

City of Gresham

Environmental Monitoring Plan

for

National Pollutant Discharge Elimination System (NPDES)
Municipal Separate Storm Sewer System (MS4)
Water Pollution Control Facilities (WPCF)
Permit Compliance

Prepared by:

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Covers stormwater and stream monitoring requirements for the City of Fairview

Covers stream monitoring requirements for Multnomah County

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1.0 INTRODUCTION

1.1 Overview

Under the federal Clean Water Act and Oregon Revised Statute 468B.050, the Oregon Department of Environmental Quality (DEQ) has issued the Cities of Gresham and Fairview a National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) Discharge Permit. As such, both cities are required to develop a monitoring program as described in the Clean Water Act (CWA) 40 CFR 122.26 (d) (2) (iii) (A) through (D) and in Schedule B Monitoring and Reporting Requirements of the NPDES MS4 permit #101315 in order to characterize stormwater discharges, assess trends in water quality and aid the adaptive management of the overall stormwater program within the permit boundary.

The City of Gresham is Co-permittee with the City of Fairview and acts as the lead applicant for the permit and has agreed to be responsible for conducting most of the monitoring program elements on behalf of the City of Fairview via an inter-governmental agreement (**See Appendix D**). The City of Gresham, including the urban growth boundary of Pleasant Valley, Kelley Creek Headwaters and Springwater represents approximately 17,000 acres (about 26.5 square miles). Just over 2,200 additional acres are managed by the City of Fairview. A more detailed discussion of the permit boundary and the history of the Co-permittees may be found in **Section 3.0** of Gresham's Stormwater Management Plan (SWMP) which includes Figure 1.0 Map of the NPDES MS4 Permit #101315 Boundary and Area Watersheds.

The primary goal for the monitoring program is to support evaluation and adaptive management of the stormwater management program in order to reduce the discharge of pollutants from the MS4 to the maximum extent practicable. The Cities of Gresham and Fairview have developed individual Stormwater Management Plans as directed by the CWA 40 CFR 122.26 (d) (2) (iv) (A) through (D) and in Schedules A, B, and D of the NPDES MS4 permit. These documents are available on the Cities' websites at www.greshamoregon.gov and www.fairvieworegon.gov and are also available upon request from each City.

The City of Gresham is also responsible for implementing a groundwater protection program to comply with a December 2012 Water Pollution Control Facility (WPCF) permit. Currently this plan is written to comply with the NPDES MS4 permit, and the stormwater monitoring components of the plan comply with the City of Gresham's WPCF permit.

In addition to complying with the NPDES MS4 permit requirements, the goal of this Monitoring Plan is to provide the Cities of Gresham and Fairview with a monitoring program that will consider Total Maximum Daily Load (TMDL) compliance objectives for water quality monitoring; provide data to help answer some of the outstanding questions about stormwater-related pollutant sources; help the Co-Permittees assess water quality impacts related to MS4 discharges; and help identify improvements in water quality over time as a result of the Co-Permittees' stormwater quality management efforts.

This Monitoring Plan reflects the requirements of the NPDES MS4 Permit issued on September 15, 2021.

1.2 Monitoring Program History and Updates

Permit Application (1993)

The Cities of Gresham and Fairview's monitoring program was originally designed by the consultant team that drafted the 1993-95 permit application submittal. A discussion of the permit and SWMP development history are included in the Introduction of the City of Gresham's SWMP. A discussion of the changes to the Monitoring Plan since its original design is included here.

Permit Renewal Submittal (2000)

The monitoring program was updated for the 2000 permit renewal submittal. During the permit renewal process, third party groups expressed concern that the DEQ permit was not protective enough to ensure that creeks, streams, and rivers would eventually meet water quality standards. The permit was initially issued in 2004, but was reconsidered by DEQ as a result of a third party appeal. The permit was reissued in 2005 and required the Co-permittees to review the previously submitted Monitoring Plan to ensure that it met final permit goals and requirements, and report findings and proposed revisions in an "Interim Evaluation Report" due in 2006.

Interim Evaluation Report (2006)

Per the 2005 NPDES MS4 Permit requirement, the Co-Permittees' stormwater monitoring program was reviewed and updated with respect to the NPDES MS4 permit objectives and TMDL requirements. Most of the changes made at that time are still incorporated in the current Stormwater Monitoring Plan. The main recommendation was that resources dedicated to monitoring should continue to be limited, due to the high variability of stormwater and the need to focus resources on activities that reduce pollution.

Monitoring program changes included:

- Added two Kelley Creek monitoring sites (Johnson Creek watershed) to the list of instream sites. Gresham began monitoring these sites in fall 2006 in order to characterize the Pleasant Valley annexation area and the Kelley Creek Headwaters annexation area, which will eventually be incorporated into the City's permit boundary when urban services are provided. Future plans may also include new monitoring site(s) to characterize the Springwater annexation area prior to planned future development.
- In order to assess progress toward meeting the TMDL in Johnson Creek for legacy pesticides, DDT monitoring was added at the two instream sampling locations on Johnson Creek and periodically in stormwater.
- PAH and PCB monitoring was implemented in Johnson Creek with a caveat that monitoring would be re-evaluated after two years if sampling failed to produce values above commercially available quantitation limits.

Permit Renewal Submittal (2008)

In preparation for the 2008 NPDES MS4 permit renewal submittal, the Co-Permittees prepared water quality trend analyses, pollutant load reduction estimates (benchmarks) and pollutant load updates. Additionally, the following activities were conducted:

- Internal reviews of all BMPs
- Review of technical information from external sources and monitoring data, including a formal literature search

- Review of data collected by staff, and knowledge of program effectiveness
- Discussion with other jurisdictions concerning best practices
- Consideration of fiscal constraints
- Input from the general public
- Deliberation by Council

Based on the findings as described above, staff recommended the changes to the Monitoring Plan as follows:

- Added annual macroinvertebrate monitoring to provide measurement of biological communities within MS4 receiving waters, in addition to bacteria. Biological monitoring provides an additional means for evaluating long term trends since these benthic organisms are exposed to chemical, biological and physical conditions of the stream that are not well characterized by point-in-time water quality grab samples for bacteria.
- Removed PCBs and PAHs from list of instream and stormwater constituents monitored in Johnson Creek since all samples analyzed over two years (2006-2008) were below the detection limit (100 ng/L). The USGS data upon which the 303(d) listing is based was a 35-day collection using semi-permeable membranes, with a reported value of 52.9 ng/L. More detail on the 303(d) listing is included in the 303(d) Analysis performed for the 2008 Permit Renewal Submittal. Because the available laboratory quantitation limits are twice the level USGS found over 35 days, grab samples are expected to be below the quantitation limit. Since both constituents have also been found in streambed sediment, the Co-Permittees plan to use TSS as a surrogate measurement for these constituents, as is done in the Columbia Slough. Resources will be reallocated to other monitoring activities.
- Removed total and dissolved nickel from list of ambient and stormwater constituents since levels are always significantly lower than chronic and acute toxicity levels and nickel tracks with other heavy metals, which will serve as surrogate measurements.
- Continue and expand monitoring of the effectiveness of large scale BMP projects built over the past few years. Monitoring will continue at the Fairview Creek Water Quality Facility for at least a portion of the permit term, and additional monitoring will be planned to evaluate the performance of the new Columbia Slough Water Quality Facility.

2010 Update

Slight modifications to the Monitoring Plan were made in 2010 based on requirements in draft NPDES MS4 and WPCF permits, and Multnomah County's application to obtain its own permit and no longer be a Co-permittee. Some cooperative monitoring efforts between Multnomah County and Gresham are still planned to occur via an inter-governmental agreement. (**See Appendix J.**) Additionally, the frequency and location of stormwater sampling were modified to ensure compatibility with the anticipated WPCF permit, as described below:

- Added pesticides (2,4-D and pentachlorophenol) to water quality constituents based on findings from a local USGS study which indicated 2,4-D exceeded an aquatic-life benchmark. Gresham also has a targeted educational BMP for 2,4-D use reduction. Pentachlorophenol has exceeded drinking water standards in stormwater. These pesticides will be monitored for all wet weather stormwater monitoring.
- Reduced instream monitoring frequency from six times to four times per year to free up resources for enhanced stormwater monitoring. Three samples per year will be focused in wet season, with one sample per year being collected during low flow in conjunction with

macroinvertebrate monitoring. Analysis of existing data (described further in **Section 2.0**) indicates no significant loss in ability to recognize changes in water quality based on this modification.

- The stormwater monitoring approach will move from sampling outfalls from three large drainage areas to sampling multiple small drainages (0.5 to 5 acres) selected using a probabilistic (random and spatially-balanced over the selected area) sampling design (see Stevens and Olsen 2004). The benefit to using the probabilistic approach is that the small drainage areas will typically be composed of a single land use, versus the mixed use inherent in the past stormwater outfall monitoring approach that focused on drainage areas that were hundreds of acres in size. This will enable the permittees to better characterize the source of various pollutants.

2011 Update

The Monitoring Plan was reorganized and elements were added to more closely follow the requirements contained in the final NPDES MS4 permit issued to Gresham and Fairview on December 30, 2010. DEQ added a new requirement not included in the applicant review draft of the permit to conduct mercury monitoring as described by the DEQ “Mercury Monitoring Requirements for Willamette Basin Permittees” memo dated December 23, 2010. (See **Appendix H**). As such, the plan was amended to include a description of the effort to monitor for mercury, which includes continued monitoring for total mercury in all stormwater and surface water sampling and adding total and dissolved mercury and methyl mercury at 4 stormwater monitoring locations annually. Additionally, requirements in the draft Water Pollution Control Facility (WPCF) permit for municipal Underground Injection Control Systems (UICs) inspired stratification of the probabilistic sampling design for stormwater based on vehicle trips per day.

The Plan was released for public comment on April 11-25, 2011 and submitted to DEQ on May 1, 2011 for implementation on July 1, 2011. On June 27, 2011, the Co-Permittees received conditional approval of the Monitoring Plan, which became final approval after the co-permittee comments.

2015 Permit Renewal Submittal

The monitoring program was updated for the 2015 permit renewal submittal. Updates were implemented July 2, 2016.

The proposed changes reduced sampling in well-characterized areas to allow for increased sampling in areas that are more likely to inform stormwater design and management in the future to improve water quality. These changes were adopted on July 1, 2016 as permitted in Schedule B.2.e. of the 2010 NPDES MS4 Permit.

Low Level Mercury Monitoring. The City of Gresham conducted low-level mercury monitoring for 2 years in response to DEQ’s “Mercury Monitoring Requirements for Willamette Basin Permittees” Memo to assist with data collection for a future Mercury TMDL (Appendix H). Two years of data for dissolved mercury did not yield environmentally relevant mercury levels (I.e., above the laboratory detection limits. In 2013, the City requested to eliminate low-

level mercury monitoring from the wet weather stormwater monitoring program, which was approved by DEQ.

Wet Weather Stormwater Monitoring. Between 2009 and 2015, Gresham collected 180 stormwater samples. All sites were selected probabilistically, and included 5 static or “fixed” locations (monitored each year) and 25 rotating sites for a total of 30 underground injection control (UIC) sites monitored annually. Data analysis showed consistent patterns that generally differentiated sites on streets with >1,000 trips/day from those with <1,000 trips/day. The City decreased the number of sites sampled from 30 to 10 sites/year (5 fixed and 5 rotating sites). This reduction allowed for an increase in best management practice (BMP) monitoring.

BMP Effectiveness Monitoring. Between 2009 and 2015, staff monitored the inlet and outlet of one structural BMP during 2 storms/year. The information from BMP sampling is valuable to inform future design and management of BMPs. The City has recently constructed several BMPs with varying structural design and is interested in understanding the effectiveness of each at removing pollutants. The City proposed increasing BMP sampling to a total of 4 “facility events”/year; for example, two facilities may be sampled for each of two storms, or four facilities may be sampled during one storm each.

