traffic categories. The 90th percentile values were higher than the guidance values.

- The median E. coli concentrations were slightly below the standard of 406 MPN/100 mL in the <1000 ADT and slightly above the standard in the > 1000 category. The 90th percentile was 10 to 15 times the single sample standard.

- The difference in the median of the analytes between the traffic categories is relatively small for dissolved copper, E. coli, and total phosphorus, but greater for TSS. Median concentrations for almost all analytes with a detection percentage above 50 percent are generally higher in the > 1,000 ADT traffic category.

- The March 3, 2015 sample collected from P6_8 (10064 SE Woodstock Blvd) had the highest TSS concentration (458 mg/L) observed at a stormwater monitoring location this fiscal year. A recycling facility operates at this location, and field crews observed poor housekeeping practices during sampling. An additional sample was collected at this location on June 2, 2015, with a TSS result of 57 mg/L.

Pesticide Monitoring

Statistic	2,4-D	2,4,5-T	2,4-DB	TP	DB	PCP	BZ
Number of Samples	91	91	91	91	91	91	91
Detection	12.1%	1.1%	2.2%	5.5%	1.1%	92%	1.1%
< 1000 ADT[1] Median [µg/L]	< 0.06	< 0.15	< 0.5	< 0.1	< 0.1	0.17	< 0.5
> 1000 ADT[1] Median [µg/L]	< 0.06	< 0.15	< 0.5	< 0.1	< 0.1	0.225	< 0.5
Maximum [µg/L]	1.4	0.31	48.8	0.19	0.17	4.3	0.54
EPA Aquatic Life BM [µg/L] [2]	12,500	NA	1,000	NA	NA	25	50000
Table 30 Criterion [µg/L] [3]	NA	NA	NA	NA	NA	8.7 4	NA

TP = 2,4,5-TP (silvex); DB = dinoseb; PCP = Pentachlorophenol; BZ = bentazon
[1] ADT = Average daily vehicle trips
[2] Lowest EPA aquatic life benchmark (invertebrate or fish)
[3] Acute freshwater criterion (OAR 340-041, Table 30, August 4, 2015)
[4] Acute freshwater criterion at pH = 7.0
NA = not available

- Of the targeted insecticides listed in Table B.1 of the City's MS4 permit, only two (fipronil and imidacloprid) were detected at one location. Fipronil was detected at a concentration slightly exceeding EPA's aquatic life criterion for invertebrates. The Fipronil reporting limit (0.12 µg/L) was slightly above the EPA freshwater acute criteria (0.11 µg/L). Fipronil is a dinitroaniline herbicide used to control ants, cockroaches, fleas, ticks, and weevils and is readily available for home use. Imidacloprid is a systemic neonicotinoid insecticide that is the most widely used insecticide for pest control in gardens and also as a flea treatment for pets.

- Of the targeted herbicides listed in Table B.1 of the City's MS4 permit, only two (pendimethalin and triclopyr) were detected at one location each, at concentrations far below the lowest EPA aquatic life benchmark. Pendimethalin is a fairly commonly used dintroaniline herbicide used to control annual grasses and certain broadleaf weeds. Triclopyr is a systemic herbicide that is used for control of broadleaf weeds.

- Of the additional 180 non-targeted pesticides, five herbicides (dichlorobenyl, diuron, ethofumesate, MCPP, and simazine) were detected with a frequency of up to 16.7 percent. Ethofumesate was detected at the highest frequency (16.7%) and is used for controlling weedgrass and annual meadow-grass in turf, primarily in commercial applications.

- In addition to the UIC PPS pesticide monitoring, a number of pesticides are analyzed as part of routine UIC WPCF monitoring. These pesticide samples were collected during three events at all 30 locations of Panels 5 and 6 between October 2014 and June 2015.

- Of the 12 pesticides analyzed, seven were detected, but the lowest EPA aquatic life benchmark was not exceeded for any pesticide.

- All analytes except for pentachlorophenol were detected infrequently and at levels well below EPA acute criteria.

Macroinvertebrate Monitoring

Watershed	FY 10-11 to FY 13-14	FY 14-15	
	Median O/E Ratio		Range of O/E Ratio
Columbia Slough	0.28	0.19	0.10 – 0.24
Fanno Creek	0.43	0.36	0.33 – 0.39
Johnson Creek	0.49	0.36	0.24 – 0.48
Tryon Creek	0.67	0.59	0.54 - 0.64
Tualatin Tributaries	0.43	0.36	0.34 – 0.37
Willamette River Tributaries	0.67	0.42	0.29 – 0.91

- Pentachlorophenol (PCP) was detected in all but seven samples (92 percent) at a maximum concentration of 4.3 μg/L, which is well below the EPA aquatic life benchmark and the Oregon Administrative Rules (OAR) 340-041 acute freshwater criterion. As has been observed in previous years, the median pentachlorophenol concentration in locations with > 1,000 ADT was greater than that in locations with < 1,000 ADT.

- The PREDATOR score (observed macroinvertebrate communities over modeled expected macroinvertebrate communities, based on reference conditions), one of a number of options to summarize macroinvertebrate data, was calculated and compared to the benchmark scores of 0.85 (scores below this are "most impacted") and 0.91 (scores above this are "least impacted") established by DEQ. Scores between 0.85 and 0.91 are "minimally impacted."

- Medians for each year ranged from a low of 0.34 (most recent sampling year) to a high of 0.48 (sampling year 3). There was considerable variability within years and the differences among years were not statistically significant or suggestive of trends over time (Figure 2).

- The highest O/E value in the most recent year was 0.90 in Balch Creek, just below the 0.91 threshold for "least impacted" streams and indicating that conditions at this location are close to reference conditions in western Oregon (Figure 2). The only location in all five monitoring years (100 locations total) that met the "least impacted" benchmark was Miller Creek in Year 4 (0.95). The only other station above the "minimally impacted" benchmark (0.85) was the same Balch Creek station sampled in the first year. (Stations are sampled on a four-year rotational panel so the current Year 5 samples are revisits of the Panel 1 stations sampled in the first year.)
- Five other locations had a score above 0.75: one each in Saltzman, Linnton, Miller and Balch creeks (all Forest Park tributaries to the Willamette River), and one in a tributary to Tryon Creek in Tryon Creek State Park.
- Year 5 is the first year in which stations in the four-year rotational panel were resampled. Although the overall differences among years were not significant, comparing the panel 1 stations sampled in Years 1 and 5 with a paired t-test indicates that the scores in Year 5 were significantly lower than the scores from the stations sampled in Year 1 (*Figure 3*). The sample size is limited, and there are a number of reasons that could explain the difference, including weather. A more rigorous test of changes over time will be a comparison of the first and second samples obtained from all four panels, which will be available in Year 8.
- There were large differences among the watersheds. The Columbia Slough was significantly lower than all other watersheds, and the Willamette streams and Tryon Creek were significantly higher than all other watersheds. It is important to note, however, that most metrics used to evaluate the health of macroinvertebrate communities are developed for pool-riffle stream systems. They are not as effective in addressing sloughs, wetlands, and large rivers, since the historical and reference macroinvertebrate communities in these systems are different from the higher-gradient, faster-water pool-riffle systems to which most of the macroinvertebrate community metrics are geared.

Commentary

Portland provided a very thorough report of their findings from monitoring efforts. The report was organized well and the statistical procedures and figures were explanatory. Portland interpreted their results to explain potential trends and processes that occur within their MS4 system. There is some concern about how samples from their UIC network are representative of stormwater that is actually being discharged into surface waters – the DEQ Lab also shared these concerns. They may need to reconsider sampling procedures to include outfalls into the Willamette and other smaller tributaries.

B. City of Eugene

Monitoring Locations

Location	MS4 System Type	Sample Type	Analyte Type
Amazon Basin Sampling Sites:			
A3 Channel: at Bertelsen at Seneca	Surface Water	Grab	Pesticides
Chambers at 18th Avenue, NE; MH 55402 NE Loading Dock Catch Basin	Piped System	Grab	Field, Bacteria
Chambers at 18th Avenue, NE; MH 55404	Piped System	Grab & Flow Proportional	Field, Metals, MeHg, Conventional, Nutrients, and Chlorinated Organics
Roosevelt Channel Upstream; MH 79222 Downstream; MH 79206		Grab	Field, Bacteria
West 5th at Seneca; MH 63693	Piped System	Grab & Flow Proportional	Field, Metals, MeHg, Conventional, Nutrients, Chlorinated Organics
Willow Creek at 18th Avenue	Surface Water	Grab & Flow Proportional	Field, Metals, Conventional, Nutrients
Willamette River Basin Sampling Sites:			
Altura; MH 99365 Copping; MH 77793	Piped System	Grab & Flow Proportional	Metals, Conventional, Nutrients, Dioxin
Spring Creek at Naismith (Upstream) at Beacon Drive East (Downstream)	Surface Water	Grab	Pesticides
Contech Structural MMP Downstream Structure 85867 Upstream Structure 85866	Piped System	Grab	Field, Metals, Conventional, Nutrients

Amazon Basin Monitoring

- Amazon Basin ambient monitoring locations indicate long-term decreasing concentration trends occur at specific sites for arsenic, cadmium, chromium, lead, mercury, molybdenum, nickel, silver, phosphorus, nitrogen, suspended solids, temperature, and turbidity; decreasing dissolved oxygen was also observed. Statistically significant long-term increasing concentration trends occur at specific sites for lead, zinc and chemical oxygen demand.

- Significant decreasing and increasing concentration trends for pollutants in the Amazon Basin occur at monitoring locations downstream of the urban environment, and serve as an indicator of the effectiveness of the sum of stormwater program elements as described in the previous sections of this report.

- While significant water quality improvements have occurred at downstream monitoring locations, activities within the permit area continue to have a measurable impact on levels of pollutants observed in Amazon Basin streams and channels. Intra-basin upstream and downstream water quality comparisons indicate the concentration of metals, temperature, chemical oxygen demand, occasionally nitrogen, suspended solids, turbidity, and fecal Coliform increase as Amazon Creek flows through the urban environment. *E. coli* counts, dissolved oxygen, pH, water hardness, dissolved solids, nutrients (nitrogen and phosphorus), and dissolved zinc decrease. Analytes for the A3 Channel are greater than those measured for Amazon Creek; dissolved arsenic, chromium and mercury are exceptions. Amazon Creek analyte concentrations are greater than those measured for Willow Creek; total arsenic is an exception. The Willow Creek drainage basin serves as a background water quality site because of its relatively low development compared to the urbanized permit area, although recent trends indicate some degradation of water quality.

- Statistical tests also indicate Amazon Basin water samples collected during the 2014/2015 permit year at specific sites had significantly lower analyte concentrations when compared to historical data, including , calcium, chemical oxygen demand and turbidity; however, chemical oxygen demand, turbidity, copper, and zinc concentrations were found to increase at other monitoring sites; average zinc concentrations increased substantially.

- Within the Willow Creek drainage basin, a statistically significantly concentration increase was observed for dissolved and total zinc during the most recent monitoring period.

Willamette Basin Monitoring

- Water quality results for ambient samples collected from the Willamette River indicate statistically significant long-term decreasing concentration trends occur at two sites for phosphorus and chromium, and one for either bacteria, pH, or mercury; an increasing trend isobserved at one site for copper and at two for conductivity. An increasing dissolved oxygen trend is also observed for Delta Ponds.

- As the Willamette River flows through the Eugene urban environment, analyte concentrations increase for arsenic, copper, lead, mercury, nickel, silver, and zinc metals; nutrients (nitrogen and phosphorus), dissolved and suspended solids, turbidity, hardness (calcium and magnesium), conductance, and bacteria (*E. coli* and fecal Coliform) also increase. Field pH decreases across the river reach through the urban environment.

- A comparison of water quality for Delta Ponds, whose riparian habitat has been restored, to the Willamette River at Owosso Bridge indicates the ponds have higher metal concentrations for arsenic, copper, lead, nickel, and zinc; chromium and mercury concentrations are higher in the Willamette River at Owosso Bridge. Other analytes with statistically significant concentrations that are higher in Delta Ponds include hardness (calcium and magnesium), conductance, total phosphorus, nitrogen, and dissolved solids; pH values and dissolved oxygen concentrations are higher in the Willamette River at Owosso Bridge. Long-term water quality characteristics for Delta Ponds will continue to change under flow management to restore the hydraulic connectivity of Delta Ponds to the Willamette River in an effort to enhance riparian habitat.

- In some instances the concentration of pollutants measured at Amazon Basin and Willamette River sites exceed Oregon water quality standards and beneficial uses for surface waters defined in Chapter 340, Division 41 of the Oregon Administrative Rules (OAR). For example, arsenic concentrations and bacteria counts in Amazon Basin streams and channels periodically exceed the human health criterion established for drinking water or recreational use. Toxicity criteria applicable to aquatic species are periodically exceeded for cadmium, copper, lead, mercury, silver, zinc, dissolved oxygen, pH, and temperature at Amazon Basin sites, and less frequently at Willamette River sites. Note, however, that exceedances of some of these pollutants in the Willamette River also occur at the monitoring location upstream of the Eugene urban area, indicating some analytes either occur naturally in the waterbody, or are affected by human activities upstream and outside of the permit boundary.

- Water quality trends and comparisons indicate measurable progress is being made toward improving the water quality of channels, streams and rivers receiving stormwater runoff from the City of Eugene. Continued improvements are anticipated through adaptive management and refinement of stormwater program BMPs as needed.

Commentary

The monitoring efforts were thorough however the reporting style was difficult to interpret. It would be preferred that City of Eugene reported their results following the table of monitoring requirements where each section reports the results from each type of monitoring. Further, Eugene relies too heavily on appendices and supplementary figures to illustrate their results. They should summarize the results by some common land use type or other relevant categorical variable. Summaries by site are not informative to readers who are not familiar with those areas and what they represent.

C. City of Salem

Monitoring Locations

Monthly Instream	
Site ID	Site Location
BAT 1	Commercial St SE
BAT 12	Rees Hill Rd SE
CGT 1	Mainline Dr NE
CGT 5	Hawthorne St NE @ Hyacinth St NE
CLA 1	Bush Park
CLA 10	Ewald St SE
CRO 1	Courthouse Athletic Club
CRO 10	Ballantyne Rd S
GIB 1	Wallace Rd NW
GIB 15	Brush College Rd NW
GLE 1	River Bend Rd NW
GLE 10	Hidden Valley Dr NW
LPW 1	Cordon Rd NE
MIC 1	Front St Bridge
MIC 10	Turner Rd SE
MRA 1	High St SE
MRA 10	Mill Race Park
PRI 1	Riverfront Park
PRI 5	Bush Park
SHE 1	Church St SE
SHE 10	State Printing Office
WR1	Sunset Park (Keizer)
WR5	Union St. Railroad Bridge
WR10	Halls Ferry Road (Independence)

Continuous Instream	
Site ID	Site Location
BAT3	Commercial St SE
BAT12	Lone Oak Rd SE
CLK1[1]	Bush Park
CLK12	Ewald St SE
GLE3	Wallace Rd NW
GLE12	Hidden Valley Dr NW
LPW1[2]	Cordon Rd
MIC3	North Salem High School
MIC12	Turner Rd SE
PRI3[1]	Pringle Park
PRI4[2]	Salem Hospital Footbridge
PRI12[1]	Trelstad Ave SE
SHE3	Winter St. Bridge

Stormwater / Pesticides / Mercury	
Site Id	Site Location
Electric[3]	Electric St. SE and Summer St. SE
Hilfiker[3]	Hilfiker Ln. SE and Commercial St. SE
Salem Industrial	Salem Industrial Dr. NE and Hyacinth St. NE

[1] Instream Storm sampling done at these sites. [2] Stage-only gauging station. [3] Mercury monitoring conducted at these sites.