During BMP sampling, City staff formerly collected time- or flow-weighted 5-12 part composite samples at the inlets and outlets. Although this is an effective method for characterizing stormwater constituents in some situations, it is difficult to accurately weight the samples due to the lack of reliable storm forecasts. The City switched to collecting a minimum of 3 individual grab samples at each inlet and outlet during each storm sampling event so that averages and ranges can be examined for each pollutant.

Dry Weather Field Screening. Historically, the City of Gresham monitored the same 30 large outfalls each year for Dry Weather Field Screening. The City switched to monitoring 8 of these high-priority fixed sites/year while sampling 22 additional sites/year that will be randomly selected based on risk from drainage area and land use. This allowed staff to expand the search for illicit connections to the stormwater system.

The sections that follow incorporate the proposed changes, and comprise the commitments of the Monitoring Plan.

2019 Adaptive Management

One adaptive management change was proposed with the 2018 Annual Report. This change allows the option to shift monitoring resources from one BMP sampling event to one instream sampling event during a storm.

City staff formerly sampled four storms at BMP sites and sample long-term instream sites at four pre-determined dates each year which generally do not fall during storm events. This change allows sampling three storms at BMP sites, one storm at long-term instream sites, while continuing to sample at four pre-determined dates at long-terms sites in a given year.

The reasoning for this proposed change was to provide better information about the effect of stormwater on streams, while maintaining the total amount of time, resources, and effort allocated to the monitoring program.

Update for 2021 Permit (2022)

The NPDES permit issued by DEQ on September 15, 2021 requires submission of an updated monitoring plan. This update includes revisions to the sampling plans for Wet Weather Stormwater monitoring, Structural BMP Monitoring, and Dry Weather Screening. There are also updates to mercury monitoring frequency and procedures, pesticide monitoring, references to permit sections, and inclusion of updated information regarding the current state of knowledge and sampling sites. All revisions comply with the requirements in Schedule B of the NPDES permit and are described below.

Wet Weather Stormwater Monitoring. Sampling effort will continue to include samples from 10 locations each year: 5 fixed sites and 5 rotating sites. The updated plan has created 5 rotating panels of 5 sites each. If the permit term is extended past 5 years, the panels will be resampled, starting with panel 1 in year 6. The sites were selected from the randomized list to be representative of land use and have historically provided adequate flow and safety for sampling. Each panel includes three high-traffic sites (> 1,000 vehicle trips per day) and two low-traffic sites (< 1,000 vehicle trips per day).

Storm Sampling Effort. Storm sampling provides opportunities to learn about sources and treatment of pollutants in runoff. It represents a large effort in terms of staff time, logistics, and lab costs. Due to the limited number of storms which meet the sampling criteria and the potential opportunity to gain knowledge about emerging pollutants, this update increases flexibility in the focus of sampling during particular storms while not reducing the total number of storms sampled. This approach meets the requirements in Schedule B Table 2. Gresham staff has sampled 5 storms each season during the 2010-2021 permit term. The focus of those storms shifted in 2016 from 3 Wet Weather Stormwater and 2 Structural BMP to 1 Wet Weather Stormwater and 4 Structural BMP events. In 2019, the Monitoring Plan was updated to allow one of these BMP events to be conducted at long-term instream sites in order to capture stream conditions during a rain event. This updated plan retains 5 sampled storms with flexibility to shift effort from up to 2 BMP storms to emerging pollutants. Therefore, the 5 storms sampled each year will include 1 Wet Weather Stormwater event, a minimum of 2 Structural BMP events, and up to 2 events used to focus on particular pollutants of concern. If fewer than 2 BMP events are sampled, the remaining events will be sampled for special projects regarding particular pollutants. For example, these events may focus on better understanding emerging pollutants of concerns such as 6ppd-quinone from tires, styrene export from new cast-in-place stormwater pipe repair technologies, pesticides, or perfluoroalkyl and polyfluoroalkyl substances (PFAS).

Structural BMP Monitoring. In addition to the shift in storm events described in the previous paragraph, Structural BMP Monitoring has been updated to include additional sites such as newly constructed facilities, pervious pavement, and stormwater planters with various media types.

Mercury Sampling. Total mercury sampling is now incorporated into several aspects of the Monitoring Plan to comply with Schedule B Table 2. Total mercury will be collected in conjunction with Total Suspended Solid samples during all Instream, Wet Weather Stormwater, and Structural BMP sampling events. Collection and analysis methods were updated to meet the requirements of Schedule B Table 2 Special Condition 11).

Pesticides. The plan has been updated to include pesticides to be assessed during Wet Weather Stormwater sampling. Each of the following 15 pesticides will be monitored at a minimum of 10 sites during the permit term: bifenthrin, chlorpyrifos, imidacloprid, fipronil, atrazine, simazine, sulfometuron methyl, diuron, 2,4-D, glyphosate and degradate (AMPA), 2,6-dichlorobenzamide, triclopyr, trifluralin, and pentachlorophenol.

Dry Weather Screening. Sampling locations for Dry Weather Screening continue to include eight fixed sites and 22 rotating sites per year. The current Plan organizes the rotating sites into five panels, which when monitored over the course of the permit term will result in all outfalls in Gresham >12” in diameter being sampled once every five years.

1.3 Permit Requirements and Goals of the Monitoring Program

As listed in Schedule B.1.a., the monitoring program must incorporate the following six objectives:

- i. *Evaluate the source(s) of and means for reducing the pollutants of concern applicable to the co-permittees' permit area, including 2018/2020 303(d) listed pollutants, as applicable;*
- ii. *Evaluate the effectiveness of Best Management Practices (BMPs) in order to help determine BMP implementation priorities;*
- iii. *Characterize stormwater based on land use type, seasonality, geography or other catchment priorities;*
- iv. *Evaluate status and long-term trends in receiving waters associated with MS4 stormwater discharges;*
- v. *Assess the chemical, biological and physical effects of MS4 stormwater discharges on receiving waters; and,*
- vi. *Assess progress towards reducing TMDL pollutant loads.*

The permit also states that:

The co-permittees may use Stormwater Management Plan measurable goals, environmental monitoring activities, historical monitoring data, stormwater modeling, national stormwater monitoring data, stormwater research or other applicable information to address the monitoring objectives.

With the exception of the SWMP and measurable goals, the Co-permittees approach for the monitoring program utilizing the tools and data as listed above are contained within this document.

The plan is required to include the following information for each monitoring project/task:

- i. Project task/organization;
- ii. Monitoring objectives, including monitoring questions and background, data analysis methodology and quality criteria, and assumptions and rationale;
- iii. Documentation and record-keeping procedures;
- iv. Monitoring process/study design, including monitoring location, monitoring frequency and duration, and responsible sampling coordinator;
- v. Sample collection methods and handling/custody procedures;
- vi. Analytical methods for each water quality parameter to be analyzed;
- vii. Quality control procedures, including quality assurance, the testing, inspection, maintenance, calibration of instrumentation and equipment; and
- viii. Data management, review, validation and verification.

The Co-permittees have used this as an outline for the structure of the information included for each activity/task described within this document.

1.4 Adaptive Management

As required in the NPDES MS4 permit, Schedule B 1.c.ii and Schedule D 4.a Adaptive Management, the City follows an annual adaptive management process to assess and modify, as necessary, program elements to achieve reductions in stormwater pollutants to the maximum extent practicable. This includes consideration of available technologies and practices; review of monitoring data generated by the implementation of this Plan and corresponding analysis of the data; review of SWMP measurable goals and tracking measures; and evaluation of Co-permittee resources available to implement the technologies and practices. The Adaptive Management Process for annual review and the Permit Renewal Submittal are further described in Section 5.2 of the City of Gresham and Fairview's NPDES MS4 Annual Report. The history and process of the stormwater program adaptive management, maximum extent practicable determination and update process for the permit renewal submittals may be found in Gresham and Fairview's respective SWMPs.

The role of the monitoring program is to provide a scientifically based feedback loop to the Co-permittees that enables them to develop and implement programs to address pollutants that are identified as a result of environmental monitoring. Additionally, the Co-permittees utilize the monitoring program, as applicable and as resources allow to assist with BMP evaluation related to performance and effectiveness estimates.

Annual implementation of the monitoring program elements as described within this Monitoring Plan, include but are not limited to: instream monitoring, macroinvertebrate monitoring, wet weather stormwater monitoring, BMP effectiveness monitoring, and dry weather screening. These elements also provide a variety of opportunities to act as an adaptive management tool for the stormwater program. Opportunities are not limited to the evaluation of the data itself, but also include the visual observation of winter weather stormwater system function, dry and wet weather stream conditions, and land use conditions such as development activities, new business openings,

etc. Examples of how monitoring data will be used to adaptively manage the stormwater program include:

- Macroinvertebrate monitoring can indicate areas of the City that might be given special protection; for example recent macroinvertebrate study results indicate that the Kelley Creek subbasin of Johnson Creek could potentially serve as a relatively-undisturbed reference site. Several years of study have supported this finding, and City staff have provided this information to planners to try to protect the subbasin from avoidable human impacts.
- Sampling of the Fairview Creek Water Quality Facility has shown that the facility causes a significant decrease in *E. coli* between influent and effluent. Further study has shown that the detention pond is the portion of the treatment train that is most effective, followed by the wetland. This information will influence the design and retrofit of future regional facilities.
- Long-term instream water quality data obtained at sites located at approximately the upstream and downstream boundaries of the City allow for trend analysis to validate (or invalidate) the benchmarks and load calculations submitted with each permit renewal application.
- Analysis of existing, statewide stormwater data has revealed that vehicle trips per day are highly correlated with pollutant concentrations. This suggests that retrofitting streets with stormwater treatment (especially through surface infiltration or evapotranspiration facilities) is the most effective way to meet benchmarks, and eventually, water quality standards. For this reason, future retrofits are likely to emphasize streets.

As described in Schedule B 1.c.v the Monitoring Plan may be modified without prior Department approval if either of the following conditions are met:

- A. The modification does not reduce the minimum number of data points, which is a product of the number of monitoring locations, frequency, duration, and pollutant parameters identified in Table 2; or,*
- B. The modification is the result of including elements of another permit, such as a WPCF UIC permit.*

For conditions not listed above, the co-permittees must submit the proposed modification of the monitoring plan to DEQ and receive written approval prior to implementation of the proposed modification.

1.5 Annual Reporting

No later than November 1 of each year, the co-permittees will submit an annual report to DEQ that includes monitoring data. The reporting period is from July 1 of the previous year through June 30 of the current year. As stated in Schedule B.3 of the NPDES MS4 Permit, the annual report will contain the following elements related to the implementation of this Monitoring Plan:

- h. A summary of monitoring program results, including monitoring data that are accumulated throughout the reporting year submitted in the approved DEQ-provided Data Submission Template, and any assessments or evaluations of that data completed by the co-permittees or an authorized third party.*

- i. Any proposed modifications to the monitoring plan that are necessary to ensure that adequate data and information are collected to conduct stormwater program assessments.

As described in 1.4 Adaptive Management above, certain modifications may be made without prior DEQ approval. When such changes to the Monitoring Plan are made, Schedule B.1.c.vi. requires the annual report to contain:

- vi. Modifications to the monitoring plan in accordance with Schedule B.1.c.v. must be documented in the subsequent annual report by describing the rationale for the modification, and how the modification will allow the monitoring program to remain compliant with the permit conditions.

1.6 Monitoring Program Objectives Summary

The permit objectives are designed to elicit answers to questions that stormwater system managers must answer in order to optimally allocate resources to efficiently and effectively protect beneficial uses and water quality. **Table 1** is a summary of management questions posed by permittees, together with the elements of the Monitoring Plan relate to these objectives. **Appendix A** provides more detail on how the elements address the permit objectives, and describes the source of information to be used to meet each of the objectives.

Table 1: Summary of Monitoring Plan Elements

Stormwater Management-related question	Monitoring activities proposed to answer this question*	Objectives addressed by monitoring activities**					
		1	2	3	4	5	6
What is the impact that Gresham and Fairview’s stormwater discharges are having on exceedances of instream water quality standards?	Sort and analyze existing instream water quality data by wet/dry weather periods and examine trends in water quality as water enters and exits the permit area (Section 2.0). Continue instream sampling in each of the major creeks to examine water quality trends over time, as described in Sections 3.0 and 4.0	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
To what degree and where are stormwater flows affecting water quality and/or aquatic life?	The City of Gresham has a cost-share agreement with the USGS to collect continuous flow and temperature data at a couple fixed locations, as described in Section 4.0 .	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Is stormwater affecting the biological community of the receiving waters?	Macroinvertebrates will be monitored at instream monitoring locations as described in Section 5.0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

Stormwater Management-related question	Monitoring activities proposed to answer this question*	Objectives addressed by monitoring activities**					
		1	2	3	4	5	6
What are typical/average concentrations of pollutants in stormwater runoff?	Evaluate data already collected (ACWA 1997 and ACWA 2009) and augment with additional monitoring where data are lacking (specifically for mercury and toxics--including pesticides). Stormwater monitoring will be conducted as described in Section 6.0	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
What is the significance of illicit discharges in the permit area? Have illicit discharge elimination programs been successful in reducing problems?	The Gresham's historic approach included dry weather screening plus CCTVing of high priority pipes; neither approach revealed significant illicit connections; therefore, future resources will emphasize source control programs (e.g. EPSC and business inspections). Illicit discharge monitoring will occur as described in Section 7.0 to meet state & federal requirements.	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
How effective are the various structural BMPs that are being implemented throughout the permit area at reducing pollutants?	Current national and regional literature related to BMP performance will be reviewed. Gresham will conduct structural BMP performance studies as described in Section 8.0 and the collective effect of structural controls and selected nonstructural controls within the permit area will be modeled.	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
How effective are the nonstructural/source control BMPs at reducing pollutants?	The list of nonstructural/source controls currently employed will be reviewed and current and on-going research on the effectiveness of source control BMPs will be tracked. An attempt to characterize pollutants associated with the sediment and debris removed through source controls will be conducted as described in Section 9.0	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Have all pollutants of potential concern been evaluated?	Conduct ongoing literature review of pollutants of concern and effectiveness of BMPs at their removal (described in Section 9.0) and conduct a pesticide assessment to determine if additional pollutants should be considered with Wet Weather Stormwater Monitoring (Section 6.0)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Stormwater Management-related question	Monitoring activities proposed to answer this question*	Objectives addressed by monitoring activities**					
		1	2	3	4	5	6
How are the answers to the above questions changing over time?	At the end of each year a simple, visual review of data collected in the past year will be conducted. At the end of year 4 for each permit, trends will be evaluated for instream quality, stormwater pollutants, and macroinvertebrates.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

* Monitoring data is most useful when evaluated using statistical tools. The study design and anticipated statistical operation planned for use in evaluating the data are discussed in each of **Sections 3** through **8** of this plan, as well as in **Appendix A**.

** Numbers 1-6 correspond with the NPDES MS4 Permit monitoring objectives listed in **Section 1.3** above and Schedule B.1.a.(i-vi) in the 2010 NPDES MS4 permit:

This Monitoring Plan describes eleven different monitoring elements that Gresham and Fairview will utilize to meet these objectives. All eleven are described in **Appendix A-1**, and seven of them are detailed in individual sections of the Monitoring Plan:

- Section 3.0 Instream Monitoring,
- Section 4.0 Continuous Instream Flow and Temperature Monitoring,
- Section 5.0 Macroinvertebrate Monitoring,
- Section 6.0 Wet Weather Stormwater Monitoring,
- Section 7.0 Dry Weather Field Screening,
- Section 8.0 Structural Best Management Practices Monitoring, and
- Section 9.0 Source Control Assessment and Solids Tracking

Appendix A-2 is a summary of the Gresham environmental monitoring program which provides a concise overview of the location, frequency, type of sample, pollutants analyzed, and potential changes planned for these seven elements.

1.7 The Relationship between Environmental Monitoring and a Long-term Monitoring Program Strategy

The goals for the monitoring program are the objectives listed in the permit (Schedule B.1.a) and in **Section 1.3** above, which relate to the management questions shown in **Section 1.6: Table 1**. The permittees use national, state and local monitoring data and values from scientific studies obtained from literature reviews, together with models and regulatory approaches such as water quality standards, the 303(d) list, and TMDLs to determine which pollutants or channel forming factors are of concern at a given point in time, and how the effects of these things change over time, both in response to Co-permittee actions (e.g. BMPs and regulations), and to outside influences. Based on such findings, Co-permittees are able to adaptively manage best management practices to achieve performance and cost effectiveness to the maximum extent practicable, and regulate/encourage specific actions by the private sector.

Historical monitoring data have answered some management questions—especially with respect to certain pollutants or BMPs, but environmental monitoring will be needed for the foreseeable future, both to allow for more findings of statistical significance, and to address new questions.

For each element discussed below, additional detail is provided regarding the relationship between the current approach and long-term goals or strategies.

2.0 DATA GATHERING STRATEGIES

There are three primary strategies that the Co-Permittees will employ to obtain data and information to meet the six monitoring objectives listed in the NPDES MS4 permit:

1. Examine and evaluate historic water quality data and other information collected as part of previous monitoring efforts specifically for meeting monitoring objectives;
2. Collect new water quality data to complement the existing data and address specific objectives that have not been previously examined; and
3. Review data and technical information related to stormwater quality collected by others and track national trends in stormwater water quality assessment and best management practice (BMP) application and performance.

An important aspect of any research is the assurance that the samples collected represent the conditions desired to be tested and that the number of samples to be collected is sufficient to provide statistically relevant conclusions. An experimental design process can be used to estimate the number of samples needed based on the allowable error, the variance of the observations, and the degree of confidence and power needed for each constituent. The number of samples needed is therefore dependent on the objectives of the data (characterization, comparison, trends, etc.), the variation of the concentrations in the category being investigated (the ratio of the mean to the standard deviation or Coefficient of Variation (COV)), and the allowable errors (Burton and Pitt 2001). Due to the variability in stormwater data (COVs greater than 1), it can be difficult to identify trends in water quality, and large sample sizes are often needed to report statistically significant findings.

The Co-Permittees will continue to focus their water quality monitoring efforts related to instream samples on developing more robust information for existing monitoring sites. Trend analysis conducted for the 2010 renewal submittal and the 2014 Pollutant Load Reduction Evaluation identified some significant trends. Based on fourteen years of data, positive trends reinforce the conclusion that the stormwater management program is yielding positive water quality effects and that the monitoring program is resulting in adequate data to help evaluate the program. New monitoring sites may be added in the future to help evaluate the effects of future development in the Springwater annexation area.

Wet Weather Sampling has occurred at 220 UIC sites over the past 13 years. From these data some clear trends have been found. The most apparent trend is that roads with >1000 trips per day have higher levels of most measured pollutants than those with <1000 trips per day. Additionally, sites draining industrial land use had higher levels of total suspended solids and several metals than other land uses, and residential streets had higher levels for some pesticides than other street types.

The City plans to prioritize reduction of pollutants from high-traffic streets by targeting these streets for retrofits, as budget and other opportunities such as other City road projects allow during this permit cycle. Further understanding of pollutant reduction strategies would greatly benefit from more information on the functioning of the City's BMPs. As such, continuing to gather data via the Monitoring Plan is paramount to informing future facility design. The City of Gresham has constructed several regional facilities with different designs, and several more are planned in the future. Understanding the effectiveness of each of these facilities helps inform

design features for reducing stormwater pollutants. Staff monitored storm events at eight facilities from 2007-2021 which has provided useful information on which features are effective for various pollutant removal purposes.

From 2009-2015 staff collected water quality samples during 5 storm events per year. Two of five events assessed stormwater BMPs and three of the five events were Wet Weather Stormwater sampling.

From 2015-2021 staff monitored 5 storm events/year and shifted effort from three events to one for Wet Weather Stormwater, and shifted from two to four events for assessing stormwater BMPs. . The Monitoring Plan also decreased the Wet Weather Stormwater monitoring from 30 sites/year to 10 sites per year and increased stormwater BMP sampling from 2 events/year at 1 facility to 4 “facility events”/year (e.g. 2 facilities may be sampled for each of 2 storms, or 4 facilities may be sampled during 1 storm each). The distribution of BMP storm monitoring may change from year to year as questions about certain facilities are addressed. During the current permit term, a minimum of 5 storm events per year are proposed: 1 for Wet Weather Stormwater, 2-4 for BMPs, 0-2 for special projects on emerging pollutants. This proposal meets the requirements of storm monitoring set forth in Schedule B Table 2 and will allow flexibility to devote storm sampling resources to better understanding emerging pollutants.

Due to the difficulty in accurately predicting the size and duration of storms, staff collect a minimum of 3 grab samples/BMP location/storm instead of collecting 5 to 12-part composite samples/BMP location/storm. Although composite sampling has been shown to be an effective method for collecting representative water samples during the duration of a storm, in practice the samples are often not taken at the ideal points during the storm due to difficulty in prediction storm patterns. This can lead to mischaracterization of pollutant loads during storms. To account for this, staff collect a minimum of 3 individual grab samples throughout each sampled storm and look at the average and peak levels for each pollutant. This change has been approved by DEQ.

The City's dry weather screening monitoring currently occurs 8 high-priority outfalls and a panel of 22 rotating outfalls every year. This approach increases the probability of detecting illicit connections and discovering illicit discharges in areas previously not frequently monitored. The 8 fixed outfalls are prioritized by drainage from high-risk properties and data of past illicit discharges. The rotating 22 new outfalls are selected by outfall size, which generally corresponds to drainage area. The rotating panels are made up of all outfalls >12” in diameter. There are five panels, so each outfall >12” will be sampled once every five years. This approach is supported by a report by the Urban Water Resources Research Council as one of the best methods for addressing the bacteria TMDL in urban areas because it is an easy way to detect illicit connections between the stormwater and sanitary sewer systems (Urban Water Resources Research Council, 2014, Pathogens in Urban Stormwater Systems Technical Report, Eds: Clary, Pitt, Steets).

NPDES MS4 permitting and other programs with surface water monitoring components have helped to identify water quality problems associated with stormwater runoff. In response to these problems, the scientific community, public agencies, and private organizations interested in stormwater management continue to conduct research related to stormwater characterization and treatment. This research is costly and it is often beyond the means of any one permittee to conduct a significant study. Organizations such as the Oregon Association of Clean Water Agencies (ACWA), the Bay Area Stormwater Management Association (BASMA), the Center for Watershed Protection, and others assist public agencies with collaborative projects to examine complex issues that individual permittees could not likely accomplish on their own.

Historically, public departments of transportation (e.g., ODOT and Caltrans) have also performed large scale studies on stormwater pollution distribution, transport, and treatment. Additionally, vendors of proprietary stormwater treatment systems often participate in evaluation studies that follow strict protocols to have their devices approved by local agencies. By participating in these groups and following current research, the Co-Permittees can realize greater benefits from labor and capital investment than if they were to attempt such studies on their own. As such, the Co-Permittees will take advantage of information garnered by these groups to meet some of the more complex and costly objectives of the permit.