BAT = Battle Creek, CGT = Claggett Creek, CLA / CLK = Clark Creek, CRO = Croisan Creek, GIB = Gibson Creek, GLE = Glenn Creek, MIC = Mill Creek, MRA = Mill Race, PRI = Pringle Creek, SHE = Shelton Ditch, LPW = West Fork Little Pudding River, WR = Willamette River

Parameters for each monitoring element

Parameter	Units	Monitoring Element			
		Instream Storm	Stormwater	Monthly Instream	Continuous Instream
Alkalinity	mg/L			x[1]	
Biological Oxygen Demand (BOD_{stream})	mg/L	x		x	
Biological Oxygen Demand (BOD_{5day})	mg/L		x		
Specific Conductivity (Sp. Cond)	µS/cm	x	x	x	x
Copper (Total Recoverable and Dissolved)	mg/L	x	x	x[2]	
Dissolved Oxygen (DO)	mg/L	x	x	x	x
E. coli	MPN/100 mL	x	x	x	
Hardness	mg/L	x	x	x[2]	
Lead (Total Recoverable and Dissolved)	mg/L	x	x	x[2]	
Ammonia Nitrogen (NH_3-N)	mg/L	x	x	x[1]	
Nitrate and Nitrite (NO_3,NO_2)	mg/L	x	x	x	
pH	S.U.	x	x	x	x
Total Dissolved Solids (TDS)	mg/L			x[1]	
Temperature	°C	x	x	x	x
Total Phosphorus (TP)	mg/L	x	x	x[1]	
Ortho Phosphorus	mg/L	x	x		
Total Solids (TS)	mg/L			x[1]	
Total Suspended Solids (TSS)	mg/L	x	x	x[1,3]	
Turbidity	NTU			x	x
Zinc (Total Recoverable and Dissolved)	mg/L	x	x	x[2]	

[1] Willamette River sites only (WR1, WR5, and WR10).

[2] Pringle Creek Watershed sites only (PRI1, PRI5, CLA1, and CLA10).

[3] West Fork of Little Pudding River site only (LPW 1).

Water quality criteria for monitored streams

Parameter	Season	Criteria	Applicable Waterbody
Dissolved Oxygen	January 1-May 15	Spawning: Not less than 11.0 mg/L or 95% saturation	Battle Creek*, Claggett Creek*, Clark Creek*[3], Croisan Creek*, Glenn Creek*, West Fork Little Pudding River*
	October 1- May 31	Spawning: Not less than 11.0 mg/L or 95% saturation	Gibson Creek*□, Glenn Creek, Willamette River
	October 15 - May 15	Spawning: Not less than 11.0 mg/L or 95% saturation	Mill Creek*, Pringle Creek*[1], Shelton Ditch*
	Year Around (Non-spawning)	Cold water: Not less than 8.0 mg/L or 90% saturation	Battle Creek*, Croisan Creek*, Clark Creek, Glenn Creek*[4], Pringle Creek[2]
		Cool water: Not less than 6.5 mg/L	Claggett Creek*, Glenn Creek*, Mill Creek, Pringle Creek[1], Shelton Ditch, West Fork Little Pudding River
pH	Year Around	Must be within the range of 6.5 to 8.5 pH units	All Monitoring Streams
Temperature	October 15 - May 15	Salmon and steelhead spawning: 13°C 7-day average maximum	Mill Creek, Shelton Ditch
	October 1- May 31	Salmon and steelhead spawning: 13°C 7-day average maximum	Gibson Creek□
	Year Around (Non-spawning)	Salmon and trout rearing and migration: 18°C 7-day average maximum	All Monitoring Streams
E. coli	Fall-Winter-Spring	30 day log mean of 126 E. coli organisms per 100 ml (or) no single sample > 406 organisms per 100 ml	All Monitoring Streams
	Summer	30 day log mean of 126 E. coli organisms per 100 ml (or) no single sample > 406 organisms per 100 ml	All Monitoring Streams
Biological Criteria	Year Around	Waters of the state must be of sufficient quality to support aquatic species without detrimental changes in the resident biological communities.	Claggett Creek*, Clark Creek*, Croisan Creek*, Glenn Creek*, Pringle Creek Trib*, Willamette River*
Copper	Year Around	Freshwater Acute and Chronic Criteria: 18 and 12 µg/L respectively with values calculated for a hardness of 100 mg/L	Pringle Creek*
Lead	Year Around	Freshwater Acute and Chronic Criteria: 82 and 3.2 µg/L respectively with values calculated for a hardness of 100 mg/L	Pringle Creek*
Zinc	Year Around	Freshwater Acute and Chronic Criteria: 120 and 110 µg/L respectively with values calculated for a hardness of 100 mg/L	Pringle Creek*

Note: All waterbodies in this table are included under the Willamette Basin or Molalla-Pudding Subbasin TMDL for Temperature and E. coli.

* Oregon's 2010 Integrated Report Section 303(d) listed.

□ Gibson Creek is referred as Gibson Gulch in Oregon's 2010 Integrated Report.

[1] Applies to Pringle Creek from river mile 0 to 2.6.

[2] Applies to Pringle Creek from river mile 2.6 to 6.2.

[3] Applies to Clark Creek from river mile 0 to 1.9.

[4] Applies to Glenn Creek from river mile 4.1 to 7.

Mediu

Station	Number of Samples	Temperature (C)	DO (mg/L)	Sp. Cond (µS/cm)	Turbidity (NTUs)	pH (S.U.)	E. Coli (MPN/100 mL)	NO_3 NO_2 (mg/L)	BOD_{stream} (mg/L)
BAT 1	12	11.9	10.0	50.0	10.4	6.6	128.0	0.77	0.98
BAT 12	12	11.4	10.3	45.8	8.1	6.9	298.5	0.68	0.88
CGT 1	12	14.6	9.7	181.2	10.1	7.3	162.0	0.37	1.57
CGT 5	12	14.8	9.9	153.9	22.7	7.4	460.5	0.54	1.87
CLA 1	12	12.7	10.0	91.8	3.9	7.1	495.0	0.92	0.98
CLA 10	12	12.6	9.4	71.4	4.2	6.6	160.5	1.40	0.86
CRO 1	12	11.6	10.3	70.0	8.2	7.0	82.0	0.47	1.08
CRO 10	12	11.5	9.6	51.7	9.5	6.7	41.5	0.40	0.88
GIB 1	12	12.7	9.7	83.4	11.2	6.9	115.5	1.00	1.06
GIB 15	12	13.2	9.9	95.9	11.1	7.1	121.0	1.74	0.86
GLE 1	12	12.9	9.8	93.1	10.9	7.1	172.0	1.13	0.86
GLE 10	10	10.8	10.6	61.6	9.3	7.0	51.0	1.47	0.75
LPW 1	9	11.6	9.7	204.8	7.3	7.0	249.0	1.29	1.14
MIC 1	12	13.9	10.0	78.1	4.3	7.0	131.0	1.09	0.98
MIC 10	12	12.8	10.8	68.2	5.4	7.3	147.5	1.03	1.06
MRA 1	12	13.7	10.1	74.8	5.1	7.1	202.5	1.08	1.13
MRA 10	12	13.4	9.5	75.6	5.2	6.9	161.0	1.05	1.07
PRI 1	11	13.9	10.2	64.4	5.6	7.1	110.0	0.55	1.09
PRI 5	12	14.3	10.0	87.7	6.3	7.1	98.0	0.99	1.60
SHE 1	12	13.3	10.2	73.3	5.2	7.2	94.5	1.08	1.07
SHE 10	12	13.3	10.3	72.4	5.3	6.9	108.0	1.09	1.07
WR1	12	14.6	11.1	69.9	4.5	7.7	25.0	0.25	0.88
WR5	12	14.3	10.0	69.5	4.6	7.2	25.0	0.23	0.88
WR10	12	14.7	10.5	67.7	4.5	7.3	8.5	0.20	0.97

Number of water quality criteria exceedances for monthly instream sites (2014-2015)

Station	Number of Samples	Dissolved Oxygen	pH	E. Coli[5]			Copper[6]		Lead[6]		Zinc[6]	
				Total #	Dry[2]	Rain[3]	Total	Dissolved	Total	Dissolved	Total	Dissolved
BAT 1	12	8	4	4	1	3						
BAT 12	12	3	2	5	3	2						
CGT 1	12	6	0	5	2	3						
CGT 5	12	3	0	8	5	3						
CLA 1	12	4	0	8	5	3	2	2	0	0	1	1
CLA 10	12	0	4	5	2	3	1	0	0	0	1	1
CRO 1	12	7	1	3	0	3						
CRO 10	12	7	2	3	1	2						
GIB 1	12	5[1]	0	2	0	2						
GIB 15	12	5	0	4	2	2						
GLE 1	12	5	0	4	1	3						
GLE 10[4]	10	6	0	3	1	2						
LPW 1[4]	9	5	0	3	1	2						
MIC 1	12	2	0	2	0	2						
MIC 10	12	1	2	0	0	0						
MRA 1	12	NA	0	4	2	2						
MRA 10	12	NA	0	4	2	2						
PRI 1[4]	11	3	0	2	0	2	0	0	0	0	0	0
PRI 5	12	5	0	3	1	2	0	0	0	0	0	0
SHE 1	12	2	0	1	0	1						
SHE 10	12	3	0	2	1	1						
WR1	12	2	0	1	1	0						
WR5	12	4	2	1	1	0						
WR10	12	7	0	1	1	0						

Note: Copper, lead, and zinc collected at Pringle Creek Watershed sites only (PRI1, PRI5, CLA1, and CLA10).

NA = Not available (No dissolved oxygen water quality criteria associated with this waterbody).

[1] No year-round dissolved oxygen water quality criteria associated with this waterbody.

[2] Dry is < 0.05 inches of rainfall in previous 24 hours.

[3] Rain is ≥ 0.05 inches of rainfall in previous 24 hours.

[4] Unable to sample all 12 due to lack of flow/too high of flow.

[5] Single sample criterion of > 406 organisms per 100 mL used.

[6] Exceedences calculated based on hardness concentration for each event.

Commentary

The City of Salem completed extensive monitoring and was able to complete monitoring requirements for pesticides, mercury, and macroinvertebrates by the submission time of the 2014-2015 annual report. In Table 5 presented above they share the number of exceedances with water quality criteria by site. In their report they provide additional tables to show the concentrations of exceedances by site (in red) in tables 7-15 (Salem 2015). In addition, they presented their findings in several figures. They also attached the analytical records from pesticides screenings. However Salem did not provide thorough interpretation and discussion of their findings. Further, they did not link these monitoring results back to BMP implementation or effectiveness monitoring. There was no discussion in the monitoring section. They should consider organizing their results by monitoring types (i.e. instream, biological, storm event, etc.) and summarize by some categorical variable that is representative of the common land use types within their jurisdiction.

D. Multnomah County

Instream Monitoring

- Instream monitoring is required at two sites in the permit area for a range of pollutant parameters shown in the table below. Monitoring is coordinated with the City of Gresham; the County maintains an intergovernmental agreement with Gresham to contract monitoring services, including monitoring scope, and sampling methods. Fairview Creek and Beaver Creek are the two priority watersheds in the Gresham area. Fairview Creek results are summarized in the Gresham NPDES Annual Report.

- Two sites in Beaver Creek are monitored by the County, one site at the boundary of the urban and agricultural land uses, and one near the mouth of the stream, where the stream joins the Sandy River. Instream monitoring results are generally within expected ranges, with exceedances in temperature and E.coli.

Monitoring location	*Sampling frequency*	*Parameters*
Lower Beaver Creek (BCI1) Upper Beaver Creek (BCI2)	4 events/year	Biological Oxygen Demand (BOD5) Total suspended sediment (TSS) Hardness Temperature Dissolved Oxygen (DO) Conductivity pH Nitrate (NO3) Ammonia nitrogen (NH3-N) Total phosphorus (TP) Ortho-phosphorus (O-PO4) Copper, total and dissolved Lead, total and dissolved Zinc, total and dissolved E.coli bacteria
Lower Beaver Creek (BCI1) Upper Beaver Creek (BCI2)	1 event/year	Macroinvertebrate

Sample ID	Site ID	Date	Time	24-hr rain (in)	Field DO (mg/L)	Field pH	Field Temp (°C)	Conductivity (uS/cm)	Turbidity (ntu)	BOD5 (mg/L)	TSS (mg/L)	NH3-N (ug/L)	Chloro-phyll-a (mg/m3)	NO3-N (ug/L)	O-PO4 (ug/L)	TKN (ug/L)	Total-P (ug/L)	Hardness (mg CaCO3/L)
W14G236-10	BCI1	7/29/2014	14:15	0.00	5.15	7.51	22.2	120	7.32	**2**	13	26	6	1400	45	420	119	73.1
W14J304-10	BCI1	10/28/2014	14:10	0.35	10.26	7.23	12.8	88	9.55	**2**	9	22	**2**	1300	**20**	420	79	37.1
W15A209-10	BCI1	1/26/2015	13:25	0.00	13.32	NM	7.7	93	8.19	**2**	**2**	**20**	NM	3200	**20**	290	41	43
W15D235-10	BCI1	4/29/2015	13:50	0.04	10.29	8.69	13	97	5.11	**2**	**2**	**20**	NM	1900	28	320	50	50.3
W14G236-11	BCI2	7/29/2014	13:25	0.00	7.07	7.26	21.1	108	2.65	**2**	2	41	2	2100	90	660	99	53.9
W14J304-11	BCI2	10/28/2014	13:00	0.35	11.17	6.89	11.8	116	8.37	2	3	**20**	**2**	3500	**20**	540	85	48
W15A209-11	BCI2	1/26/2015	12:25	0.00	10.72	NM	7	68	14.4	**2**	**2**	**20**	NM	3700	**20**	240	34	29.8
W15D235-11	BCI2	4/29/2015	12:55	0.04	12.44	8.34	12.8	73	5.82	**2**	**2**	**20**	NM	3100	**20**	520	47	34.5

Sample ID	Site ID	Date	Time	Hg-Total (ug/L)	Cu-Total (µg/L)	Pb-Total (µg/L)	Zn-Total (µg/L)	Cu-Diss (µg/L)	Pb-Diss (µg/L)	Zn-Diss (µg/L)	E. coli (MPN/100ml)
W14G236-10	BCI1	7/29/2014	14:15	0.00214	1.84	0.264	7.7	1.2	**0.10**	2.31	110
W14J304-10	BCI1	10/28/2014	14:10	0.00388	3.18	0.486	23.5	2.24	0.10	14.2	430
W15A209-10	BCI1	1/26/2015	13:25	**0.0010**	0.78	0.109	7.7	0.561	**0.10**	4.95	20
W15D235-10	BCI1	4/29/2015	13:50	**0.0010**	1.45	**0.1**	4.0	1.2	**0.10**	1.8	31
W14G236-11	BCI2	7/29/2014	13:25	0.00198	2.43	**0.100**	1.2	1.97	**0.10**	0.986	300
W14J304-11	BCI2	10/28/2014	13:00	0.00228	1.56	0.139	1.8	1.26	**0.10**	1.2	>2400
W15A209-11	BCI2	1/26/2015	12:25	0.00123	0.64	0.107	1.3	0.432	**0.10**	0.639	**10**
W15D235-11	BCI2	4/29/2015	12:55	0.0012	1.70	**0.1**	1.5	1.42	**0.10**	0.832	460

**exceedances highlighted in green*

Macroinvertebrate Monitoring

- Macroinvertebrate scores are low, which is consistent with previous sampling results.