The Co-Permittees believe this Monitoring Plan represents the best possible allocation of limited resources, considering that water quality sampling requires significant staff time and funds, yet the activity itself does not result in direct water quality improvements. By continuing to collect data at existing instream sampling locations, and collaborating with other jurisdictions on larger studies and literature reviews, information will be gathered over time that will be useful to make informed adaptive management decisions.

The most resource-intensive element of water quality monitoring is sampling of storms. Because of the difficulty obtaining accurate weather forecasts of suitable storms that meet size and duration requirements, combined with the labor intensive efforts necessary to mobilize staff and equipment during a 24-hr timeframe, each storm may represent one or more failed attempts to sample. Therefore, to achieve the minimum storm sampling commitment represents a significant program administration costs. To this end, staff are assigned other responsibilities in addition to monitoring, such as erosion control inspections, water quality facility inspections, business inspections, spill response, citizen complaint response, and research and program evaluation.

- Thus, to ensure that monitoring does not consume inordinate resources at the expense of activities that prevent or reduce pollution, while still meeting NPDES MS4 and WPCF permit objectives, the following storm sampling limitations apply: In a given year, staff will endeavor to obtain samples from two to four storms at Gresham's structural BMPs, and from 10 stormwater monitoring sites by tracking daily weather patterns. Staff will clear work and/or personal schedules up to fifteen times to allow for mobilization and mobilize up to eight times. Once this level of effort has been made, the Co-Permittees will consider the storm monitoring commitment for the year to have been met.
- Storms will not be sampled on federal holidays such as: Thanksgiving, Christmas, and New Year's Eve.

- The criteria for determining whether a storm is appropriate for sampling will be based on the climate of the Pacific Northwest and the specific weather patterns of a given year. For example, in a dry year, the size of an acceptable storm may be smaller than in a wet year. In a wet year the dry period preceding a storm may be shorter than average.
- The criteria for determining whether a storm is appropriate for sampling will also depend on the size of the drainage area for the stormwater being sampled, and the amount of base flow, if any, that normally exists within the catchment.
- The duration of time between samples taken as part of a composite sample, or as part of a time series will be varied as necessary to meet the goal of obtaining at least three samples per storm. Samples will not be taken more frequently than once each half hour, and a good-faith attempt will be made to characterize the duration of each storm.
- Stormwater sampling will target daylight hours to enhance the safety of sampling staff. A portion of the area to be sampled lies within an area of Gresham that has documented gang activity and experiences higher crime rates than other areas. If daylight hours prove too limiting to collect the required data, the monitoring locations may be adjusted away from some wet weather stormwater sampling sites selected through the GRTS protocol addressed in **Section 6.0** of this plan.

3.0 INSTREAM MONITORING

3.1 Project/Task Organization

As required by the NPDES MS4 permit, Schedule B, Table 2, Instream monitoring refers to the monitoring of major streams and Fairview Lake within the permit area. Routine monitoring began at most instream sites in 2000; continued monitoring seeks to determine whether trends are showing improvements in water quality.

3.2 Monitoring Objectives

3.2.1 Monitoring Question and Background

Instream monitoring is intended to track the status and trends of water quality in water bodies receiving MS4 discharges to address the question “What is the impact that Gresham and Fairview’s stormwater discharges are having on the exceedances of instream water quality standards?” It is assumed that by comparing water quality as each stream enters and exits the permit area, the effect on water quality of actions under the Co-permittees’ jurisdiction may be discerned. It is further assumed that sampling during both wet and dry periods will allow the Co-permittees to distinguish between the effects of runoff, versus other effects, on streams.

As shown in **Appendix A**, instream monitoring contributes to meeting NPDES MS4 monitoring objectives 1, 2, 3, 4, 5 and 6.

- Objective 1. Evaluate the source(s) of and means for reducing the pollutants of concern applicable to the co-permittees' permit area, including 2018/2020 303(d) listed pollutants, as applicable*
- Objective 2. Evaluate the effectiveness of Best Management Practices (BMPs) to assist in identifying BMP priorities;*
- Objective 3. Characterize stormwater runoff discharges based on land use, seasonality, geography or other catchment characteristics;*
- Objective 4. Evaluate status and long-term trends in receiving waters associated with MS4 stormwater discharges;*
- Objective 5. Assess the chemical, biological and physical effects of MS4 stormwater discharges on receiving waters;*
- Objective 6. Assess progress towards reducing TMDL pollutant loads.*

3.2.2 Data Analysis Methodology and Quality Criteria

Instream water quality data will be assessed using a trend analysis, conducted at least once for the NPDES MS4 permit cycle. Since environmental data typically does not follow a normal distribution, a nonparametric equivalent to ordinary least squares regression will be used – the Seasonal Kendall, and the associated statistic, Kendall’s tau. Because instream data has been and will be collected during the wet and dry season, trends will be assessed by those two periods. Data may also be evaluated by flow or rainfall data, since data collected in the wet season may not always be associated with higher flows or MS4 discharges. An assessment of trends based on potential for MS4 contribution might focus on instream monitoring events collected after 0.1” or more rain occurred within the preceding 24 hours. The significance of any trend would be

evaluated against an alpha (α) value of at least 0.1, with a goal to demonstrate significance at $\alpha=0.05$.

3.2.3 Assumptions and Rationale

The instream monitoring program described in this section was originally designed to determine whether water quality changes could be measured over time at sites selected to represent the upper and lower bounds of the permit area. Continued monitoring at the same locations will allow for assessing trends over time based on both wet and dry weather conditions. With more than 15 years of monitoring data already collected at most instream monitoring sites, continued monitoring will allow for assessment of long-term water quality trends.

3.2.4 Relationship to Long-term Monitoring Program Strategy

Instream monitoring provides a direct measure of the chemical, physical, and biological condition of waters of the state which receive MS4 stormwater discharges. The periodic water quality measurements described in this section are augmented by 1) correlating this data with continuous monitoring data described in **Section 4.0**, 2) collecting instream macroinvertebrate data as described in **Section 5.0** to assess biological condition, 3) comparing instream data to the Wet Weather Stormwater Monitoring data described in **Section 6.0**, to determine if changes in stormwater quality are related to changes in instream monitoring data, and 4) determining whether pollutant reduction estimates measured through the Structural BMP Monitoring described in **Section 8.0** are validated by trends detected instream. Continuing to conduct instream monitoring using an approach consistent with past instream monitoring efforts should enable the Co-Permittees to determine if short or long-term water quality trends are evident based on MS4 management decisions associated with implementation of their SWMPs.

3.3 Documentation and Record-keeping Procedures

Consistent with permit requirements specified in NPDES MS4 permit Schedule F.C.8, the Co-Permittees will retain records of all monitoring information, including: all calibration, major maintenance records, all original lab and field data (see **Appendix C** for example of field data sheet), copies of all reports required by the NPDES MS4 permit, and records of data used to complete the application for the NPDES MS4 permit for a period of at least 5 years from the date of the sample, measurement, report, or application.

Records will contain:

1. The date, exact place, time, and methods of sampling or measurements;
2. The individual(s) who performed the sampling or measurements;
3. The date(s) analyses were performed;
4. The individual(s) who performed the analyses;
5. The analytical techniques or methods used; and
6. The results of such analyses.

3.4 Monitoring Process/Study Design

3.4.1 Study Design

Instream Monitoring is conducted to help characterize or estimate the potential impacts of MS4 stormwater runoff on streams, as well as the potential benefits of the best management practices

being applied by the Co-Permittees as described within their SWMPs. The study design is a paired test, where samples have historically been taken at even intervals throughout the year from where a stream enters and exits the permit boundary. Sites are always sampled in the same order at approximately the same time of day in order to facilitate long term trending of data collected at the same location over time. The timing interval between the paired upstream/downstream locations is always less than 2 hours, with the target being to collect samples on the same stream within an hour of each other.

The current study design has enabled the Co-permittees to conduct a Seasonal Kendall test and to check for trends over time. To date, stream quality has been well characterized, and some differences between upstream and downstream have been identified with statistical significance at the 95% confidence ($\alpha=0.05$) level. When possible, a relationship will be made between BMP implementation and improving water quality trends, particularly for events collected during rain events or during the wet weather season. Continued monitoring will allow the Co-permittees to look for additional findings of significance.

The City will continue to monitor the fixed instream sampling locations in the following ways: water quality 4 times/year, macroinvertebrates 1 time/year, and continuous summer temperatures.

3.4.2 Monitoring Locations

Instream monitoring stations are located in major creeks as close to the upstream and downstream intersections with Gresham and Fairview City boundaries as feasible. There are three major receiving waters for the Co-Permittees' surface water runoff. These include:

1. The Columbia Slough
2. Kelly/Burlingame/Beaver Creek system (Sandy River watershed)
3. Johnson Creek

Samples are also collected at sites in the following water bodies:

1. Fairview Creek (drains to Fairview Lake, and then to Columbia Slough)
2. Fairview Lake (drains to the Columbia Slough)
3. Kelley Creek (tributary to Johnson Creek)

Columbia Slough

The Columbia Slough flows east to west from the north end of the City of Gresham and Fairview toward Portland. The Slough proper begins at the outlet from Fairview Lake, so most of this narrow and shallow channel flows within the City of Portland. Instream Columbia Slough monitoring is being conducted through an inter-governmental agreement (IGA) with the City of Portland Bureau of Environmental Services (BES) **See Appendix F**. In 2010, Portland altered their historic fixed station monitoring and began sampling using a probabilistic spatially-balanced and random approach (description of Oregon master sample in Larsen et al. 2008). Portland's monitoring includes the segment of the Slough within Gresham, but the specific locations to be monitored on their 4-year rotation and are not reflected in **Table 2** or on **Figure 1**. For more detail, please see City of Portland Environmental Monitoring Plan. The monitoring complies with the sampling requirements of the 1998 Columbia Slough TMDL. The sites within Fairview Creek and

Fairview Lake will be used to meet the required number of monitoring sites in the NPDES MS4 permit Schedule B Table 2.

Fairview Creek and Fairview Lake

The headwaters of Fairview Creek are within the City of Gresham's boundary. The creek flows through Gresham and Fairview and discharges to Fairview Lake. Fairview Lake discharges to the Columbia Slough. Gresham will conduct instream monitoring at two locations on Fairview Creek and one in Fairview Lake. Currently, the instream locations include one site just north of Stark Street, upstream of the Gresham-Fairview boundary and the other site is located within the City of Fairview just upstream of the discharge to Fairview Lake (see Stations 1, 2, and 3 on **Figure 1**). Monitoring activities at the two stream and one lake locations will be conducted by City of Gresham staff based on an inter-governmental agreement between Gresham and Fairview.

Beaver Creek

Beaver Creek flows from south to north mostly outside the eastern edge of Gresham. Kelly Creek is a major tributary. Two instream monitoring locations are established on this creek, one upstream of urban influences near the city boundary, and a second in the Beaver Creek Canyon in Troutdale (see stations 4 and 5 on **Figure 1**). These sites are monitored on behalf of Multnomah County through an IGA to meet their NPDES permit. Monitoring on Beaver Creek will be conducted by City of Gresham staff.

Kelly Creek (Beaver Creek tributary)

Kelly Creek enters and exits the City of Gresham on its eastern boundary. Two instream monitoring locations are located on this creek, one on the upstream section of the creek at the Gresham boundary and the other on the downstream section of the creek near Mount Hood Community College (MHCC) (see Stations 6 and 7 on **Figure 1**). Monitoring on Kelly Creek will be conducted by City of Gresham staff.

Johnson Creek

Johnson Creek flows from east to west across the southern part of the City of Gresham. Two instream monitoring locations are established on this creek, one on the upstream section of the creek near the City's eastern boundary, and a second on the downstream section near the City's boundary with Portland (see Stations 8 and 9, on **Figure 1**). Monitoring on Johnson Creek will be conducted by City of Gresham staff. The City of Gresham evaluated resources available to support the addition of one or two additional sampling locations in the Johnson Creek basin in order to characterize the Springwater annexation area prior to future development. At this time, it was determined that additional sites were not feasible.

Kelley Creek (Johnson Creek tributary)

Kelley Creek flows from east to west across the southwestern part of Gresham, starting in the Kelley Creek Headwaters area and flowing through the Pleasant Valley area as shown on **Figure 1**. Two instream monitoring locations are established on this creek, one on the upstream section of the creek outside the Gresham's current boundary, and a second on the downstream section near the Gresham's boundary with Portland (see Stations 10 and 11 on **Figure 1**). Monitoring on Kelley Creek will be conducted by City of Gresham staff.

Table 2 summarizes the instream monitoring locations.

Table 2: Instream Monitoring Locations

Station Number*	Site Code	Stream	Location
Columbia Slough Basin			
1	FVL1	Fairview Lake	Lakeshore Park in City of Fairview
2	FCI0	Fairview Creek	Mobile estates upstream of Fairview Lake in City of Fairview
3	FCI1	Fairview Creek	Conifer Park (205 th and Stark) in City of Gresham
Sandy River Basin			
4	BCI1	Beaver Creek	At the footbridge below Weedin Park in Troutdale
5	BCI2	Beaver Creek	At the intersection of SE Division St. and SE Troutdale Rd.
6	KCI1	Kelly Creek	Downstream of Mount Hood Community College pond
7	KCI4	Kelly Creek	Upstream from Kelly Creek Detention Pond
Johnson Creek Subbasin			
8	JCI1	Johnson Creek	Near Jenne Rd Bridge
9	JCI2	Johnson Creek	Near Palmblad Bridge upstream of Gresham
10	KI1	Kelley Creek	Pleasant Valley Grange
11	KI2	Kelley Creek	Rodlun Rd near Alder Ridge

* Station numbers relate to Figure 1.



Figure 1. Instream Monitoring Locations

3.4.3 Sampling Event Criteria

The NPDES MS4 permit (Schedule B.1.d.i. requires that a minimum of 50% of instream monitoring be conducted during the wet season (September 1 to April 30) and that each sample event be a minimum of 72 hours apart. Reasonable attempts will be made to conduct sampling during storm events, since rainfall is related to stormwater runoff. A 2022 analysis of bi-monthly or quarterly monitoring over a 22year period (1255 samples) indicated that 46% of monitoring events had measurable precipitation (0.01” min, 0.88” max) in the preceding 24 hours; 31% had 0.10” or more in the preceding 24 hours. This suggests that the current approach of sampling at a fixed date is an effective strategy for gathering wet weather data.

3.4.4 Frequency and Duration

Instream water quality samples will be collected during the dry season and wet season. At a minimum, grab samples will be collected four times per year at the instream sampling locations listed in **Table 2**.

3.4.5 Responsible Sampling Coordinator

This monitoring task is coordinated by the City of Gresham’s Water Resources Division on behalf of Gresham and Fairview, who target events, calibrate equipment, perform in-situ field measurements, collect samples for lab analysis, and coordinate delivery to the lab. Laboratory analysis for instream samples is conducted by Portland’s Water Pollution Control Laboratory under an IGA with the City of Gresham for laboratory services, included as **Appendix F**.

3.5 Sample Collection and Handling

3.5.1 Sample Collection Method

The sample collection method varies by constituent. **Table 3** shows the collection method for each constituent, the instream monitoring locations, and periods when each constituent is monitored.

Table 3: Sample Collection Methods for Instream Monitoring

Constituents	Collection Method	Stations	Period
Field			
Temperature, DO, Conductivity, pH	In-situ	1-11	Quarterly
Turbidity	Grab	1-11	Quarterly
Conventional			
Biochemical Oxygen Demand (BOD ₅), Total Suspended Solids, Hardness, <i>E. coli</i> , Total Alkalinity, Dissolved Organic Carbon (DOC)	Grab	1-11	Quarterly
Chlorophyll- <i>a</i>	Grab	1-11	Summer*
Total Recoverable Metals			
Copper, Lead, Mercury, Zinc	Grab	1-11	Quarterly
Dissolved Metals			
Copper, Lead, Zinc	Grab	1-11	Quarterly
Nutrients			

Nitrate + Nitrite Nitrogen, Total Kjeldahl Nitrogen (TKN)**, Ammonia Nitrogen, Total Phosphorus, Ortho-phosphorus	Grab	1-11	Quarterly
Pesticides***			
DDT, Dieldrin	Grab	8, 9	Quarterly
Bifenthrin, Chlorpyrifos, Imidacloprid, Fipronil, Atrazine, Simazine, Sulfometuron methyl, Diuron, 2,4-D, Glyphosate and degradate (AMPA), 2,6-dichlorobenzamide, Triclopyr, Trifluralin, and Pentachlorophenol	Grab	4, 5	At least once during permit term

* Chlorophyll-*a* is monitored May through October only.

** TKN is not required in Table 2 of the NPDES MS4 permit, so is subject to the Adaptive Management process described in **Section 1.4**.

*** Legacy pesticide monitoring (DDT, Dieldrin) must be conducted for streams where an established TMDL requires it. Other pesticides listed will be monitored in the two Beaver Creek sites at least once during the permit term to comply with Multnomah County's NPDES permit pesticide monitoring requirement.

3.5.2 Handling and Custody Procedures

Field measurements are collected by placing the multi-meter probe directly into the thalweg of the stream, and waiting for readings to stabilize. For grab samples, samples are collected directly into the appropriate containers directly from the thalweg, when possible. One bottle is field-filtered for ortho-phosphorus analysis. If needed, samples will be collected using a clean stainless steel bailer attached to an extension rod. The stainless steel bailer is cleaned prior to each site using laboratory-grade soap and distilled water or rinsed 3 times with the water to be sampled at each site prior to sampling.

Two-person clean sample collection techniques are followed to minimize the potential for contamination of samples: one person acts as “dirty hands” to move equipment, document field measurements, grab samples using the bailer and remove manhole lids; and one person acts as “clean hands” to fill sample bottles. The “clean hands” person wears powder-free nitrile gloves to avoid contamination of the sample and protect staff from possible health risks. If field blanks are shown to demonstrate any contamination, then field protocols will be amended to reduce contamination.

All samples collected for laboratory analysis are immediately placed into a cooler containing ice and transported to the lab immediately following sample collection. **Table 4** lists the volume of sample collected, the container used and maximum holding time. Once samples are delivered to Portland's Water Pollution Control Laboratory, they are responsible for following their own Quality Assurance Project Plan (QAPP) to ensure that samples are analyzed within the proper holding time (see **Appendix G**).

For total Hg sampling, a version of field method 1669 is used (EPA 1996). This method is performance-based and allows for modification if contamination does not occur. Grab samples are collected as described below and will include field blanks. If field blanks are shown to demonstrate any contamination, then field protocols will be amended to reduce contamination. Samples are collected directly into the container when possible. If needed, samples will be collected using a clean stainless steel bailer attached to an extension rod. The stainless steel bailer is cleaned prior

to each site using laboratory-grade soap and distilled water or rinsed 3 times with the water to be sampled at each site prior to sampling. Two-person clean sample collection techniques are followed to minimize the potential for contamination of samples: one person acts as “dirty hands” to move equipment, document field measurements, grab samples using the bailer and remove manhole lids; and one person acts as “clean hands” to fill sample bottles. The “clean hands” person wears powder-free nitrile gloves to avoid contamination of the sample and protect staff from possible health risks.

Table 4: Sample Containers and Holding Times for Instream Monitoring

Constituent	Minimum Sample Volume	Bottle Type	Holding Time
Conventional Constituents			
Biochemical Oxygen Demand (BOD ₅)	250 mL	Plastic	24 hours
Dissolved Organic Carbon (DOC)*	125 mL	Amber Glass	28 days
Total Suspended Solids	500 mL	Plastic	7 days
Hardness/Total Alkalinity	250 mL	Plastic	6 months
<i>E. coli</i>	100 mL	Sterile Plastic	6 hours (max 24 hrs.)
Chlorophyll- <i>a</i>	1 liter	Amber Glass	3 weeks once filtered
Nutrients			
Nitrate Nitrogen	100 mL	Plastic	48 hours
Total Kjeldahl Nitrogen (TKN)	100 mL	Plastic	28 days
Ammonia Nitrogen	100 mL	Plastic	28 days
Total Phosphorus	100 mL	Plastic	28 days
Ortho-phosphorus*	250 mL	Plastic	48 hours
Total Recoverable Metals			
Copper	400 mL	Plastic	6 months, once preserved
Lead			
Zinc			
Mercury	250 mL	Plastic	28 days
Dissolved Metals			
Copper	400 mL	Plastic	6 months, once preserved
Lead			
Zinc			
Legacy Pesticides			
DDT	1 liter	Amber Glass	28 days once extracted
Dieldrin			

* Sample requires field filtering

After samples have been obtained and the collection procedures properly documented, a written record of the chain of custody for each sample requiring laboratory analysis is completed (see **Appendix C**). Information included on the chain of custody includes:

- Name of the persons collecting the sample(s)
- Date and time of sample collection
- Location of sample collection
- Names and signatures of all persons handling the samples in the field and in the laboratory
- Laboratory analysis requested and control information (e.g., duplicate or spiked samples etc.) and any special instructions (e.g., time sensitive analyses).

To ensure that all necessary information is documented, a chain of custody form will accompany each sample or set of samples and a copy of the form is retained. Each person who takes custody will sign and date the appropriate portion of the chain of custody documentation.

3.6 Constituents and Methods

The analytical methods and method reporting limits (MRLs) for constituents monitored for instream sampling are listed in **Table 5**.

Although iron and manganese are included on the 2004/06 303(d) list for the Columbia Slough and Lower Willamette River, DEQ has stated that these concentrations are naturally elevated due to local geology. DEQ has also stated that a future Willamette River TMDL for iron and manganese is extremely unlikely given the data that the current listings are based upon. Therefore, iron and manganese have not been included in the list of constituents for analyses.

The only form of mercury that the NPDES permit and Willamette Basin TMDL requires is total recoverable mercury. Past monitoring efforts for dissolved mercury found that most instream samples were below the detection limit.

Table 5: Constituents, Methods and MRLs for Instream Monitoring

Field Constituents	Analytical Method	MRL*	Units
Temperature	SM 2550 B	-5	Degrees C
DO	SM 4500-OG	0.1	mg/L
Conductivity	EPA 120.1	1.0	µs/cm
pH	EPA 150.1	3.0	S.U.
Turbidity	EPA 180.1	0.05	NTU
Conventional Constituents			
Biochemical Oxygen Demand (BOD ₅)	SM 5210 B	2	mg/L
Dissolved Organic Carbon (DOC)	SM 5310B	1	mg/L
Total Suspended Solids	SM 2540 D	2	mg/L
Hardness/Total Alkalinity	SM 2340 B	0.5	mg/L as CaCO ₃

<i>E. coli</i>	COLILERT QT	10	MPN/100 mL
Chlorophyll- <i>a</i>	SM 10200 H	2.0	mg/M3
Nutrients			
Nitrate Nitrogen	EPA 300.0	1.10	mg/L
Total Kjeldahl Nitrogen	PAI-DK03 ¹	0.20	mg/L
Ammonia Nitrogen	EPA 350.1	0.02	mg/L
Total Phosphorus	EPA 365.4	0.02	mg/L
Ortho-phosphorus	EPA 365.1	0.02	mg/L
Total Recoverable Metals			
Copper	EPA 200.8	0.2	µg/L
Lead	EPA 200.8	0.1	µg/L
Mercury	EPA 1631E or WPCLSOP M- 10.02 ²	0.0005	µg/L
Zinc	EPA 200.8	0.5	µg/L
Dissolved Metals			
Copper	EPA 200.8	0.2	µg/L
Lead	EPA 200.8	0.1	µg/L
Zinc	EPA 200.8	0.5	µg/L
Legacy Pesticides			
DDT	EPA 8081 ³	2.5	ng/L
Dieldrin	EPA 8081 ³	2.5	ng/L

*Method Reporting Limit

¹ The PAI-DK03 method for TKN is a 40 CFR 136 method (flow injection gas method, see footnote 41, Table 1B, 40 CFR Part 136.3).