Macroinvertebrate Site	B-IBI score
BCI1	22
BCI2	14

Pesticide Monitoring

- Pesticide data was collected through the County's Underground Injection Control (UIC) Program, as described in the letter to DEQ, April 25, 2011. Details of the pesticide selection process are found in the County's UIC Monitoring Plan (2014), which can be downloaded from the County's Water Quality Program website (https://multco.us/water-quality-program/reports-and-plans).

- The objective of this pesticide sampling is to fill data gaps about pesticides that may be commonly used along County's urban roadways and at County facilities. 179 different pesticides were screened using two methods to provide a baseline of pesticide information: Pacific Agricultural Laboratory Multi-residue Pesticide Screen and the Chlorinated Acid Herbicide Profile. Data were collected from two UICs and three facilities.

- Five pesticides were detected from the two UICs on roadways, and two pesticides were detected at two County facilities. Only one site had two pesticide concentrations significantly above the quantitation limit.

Analyte	Sample Date	Result	QL	Unit	Location of Sample
2,4-D	5/11/2015	0.08	0.08	µg/L	Hansen Complex
Pentachlorophenol	5/11/2015	0.27	0.16	µg/L	Hansen Complex
Pentachlorophenol	10/22/2014	0.39	0.16	µg/L	Hansen Complex
2,4-D	5/11/2015	0.1	0.08	µg/L	Juvenile Justice Center
MCPP	5/5/2015	0.15	0.08	µg/L	SW 257th Ave
Pentachlorophenol	5/5/2015	0.16	0.16	µg/L	SW 257th Ave
Triclopyr	5/5/2015	0.16	0.08	µg/L	SW 257th Ave
Pentachlorophenol	10/22/2014	0.23	0.16	µg/L	SW 257th Ave
2,4-D	5/5/2015	1.2	0.08	µg/L	SW 257th Ave
Carbaryl	5/11/2015	0.14	0.06	µg/L	SW Cherry Park Road (west)
Triclopyr	5/11/2015	**3.8**	0.080	µg/L	SW Cherry Park Road (west)
2,4-D	5/11/2015	**5.2**	0.8	µg/L	SW Cherry Park Road (west)

Recommendations

Multnomah County has a small jurisdiction relative to Portland, Eugene, and Salem. Their monitoring results summary is organized well however they do not provide the same level of comprehensive interpretations. For example, macroinvertebrates scores were reported low, but by what metric and if it is consistent with previous sampling results what are the likely drivers? Since monitoring is intended to direct best management practices, what is Multnomah County doing to improve stormwater quality and habitat conditions for macroinvertebrates in sampled streams? The form of adaptive management needs to be clearer. Further Multnomah County provided pesticide results in a series of spreadsheets; no other results were reported or interpreted.

E. Gresham Group

Instream Monitoring

Instream-Longterm & Macroinvertebrate Site Locations	
FCI0	Fairview Creek @ West of Blue Lake Rd in Trailer Park
FCI1	Fairview Creek @ Conifer Park Subdivision, N of Stark
FVL1	Fairview Lake @ Public Dock on NE 217th
JCI1	Johnson Creek @ 174th Ave (Jenne Rd)
JCI2	Johnson Creek @ 252nd Ave. (Palmblad)
KI1	Kelley Creek @ Foster Rd. (tributary of JC)
KI2	Kelley Creek @ Rodlun Rd (tributary of JC)
KCI1	Kelly Creek @ Mt. Hood Community College Pond Outflow
KCI3	Kelly Creek @ Detention Pond Outflow
KCI4	Kelly Creek @ Detention Pond Inflow
BCI1	Beaver Creek @ Lower Bridge (Monitored on behalf of Multnomah County, not shown on Gresham Map of Instream Sites)
BCI2	Beaver Creek @ Division X Troutdale Rd. (Monitored on behalf of Multnomah County, not shown on Gresham Map of Instream Sites)

Structural BMP Evaluation Monitoring Locations	
CSWQF-1	Columbia Slough Water Quality Facility - Stormdrain Creek
CSWQF-2	Columbia Slough Water Quality Facility - East Inlet
CSWQF-3	Columbia Slough Water Quality Facility - Outlet

Analysis Coding for the Reported Data

Bold = < than detection value or an Estimated value for bacteria

NA = constituents not sampled due to equipment failure or other extenuating circumstance

NM= not measured **ND**= not detected

MRL = method reporting limits are included at the top of each data set where they are constant. For parameters were no MRL is included, this means they vary by sample.

Dup = Duplicate Sample

FD = Field Duplicate Sample

Blank = Deionized Water Sample

Exceedance of TMDL or other water quality criteria

Chronic exceedance of metal (Table 30)

Acute exceedance of metal (Table 30)

TMDL Constituent	Water Quality Criteria
Fairview Creek & Lake	
Temperature	No designated salmon and steelhead spawning use. Rearing: 18 degrees Celsius
E. coli	406 organisms/100mL (OAR 340-41)
Phosphorus	0.1549 mg/L (Columbia Slough 1998 TMDL)
Mercury	Aquatic life: 2.4 ug/L acute; 0.012 ug/L chronic. MCL: 2 ug/L
Johnson Creek (including Kelley Creek trib)	
Temperature	Spawning: 13 degrees Celsius (55.4 F) - October 15 to May 15. Rearing: 18 degrees Celsius
E. coli	406 organisms/100mL (OAR 340-41)
PCBs	Acute 2.0 ug/L, Chronic 0.014 ug/L (per Table 30)
PAHs	Not included in Table 40 or 41. Table 30 only lists saltwater acute level of 300 ug/L
Dieldrin	Acute 0.24 ug/L, Chronic 0.056 ug/L (per Table 30)
DDT	Acute 1.1 ug/L, Chronic 0.001 ug/L (per Table 30)
Mercury	Acute 2.4 ug/L, Chronic 0.012 ug/L (per Table 30)
Kelly Creek	
Temperature	Spawning: 13 degrees Celsius (55.4 F) - October 15 to May 15. Rearing: 18 degrees Celsius
E. coli	406 organisms/100mL (OAR 340-41)

Columbia Slough	
Temperature	No designated salmon and steelhead spawning use. Rearing: 18 degrees Celsius
E. coli	406 organisms/100mL (OAR 340-41)
pH	between pH 6.5 - 8.5
DO	No spawning 6.5 mg/L: cool-water aquatic life (avg) 4.0 mg/L: absolute minimum (Columbia Slough TMDL) 5.5 mg/L: warm-water aquatic life
Phosphorus	0.1549 mg/L (Columbia Slough 1998 TMDL)
Chlorophyll-*a*	0.015 mg/L
Pb	Based on hardness. Table 30 has formula
PCBs	Acute 2.0 ug/L, Chronic 0.014 ug/L (per Table 30)
Dieldrin	Acute 0.24 ug/L, Chronic 0.056 ug/L (per Table 30)
DDT/DDE	Acute 1.1 ug/L, Chronic 0.001 ug/L (per Table 30)
Dioxins	Fish tissue 0.07 ng/kg (Columbia Slough 1998 TMDL)
Mercury	Acute 2.4 ug/L, Chronic 0.012 ug/L (per Table 30)
Non-TMDL WQ Constituents from OAR 340-41 Table 30	
Metals	Based on hardness, formula in Table 30
pH	Between 6.5-8.5: same for all watersheds in the permit area (OAR 340-41)
DO	Not evaluated, since the criteria are for averages. Cold water aquatic life; spawning: 11 mg/L; nonspawning 8.0 mg/L

- Instream monitoring results are generally within expected ranges. Some sites were above the temperature standard in late July when there was no rainfall, and some sites had periodic exceedances of the 406 colony forming units (CFU/100ml) E. coli standard, primarily after events associated with rainfall.

- All of the sampled streams currently have TMDLs for both of these pollutants, although stormwater is not an associated cause for temperature exceedances. Some sites also had dissolved oxygen lower than some aquatic life criteria in late July; these samples were associated with high temperatures that likely drove the phenomenon.

Continuous Monitoring

Continuous Temperature Monitoring

Basin	Site	Days 7DADM	Max of	Comments
Kelly/Beaver	Kelly Creek downstream of detention pond	0*	16.7*	data only go through mid-July due to equipment error
Kelly/Beaver	Kelly Creek upstream of detention pond	8*	19.9*	data only go through mid-July due to equipment error
Kelly/Beaver	Arrow Creek @ mouth	43	20.74	
Kelly/Beaver	Kelly Creek @ Kane Rd	63	20.6	
Kelly/Beaver	Kelly Creek upstream of Mt. Hood Community College pond	67	21.2	
Kelly/Beaver	Beaver Creek @ Division	70	22.2	
Kelly/Beaver	Beaver Creek @ upper footbridge	78	21.7	
Kelly/Beaver	Beaver Creek @ Cochran	80	22.7	
Kelly/Beaver	Beaver Creek @ Cory	88	23.4	
Kelly/Beaver	Beaver Creek @ Stark	119	25.8	
Johnson	Badger Creek @ Telford	58	20.5	
Johnson	Badger Creek @ Kluth residence	59	20.9	
Johnson	Badger Creek @ Telford	9	18.9	
Johnson	Sunshine Creek @ Rugg Road	70	23.0	
Johnson	North Fork Johnson Creek @ Telford	16	18.9	
Johnson	Hogan Creek @ mouth	86	22.5	
Johnson	Butler Creek @ SW 14th	76	21.4	
Johnson	Kelley Creek @ Rodlun	0	17.3	
Johnson	Kelley Creek @ 190th	38	19.6	
Johnson	Kelley Creek @ PV Grange	62	20.5	
Johnson	Kelley Creek @ mouth	70	21.3	
Johnson	Johnson Creek @ 282nd	65	21.7	
Johnson	Johnson Creek @ Telford	68	21.1	
Johnson	Johnson Creek @ Telford	69	22.7	
Fairview	Fairview Creek @ Division	109	23.8	
Fairview	Fairview Creek @ Birdsdale	114	22.8	
Fairview	Fairview Creek @ Conifer Park	60	19.4	
Fairview	Fairview Creek @ Glisan	156	26.5	
Fairview	Fairview Creek @ trailer park	130	23.4	

Red =temperature exceedances for more than 100 days
Blue = no temperature exceedances
Temperature is not a pollutant associated with stormwater runoff since the rainy season does not coincide with summer temperatures. This data is provided to help the reader understand the general condition and impacts to streams in Gresham and Fairview.

- The data from the continuous instream monitoring being conducted by USGS is available at www.usgs.gov. In addition to the data collected at the two USGS gages on Johnson and Fairview Creeks, the City of Gresham also collected continuous temperature data at all of the instream monitoring locations, as well as other locations.

- A summary of the number of days that the maximum daily temperature at each continuous temperature monitoring station exceeded the temperature standard (17.8 C), as well as the highest temperature reached at each station is included in the Appendix.

- Very few sites had no exceedances (highlighted in blue), while several streams had sites where the 7-day average of the daily maximum (7DADM) was >18 for 100 days or more (highlighted in red).

- The city is aware of the impact in-line ponds can have on temperature - Fujitsu Pond is a highly ranked Natural Resource CIP project, and the City is also studying ways to improve public and private ponds on Butler and Hogan Creeks.

Stormwater Monitoring

- Similar to previous years, stormwater monitoring data revealed that higher traffic sites (>1000 vehicle trips per day) have higher pollutant concentrations for most pollutants (e.g. TSS, total and dissolved metals, nutrients, phthalates, and pesticides) in comparison to residential streets (<1000 trips/day).
- There were two instances of very high E. coli levels (>24,000). which were investigated. In both cases there was very low flow, and water samples were collected by placing a bailer against a pipe to collect trickling water.

- Biofilms in stormwater pipes have recently been shown to be significant sources of E. coli, but have not been shown to be related to human illness causing pathogens. Our hypothesis is that biofilms were incidentally scraped off the pipes at these two sites, leading to high E. coli measurements.

Structural BMP Monitoring

- Structural BMP monitoring during 2014-15 included monitoring inlet and outlet locations at the Columbia Slough Water Quality Facility. In general, results show that the facility is reducing metals and other pollutants associated with sediment, as well as reducing nutrients and bacteria. The removal of total suspended solids has increased over the past few years, and removal was very good during the 2014-2015 monitoring season

Macroinvertebrate Monitoring

- Macroinvertebrates were collected at all of the instream monitoring locations, except Fairview Lake. Results are similar to previous years, with the Kelley Creek location (KI2) showing the least amount of impairment (i.e., the greatest abundance and highest number of sensitive species). This site is predominantly surrounded by an undeveloped forested area.

- All of the other locations have biological communities that indicate moderate or severe impairment according to the statewide Benthic Index of Biological Integrity (B-IBI). Data trends will be assessed on a five year basis as described in the Environmental Monitoring Plan.

Recommendations

While their monitoring was comprehensive, Gresham reported their results in raw tabular form and did not summarize the findings by a land use type or some other categorical criterion. As presented it is difficult to discern trends with their monitoring program. It is recommended that Gresham provide a summary of their findings in a summary statistics table (see City of Portland for an example) along with a discussion of how these findings contribute to effectiveness monitoring and BMP performance.

F. Clackamas Group

Report from Water Environment Services (WES) covers the following co-permittees:

1. Clackamas County Service District #1
2. City of Happy Valley
3. Surface Water Management Agency of Clackamas County
4. City of Rivergrove

**Note that reporting style is by location. Each location has a table of results with some discussion of the results. This style is consistent across co-permittees.

Instream Monitoring

- Instream monitoring was conducted at eight locations on seven tributaries to the Willamette River within the CCSD#1 service boundary and at one location on one tributary to the Tualatin River within the SWMACC service area. Note that the SWMACC creek monitoring location is not located in the geographic area which is regulated by SWMACC's MS4 permit.

1) Carli Creek

	Temperature (C)	Dissolved Oxygen (mg/L)	Nitrate (mg/L)	E coli (Counts/100 mL)	Total Copper (ug/L)	Dissolved Copper (ug/L)	Total Lead (ug/L)	Dissolved Lead (ug/L)	Total Zinc (ug/L)	Dissolved Zinc (ug/L)	Total Solids (mg/L)	Total Suspended Solids (mg/L)	BOD (mg/L)	Ammonia (mg/L)	Total Phosphorus (mg/L)	Orthophosphate (mg/L)	Hardness (mg/L)	pH
Monitored Storms (3 events)																		
Mean	14.9	9.1	0.37	625	5.20	2.9	1.62	0.15	64.0	42.3	96	7	4.0	0.21	0.06	0.04	68	6.4
Maximum	18.0	10.4	0.48	2420	7.10	4.3	2.61	0.29	88.0	54.0	110	14	6.0	0.59	0.09	0.05	156	6.9
Minimum	9.1	8.2	0.28	131	2.40	1.2	0.85	0.05	39.0	26.0	78	2	1.6	<0.05	0.04	0.04	21	5.9
Exceedance of guidance value or criteria (# exceed/total)	0/3	0/3	0/3	2/3	1/3	1/3	2/3	0/3	2/3	1/3	NA	NA	NA	0/3	0/3	NA	NA	2/3
Other Weather Conditions (7 monitoring events)																		
Mean	14.3	8.7	1.29	17	1.41	0.8	0.28	0.03	21.7	12.7	214	5	0.4	0.04	0.05	0.07	101	7.4
Maximum	16.7	9.4	2.10	30	3.80	2.2	0.65	0.15	45.0	30.0	276	21	2.6	0.10	0.07	0.09	125	7.8
Minimum	12.5	7.4	0.95	4	0.70	0.4	0.10	0.01	15.0	7.0	160	2	0.0	<0.05	<0.04	0.06	85	6.7
Exceedance of guidance value or criteria (# exceed/total)	0/7	0/7	0/7	0/7	0/7	0/7	0/7	0/7	0/7	0/7	NA	NA	NA	0/7	0/7	NA	NA	0/7

Note: Exceedance totals for metals data is based on exceedances of chronic guidance values and chronic criteria, not acute guidance values and acute criteria.