² The WPCLSOP M-10.02 method cited for total Hg is EPA 200.8 w/CEM digestion (footnote 4, Table 1B, 40 CFR Part 136.3)

³ EPA SW846 Method 8081 is nearly identical to 40 CFR 136 approved method EPA 608 and is often used interchangeably with EPA Method 608 for analyzing organochlorine pesticides, including DDT, DDD, DDE and Dieldrin. Based on a DEQ response dated 7/27/2011 citing similarities between the methods, method 8081 meets the criteria of a modified version of 608 under the description outlined in 40 CFR Part 136.6 “Method Modifications and Analytical Requirements”.

3.6.1 Pesticides

In order to better understand the prevalence of pesticides in surface waters, 15 pesticides will be monitored at Instream locations during the 2021-2026 permit term. This includes the 12 pesticides listed in the NPDES MS4 permit, Schedule B, Table 2, Special Condition 9: bifenthrin, chlorpyrifos, imidacloprid, fipronil, atrazine, simazine, sulfometuron methyl, diuron, 2,4-D, glyphosate, AMPA, and 2,6-dichlorobenzamide. Additionally, the following three pesticides will be monitored because of past detections or use by City operations: pentachlorophenol, triclopyr, and trifluralin. Each of these 15 pesticides will be sampled at each Instream location at least once during the permit term.

Seven additional pesticides will be considered for sampling during the 2021-2026 permit term if resources allow: carbaryl, chlorothalonil, dicamba, malathion, MCPP, permethrin, and propiconazole. These pesticides were determined to be of interest due to their toxicity and availability as summarized in the Pollutant Risk Tool developed by Clean Rivers Coalition members (Alix Danielsen and Keri Handaly) with input from DEQ and regional water quality experts.

Pesticide monitoring at Instream locations will be conducted during the normal quarterly sampling event in the spring or during a separate targeted sampling event. The goal will be to collect samples during a time when pesticides are likely to be in use and mobilized in runoff.

3.7 Quality Control Procedures

3.7.1 Quality Assurance

The data quality objectives for field measurements are listed in **Table 6**. Precision and accuracy are referenced from the DEQ Data Quality Matrix. Because field measurements for temperature, pH, DO and conductivity are made using a multi-meter probe, precision between replicates is usually not assessed since meter values are continuously assessed and not documented until they stabilize. Accuracy for field measurements is determined by measuring standards before and after each sampling event and assessing deviation from the standard in comparison to accuracy ranges in **Table 6**.

Table 6: Accuracy and Precision Targets for Instream Field Measurements

Parameter	Precision	Accuracy	Measurement Range
Temperature	± 1.0 °C	± 0.5 °C	-5 to 45 °C
pH	± 0.3 SU	± 0.2 SU	0 to 14 SU
Dissolved Oxygen	± 0.3 mg/L	± 0.2 mg/L	1 to 50 mg/L
Conductivity	± 10% of Std. Value	± 7% of Std. Value	0 to 200 mS/cm
Turbidity	± 5% of Std. Value ± 1 NTU if NTU <20	± 5% of Std. Value	0 to 1000 NTU

Analytical methods for grab samples analyzed at Portland’s Water Pollution Control Laboratory use an appropriate balance of quality assurance/quality control measures, including replicates, blanks, spiked samples and other measures approved under 40 CFR 136 to ensure that data meet quality objectives appropriate for compliance with state and federal regulatory requirements. A copy of the WPCL’s QAPP is included in **Appendix G**.

Field duplicate samples will be collected at a minimum of 10% of the total number of monitoring locations (1 duplicate for every 10 sites). For in-stream sampling, one lab replicate will be collected from one of the 10 in-stream sampling sites on a random rotating basis. Any data or sample values outside of the expected range for the constituent being measured will be rechecked

for validity with the laboratory or in the field by the field team as appropriate. Data that continue to be outside the expected values will be further evaluated to determine potential causes.

Duplicate measurements are not collected for field constituents (DO, pH, temperature, conductivity, turbidity). Instead, quality assurance for field constituents will be assessed by calibrating the equipment prior to mobilization on the day of the monitoring event and by measuring equipment with a known standard after each monitoring event to measure how accurately the equipment can still read the standard within the accuracy ranges specified in **Table 6**.

Field blanks will also be collected for 10% of sampling mobilization events. Equipment blanks will be generated annually by the WPCL to ensure that equipment and bottles provided by the lab are not producing false positive readings.

3.7.2 Representativeness

Instream samples are collected about 4 inches below the water surface from within the thalweg or near the center of the stream channel where the water is assumed to be well mixed and representative of the ambient conditions.

3.7.3 Comparability

The objective is to ensure that collected data are either directly comparable or comparable, with defined limitations, to literature data or other applicable criteria. Instream samples are collected and analyzed in the same manner as those collected for Wet Weather Stormwater Monitoring and Structural Best Management Practice Monitoring. Grab samples are analyzed at Portland's Water Pollution Control Laboratory to minimize variability and increase comparability of data collected on streams flowing through both jurisdictions.

3.7.4 Completeness

Completeness is a measure of the amount of valid data obtained from the analytical measurement system compared to the amount that was expected to be obtained. It is defined as the total number of samples taken for which valid analytical data are obtained divided by the total number of samples collected and multiplied by 100.

The goal for Instream Monitoring is to achieve a 100 percent complete data set for all analyses. It is anticipated that over the 5 year permit term, 20 samples will be collected from each monitoring location. It is understood that due to unforeseen circumstances, such as abnormal climatic conditions, unsafe or impractical sampling conditions, equipment vandalism or equipment failures that occur despite proper operation and maintenance, some results may be lost. Field and Laboratory staff will attempt to minimize data loss to the best of their ability by carefully following all protocols and procedures. If data sets are not 100 percent complete for this study, analyses will be evaluated on a case by case basis to determine whether additional samples are able to be collected considering available time, season, competing regulatory obligations, and cost.

3.7.5 Instrument Inspection and Maintenance

Field sampling equipment is inspected before and after each monitoring event. The multi-meter and turbidimeter will be cleaned and maintained according to the manufacturer's guidelines.

Multi-meters will be professionally inspected, maintained and calibrated annually by Quality Control Services (2340 SE 11th Ave, Portland, OR. 503-236-2712).

Portland's Water Pollution Control Laboratory performs inspection and maintenance of laboratory instruments used for analysis of grab samples. A copy of the WPCL's QAPP is included in **Appendix G**.

3.7.6 Instrument Calibration

The multi-meter probe used to collect field measurements (temperature, pH, DO, and conductivity) will be calibrated prior to each event at mobilization. pH will be calibrated using a 3-point calibration (pH 4, 7 and 10 buffers). Conductivity will be calibrated using a standard within the range of expected measurement (typically 100 $\mu\text{S}/\text{cm}$). DO will be calibrated using percent saturation at the current barometric pressure. Meter calibration will be recorded in an electronic calibration log. Meters will be calibrated halfway through the monitoring event if the accuracy of the meter drifts during the monitoring event. After each sampling event the meter will be measured against known standards to check measurement accuracy.

The turbidimeter will be calibrated annually. Prior to each sampling event, the meter will be measured against known secondary Gelex sample standards to ensure accuracy. Readings will be recorded in the electronic calibration log.

Portland's Water Pollution Control Laboratory performs calibration of laboratory instruments used for analysis of grab samples. A copy of the WPCL's QAPP is included in **Appendix G**.

3.8 Data Management, Review, Validation and Verification

3.8.1 Data Management

Results will be provided to Gresham by the laboratory in electronic format and shared with the City of Fairview. QA/QC files are included with the electronic reports and will be stored electronically on the City of Gresham's servers. A separate record will be generated for each sample date.

In addition, the key information such as station ID, sample date and time, name of sampler, name of constituent, all results, units, detection limits, EPA methods used, name of the laboratory, and any field notes will be entered into the database. Additional information, such as compositing of multiple samples, or the use of grab or automatic samples, will also be included.

All analytical results and applicable field measurements, including field data sheet information, will be stored in Gresham's Monitoring Program database. Lab data will be reviewed and entered as soon as practicable, with data entry, analysis, and summarization being shared with Fairview and summarized in the NPDES MS4 Annual Report. Data will be submitted to DEQ using the template to include into the Ambient Water Quality Management System (AWQMS) database.

Additional analysis will be conducted for the permit renewal to assess instream trends. Periodic analysis of data may also occur to assess whether adaptive management of the Monitoring Plan or program is appropriate.

3.8.2 Data Review, Validation and Verification

The Monitoring Program Coordinator will check all field data sheets for completeness and accuracy at the end of each sampling event. Errors will be corrected prior to sample delivery and data entry. All data will be entered into Gresham's master NPDES MS4 data spreadsheet. The data will be reviewed and input by the sampling team leader within 5 days of receipt from the lab. Values are compared against water quality standards, as well as the Pollutant Parameter Action Levels described in section 3.8.3.

Ideally, the data should be reviewed for input accuracy, however, limited staff time does not typically allow for this step. A secondary check will be used to periodically validate data entry accuracy.

Once the data has been entered in the project database, the Monitoring Program Coordinator will proofread it against the original field data sheets. Statistical and graphical analysis may be used to reveal whether keystroke errors occurred during data entry. Potential errors in the database will be checked against field data sheets and lab reports. Once verified, errors in data entry will be corrected at that time. Outliers and inconsistencies will be flagged for further review, investigation, and if appropriate, discarded. Data quality problems will be discussed as they occur and in the final report to data users.

Reconciliation with data quality objectives as noted above will be performed as soon as possible after each sampling event. Calculations and determinations for precision, completeness, and accuracy will be made and corrective action implemented if needed. If data quality indicators do not meet the monitoring program's specifications, data may be discarded and re-sampling may occur. The cause of the failure will be evaluated. If the cause is found to be equipment failure, calibration and/or maintenance techniques will be reassessed and improved. If the problem is found to be sampling team error, field techniques will be assessed, revised, and retrained as needed.

3.8.3 Pollutant Parameter Action Levels

Instream water quality data are compared against water quality standards, and any excursion is evaluated to explain the value. In order to more rapidly identify and respond to potential issues, Gresham developed "action levels" to identify when the lab would immediately notify the monitoring coordinator so that staff could respond promptly to potential issues (Table 7). The action levels in Table 7 were developed by analyzing Gresham Instream data from 1999-2021 and Wet Weather Stormwater data from 2009-2021 for parameters that have an instream water quality standard.

Many parameters rarely or never exceeded the acute water quality standard (e.g. DDT/Dieldrin, maximum pH, dissolved oxygen, and dissolved lead). For these parameters, the action levels are set at the acute water quality standard.

Some parameters frequently exceed the water quality standards: (e.g., *E. coli*, total mercury, minimum pH, dissolved Cu, and dissolved Zn). These parameters generally have known sources and reduction is currently covered by the City's Stormwater Management Plan. For these parameters, action levels are outside of the water quality standard in order to quickly identify

situations where there may be an unusual discharge to the stream which is causing or contributing to the exceedance of the water quality standard. These action levels were determined by evaluating Wet Weather Stormwater data from 2009-2021, identifying the 95th and 99th percentile for each parameter, and choosing an action level in that range.

An action levels are also included for ammonia and phosphorus because high levels can indicate presence of sewage.

For parameters whose water quality standard is based on other parameters (e.g., lead, copper, and zinc), the median value of the other constituents from 1999-2021 instream data was used in these calculations.

When an Instream monitoring result exceeds an action level, staff will begin investigating potential sources within 48 hours of becoming aware of the exceedance. Investigations may include searching the catchment area for possible sources or collecting additional samples. DEQ will be notified if/when a stormwater source is found to be causing or contributing to an action level exceedance.

Table 7: Instream and Wet Weather Stormwater Water Quality Action Levels¹

Parameter	Unit	Water Quality Standard ²	Interquartile range ³	Action Level ⁴
E. coli	MPN/100 mL	406	74 - 795	10,000
Ammonia	mg/L	NA	.020 - 0.261	2
Total phosphorus	mg/L	NA	0.055 - 0.171	1
Dieldrin	µg/L	0.24 µg/L	NA	0.24
DDT	µg/L	1.1 µg/L	NA	1.1
pH	-	6.5	5.9 - 6.97	<4.0, >8.5
Total Hg	µg/L	0.00014 µg/L	0.00313 - 0.00817	0.02
Dissolved Cu	µg/L	8.8 µg/L	1.3 - 4.7	25
Dissolved Pb	µg/L	3.5 µg/L	0.10 - 0.12	0.4
Dissolved Zn	µg/L	62.7 µg/L	9.3 - 32.9	300

¹Action levels may be updated with DEQ approval.

²Acute standard used for parameters with chronic and acute levels

³Interquartile range given is derived from City of Gresham Wet Weather Stormwater data 2009-2021

⁴Action levels are set at either the Water Quality Standard or at a number between the 95th and 99th percentile of City of Gresham Wet Weather Stormwater data 2009-2021

4.0 CONTINUOUS INSTREAM FLOW AND TEMPERATURE MONITORING

4.1 Project/Task Organization

As required by the NPDES MS4 permit, Schedule B, Table 2, continuous instream flow and temperature monitoring refers to the ongoing collection of data at short intervals (every 15, 30, or 60 minutes, depending on constituent) at fixed locations throughout key watersheds. There are three different sources of continuous data within the permit area:

1. The USGS operates and maintains gages on Johnson and Fairview Creeks that collect continuous flow data, based on a cost-sharing agreement with the City of Gresham (Johnson Creek gage also collects temperature and turbidity);
2. The City of Gresham deploys continuous temperature data loggers during summer months at the fixed Instream Monitoring locations listed in **Section 3.4.2, Table 2.**

The USGS currently operates stream discharge gages and has a joint funding agreement (see **Appendix E**) with Gresham to do so at two locations. Gresham also contributes to USGS monitoring efforts in the Johnson Creek watershed that cooperatively funds a gaging station at the mouth of Kelley Creek. **Section 4.4.2, Table 8** describes the USGS Gaging Stations.

During the review required for the 2006 Interim Evaluation Report, the City's consultant recommended that the Co-Permittees explore the potential for collecting continuous flow and temperature data at each of the instream monitoring locations. Summer temperature monitoring at each instream location has been conducted since summer 2008. Additional flow sites were considered, but it was determined that the calibration of models developed for the Stormwater Master Plans for each drainage basin has adequately characterized flows, and that additional continuous flow monitoring is not merited, especially given the Gresham's need to maximize the benefit of limited staff and financial resources.

4.2.1 Monitoring Question and Background

Continuous Instream Flow and Temperature Monitoring is intended to track water quantity trends in two of the major water bodies within the permit area that receive MS4 discharges – Johnson and Fairview Creeks. Together with other data collected by the monitoring program, the use of flow and temperature models, and statistical analysis such as trending, this information should contribute toward an answer to the question: “To what degree and where are stormwater flows affecting water quality and/or aquatic life?” In addition to collecting rainfall data, continuous flow data helps the Co-permittees put the Instream Monitoring data described in **Section 3.0** into perspective and address the question “What is the impact that Gresham and Fairview's stormwater discharges are having on the exceedances of instream water quality standards?” As shown in **Appendix A**, continuous instream monitoring contributes to meeting NPDES MS4 monitoring objectives 1, 2, 3, 4, 5 and 6.

- Objective 1. Evaluate the source(s) of and means for reducing the pollutants of concern applicable to the co-permittees' permit area, including 2018/2020 303(d) listed pollutants, as applicable;*
- Objective 2. Evaluate the effectiveness of Best Management Practices (BMPs) to assist in identifying BMP priorities;*

- Objective 3. Characterize stormwater runoff discharges based on land use, seasonality, geography or other catchment characteristics;*
- Objective 4. Evaluate status and long-term trends in receiving waters associated with MS4 stormwater discharges;*
- Objective 5. Assess the chemical, biological and physical effects of MS4 stormwater discharges on receiving waters;*
- Objective 6. Assess progress towards reducing TMDL pollutant loads.*

4.2.2 Data Analysis Methodology and Quality Criteria

Continuous instream flow and temperature data will be assessed graphically and through computation of summary statistics. The USGS graphs time plots of data they collect, as well as computing minimum, maximum and mean values. For flow and temperature, extreme values are the most critical for fish and aquatic life, so these extremes will be evaluated for ways the stormwater program can be adaptively managed to improve the chemical, physical and biological health of the MS4 receiving water.

4.2.3 Assumptions and Rationale

The Continuous Instream Flow and Temperature Monitoring performed by the USGS takes place at fixed locations. Continued monitoring at the same locations will allow for assessing long-term trends over time and provide a source of continuous information that can be used to put the Instream Monitoring described in **Section 3.0** into perspective. With 15-25 years of monitoring data already collected at the two continuous monitoring locations, continued monitoring over the next NPDES MS4 permit cycle and into the future will allow for assessment of long-term status and trends.

4.2.4 Relationship to Long-term Monitoring Program Strategy

Continuous flow and temperature monitoring provides a direct measure of the chemical and physical condition of waters of the state which receive MS4 stormwater discharges. The continuous measurements described in this section are augmented by 1) correlating this data with periodic water quality monitoring data described in **Section 3.0**, 2) determining how flow and temperature affect the macroinvertebrate sampling described in **Section 5.0**, 3) comparing rainfall and instream flow data to the Wet Weather Stormwater Monitoring data described in **Section 6.0**, and 4) determining whether BMPs implemented and monitored (described in **Section 8.0**) result in improvements to instream flow or temperature measurements. Continuing to conduct continuous instream monitoring using an approach consistent with past monitoring efforts will assist the Co-Permittees in determining if flow or temperatures trends are evident based on MS4 management decisions associated with implementation of their SWMPs.

4.3 Documentation and Record-keeping Procedures

Consistent with permit requirements specified in Schedule F, Section C.8., the Co-Permittees will retain records of all monitoring information, including: all calibration, major maintenance records, all original data, copies of all reports required by the NPDES MS4 permit, and records of data used to complete the application for the NPDES MS4 permit for a period of at least 5 years from the date of the sample, measurement, report, or application. The USGS currently manages this data, and all data are available on-line through the Water Resources of Oregon, <http://or.water.usgs.gov/>

4.4 Sampling Process/Study Design

4.4.1 Study Design

Continuous flow and temperature monitoring conducted by the USGS was established to respond to the need for streamflow data related to the high-flow and low-flow hydrologic conditions. The sites were selected as part of a larger watershed study described in the “Hydrology of the Johnson Creek Basin” scientific investigation report (Lee and Snyder 2009). The City of Gresham began collecting continuous temperature data at fixed instream monitoring locations in an effort to better understand the diurnal fluctuations, determine the magnitude of summer maximums, and to develop a long-term baseline of temperature data that can be used to compare to shade targets established with the temperature TMDL.

4.4.2 Monitoring Locations

The City of Gresham deploys continuous temperature data loggers at stations 2-11 of the fixed instream sampling locations listed in **Section 3.4.2 Table 2**. As stated in 4.3.1, continuous temperature monitoring may move to other locations if it is determined that annual measurement at the same fixed locations is too frequent for meeting the monitoring program objectives.

The USGS monitors continuous flow at the locations listed in **Table 8**. The first two locations listed are within the City of Gresham, while the third location on Kelley Creek is within Portland, but was added to assess flow from the Pleasant Valley Concept Plan area, which will eventually be within the cities of Damascus, Gresham, and Portland.

Table 8: USGS Continuous Monitoring Locations*

#	Stream	Location (USGS Station ID)	Type	Constituents
1	Johnson Creek	Regner (USGS # 14211400)	Continuous	Flow Temperature Turbidity
2	Fairview Creek	Glisan (USGS #14211814)	Continuous	Flow
3	Kelley Creek	159 th , upstream from Johnson Creek Confluence (USGS #14211499)	Continuous	Flow Temperature Turbidity

*Continuation of these gages is contingent on ongoing support by USGS.

4.4.3 Sampling Event Criteria

Continuous sampling equipment is designed to be in place regardless of any specific flow or temperature extreme. Continuous temperature data loggers deployed by the City of Gresham during months where potential for temperatures to exceed water quality standards is high, generally June through September. USGS gaging stations operate year-round.

4.4.4 Frequency and Duration

Continuous temperature data loggers deployed by the City of Gresham are set to collect data at hourly intervals. Continuous temperature monitoring has been conducted each summer since 2008. This activity will continue to occur annually at the instream monitoring locations in **Section 3.4.2 Table 2**, unless evaluation of data indicates that sampling an equal number of other locations makes more sense.

Continuous flow is measured by the USGS at either 15 or 30 minute intervals, depending upon the gage. The Johnson Creek gage at Regner has been in operation since February 1998. The Fairview Creek gage at Glisan has been in operation since May 1992. The Kelley Creek gage near the confluence with Johnson Creek has been in operation since March 2000.

4.4.5 Responsible Sampling Coordinator

Continuous temperature monitoring is coordinated by the City of Gresham, who deploy and retrieve data loggers, then download the data.

The U.S. Geological Survey's Oregon Water Resource Center manages the collection of flow and temperature data at their gaging stations, including equipment calibration and maintenance.

4.5 Sample Collection and Handling

4.5.1 Sample Collection Method

Continuous measurements are made in-situ by securing the data collection devices into the stream channel. Measurements are collected at regular intervals ranging from 15-minutes to 1-hour, depending upon the station and constituent.

4.5.2 Handling and Custody Procedures

Because instream flow and temperature measurements are collected in-situ, sample handling is not involved in collection of these measurements.

4.6 Constituents and Methods

Streamflow: The USGS measures streamflow according to methods described in Rantz and others (1982).

Temperature: Continuous temperature data collected by the City of Gresham is obtained using temperature data loggers with a measurement range of -5°C to 35°C . Methods for USGS measurement of temperature and turbidity are contained in the "National Field Manual for the Collection of Water-Quality Data" (USGS, variously dated).

4.7 Quality Control Procedures

4.7.1 Quality Assurance

The data quality objectives for continuous temperature data measured by the City of Gresham are determined by pre- and post-deployment accuracy checks and by assessing precision between the temperature from the data logger versus in-stream measurements made during Instream Monitoring. The data quality objectives are accuracy: $\pm 0.5^{\circ}\text{C}$, precision: $\pm 0.5^{\circ}\text{C}$.