Also Note: The geometric mean value is shown for E. coli in the row titled "Mean"

2) Sieben Creek

	Temperature (C)	Dissolved Oxygen (mg/L)	Nitrate (mg/L)	E coli (Counts/100 mL)	Total Copper (ug/L)	Dissolved Copper (ug/L)	Total Lead (ug/L)	Dissolved Lead (ug/L)	Total Zinc (ug/L)	Dissolved Zinc (ug/L)	Total Solids (mg/L)	Total Suspended Solids (mg/L)	BOD (mg/L)	Ammonia (mg/L)	Total Phosphorus (mg/L)	Orthophosphate (mg/L)	Hardness (mg/L)	pH
Monitored Storms (3 events)																		
Mean	14.6	8.8	0.44	2165	8.13	3.7	1.85	0.09	59.3	21.0	146	75	3.5	0.04	0.14	0.04	101	6.4
Maximum	17.6	9.7	0.50	>2420	12.00	5.8	3.40	0.12	98.0	29.0	240	170	5.5	0.07	0.30	0.06	264	6.7
Minimum	8.9	8.1	0.35	1733	5.00	1.8	0.74	0.06	35.0	14.0	97	14	1.6	<0.05	0.04	<0.04	19	6.0
Exceedance of guidance value or criteria (# exceed/total)	0/3	0/3	0/3	3/3	2/3	1/3	2/3	0/3	2/3	1/3	NA	NA	NA	0/3	1/3	NA	NA	1/3
Other Weather Conditions (7 monitoring events)																		
Mean	10.9	9.3	1.74	220	0.96	0.6	0.14	0.03	13.6	7.4	155	5	0.3	0.03	0.04	0.06	59	7.2
Maximum	16.0	10.2	2.30	866	1.20	0.7	0.18	0.12	22.0	12.0	207	9	0.5	<0.05	0.09	0.10	63	7.8
Minimum	6.5	8.2	1.00	28	0.70	0.5	0.08	<0.01	8.0	4.0	120	3	<0.0	<0.05	<0.04	<0.04	50	6.4
Exceedance of guidance value or criteria (# exceed/total)	0/7	0/7	0/7	1/7	0/7	0/7	0/7	0/7	0/7	0/7	NA	NA	NA	0/7	0/7	NA	NA	1/7

3) Phillips Creek

	Temperature (C)	Dissolved Oxygen (mg/L)	Nitrate (mg/L)	E coli (Counts/100 mL)	Total Copper (ug/L)	Dissolved Copper (ug/L)	Total Lead (ug/L)	Dissolved Lead (ug/L)	Total Zinc (ug/L)	Dissolved Zinc (ug/L)	Total Solids (mg/L)	Total Suspended Solids (mg/L)	BOD (mg/L)	Ammonia (mg/L)	Total Phosphorus (mg/L)	Orthophosphate (mg/L)	Hardness (mg/L)	pH
Monitored Storms (3 events)																		
Mean	15.3	9.0	0.47	1917	7.70	3.9	2.80	1.63	68.3	32.7	109	31	4.9	0.12	0.09	0.03	90	6.6
Maximum	18.4	10.6	0.49	>2420	11.50	5.0	5.55	2.60	97.0	36.0	140	72	8.9	0.22	0.19	0.05	218	7.0
Minimum	9.4	8.2	0.43	1203	4.60	2.0	1.32	0.09	53.0	28.0	93	10	1.9	<0.05	<0.04	<0.04	21	6.1
Exceedance of guidance value or criteria (# exceed/total)	2/3	0/3	0/3	3/3	2/3	1/3	2/3	1/3	2/3	1/3	NA	NA	NA	0/3	1/3	NA	NA	1/3
Other Weather Conditions (7 monitoring events)																		
Mean	13.1	8.6	0.90	181	0.87	0.9	2.22	0.05	16.3	8.9	168	3	0.5	0.03	0.03	0.04	72	7.3
Maximum	18.2	9.4	1.40	461	1.50	1.1	3.40	0.08	20.0	11.0	212	6	0.8	<0.05	0.07	0.06	80	7.8
Minimum	8.3	8.2	0.72	17	0.09	0.6	0.23	0.02	13.0	7.0	130	1	0.0	<0.05	<0.04	0.03	61	6.7
Exceedance of guidance value or criteria (# exceed/total)	1/7	0/7	0/7	1/7	0/7	0/7	5/7	0/7	0/7	0/7	NA	NA	NA	0/7	0/7	NA	NA	0/7

4) Kellogg Creek at SE Rusk Rd

Kellogg Ck at SE Rusk Rd	Temperature (C)	Dissolved Oxygen (mg/L)	Nitrate (mg/L)	E coli (Counts/100 mL)	Total Copper (ug/L)	Dissolved Copper (ug/L)	Total Lead (ug/L)	Dissolved Lead (ug/L)	Total Zinc (ug/L)	Dissolved Zinc (ug/L)	Total Solids (mg/L)	Total Suspended Solids (mg/L)	BOD (mg/L)	Ammonia (mg/L)	Total Phosphorus (mg/L)	Orthophosphate (mg/L)	Hardness (mg/L)	pH
Monitored Storms (3 events)																		
Mean	12.4	7.7	1.39	1047	4.17	2.2	1.38	0.12	37.3	23.3	157	21	3.1	0.04	0.12	0.07	49	6.6
Maximum	16.4	9.5	1.57	>2420	7.40	3.5	2.31	0.15	46.0	25.0	190	34	6.9	0.08	0.18	0.08	57	6.7
Minimum	9.8	4.5	1.19	548	1.60	1.2	0.48	0.09	27.0	22.0	140	5	0.9	<0.05	0.05	0.06	36	6.5
Exceedance of guidance value or criteria (# exceed/total)	0/3	1/3	0/3	3/3	1/3	0/3	2/3	0/3	0/3	0/3	NA	NA	NA	0/3	1/3	NA	NA	0/3
Other Weather Conditions (7 monitoring events)																		
Mean	13.1	7.3	2.23	232	1.20	0.6	0.44	0.07	12.0	7.3	201	9	0.8	0.03	0.09	0.07	78	6.8
Maximum	17.0	8.4	2.50	770	1.50	0.8	0.59	0.10	16.0	12.0	240	14	1.1	<0.05	0.14	0.08	92	7.1
Minimum	9.2	5.7	1.90	78	0.90	0.3	0.35	0.03	8.0	4.0	160	6	0.5	<0.05	<0.04	0.06	66	6.3
Exceedance of guidance value or criteria (# exceed/total)	0/7	1/7	0/7	1/7	0/7	0/7	0/7	0/7	0/7	0/7	NA	NA	NA	0/7	0/7	NA	NA	3/7

5) Kellogg Creek at Rowe Middle School

Kellogg Ck at Rowe Middle School	Temperature (C)	Dissolved Oxygen (mg/L)	Nitrate (mg/L)	E coli (Counts/100 mL)	Total Copper (ug/L)	Dissolved Copper (ug/L)	Total Lead (ug/L)	Dissolved Lead (ug/L)	Total Zinc (ug/L)	Dissolved Zinc (ug/L)	Total Solids (mg/L)	Total Suspended Solids (mg/L)	BOD (mg/L)	Ammonia (mg/L)	Total Phosphorus (mg/L)	Orthophosphate (mg/L)	Hardness (mg/L)	pH
Monitored Storms (3 events)																		
Mean	12.7	8.6	0.72	1203	7.83	2.7	5.67	0.17	60.3	18.0	177	75	6.0	0.06	0.17	0.03	42	6.7
Maximum	18.2	10.3	0.77	>2420	15.20	4.4	7.62	0.21	109.0	21.0	290	170	15.0	0.12	0.34	0.06	46	6.9
Minimum	9.0	6.2	0.63	687	3.40	1.8	2.10	0.11	24.0	13.0	110	11	1.4	<0.05	<0.04	<0.04	34	6.6
Exceedance of guidance value or criteria (# exceed/total)	1/3	1/3	0/3	3/3	2/3	0/3	3/3	0/3	2/3	0/3	NA	NA	NA	0/3	2/3	NA	NA	0/3
Other Weather Conditions (7 monitoring events)																		
Mean	13.1	9.1	1.36	225	1.45	0.8	3.65	0.05	17.0	5.5	188	6	0.7	0.03	0.06	0.07	83	7.2
Maximum	18.3	10.3	1.60	579	1.90	1.3	6.40	0.07	34.0	9.0	238	9	1.1	0.09	0.14	0.10	89	7.7
Minimum	8.2	7.6	1.20	36	1.00	0.6	2.10	0.04	10.0	2.0	140	4	0.2	<0.05	<0.04	0.05	70	6.5
Exceedance of guidance value or criteria (# exceed/total)	1/7	0/7	0/7	2/7	0/7	0/7	6/7	0/7	0/7	0/7	NA	NA	NA	0/7	0/7	NA	NA	0/7

6) Mt. Scott Creek

	Temperature (C)	Dissolved Oxygen (mg/L)	Nitrate (mg/L)	E coli (Counts/100 mL)	Total Copper (ug/L)	Dissolved Copper (ug/L)	Total Lead (ug/L)	Dissolved Lead (ug/L)	Total Zinc (ug/L)	Dissolved Zinc (ug/L)	Total Solids (mg/L)	Total Suspended Solids (mg/L)	BOD (mg/L)	Ammonia (mg/L)	Total Phosphorus (mg/L)	Orthophosphate (mg/L)	Hardness (mg/L)	pH
Monitored Storms (3 events)																		
Mean	12.9	8.1	0.56	699	7.90	2.8	3.47	0.17	62.3	18.0	177	76	5.4	0.07	0.16	0.03	34	6.8
Maximum	18.5	9.9	0.68	>2420	15.60	4.7	7.44	0.21	113.0	22.0	270	170	13.0	0.15	0.34	0.06	42	7.1
Minimum	9.3	5.3	0.44	205	3.10	1.9	0.88	0.12	27.0	15.0	120	13	1.4	<0.05	<0.04	<0.04	33	6.5
Exceedance of guidance value or criteria (# exceed/total)	1/3	1/3	0/3	2/3	2/3	1/3	2/3	0/3	2/3	0/3	NA	NA	NA	0/3	1/3	NA	NA	0/3
Other Weather Conditions (7 monitoring events)																		
Mean	13.5	8.5	1.08	204	1.44	0.8	0.30	0.05	10.9	5.7	187	5	0.7	0.03	0.06	0.07	86	7.1
Maximum	19.5	9.3	2.88	488	1.60	0.9	0.46	0.07	15.0	7.0	252	8	1.2	<0.05	0.15	0.11	93	7.6
Minimum	8.2	7.5	0.48	24	1.20	0.7	0.22	0.02	8.0	4.0	140	3	0.2	<0.05	<0.04	0.04	69	6.5
Exceedance of guidance value or criteria (# exceed/total)	2/7	0/7	0/7	1/7	0/7	0/7	0/7	0/7	0/7	0/7	NA	NA	NA	0/7	1/7	NA	NA	0/7

7) Rock Creek

	Temperature (C)	Dissolved Oxygen (mg/L)	Nitrate (mg/L)	E coli (Counts/100 mL)	Total Copper (ug/L)	Dissolved Copper (ug/L)	Total Lead (ug/L)	Dissolved Lead (ug/L)	Total Zinc (ug/L)	Dissolved Zinc (ug/L)	Total Solids (mg/L)	Total Suspended Solids (mg/L)	BOD (mg/L)	Ammonia (mg/L)	Total Phosphorus (mg/L)	Orthophosphate (mg/L)	Hardness (mg/L)	pH
Monitored Storms (3 events)																		
Mean	12.3	9.0	1.09	1599	4.53	1.5	1.81	0.10	20.3	7.7	160	60	2.8	0.03	0.16	0.07	34	7.0
Maximum	17.3	10.3	1.52	>2420	6.40	2.4	2.10	0.13	26.0	10.0	200	71	5.8	<0.05	0.23	0.10	47	7.2
Minimum	9.3	6.8	0.54	1300	3.40	1.1	1.50	0.05	16.0	6.0	140	51	1.2	<0.05	0.10	0.04	28	6.6
Exceedance of guidance value or criteria (# exceed/total)	0/3	0/3	0/3	3/3	1/3	0/3	3/3	0/3	0/3	0/3	NA	NA	NA	0/3	2/3	NA	NA	0/3
Other Weather Conditions (7 monitoring events)																		
Mean	11.6	9.6	1.26	133	0.81	0.5	0.14	0.03	6.1	2.7	129	3	0.3	0.03	0.03	0.06	54	7.3
Maximum	16.9	10.4	2.40	461	1.00	0.6	0.23	0.05	8.0	4.0	194	6	0.5	<0.05	0.08	0.09	75	7.9
Minimum	6.3	8.7	0.63	17	0.60	0.4	0.06	0.01	5.0	1.0	92	<1	0.0	<0.05	<0.04	0.03	37	6.4
Exceedance of guidance value or criteria (# exceed/total)	0/7	0/7	0/7	1/7	0/7	0/7	0/7	0/7	0/7	0/7	NA	NA	NA	0/7	0/7	NA	NA	1/7

8) Cow Creek

	Temperature (C)	Dissolved Oxygen (mg/L)	Nitrate (mg/L)	E coli (Counts/100 mL)	Total Copper (ug/L)	Dissolved Copper (ug/L)	Total Lead (ug/L)	Dissolved Lead (ug/L)	Total Zinc (ug/L)	Dissolved Zinc (ug/L)	Total Solids (mg/L)	Total Suspended Solids (mg/L)	BOD (mg/L)	Ammonia (mg/L)	Total Phosphorus (mg/L)	Orthophosphate (mg/L)	Hardness (mg/L)	pH
Monitored Storms (3 events)																		
Mean	15.4	7.5	0.37	1561	8.60	5.3	1.70	0.16	80.7	51.3	79	17	5.1	0.55	0.10	0.05	59	6.6
Maximum	18.7	9.2	0.58	>2420	11.40	7.2	1.90	0.20	83.0	64.0	82	26	8.8	1.44	0.14	0.08	134	7.2
Minimum	9.2	5.6	0.17	649	5.80	2.0	1.47	0.09	77.0	42.0	77	9	2.0	0.09	<0.08	<0.04	20	6.0
Exceedance of guidance value or criteria (# exceed/total)	2/3	1/3	0/3	3/3	2/3	1/3	2/3	0/3	2/3	2/3	NA	NA	NA	0/3	0/3	NA	NA	1/3
Other Weather Conditions (7 monitoring events)																		
Mean	11.8	8.3	0.52	429	1.76	0.9	0.40	0.05	26.3	13.4	163	7	0.5	0.03	0.04	0.05	79	7.1
Maximum	16.5	9.6	0.76	1050	2.80	1.2	0.67	0.14	51.0	35.0	230	14	1.0	<0.05	0.12	0.07	86	7.6
Minimum	7.4	6.6	0.20	3	1.20	0.6	0.15	0.01	12.0	4.0	134	<1	0.2	<0.05	<0.04	0.03	70	6.5
Exceedance of guidance value or criteria (# exceed/total)	0/7	0/7	0/7	3/7	0/7	0/7	0/7	0/7	0/7	0/7	NA	NA	NA	0/7	0/7	NA	NA	0/7

- Time-weighted instream composite samples were collected three times during storms during the monitoring year in CCSD#1 and SWMACC; grab samples were collected during an additional routinely scheduled six visits to all nine instream monitoring locations under varying weather conditions during the July 1st-June 30th monitoring year.

- Storm sewer outfall monitoring was conducted at four locations which discharge to tributaries of the Willamette and Clackamas Rivers in CCSD#1. Outfall monitoring was also conducted at a location in the City of Rivergrove in SWMACC. Time-weighted composite samples were taken during three visits to these five outfall locations during the year.

- Complete results of the instream and outfall sample collection efforts conducted by WES for the 2013-2014 monitoring year are provided in Table 4 (for monitoring conducted within CCSD#1) and Table 5 (for monitoring conducted within SWMACC).

  Monitoring Results Discussion

  - During 9 monitoring events, pH levels were between 6.5 and 8.5, which is protective of watershed health; the level was below 6.5 during the storm monitoring event on March 24, 2014.

  - The 406 colonies/100 ml standard for E. coli was exceeded on 4 occasions, including all 3 monitored storms.

  - Total phosphorus exceeded the 0.14 mg/L guidance value during the storm on July 22, 2014, but was at lower levels during the other 9 monitoring events.

  - The total suspended solids concentration was72 mg/L during the July 22, 2014 storm.

- Dissolved oxygen levels were above 8.0 mg/L, which is protective of watershed health, during all 10 monitoring events. Water temperature was slightly above 18 C during three monitoring events, including two of the storms.

- The regulated criterion for total copper was exceeded during two storms. The guidance values for *total* zinc and *total* lead were also exceeded during 2 storms. The regulated criterion for *dissolved* lead and *dissolved* zinc, and the guidance value for *dissolved* copper, were all exceeded during the July 22, 2014 storm

Report from the City of West Linn:

Monitoring Summary
*Note West Linn reported results in tabular form in Appendix B of their report.

- West Linn conducted instream monitoring at three locations:
  Site #1: Trillium Creek at Caloroga Road, a tributary to the Willamette River
  Site #2: Tanner Creek at Imperial Drive, a tributary to the Willamette River,
  Site #3: Unnamed Creek at Ryan Court & Johnson Road, a tributary to the Tualatin River

- Outfall monitoring was conducted at an outfall to Barlow Creek, a tributary to the Willamette River (Site #4).

- In accordance with the frequencies outlined in the 2013 CCCSMP, time composite grab samples are taken at the instream monitoring locations a minimum of three times a year (during storm events). Single grab samples are taken during two additional monitoring events (not during storms) at the instream monitoring locations.

- For instream monitoring, 50% of the samples need to be collected during the wet weather season (October 1st - April 30th). Time composite grab samples are taken at the outfall monitoring location three times a year during rain events.

- Since 2012, the City of West Linn has been participating in a coordinated pesticide monitoring effort with other Clackamas County co-permittees and the USGS. Sediment and instream water samples were collected in the summer of 2013. Preliminary results were provided by USGS to the participating jurisdictions in April 2014. The USGS submitted the draft report for final internal review and approval on October 8, 2015.

- A first round of mercury sampling took place in March and April of 2013. As the initial obligations for mercury monitoring were fulfilled, and as DEQ was unclear in how they intended to use the data, in December 2014 we asked DEQ if we could forgo the second round of mercury sampling. DEQ agreed that a second round would not be necessary at this time.

- Biological monitoring was conducted early in the permit cycle and a final report was prepared for the cities of Gladstone, Lake Oswego, Milwaukie, Wilsonville and West Linn in February 2014 and was submitted with last year’s annual report. Complete instream and stormwater outfall sampling results are included and summarized in Appendix B. The sampling results represented have been formatted to simplify the data review process.

Report from the City of Lake Oswego:

Monitoring Summary
* Note Lake Oswego reported results in tabular form in Appendix B of their report.

- In accordance with the 2012 Stormwater Monitoring Plan, Lake Oswego conducted instream ambient water quality, dry weather mercury monitoring, macroinvertebrate monitoring, and pesticide monitoring.

- Lake Oswego conducted instream monitoring at seven locations.

- Lake Oswego uses grab sampling methods to collect the instream samples at 5 sites, with a combination of continuous records of turbidity, pH, and dissolved oxygen and grab samples for other analytes at 2 sites.

- A total of 12 sampling events are required with 50% during the wet weather season and 50% during the dry weather season. Complete grab sampling results are summarized and included in Appendix B. The sampling results presented have been formatted to simplify the data review process.

- Continuous records are maintained in our AQUARIUS database.

- As required by Lake Oswego's permit, a trends analysis on the sampling record through June 30, 20151 was completed and will be submitted as part of the required pollutant load reduction evaluation. The most statistically significant water quality trends are shown in Table 3 by parameter, site, and dry vs. wet weather trend.

- To fulfill the pesticide monitoring component of the MS4 permit, the Clackamas County co-permittees engaged the United States Geological Survey (USGS) to sample and analyze instream waters, water discharged from stormwater outfalls, suspended sediment, and streambed sediment for over 100 pesticides and compounds of emerging concern across the urban areas of the county. The co-permittee group elected to focus sampling on pesticides for which the environmental occurrence had not to date been widely evaluated in the region. There was particular focus on insecticides that could have unintended targets among aquatic organisms, to determine whether there might be a link between observed patterns in benthic communities and pesticide concentrations. The sampling occurred in late August and early September, 2013. Two sites were sampled in Lake Oswego: Ball Creek downstream of the Kruse Oaks Way crossing, and Lost Dog Creek at Lake Front Road. The final results were presented in the 2013- 2014 Annual Report. Key findings are that surface waters sampled in Lake Oswego did find detectable quantities of several current use pesticides. Samples from Lost Dog Creek contained quantities of bifenthrin, fipronil, and DDT-degradation products above aquatic life benchmarks. None of these compounds are now used Lake Oswego (see Appendix A). Publication of the USGS findings as a journal article is currently expected during the 2015-2016 reporting period.

Report from the City of Wilsonville:

Monitoring Summary
Did not provide an effective summary or interpretation of the results but instead submitted an attached summary by Cole Ecological Inc. See A3.6 for a visual reference.

Report from the City of Milwaukie:

Monitoring Summary
* Note City of Milwaukie reported results in tabular form in Appendix B of their report..

- Milwaukie conducted instream and outfall monitoring.
- Continuous instream monitoring of Johnson Creek was also performed by USGS.
- The City conducted instream monitoring at one location (Minthorn Springs Creek at Harmony Road), a tributary to the Kellogg Creek.
- Outfall monitoring was conducted at one outfall location (Roswell Street prior to discharge in Johnson Creek).
- Time composite grab samples are required at the instream monitoring location twice during the reporting year (during storm events over the wet weather season). Single grab samples are also required during two additional monitoring events (during the dry weather season) at the instream monitoring location. Time composite grab samples are required at the outfall monitoring location three times during the monitoring year.
- In addition to the required instream and outfall monitoring, the City was required to conduct mercury monitoring at one location (Roswell Street outfall) during the 2012-2013 water year (October 1, 2012 to September 30, 2013). Two samples, one during the wet weather season and one during the dry weather season, were required. The City's reissued MS4 NPDES permit (effective date: March 16, 2012) prescribed new monitoring requirements that were to take effect October 1, 2012.
- During the 2012-2013 monitoring year, the City collected their wet weather season mercury sample on 3/20/2013. The City also collected a dry weather season mercury sample on 5/29/2013. Complete sampling results are summarized and included in Appendix B.
- The sampling results presented have been formatted to simplify the data review process.
- The City of Milwaukie completed the two Mercury monitoring events in 2013 as required by permit conditions and petitioned DEQ to request eliminating further Mercury monitoring in a letter sent to DEQ via email on 1/30/2015.
- The City of Milwaukie received confirmation of permission to eliminate Mercury monitoring from its environmental monitoring requirements in an email from Lisa Cox, Municipal Stormwater Coordinator at DEQ on 4/16/2015.

Report from the City of Oregon City:

Monitoring Summary
*Note City of Oregon City reported results in tabular form in Appendix B of their report. This mirrors closely the format of the report from City of Milwaukie, West Linn, and Lake Oswego.

- Oregon City is required to conduct in-stream and outfall monitoring.
- In-stream monitoring is required at six locations reflecting four tributaries to the Willamette River. Outfall monitoring is required at two outfall locations that discharge to the Clackamas River.
- Time-weighted composite (during storm events) and single grab samples are taken in accordance with the frequencies outlined in Table 3 below.
- During the 2014–2015 monitoring year, the City of Oregon City collected all required instream samples (four monitoring events at six sites). However, only two of three required outfall samples (at two sites) were collected due to lack of late winter/early spring rainfall (no flow at outfalls).
- Oregon City is committed to collecting the additional outfall samples during the 2015 – 2016 monitoring year in order to make up for the reduced number of samples collected. Complete sampling results are summarized and included in Appendix B. The sampling results presented have been formatted to simplify the data review process.

Report from the City of Gladstone:

Monitoring Summary
*Note City of Gladstone reported results in tabular form in Appendix B of their report.

- The City of Gladstone has one instream monitoring location on Rinearson Creek at Risley Avenue. Time-weighted composite samples are required three times per year during rainfall events. In late 2007, the City and Clackamas County Water Environment Services (WES) signed an intergovernmental agreement (IGA) for stormwater monitoring, and WES now monitors Gladstone's location on the City's behalf. Results of the monitoring effort are summarized in Appendix B.
- Results of the monitoring indicate lower levels of bacteria compared to the previous year's results. Historic high levels of bacteria are likely associated with the limited development setback from the stream channel and the prevalence of wildlife in the area. The concentrations of other parameters appear typical for the receiving water. It should be noted due to limited rainfall, two samples were collected less than the required 14 day minimum sampling frequency for instream samples. This oversight was reported to WES, and an extra sample will be collected during the 2015-2016 reporting year to compensate for this issue.
- During the 2014-2015 reporting year, Gladstone completed their participation in a coordinated pesticide monitoring effort with Clackamas co-permittees and USGS. Sampling was conducted in the summer and fall 2013. Gladstone financially participated in this study; however, no monitoring sites in Gladstone were included. The draft report was completed by USGS in February 2015, and the final report was completed in November 2015

Report from the City of Johnson City:

Monitoring Summary

*Nearly no monitoring has been done. Although the permittee acknowledges that they are an incorporated manufactured home park with no tax base. All wastes, debris, and recyclables are transferred to facilities outside of the city. Entire report was 3 pages in length.

Report from the Oak Lodge Sanitary District.

Monitoring Summary

*Note City of Oregon City reported results in tabular form in Appendix B of their report. Their summary and interpretation of the results were prepared by Brown and Caldwell consulting firm.

- Surface water sampling occurred four times annually as is required in the NPDES permit. The sites sampled included instream samples from each site, and two outfalls. In reviewing the water quality data, water quality elements for sediment and bacteria are elevated, with periodic exceedances of the state standard for E. coli.

- Other testing elements appear to be within DEQ range, and program monitoring will continue per the procedures outlined in the 2012 Monitoring Plan. Sample results are provided in Appendix A where analyses were completed by Brown and Caldwell.

Commentary (Clackamas Group)

Some permittees reporting styles were different despite them following a similar pattern or template. While the Clackamas Group followed a similar approach for monitoring stormwater their method of reporting and interpreting the results is lacking. In fact, the style of reporting the monitoring results is essentially restating the methods with comments about the actual results peppered in the text. Further each co-permittee directs the reader to a table of summary statistics in the Appendix. This monitoring is central to understanding stormwater quality and interpretation of the results is required by permit. Therefore the Clackamas Group needs to provide detailed results interpretation with appropriate tables and figures that make reader comprehension easier to follow. As is, the reporting style is ambiguous at best.

G. Clean Water Services

Stormwater Monitoring Summary

- This portion of the MS4 Annual Report discusses District efforts to identify water quality improvements or degradation. In previous reporting years, the District addressed the issue of water quality improvements or degradation by conducting statistical testing for trends in the monitoring data from the Tualatin mainstem and tributary sampling locations. These evaluations tended to focus on identification of long-term trends over a period of 10 to 20 years. The long-term trends were generally found to be relatively consistent from one year to the next. For the present report, trend analyses were performed for pollutant data from the District's stormwater monitoring sites. The monitoring sites and pollutant parameters are described in Appendix B of this report (Table B-1 and Table B-2, respectively). Trend analyses of stormwater data were conducted in 2013 and resulted in the identification of several trends and tentative trends (trends which were not significant at the chosen significance level (α) of 0.05 but which had p-values that were still relatively low). The trend analyses reported for the current annual report serve to help identify which of the previously identified trends are continuing, and which have run their course.

- Monitoring data were evaluated by computing the values and reporting the statistical significance of Kendall's tau correlation coefficient, a nonparametric procedure that is used to determine whether values tend to increase or decrease monotonically (i.e., changes over time that may or may not be linear). For data series that included nondetects (reported as less than the reporting limit), a Minitab macro was employed that estimates Kendall's tau while using the information contained in nondetects. All evaluations used a statistical significance level (α) of 0.05. Thus, for trends determined to be significant, the estimated probability that a trend is actually present (and not arising due to chance) is at least 95%. This screening level effort did not attempt to account for the many factors, such as weather conditions or streamflow, which might be expected to influence trends. Table D-1 below displays the monitoring site, pollutant, value of Kendall's tau correlation coefficient, and p-value for the statistically significant trends. The table also includes identification of tentative trends, for which the p-value was greater than 0.05 but less than about 0.10. The results are included to indicate trends that, while not significant at the chosen significance level, are worthy of note as the District continues its monitoring at these stormwater sites. These sites have been monitored since 2008 or 2009 (with the exception of Amberglen, where monitoring began in 2012, and Maple, where monitoring began in 2014).

- Most of the identified trends and tentative trends were found at the MS4 sites at 209th and at 39th Loop. At the 209th site, three increasing trends (for orthophosphate, soluble zinc, and total recoverable zinc) and one decreasing trend (for soluble lead) were detected. At the 39th Loop site, all of the trends and tentative trends were decreasing. The parameters for these decreasing trends and tentative trends were soluble chloride, hardness, total recoverable nickel, nitrate/nitrite, soluble lead, total dissolved solids, total Kjeldahl nitrogen, soluble zinc, and total recoverable zinc. One trend (a negative trend for chloride) was found at Maple, while no trends were identified at Paddington or at Amberglen.

Commentary

Clean Water Services District did a thorough job of providing interpretation of their results from this year while also connecting them to overall trends in their sampling area. Their summary was succinct, but could be broken up into sections that make readability somewhat better.

Appendix 1. MS4 Phase 1 Permittee Monitoring Requirements Summary

MS4 Jurisdiction	Permit Year	Approximate Size (acres) / Population	Monitoring Type	Monitoring Location(s)	Monitoring Frequency	Pollutant Parameter Category
Gladstone[1]	2005	2550 / 12000	SW Instream	1 1	1x/year 1x/year	TSS, TDS, BOD, COD, pH, temp, TP, TKN, Fecal (fc), O&G Visual, Field Kit
	2012	-	Instream Pesticide[2]	1	3x/year	Field[3], Conventional[4], Metals[5], Nutrients[6], Biological[7]
Johnson City	2005	75 / 600	none	-----	-----	-----
	2012	-	Instream	1	5x/year	Field, Conventional, Metals, Nutrients
Lake Oswego	2005	6700 / 36600	Instream	7	12x/year	pH, DO, temp, turbidity, conductivity, TSS, flow, Zn (T), nitrate, Ortho-P, TP, Ecoli
	2012	-	SW Instream Pesticide[3]	2 7	2x/year 12x/year	Field, Conventional, Metals, Nutrients “ (+Biological)

[1] Gladstone is required in Schedule D Special Condition to complete a Stormwater Master Plan by January 2014.
[2] Permit condition to “Conduct or contribute to a pesticide stormwater characterization monitoring or instream pesticide monitoring project/task.
[3] Field - DO, pH, temp, Conductivity
[4] Conventional – E. coli, hardness, BOD, TSS, TDS, VS
[5] Metals (total & dissolved) – Cu, Pb, Zn, Hg, MeHg [Note: Hg and MeHg are only required for SW samples]
[6] Nutrients – NO3, NH3-N, TP, Ortho-P
[7] # of sites vary by permittee, and typically not required at the same # of monitoring locations as other instream monitoring. Must be conducted in accordance with generally accepted biological monitoring methodology.

MS4 Jurisdiction	Permit Year	Approx. Jurisdiction Size (acres) / Population	Monitoring Type	Monitoring Location(s)	Monitoring Frequency	Pollutant Parameter Category
Milwaukie	2005	3075 / 25000	SW Instream	2 1 1	4x/year 12x/year Continuous	TDS, TSS, DO, temp, E coli, O&G, NH3, COD, hardness, NO3, NO2, TP, ortho-P, Total Metals (TM) - Cu, Pb, Zn, Cd, Cr, Ni ---[*not specified*]--- USGS – Johnson Creek
	2012	-	SW Instream Pesticide	1 1	3x/year 4x/year	Field, Conventional, Metals, Nutrients “ (+ Biological)
Oregon City	2005	5375/ 30000	SW Instream	2 1 10	1x/year 4x/year 4x/year	TSS, COD, TOC, temp, fc, conduct., (TM) - As, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Ni, Zn TSS, TDS, TOC, temp, TKN, TP, E coli, (TM) - As, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Ni, Zn Visual, Field Kit
	2012		SW Instream Pesticide	2 6	3x/year 4x/year	Field, Conventional, Metals, Nutrients “ (+Biological)
West Linn	2005	5050 / 24000	SW Instream	1 4	2x/year 3x/year	TS, TSS, DO, temp, TDS, TVS, COD, BOD, NO3, TP, Ecoli, O&G “ (subtract O&G)
	2012	-	SW Instream Pesticide	1 3	3x/year 5x/year	Field, Conventional, Metals, Nutrients “ (+Biological)

MS4 Jurisdiction	Permit Year	Approx. Jurisdiction Size (acres) / Population	Monitoring Type	Monitoring Location(s)	Monitoring Frequency	Pollutant Parameter Category
Wilsonville	2005	4425 / 18000	SW Instream	1 4	1x/year 4x/year	TSS, TDS, COD, BOD, pH, temp, DO, TP, TKN, NH3, Ecoli “[8]
	2012	-	SW Instream Pesticide	1 3	3x/year 4x/year	Field, Conventional, Metals, Nutrients “ (+Biological)
CCSD#1	2005	1725 / 7000	SW Instream	3 8	1x/year 3x/year	TSS, TDS, DO, conductivity, pH, temp, NO3, NH3, ortho-P, TP, Ecoli, (TM) - Cu, Pb, Zn “
	2012	-	SW Instream Pesticide Geomorphic	8 4 7	9x/year 3x/year 1x/permit	Field, Conventional, Metals, Nutrients “(+Biological)
SWMACC	2005	830 / 300	Instream	1	1x/year	TSS, TDS, DO, conductivity, pH, temp, NO3, NH3, ortho-P, TP, Ecoli, (TM) - Cu, Pb, Zn
	2012	-	SW Instream Pesticide	1 1	3x/year 9x/year	Field, Conventional, Metals, Nutrients “(+Biological)
OLSD	2005	3600 / 32000	SW	2	4x/year	TSS, TDS, turbidity, BOD, pH COD, temp, TKN, TP, fc, O&G
	2012	-	SW Instream Pesticide	3 3	3x/year 4x/year	Field, Conventional, Metals, Nutrients “(+Biological)

[8] See permit for some variation of pollutant parameters based on drainage basin

MS4 Jurisdiction	**Permit Year**	Approx. Jurisdiction Size (acres) / Population	**Monitoring Type**	**Monitoring Location(s)**	**Monitoring Frequency**	**Pollutant Parameter Category**
Clackamas County Group	2012	32725 / 185000	SW Instream Mercury Geomorphic Pesticide Biological	109 total sampling events/year from 19 locations 180 total sampling events/year from 30 locations 8 total sampling events/year from 4 locations 7 total sampling events/permit term from 1 location To be identified Minimum - 18 total sampling events/permit term from 18 locations		
Gresham/Fairview	2010	17000 / 115000	SW Instream Continuous Mercury Pesticide Biological BMP	9 total sampling events/year from 3 locations 36 total sampling events/year from 9 locations 2 continuous instream monitoring locations 4 total sampling events/year from 2 locations 9 total sampling events/year from 3 locations 4 total sampling events/year from 4 locations 4 total sampling events/year from 2 locations (inlet/outlet)		
Portland/Port of Portland	2011	22000 / >100000	SW Instream Continuous Mercury Pesticide Biological	45 total sampling events/year from 15 locations 64 total sampling events/year from 16 locations 3 continuous instream monitoring locations 4 total sampling events/year from 2 locations 45 total sampling events/year from 15 locations 16 total sampling events/year from 16 locations		
Eugene	2010	27750 / 156000	SW Instream Mercury Geomorphic Pesticide Biological BMP	6 total sampling events/year from 2 locations (includes organics) 72 total sampling events/year from 12 locations (includes organics) 4 total sampling events/year from 2 locations Annually 6 total sampling events/year from 2 locations 12 total sampling events/permit term from 12 locations 3 sampling events/permit term from one BMP		
Salem	2010	30000 / 155000	SW Instream Continuous Mercury Pesticide Biological	9 total sampling events/year from 3 locations 225 total sampling events/year from 24 locations 10 continuous instream monitoring locations 4 total sampling events/year from 2 locations 12 total sampling events/permit term from 3 locations 6 total sampling events/permit term from 3 locations		
Multnomah County	2010	2250/linear system serving the general Metro population	Instream Mercury Pesticide Biological	8 total sampling events/year from 2 locations 2 total sampling events/year from 1 location To be identified 2 total sampling events/year from 2 locations		

Appendix 2. Excerpts from Phase 1 Permittees Annual Reports

The following is a list of excerpts taken directly from Phase 1 Permittees for visual reference. Note that each report contains much more information and DEQ recognizes the significant work each permittee contributes to these reports. The following excerpts are useful for demonstrating the disparity of reporting styles found in annual reports. Without consistent reporting requirements, it will be nearly impossible for DEQ to coordinate any regional approach to stormwater management.

A2.1. City of Portland

a. Instream Results IV-3 Comprehensive Ambient Sampling – Summary

Surface Water Body	No. of Locations 1 Fixed/Probabilistic	Monitoring Frequency 1 Fixed/Probabilistic
Columbia Slough2	2 / 6	Bi-monthly/quarterly + 1 storm
Fanno Creek	3 / 4	Monthly to quarterly/quarterly + 1 storm
Johnson Creek2	2 / 2	Bi-monthly/quarterly + 1 storm
Tryon Creek	3 / 1	Most monthly/quarterly + 1 storm
Willamette River Tributaries	0 / 4	---/quarterly + 1 storm
Willamette River3	1 / 0	monthly to quarterly/---

1 The numbers of sampling locations and monitoring events are greater than shown in Table B-1 of the MS4 permit, but do not necessarily represent future sampling activities.
2 Some sampling locations are outside the City of Portland urban services boundary (USB).
3 There are no probabilistically selected monitoring locations in the Willamette River.

b. MS4 Pesticide Monitoring –Summary of Detected Pesticides IV-6

Statistic	2,4-D	DC	DCP	MCPP	PCP	TP	CB	IM
Number of Samples	6	6	6	6	4	6	6	6
Detection	83%	17%	33%	50%	75%	33%	17%	17%
< 1000 ADT Detections 1	3	1	0	1	2	1	1	1
> 1000 ADT Detections 1	2	0	2	2	1	1	0	0
< 1000 ADT Max [µg/L]	6.1	1.8	<0.08	0.11	0.32	0.19	1.00	0.06
> 1000 ADT Max [µg/L]	2.7	<0.08	1.1	0.98	0.19	0.082	<0.06	<0.06
EPA Aquatic Life Benchmark [µg/L] 2	12,075	14,000	NA	>45,500	25	58,500	110	34.5
Table 30 Criteria [µg/L] 3	NA	NA	NA	NA	8.7	NA	NA	NA

DC = dicamba; DCP – dichloroprop; TPCP = pentachlorophenol; P = triclopyr; CB = carbaryl; IM = imidacloprid
1 ADT = Average Daily Trips
2 Lowest EPA aquatic life benchmark (invertebrate or fish)
3 Acute freshwater criterion (OAR 340-041, Table 30)

c. UIC WPCF Pesticide Monitoring –Summary of Detected Pesticides IV-9

Statistic	2,4-D	2,4-DB	TP	DC	DCP	PCP	BZ
Number of Samples	46	46	46	46	46	46	46
Detection	28%	22%	7%	7%	2%	91%	7%
< 1000 ADT Median [μg/L] [1]	<0.06	<0.5	<0.05	<0.05	<0.7	0.077	<0.5
> 1000 ADT Median [μg/L] [1]	<0.06	<0.5	<0.05	<0.05	<0.7	0.16	<0.5
Maximum [μg/L]	8.9	4.0	0.24	2.5	2.3	2.9	2.5
EPA Aquatic Life BM [μg/L] [2]	12,075	1,000	NA	14000	NA	25	50000
Table 30 Criterion [μg/L] [3]	NA	NA	NA	NA	NA	8.7 [4]	NA

TP = 2,4,5-TP (silvex); DC = dicamba; DCP = dichloroprop; PCP = Pentachlorophenol; BZ = bentazon

[1] ADT = Average daily trips
[2] Lowest EPA aquatic life benchmark (invertebrate or fish)
[3] Acute freshwater criterion (OAR 340-041, Table 30)
[4] Acute freshwater criterion at pH = 7.0
NA = not availabl

A2.2. City of Eugene

a. Summary of metals detected by site

Table A.9
2013/2014 QA/QC Qualified Ambient Water Quality Data
Amazon Basin and Willamette River Monitoring Sites
Metals (μg/L)

Date / Site	As (D)	As (T)	Cd (D)	Cd (T)	Cr (D)	Cr (T)	Cu (D)	Cu (T)	Pb (D)	Pb (T)	Hg (D)	Hg (T)	Mo (D)	Mo (T)	Ni (D)	Ni (T)	Se (D)	Se (T)	Ag (D)	Ag (T)	Zn (D)
Amazon Creek at 29th Avenue																					
7/31/2013	1.28	1.44	<0.0176	<0.0201	0.192	0.272	0.941	1.50	0.0279	0.240	<0.0005	<0.0005	0.571	0.603	1.46	1.68	0.174	0.213	<0.0059	<0.0190	16.4
9/25/2013	0.937	1.06	<0.0176	<0.0201	0.489	1.08	2.98	4.24	0.124	0.375	0.00126	0.00258	0.243	0.248	1.58	1.85	0.203	0.198	0.0117	<0.0190	19.3
11/6/2013	0.851	0.985	<0.0176	<0.0201	0.302	0.478	1.82	2.32	0.0467	0.151	0.00087	0.00168	0.262	0.288	1.49	1.48	0.153	0.138	0.0121	<0.0190	23.6
1/22/2014	0.660	0.823	<0.0176	<0.0201	0.537	1.42	1.47	2.87	0.0788	0.434	0.00102	0.00128	0.170	0.199	1.40	1.98	0.158	0.238	0.0063	<0.0190	21.5
3/19/2014	0.605	0.732	<0.0176	<0.0201	0.880	1.48	2.12	3.69	0.0582	0.224	0.00159	0.00285	0.154	0.161	1.41	1.66	0.094	0.162	0.0091	<0.0190	17.2
5/21/2014	0.917	1.03	<0.0176	<0.0201	0.0680	0.303	1.15	1.55	0.0242	0.113	0.00061	0.00108	0.299	0.297	1.46	1.60	0.234	0.166	<0.0059	<0.0190	21.2
Willow Creek near 18th Avenue																					
7/31/2013*																					
9/25/2013	0.856	1.01	<0.0176	<0.0201	0.200	0.276	1.25	1.49	0.0403	0.110	<0.0005	0.00081	0.363	0.358	4.03	4.12	0.176	0.220	0.0168	<0.0190	37.0
11/6/2013	0.717	0.889	<0.0176	<0.0201	Outlier	0.0851	Outlier	1.49	0.0110	0.0293	<0.0005	0.00108	0.122	0.131	2.97	2.75	0.285	0.239	0.0099	<0.0190	10.2
1/22/2014	0.755	1.08	<0.0176	<0.0201	0.461	0.948	1.88	2.66	0.170	0.237	0.00229	0.00225	0.068	0.077	1.19	1.44	0.129	0.190	0.0131	<0.0190	3.08
3/19/2014	0.935	1.37	<0.0176	<0.0201	0.494	0.823	1.92	3.01	0.0879	0.254	0.00186	0.00431	0.079	0.088	1.17	1.42	0.079	0.120	0.0099	<0.0190	6.80
5/21/2014	1.47	2.24	<0.0176	<0.0201	0.070	0.188	1.04	1.33	0.0267	0.0959	0.00090	0.00148	0.207	0.220	2.63	2.72	0.274	0.258	<0.0059	<0.0190	Outlier
Amazon Creek at Railroad Crossing																					
7/31/2013	5.15	8.32	<0.0176	<0.0201	0.183	0.959	1.13	2.77	0.116	1.90	<0.0005	0.00291	0.849	0.855	2.17	2.86	0.298	0.360	<0.0059	<0.0190	5.82
9/25/2013	2.48	2.82	<0.0176	<0.0201	0.464	1.06	3.23	4.51	0.156	0.729	0.00124	0.00354	0.403	0.388	1.46	1.78	0.124	0.115	Outlier	<0.0190	29.5
11/6/2013	2.77	3.23	<0.0176	<0.0201	0.404	0.562	2.66	3.38	0.224	0.543	0.00254	0.00455	1.05	1.16	1.61	1.65	0.130	0.133	0.0090	<0.0190	24.2
1/22/2014	2.04	2.62	<0.0176	<0.0201	0.408	0.882	1.70	2.62	0.109	0.466	0.00274	0.00464	0.64	0.634	1.57	1.81	0.277	0.308	<0.0059	<0.0190	15.7
3/19/2014	1.71	2.29	<0.0176	<0.0201	0.514	0.929	2.19	3.14	0.112	0.441	0.00338	0.00690	0.235	0.272	1.50	1.77	0.126	0.156	<0.0059	<0.0190	18.9
5/21/2014	2.51	5.21	<0.0176	0.0285	0.0823	2.27	1.80	6.53	0.0901	3.070	0.00146	0.0147	0.539	0.536	1.75	3.21	0.293	0.260	<0.0059	<0.0190	4.31
Amazon Diversion Channel at Royal Avenue																					
7/31/2013	6.66	9.60	<0.0176	0.0213	0.217	1.80	1.10	4.24	0.134	2.34	<0.0005	0.00394	1.12	1.11	2.28	3.40	0.359	0.364	<0.0059	<0.0190	1.21
9/25/2013	2.12	2.16	<0.0176	0.0209	0.600	1.05	5.95	7.82	0.343	0.996	0.00188	0.00532	0.672	0.697	1.30	1.68	0.159	0.117	0.0083	<0.0190	26.5
11/6/2013	1.66	2.07	<0.0176	<0.0201	0.331	0.369	2.89	3.35	0.157	0.430	0.00174	0.00419	1.30	1.31	1.80	1.68	0.165	0.174	<0.0059	<0.0190	14.3
1/22/2014	0.923	1.48	<0.0176	<0.0201	0.306	0.542	2.67	3.36	0.105	0.555	0.00114	0.00311	0.718	0.735	2.02	2.26	0.265	0.334	<0.0059	<0.0190	23.7
3/19/2014	1.06	1.72	<0.0176	<0.0201	0.247	0.448	2.55	3.39	0.107	0.523	0.00138	0.00402	0.762	0.784	1.80	1.98	0.157	0.148	<0.0059	<0.0190	19.5
5/21/2014	1.74	4.93	<0.0176	0.0552	0.0835	4.41	1.23	10.5	0.093	5.150	0.00056	0.0214	0.713	0.718	1.56	4.31	0.188	0.211	<0.0059	0.0293	2.15
A3 Channel at Terry Street																					
7/31/2013*																					
9/25/2013	1.57	1.59	0.0232	0.0316	0.651	1.04	7.41	9.39	0.522	1.52	0.00404	0.0103	0.922	0.933	1.55	1.94	0.120	0.103	0.0177	0.0261	41.1
11/6/2013	1.23	1.70	<0.0176	0.0272	0.366	0.685	3.34	4.70	0.246	1.14	0.00127	0.00739	1.06	1.09	1.73	1.84	0.200	0.154	<0.0059	<0.0190	15.4
1/22/2014	0.791	1.24	<0.0176	0.0202	0.263	0.521	1.74	3.09	0.054	0.933	0.00080	0.00486	0.798	0.795	2.50	2.61	0.330	0.340	<0.0059	<0.0190	26.1
3/19/2014	0.920	1.79	<0.0176	0.0213	0.186	0.310	1.84	2.93	0.048	0.526	0.00084	0.00407	0.819	0.906	2.28	2.46	0.283	0.260	<0.0059	<0.0190	22.7
5/21/2014	2.70	4.48	<0.0176	<0.0201	0.0653	0.624	1.32	3.01	0.067	1.62	0.00068	0.00803	1.39	1.56	2.05	2.64	0.258	0.220	<0.0059	<0.0190	12.3
Amazon Creek at Royal Avenue																					
7/31/2013*																					
9/25/2013	2.29	2.56	<0.0176	<0.0201	0.434	1.13	3.26	4.61	0.128	0.794	0.00099	0.00327	0.388	0.405	1.37	1.78	0.116	0.124	<0.0059	<0.0190	26.1
11/6/2013	2.33	2.82	<0.0176	<0.0201	0.435	0.596	2.79	3.53	0.215	0.525	0.00172	0.00376	1.73	1.83	1.62	1.64	0.188	0.120	0.0070	<0.0190	21.0
1/22/2014	1.72	2.36	<0.0176	<0.0201	0.342	0.863	1.74	2.68	0.114	0.461	0.00284	0.00521	0.541	0.576	1.47	1.82	0.234	0.242	<0.0059	<0.0190	16.2
3/19/2014	1.63	2.35	<0.0176	<0.0201	0.389	1.04	2.12	3.43	0.106	0.564	0.00322	0.00658	0.264	0.311	1.44	1.89	0.157	0.115	<0.0059	<0.0190	27.4
5/21/2014	1.88	3.45	<0.0176	<0.0201	0.116	1.61	1.65	4.19	0.124	1.56	0.00109	0.00702	0.439	0.438	1.76	2.64	0.191	0.149	<0.0059	<0.0190	17.3

b. Summary statistics for ambient water quality data

Table A.12
Summary Statistics for QA/QC Qualified Ambient Water Quality Data
Metals

Surface Water Sample Location: Metals (µg/L)	Statistic	Amazon Creek at 29th Avenue	Willow Creek near 18th Avenue	Amazon Creek at Railroad Crossing	Amazon Diversion Channel at Royal Avenue	A3 Channel at Terry Street	Amazon Creek at Royal Avenue	Willamette River Upstream of Urban Growth Boundary (RM 186.9)	Willamette River at Knickerbocker Bridge (RM 183.9)	Willamette River at Owosso Bridge (RM 178.6)	Delta Ponds Above Willamette River Confluence	Willamette River Downstream of Beltline Bridge (RM 176.8)	Spring Creek at Beacon Drive East
As (D)	$\hat{\mu}$	0.888	0.911	2.49	2.33	2.19	2.28	0.203	0.236	0.243	0.404	0.245	0.329
	$\hat{\sigma}$	0.336	0.442	1.03	1.22	1.23	1.06	0.0575	0.0604	0.0645	0.175	0.0660	0.0790
As (T)	$\hat{\mu}$	1.09	1.41	3.97	3.95	3.64	3.40	0.268	0.313	0.326	0.543	0.330	0.392
	$\hat{\sigma}$	0.337	0.644	1.76	2.07	3.00	1.41	0.101	0.099	0.106	0.364	0.105	0.0803
Cd (D)	$\hat{\mu}$	0.00066	0.00125	0.00277	0.00462	0.0121	0.00270	0.00062	0.00262	0.00120	INS	0.00149	INS
	$\hat{\sigma}$	0.00117	0.00190	0.00385	0.00776	0.0125	0.00465	0.00246	0.00858	0.00425	INS	0.00430	INS
Cd (T)	$\hat{\mu}$	0.00598	0.00256	0.0161	0.0250	0.0466	0.0146	0.00161	0.00339	0.00180	0.00078	0.00213	INS
	$\hat{\sigma}$	0.00768	0.00324	0.0137	0.0180	0.0274	0.0143	0.00417	0.00685	0.00409	0.00387	0.00542	INS
Cr (D)	$\hat{\mu}$	0.592	0.344	0.600	0.631	0.672	0.590	0.139	0.152	0.151	0.0933	0.170	0.151
	$\hat{\sigma}$	0.403	0.239	0.389	0.419	0.451	0.383	0.109	0.112	0.111	0.0834	0.122	0.0735
Cr (T)	$\hat{\mu}$	1.56	0.885	1.66	1.84	1.53	1.63	0.353	0.389	0.388	0.148	0.379	0.287
	$\hat{\sigma}$	0.902	0.577	0.979	0.95	1.15	0.811	0.238	0.255	0.260	0.121	0.243	0.181
Cu (D)	$\hat{\mu}$	1.76	1.21	1.74	2.31	2.29	1.87	0.301	0.369	0.372	0.486	0.439	0.663
	$\hat{\sigma}$	0.673	0.381	0.572	0.987	1.30	0.622	0.113	0.132	0.122	0.214	0.143	0.424
Cu (T)	$\hat{\mu}$	3.38	2.30	3.96	5.98	6.21	4.02	0.569	0.686	0.697	0.789	0.794	1.05
	$\hat{\sigma}$	1.44	0.902	1.39	3.91	4.12	1.37	0.280	0.336	0.317	0.788	0.345	0.765
Pb (D)	$\hat{\mu}$	0.0389	0.0269	0.0967	0.0996	0.140	0.0980	0.00655	0.0107	0.0110	0.0253	0.0171	0.0235
	$\hat{\sigma}$	0.0251	0.0199	0.0508	0.0539	0.0918	0.0462	0.00784	0.0114	0.00899	0.0161	0.0101	0.0157
Pb (T)	$\hat{\mu}$	0.595	0.270	2.02	2.18	2.29	1.71	0.0805	0.0857	0.099	0.129	0.107	0.342
	$\hat{\sigma}$	0.342	0.161	1.22	1.28	1.52	0.935	0.0455	0.0448	0.0470	0.0697	0.0490	0.406
Hg (D)	$\hat{\mu}$	0.00099	0.00104	0.00205	0.00123	0.00128	0.00169	0.00073	0.00085	0.00084	0.00010	0.00086	0.00012
	$\hat{\sigma}$	0.00050	0.00051	0.00093	0.00072	0.00062	0.00084	0.00034	0.00039	0.00035	0.00012	0.00037	0.00003
Hg (T)	$\hat{\mu}$	0.00254	0.00260	0.00833	0.00718	0.00992	0.00647	0.00161	0.00172	0.00180	0.00078	0.00188	0.00078
	$\hat{\sigma}$	0.00136	0.00141	0.00377	0.00389	0.00499	0.00311	0.00088	0.00085	0.00091	0.00051	0.00096	0.00053
Mo (D)	$\hat{\mu}$	0.271	0.115	0.534	1.00	1.25	0.625	INS	INS	INS	INS	INS	INS
	$\hat{\sigma}$	0.146	0.100	0.292	0.456	0.565	INS	INS	INS	INS	INS	INS	INS
Mo (T)	$\hat{\mu}$	0.284	0.114	0.519	1.030	1.302	0.637	INS	INS	INS	INS	INS	INS
	$\hat{\sigma}$	0.144	0.096	0.273	0.559	0.5796	0.363	INS	INS	INS	INS	INS	INS
Ni (D)	$\hat{\mu}$	1.43	1.83	1.68	2.06	2.15	1.69	0.191	0.205	0.207	0.644	0.230	0.701
	$\hat{\sigma}$	0.374	1.27	0.415	0.671	0.657	0.444	0.0670	0.0691	0.0671	0.207	0.0796	0.186
Ni (T)	$\hat{\mu}$	2.06	2.23	2.40	3.12	2.96	2.44	0.308	0.340	0.341	0.754	0.360	0.826

c. Mann-Whitney Statistic Output for Intra-Basin Comparison of Water Quality Data

Table A.21
Mann-Whitney Statistic Output for
Intra-Basin Comparison of Water Quality Data

Monitoring Location	NH_3	BOD	Ca (T)	COD	Cond	DO	E. coli	Fecal Coliform	Hardness	Mg (T)	NO_3+NO_2	Field pH	Ortho P	Total P	Temp	TDS	TKN
Amazon Creek at 29th Avenue : Willow Creek																	
Mann-Whitney U	2916	4709	4509.5	4197.5	4773	4385.5	1070	847	4157	3764.5	644	2123	1306.5	2324	4444.5	4439.5	4290.5
Z	-1.32	-0.57	-0.82	-1.49	-0.16	-0.04	-9.28	-7.04	-1.48	-2.68	-10.60	-6.73	-8.55	-6.32	-0.86	-0.76	-1.41
Asymp. Sig. (2-tailed)	0.186	0.568	0.413	0.137	0.875	0.969	0.000	0.000	0.139	0.007	0.000	0.000	0.000	0.000	0.392	0.447	0.159
Amazon Creek at 29th Avenue : Amazon Creek at Railroad Track Crossing																	
Mann-Whitney U	3361.5	3174.5	3314	2432.5	4195	3012	2546	2069.5	3255	3221.5	3533.5	2515	1989.5	3945	3581.5	3442	3867
Z	-0.83	-4.51	-2.96	-5.35	-0.60	-3.30	-4.78	-2.90	-3.03	-3.21	-2.28	-5.11	-6.25	-1.28	-2.24	-2.17	-1.51
Asymp. Sig. (2-tailed)	0.407	0.000	0.003	0.000	0.547	0.001	0.000	0.004	0.002	0.001	0.023	0.000	0.000	0.202	0.025	0.030	0.131
Amazon Creek at 29th Avenue : Amazon Diversion Channel at Royal Avenue																	
Mann-Whitney U	3197	2370	4734.5	1558.5	4914.5	3398	2372.5	1268.5	5068	3935.5	4148.5	3872.5	3120	2778.5	3769.5	5048.5	2389
Z	-1.94	-8.04	-1.55	-8.83	-1.14	-3.63	-6.78	-6.12	-0.55	-3.40	-2.81	-3.55	-5.06	-6.00	-3.78	-0.36	-6.96
Asymp. Sig. (2-tailed)	0.053	0.000	0.120	0.000	0.255	0.000	0.000	0.000	0.579	0.001	0.005	0.000	0.000	0.000	0.000	0.716	0.000
Amazon Creek at 29th Avenue : Amazon Creek at Royal Avenue																	
Mann-Whitney U	3194.5	3669	3563	2744	4592	3723	3146	1930.5	3661	3920.5	3692	4356.5	2197	5060	4025	3842.5	3827
Z	-1.47	-5.08	-4.17	-5.99	-1.77	-2.82	-4.88	-3.42	-3.76	-3.33	-3.68	-2.32	-7.20	-0.45	-3.09	-3.13	-3.51
Asymp. Sig. (2-tailed)	0.141	0.000	0.000	0.000	0.076	0.005	0.000	0.001	0.000	0.001	0.000	0.020	0.000	0.649	0.002	0.002	0.000
Amazon Creek at Railroad Track Crossing : Amazon Diversion Channel at Royal Avenue																	
Mann-Whitney U	3283	2880.5	3945.5	2893.5	3860	4023.5	3323.5	2015	3234	2465	4286.5	4273.5	3892	2670.5	3929.5	3631.5	2393.5
Z	-1.16	-4.37	-1.27	-4.01	-1.50	-0.14	-2.93	-3.74	-3.08	-5.23	-0.36	-0.39	-1.06	-4.61	-1.31	-1.43	-5.39
Asymp. Sig. (2-tailed)	0.245	0.000	0.204	0.000	0.134	0.886	0.003	0.000	0.002	0.000	0.719	0.694	0.288	0.000	0.190	0.152	0.000
A3 Channel at Terry Street : Amazon Creek at Royal Avenue																	
Mann-Whitney U	2441	2752	2538.5	2438	2353	3164	3854	2405	1963.5	1420	3056.5	3594.5	2528	1322	4043.5	2256	3066
Z	-3.68	-4.09	-4.45	-4.67	-4.97	-1.19	-0.61	-1.26	-6.01	-7.60	-2.92	-1.48	-4.46	-7.78	-0.22	-4.83	-2.90
Asymp. Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.236	0.543	0.207	0.000	0.000	0.004	0.138	0.000	0.000	0.830	0.000	0.004

Shaded cells significant at a = 0.05

A2.3. Clackamas County Service District # 1 (CCSD#1)

a. Storm Event Monitoring Summary

Storm Event Monitoring Date	Sites Monitored	Rain Prior to Event	Rain During Sample Collection Period	Total Rainfall (prior to & during event)
11/7/2013	5 CCSD#1 Creeks	2.28 inches fell in the 6.5 days prior to collecting the samples (0.72 inch fell in the 24 hours prior to collecting the samples).	0.17	2.45 inches
11/19/2013	3 CCSD#1 Creeks and Pecan Creek in SWMACC	SWMACC: 0.75 inch in preceding 24 hrs CCSD#1: 0.77 inch in preceding 24 hrs	SWMACC: 0.07 inch CCSD#1: 0.09 inch	SWMACC: 0.82 inch CCSD#1: 0.86 inch
1/28/2014	All 4 CCSD#1 outfalls	0.01 inch (There were 9 rain-free days prior to this storm)	0.38 inch	0.39 inch
2/12/2014	All 8 CCSD#1 Creeks	1.77 inches in preceding 66 hours (0.57 inch in the 24 hours before samples were collected)	none	1.77 inches
2/27/2014	All 4 CCSD#1 outfalls	0.01 in the preceding 24 hours (Only 0.01 additional rain fell in the preceding 65 hours)	0.20 inch	0.21 inch
3/3/2014	Pecan Creek in SWMACC	0.87 inch during preceding 29 hours (from 6am on March 2nd to 10am on March 3rd)	none	0.87 inch
3/5/2014	All 8 CCSD#1 Creeks	0.31 inch in preceding 8 hours	0.09	0.4 inch
3/28/2014	Cow Creek in CCSD#1	1.72 inch fell in the 80 hours prior to collecting the samples at 11:55am (0.57 inch fell in the 7 hours before the sample was collected).	0.01 inch (this was a Routinely scheduled visit, so samples were not composited over a 2-4 hour period, unlike the other monitoring events in this table)	1.73 inches
3/28/2014	Pecan Creek in SWMACC	0.49 inch fell in preceding 11 hours	0.18	0.67 inch
4/17/2014	3 CCSD#1 outfalls and the SWMACC outfall	SWMACC: 0.32 inch in preceding 14 hrs * CCSD#1: 0.25 inch in preceding 12 hrs*	SWMACC: 0.16 inch CCSD#1: 0.10 inch	SWMACC: 0.48 inch CCSD#1: 0.35 inch
5/8/2014	One CCSD#1 outfall and the SWMACC outfall	SWMACC: 0.09 or 0.10 (only 0.01 inch fell in the 76 hrs prior to this rain) CCSD#1: 0.07 (no rain fell in the 77 hours prior to this rainfall)	SWMACC: 0.25 CCSD#1: 0.31	SWMACC: 0.34 or 0.35 inch CCSD#1: 0.38 inch
6/12/2014	SWMACC outfall	0.0 inch in the preceding 24 hours (zero rain fell in the preceding 13 days)	0.13 inch (measured at the Conestoga Aquatic Center in Tigard, OR)	0.13

* = The monitoring event at outfalls on April 17, 2014 did not have an Antecedent Dry Period as defined by the MS4 permit

In conjunction with the monitoring data summary included in Tables 4 and 5, WES has prepared a generalized stormwater quality index to assist the reader with drawing conclusions and making informed decisions based on the monitoring results. This index has been included as Attachment 1.

A2.4. City of Oregon City

a. Monitoring Locations and Frequencies

Site #	Location	Sample Type	Required Frequency	Weather
In-Stream Monitoring				
OC010is	Abernethy Creek At 17082 Holly Ln., (Holly Ln. Bridge)	Grab & Composite	4/year	Dry Weather (2/year) and Storm Event (2/year)
OC011is	Abernethy Creek At 316 17th St. (17th @ railroad trestle)	Grab & Composite	4/year	Dry Weather (2/year) and Storm Event (2/year)
OC012is	Coffee Creek Behind 415 McLoughlin (outfall @ Willamette)	Grab & Composite	4/year	Dry Weather (2/year) and Storm Event (2/year)
OC013is	Park Place Creek Behind 13530	Grab &	4/year	Dry Weather (2/year) and

A2.5. Oak Lodge Sanitary District

a. Results from Storm and Quarterly Ambient Sampling

OLSD 2013-2014 Water Quality Sampling Data Results: Storm Sampling and Quarterly

SW 8 – SE Naef Rd / SE Blanton St – South Boardman Creek, 60' north of intersection
MS4 Sample Type: WET WEATHER, 3 events per year

DATE	TSS (mg/L)	BOD (mg/L)	Fecal coliform	pH	Temp (celsius)	E. Coli (col/100)	CL2 (mg/L)	TDS (MGL)	COD (mg/L)	O&G (mg/L)	Tot Phosphat	TKN (mg/L)	FLOATING SOLIDS	O&G SHEEN	Luminescent DO	Conductivity (µS/cm)	Nitrate (mg/L)	H
11/19/2013	19	ND<4	N/A	6.93	22.9	1550	N/A	35	N/A	ND	0.192	N/A	NONE	ND<5.05	10.78	41.1	0.776	
10/8/2013	ND	ND<4	N/A	7.49	18	3.1	N/A	80	N/A	ND	ND	N/A	NONE	ND<4.9	9.86	86	ND<0.25	
2/20/2014	ND	ND	N/A	7.38	23.2	172	N/A	110	N/A	ND	ND	N/A	NONE	ND	11.18	111.6	1.93	

SW 5 – 15100 SE Woodland Way – River Forest Creek – 48" CMP outfall on west side of road
MS4 Samlpe Type: WET WEATHER, 3 events per year

DATE	TSS (mg/L)	BOD (mg/L)	Fecal coliform	pH	Temp (celsius)	E. Coli (col/100)	CL2 (mg/L)	TDS (MGL)	COD (mg/L)	O&G (mg/L)	Tot Phosphat	TKN (mg/L)	FLOATING SOLIDS	O&G SHEEN	Luminescent DO	Conductivity (µS/cm)	Nitrate (mg/L)	H
11/19/2013	10	ND<4.00	N/A	7.17	22.8	1410	N/A	ND<10.0	ND	ND<4.72	0.102	N/A	NOND	NO	10.85	27.1	0.418	
10/8/2013	10	ND<4.00	N/A	7.95	18	24.1	N/A	114	ND	ND<5.21	0.114	N/A	NONE	NO	9.77	147.8	2.4	
2/20/2014	ND	ND	N/A	6.91	23.1	162	N/A	104	ND	ND	ND	N/A	NONE	NO	10.92	124.8	3.02	

SW 2 – SE Courtney Ave / SE Rupert Dr – MH on SW corner
MS4 Sample Type: WET WEATHER, 3 events per year

DATE	TSS (mg/L)	BOD (mg/L)	Fecal coliform	pH	Temp (celsius)	E. Coli (col/100)	CL2 (mg/L)	TDS (MGL)	COD (mg/L)	O&G (mg/L)	Tot Phosphat	TKN (mg/L)	FLOATING SOLIDS	O&G SHEEN	Luminescent DO	Conductivity (µS/cm)	Nitrate (mg/L)	H
11/19/2013	20	ND <4.00	N/A	6.74	24.6	2419.6	N/A	13	ND <10.0	ND<5.56	0.138	N/A	NONE	NO	10.25	40.4	0.446	
10/8/2013	ND	ND <4.00	N/A	7.61	18.1	276	N/A	141	ND <10.0	ND <5.00	ND <0.100	N/A	NONE	NO	8.87	162.6	2.01	
2/20/2014	ND	ND <4.00	N/A	6.87	25.5	517	N/A	128	ND <10.0	ND <5.00	ND <0.100	N/A	NONE	NO	10.59	143.3	3.73	

SW 15 – 15000 SE Fairoaks Ave – River Forest Creek – River Forest Lake influent
MS4 SAMPLE TYPE: Instream Sample, 4 times per year

	TSS (mg/L)	BOD (mg/L)	Fecal coliform (MPN)	pH	Temp ©	E. Coli	CL2	TDS	COD	O&G	TOTAL	TKN	FLOATING	O&G	Luminescent DO (mg/L)	Conductivity (µS/cm)	Nitrate (mg/L)	H
9/11/2013	5	ND		7.62	19.7	1550		128		ND			No	No	7.11	160.2	0.291	
12/31/2013	ND<5	ND	N/A	7.44	23.3	101	N/A	143	N/A	ND	ND	NA	NO	NO	11.65	191.1	0.785	
3/13/2014	18	ND	N/A	7.42	25	76.3	N/A	130	NA	ND	ND	NA	NO	NO	11.39	178	2.45	
5/9/2014	7	ND	N/A	7.28	22.6	306	N/A	116	N/A	ND	ND	N/A	NO	NO	9.77	140.5	0.954	
						Avg:												

SW 12 – 3131 SE Walta Vista Ct – Lower Boardman Creek – 48" CMP outfall
MS4 SAMPLE TYPE: Instream Sample, 4 times per year

DATE	TSS (mg/L)	BOD (mg/L)	Fecal coliform	pH	Temp (celsius)	E. Coli (col/100)	CL2 (mg/L)	TDS (MGL)	COD (mg/L)	O&G (mg/L)	Tot Phosphat	TKN (mg/L)	FLOATING	O&G SHEEN	Luminescent DO	Conductivity (µS/cm)	Nitrate (mg/L)	H
9/11/2013	ND	ND		7.63	19.2	206		178		ND	0.198		No	No	6.94	231	0.473	
12/31/2013	ND	ND	N/A	7.36	23.4	548	N/A	164	N/A	ND	ND	N/A	NO	NO	10.26	222	0.85	
3/13/2014	6	ND	N/A	7.29	25.3	59.1	N/A	144	N/A	ND	ND	N/A	NO	NO	10.86	186.7	1.7	
5/9/2014	7	ND	N/A	7.03	21.8	816	N/A	100	NA	ND	0.106	N/A	NO	NO	8	127.6	0.485	

SW 3 – Courtney Springs Creek on east side of SE McLoughlin Blvd, 350' north of SE Park Ave – outfall of 5' x 5' concrete box culvert
MS4 SAMPLE TYPE: Instream Sample, 4 times per year

DATE	TSS (mg/L)	BOD (mg/L)	Fecal coliform	pH	Temp (celsius)	E. Coli (col/100)	CL2 (mg/L)	TDS (MGL)	COD (mg/L)	O&G (mg/L)	Tot Phosphat	TKN (mg/L)	FLOATING SOLIDS	O&G SHEEN	Luminescent DO	Conductivity (µS/cm)	Nitrate (mg/L)	H
9/11/2013	ND <5.00	ND <4.00		7.98	19.1	179		168		ND	ND <0.100		No	No	8.91	226	0.668	
12/31/2013	39	ND <4.00	N/A	7.55	23.4	64.4	N/A	143	NA	ND<5.95	N/A	N/A	NO	NO	11.5	200.2	1.42	
3/13/2014	ND <5.00	ND <4.00	N/A	7.5	25.7	35.9	N/A	139	N/A	ND	ND <0.100	N/A	NO	NO	11.18	174.3	2.9	
5/9/2014	ND <5.00	ND <4.00	N/A	7.44	22.6	1300	N/A	127	N/A	ND	ND <0.100	N/A	NO	NO	10.17	155.1	1.44	

ND = non detect
NO = None Observed

A2.6 City of Wilsonville

a. Reach Assessment Summary – Cole Ecological, Inc.

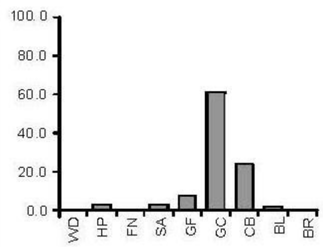
Reach Assessment Summary

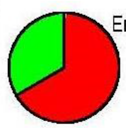
COLE ECOLOGICAL, INC.

Stream Name:	Boeckman Creek		
Location:	Boeckman Creek DS Rose Ln	Latitude:	45.29917142
County, State:	Clackamas, Oregon	Longitude:	-122.754864
Date sampled:	9/22/2013	Reach Length:	100 m
Personnel:	M. Cole and A. Miller		

Physical and Chemical Conditions Summary

InstreamPhysicalCharacteristics		
Wetted Width (m)		1.9
Bankfull Width (m)		3.4
% Rapids/Casc.		0.0
% Riffles		25.0
% Glides/Runs		30.0
% Pools		45.0
Substrate		
% Wood	WD	0.0
% Hardpan	HP	3.0
% Fines	FN	0.0
% Sand	SA	3.0
% Fine Gravel	GF	7.9
% Crse Gravel	GC	60.4
% Cobble	CB	23.8
% Bulder	BL	2.0
% Bedrock	BR	0.0
% Embeddedness		66.6
Large Wood Rating		1.74
Eroding Banks (%)		85.3
Undercut Banks (%)		6.4



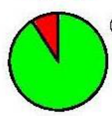


Embeddedness

Survey start, facing upstream

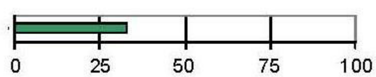
Survey end, facing downstream

RiparianZoneCharacteristics	
Canopy Cover (%)	90.8824
Riparian Buffer Width (m)	33
Rip Zone Tree Cover (%)	65
Rip Non-Native Cover (%)	48



Canopy Cover

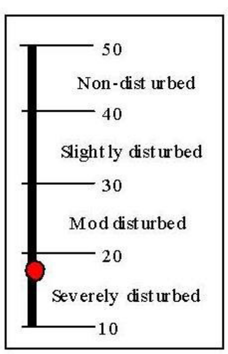
ChemicalCharacteristics	
Water Temperature (°C)	14.1
Specific Cond (µS/cm)	175.5
Dissolved Oxygen (% sat)	89
Time of Measurement	1040



Biological Conditions Summary

CE Sample ID: 13-121-12
Sample Method: OR 8-kick
Target Habitat: Riffle

	Raw	Stand.
Richness	19	3
Mayfly	1	1
Caddisfly	2	1
# Sensitive Tax	0	1
# Sed Sens Taxa	0	1
% Tolerant Taxa	36.6	3
% Sed Tol Taxa	5.7	5
% Dominant (1)	30.9	3
TOTAL MMI SCORE		20



Year	Score	Disturbance Level
2013	0.388	Most

Stressor Scores	
Temperature Stress:	22.9
Fine Sediment Stress:	30.6

b. Wet and Dry Season Screening Results (Boeckman Creek at Memorial Park)

Analyte	Dry Season May 1 to Sep 30				Wet Season Oct 1 to Apr 30		Unit
	Date	Date	Date	Date	Date	Date	
	09/06/13	09/23/13	06/12/14	06/26/14	02/18/14	03/05/14	
rainfall	0.2	0.21	0.45	0.5	0.8	1.5	Inches
specific conductivity	68	105.6	92.3	214.9	85.2	30.8	µmhos/cm
pH	6.35	6.8	7.2	7.16	6.39	6.74	Std. Units
temperature	17.1	15.5	16	16.4	11.1	13.0	degrees C
D.O.	9.6	9.8	9.41	9.45	11.18	10.8	mg/L
copper, total	9.23	5.7	1.3	1.8	2	5.2	µg/L
copper, dissolved	2.64	4.4	0.8	1.0	1.7	1.7	µg/L
E. coli	2419	2419	291	291	66	687	MPN/100 mL
Biochemical Oxygen Demand (BOD5)	5.2	4.6	>2	2.4	3.2	3.7	mg/L
total hardness	64	48	80	80	64	24	mg CaCO3/L
lead, total	3.23	0.637	0.29	0.02	0.5	3.22	µg/L
lead, dissolved	0.06	0.07	0.02	6	0.08	0.5	µg/L
nitrogen–ammonia	0.3	0.2	0.1	0.1	2.06	<0.1	mg/L
nitrate-nitrite	0.348	0.437	1.48	0.997	4.07	1.35	mg/L
phosphorus, total	1.45	0.44	0.51	0.59	0.73	1.7	mg/L
phosphorus, ortho-phosphate	0.22	0.03	0.06	>0.03	<0.06	<0.03	mg/L
solids–total suspended	263	15	3.8	7.5	21	66	mg/L
solids-total dissolved	107	68	133	133	67	50	mg/L
solids–total volatile	208	208	92	36.6	62	45	mg/L
zinc, total	51.0	20	6	6	10	29	mg/L
zinc, dissolved	11.0	18	5	6	7	9	mg/L