The USGS manages all aspects of installation, maintenance, calibration, reporting and storage of data from their gaging stations. USGS data is flagged as provisional until it is reviewed and meets USGS data quality standards. Quality assurance procedures for USGS streamflow data is described in Rantz and others (1982).

4.7.2 Representativeness

All continuous instream monitoring locations are positioned to capture the most representative readings for ambient conditions at each site, considering flow, shading, depth, and other factors. Temperature data loggers are placed in areas where they will not be subject to direct solar radiation, while also targeting locations that will not be vandalized or dry during low summer flows.

4.7.3 Comparability

The USGS uses similar equipment at all of the gaging locations so that flow and temperature data can be compared between locations. The City of Gresham uses the same model of data loggers at all locations, and syncs the internal timing device so that data collected by each device is at the same time. This allows for temperature data to be compared between each of the in-stream sites monitored for temperature.

4.7.4 Completeness

The key period for continuous temperature data is the low flow summer months – primarily July, August and September. The goal for continuous instream temperature monitoring is to achieve a 100 percent complete data set for the summer months. Hourly measurements for a 3 month period will result in approximately 2160 data points each summer. Due to unforeseen circumstances some results may be lost. Field staff will attempt to minimize data loss to the best of their ability by carefully following all protocols and procedures. If data sets are not 100 percent complete for this monitoring task, analyses will be evaluated on a case by case basis to determine whether the monitoring program needs to collect additional samples in the future in order to meet monitoring objectives in order to accommodate data loss.

For USGS gaging stations collecting data points every half hour (48 data points per day), an annual period would produce 17,520 data points. USGS stations collecting data points every 15 minutes would produce 35,040 data points annually. The USGS manages all aspects of installation, maintenance, calibration, reporting and storage of data from their gaging stations.

4.7.5 Instrument Inspection and Maintenance

The continuous temperature data loggers are cleaned and inspected annually before and after deployment. The USGS manages all aspects of installation, maintenance, calibration, reporting and storage of data from their gaging stations.

4.7.6 Instrument Calibration

The continuous temperature data loggers cannot be calibrated. Pre- and post-deployment accuracy checks and in-situ precision checks are used to determine whether data meet the quality objectives outlined in **Section 4.7.1**. Accuracy checks are performed using a water bath at both cold and room temperature conditions. All data loggers are deployed and submerged in the water bath; the readouts from each data logger is compared with the other loggers as well as to a NIST-traceable thermometer inserted into the water bath.

The USGS manages all aspects of installation, maintenance, calibration, reporting and storage of data from their gaging stations.

4.8 Data Management, Review, Validation and Verification

4.8.1 Data Management

The continuous temperature data collected by the City of Gresham will be stored in a spreadsheet file stored on the City's server. Data collected by Gresham will be submitted to DEQ using the template to include into the AWQMS database.

The USGS manages the flow and temperature data they collect, and all data are available on-line through the Water Resources of Oregon web site at: <http://or.water.usgs.gov/>.

4.8.2 Data Review, Validation and Verification

The Monitoring Program Coordinator will use statistical and graphical analysis to reveal whether errors occurred during data download. Potential errors in the dataset will be checked against field duplicate measurements and date/time of deployment/retrieval. Once verified, errors in data entry will be corrected at that time. Outliers and inconsistencies will be flagged for further review, investigation, and if appropriate, discarded. Data quality problems will be discussed as they occur and in the final report to data users.

The USGS utilizes their own documented procedures for validating flow and temperature data that is considered provisional until it has been reviewed and verified. Quality assurance procedures for USGS streamflow data is described in Rantz and others (1982).

5.0 MACROINVERTEBRATE MONITORING

5.1 Project/Task Organization

As required by the NPDES MS4 permit, Schedule B, Table 2, macroinvertebrate monitoring refers to the annual monitoring of benthic macroinvertebrates from the fixed sampling locations where instream monitoring occurs. Monitoring began at most instream sites in 2008; continued monitoring seeks to determine whether and to what degree the biological conditions of streams are changing related to habitat, hydrology, or water quality conditions. Macroinvertebrate monitoring may be timed to coincide with instream monitoring in order to collect biological information at the same time summer water quality data is collected.

5.2 Monitoring Objectives

5.2.1 Monitoring Question and Background

Macroinvertebrate monitoring is intended to track the status and trends of the biological community within water bodies receiving MS4 discharges to address the question “Is stormwater affecting the biological community of the receiving waters?” The Co-Permittees will monitor benthic macroinvertebrates at instream sampling sites in order to more adequately assess the long-term trends in objective 4, and the biological component of objective 5, in addition to helping meet objective 6. As shown in **Appendix A**, macroinvertebrate monitoring also helps address other goals as well.

Objective 4. Evaluate status and long-term trends in receiving waters associated with MS4 stormwater discharges;

Objective 5. Assess the chemical, biological and physical effects of MS4 stormwater discharges on receiving waters; and,

Objective 6. Assess progress towards reducing TMDL pollutant loads.

5.2.2 Data Analysis Methodology and Quality Criteria

The tool(s) used to assess macroinvertebrate data is almost as important as the protocol used for collection and identification. Several tools are available for analyzing macroinvertebrate data, and the preferred choice changes as more knowledge is gained, so it is critical to keep both the data and the tool. The City of Gresham will provide data to DEQ for assessment using DEQ’s best available bioassessment methods. This would likely include O/E and IBIs, plus a Biological Condition Gradient model that will provide an alternative assessment tool that doesn’t require reference sites. Taxonomists will utilize lowest-practical levels of identification and will use DEQ’s own taxonomy table for target identifications. Data will be provided to DEQ in a standardized format for easy upload into the AWQMS database.

Multi-metric indices, such as Oregon’s Benthic Index of Biological Integrity (B-IBI), can be used to look at multiple measures of the biological community, including: Total Taxa, Mayfly Taxa, Stonefly Taxa, Caddisfly Taxa, Sensitive Taxa, Sediment Sensitive Taxa, Hilsenhof Biological Index (HBI), Percent Tolerant Taxa, Percent Sediment Tolerant Taxa, and Percent Dominance.

Macroinvertebrates will be identified to a taxonomic level that allows for calculation of an IBI. DEQ has been moving away from the use of the IBI as other tools have become available.

Currently, the Predictive Assessment Tool for Oregon (PREDATOR) allows for comparison of the biological community observed in stream sites with the expected community that is present in best available condition reference sites within the same eco-region. DEQ's PREDATOR model can be used with macroinvertebrate data identified to the same taxonomic level required by the IBI, so ensuring that macroinvertebrate samples are identified to the same taxonomic level as DEQ (generally genus/species) is the primary criteria for selection of a taxonomist. To the degree practicable, an attempt will be made to use the same taxonomist over time to maximize consistency.

5.2.3 Assumptions and Rationale

Macroinvertebrates live in the streambed substrate and are therefore affected by short and long-term exposures to pollution. The biological community may be affected by a wide range of factors including temperature, sediment, in-stream and near-stream riparian habitat, hydro-modification, and water quality pollutants from land use in the contributing watershed area. It is assumed that long-term monitoring of macroinvertebrates will aid the Co-permittees in determining whether the physical, biological, and chemical condition of MS4 receiving water bodies is improving over time due to efforts to manage stormwater and improve habitat. Continued monitoring at the same locations will allow for assessing long-term trends over time.

5.2.4 Relationship to Long-term Monitoring Program Strategy

Macroinvertebrate monitoring provides a periodic measure of the biological condition of waters of the state which receive MS4 stormwater discharges. The annual biological monitoring described in this section augments other monitoring efforts by 1) comparing instream water quality trends described in **Section 3.0** with biological conditions, 2) evaluating how the biological community is affected by the flow and temperature data described in **Section 4.0**, and 3) determining if changes in stormwater data described in **Section 6.0** relate to changes in the instream macroinvertebrate community. Continuing macroinvertebrate monitoring using an approach consistent with instream water quality monitoring efforts should enable the Co-Permittees to determine if short or long-term water quality trends are evident based on MS4 management decisions associated with implementation of their SWMPs.

5.3 Documentation and Record-keeping Procedures

Consistent with permit requirements specified in Schedule F, Section C.8., the Co-Permittees will retain records of all monitoring information, including: all original data, copies of all reports required by the NPDES MS4 permit, and records of data used to complete the application for the NPDES MS4 permit for a period of at least 5 years from the date of the sample, measurement, report, or application.

Records will contain:

1. The date, exact place, time, and methods of sampling or measurements;
2. The individual(s) who performed the sampling or measurements;
3. The date(s) analyses were performed;
4. The individual(s) who performed the analyses;
5. The analytical techniques or methods used; and
6. The results of such analyses.

5.4 Sampling Process/Study Design

5.4.1 Study Design

Collecting benthic macroinvertebrate samples provides a direct measure of the biological health of the streams within the permit area. Macroinvertebrate sampling will be conducted as close to the Co-permittee's instream fixed sampling locations as possible. Following DEQ's biological monitoring procedure requires selection of riffles or the best available fast water habitat near the monitoring stations, focusing on an area upstream equal to 40 times the wetted stream width.

5.4.2 Monitoring Locations

Macroinvertebrates are currently monitored at the same fixed instream monitoring locations where instream water quality monitoring occurs. The instream macroinvertebrate sampling locations are listed in **Table 9**. Sampling locations may be moved to random sites selected probabilistically if data analysis reveals that annual monitoring of the same locations is not needed to show long-term changes in the biological community.

Table 9: Instream Macroinvertebrate Monitoring Locations

Station Number*	Site Code	Stream	Location
Columbia Slough Basin			
1**	FCI0	Fairview Creek	Mobile estates upstream of Fairview Lake in City of Fairview
2	FCI1	Fairview Creek	Conifer Park (205 th and Stark) in City of Gresham
Sandy River Basin			
3	BCI1	Beaver Creek	At the footbridge below Weedin Park in Troutdale
4**	BCI2	Beaver Creek	At the intersection of SE Division St. and SE Troutdale Rd.
5	KCI1	Kelly Creek	Downstream Mount Hood Community College
6**	KCI4	Kelly Creek	Upstream from Kelly Creek Detention Pond
Johnson Creek Subbasin			
7	JCI1	Johnson Creek	Near Jenne Rd Bridge
8	JCI2	Johnson Creek	Near Palmblad Bridge upstream of Gresham
9**	KI1	Kelley Creek	Pleasant Valley Grange
10**	KI2	Kelley Creek	Rodlun Rd near Alder Ridge

* Station numbers refer to locations on **Figure 1** (see **Section 3.0**).

** These sampling locations will be monitored each year only if adequate summer flows, or presence of suitable fast water habitat, are present. Not sampling these sites will still meet the minimum requirements listed in Table 2 of the

NPDES MS4 permit (1 site in Columbia Slough basin, 1 site in the Sandy River basin, and 2 sites in the Johnson Creek subbasin).

5.4.3 Sampling Event Criteria

Macroinvertebrate data collection will occur once each year during summer low flows. This activity will most likely occur during July or August in conjunction with instream water quality monitoring.

5.4.4 Frequency and Duration

A single sample will be collected at each site annually. Sampling began in 2008, and is planned to continue, but changes in location or frequency may be proposed if data analysis reveals that annual monitoring of the same locations is not needed to show long-term changes in the biological community.

5.4.5 Responsible Sampling Coordinator

This monitoring task is coordinated by the City of Gresham, who determine sample collection timing, gather needed equipment, collect samples for lab analysis, and coordinate delivery to the taxonomist.

5.5 Sample Collection and Handling

5.5.1 Sample Collection Methods

Macroinvertebrate samples will be collected according to DEQ's Field Methods for the Collection of Macroinvertebrates in Wadeable Streams (DEQ 2009). Samples will be collected from suitable fast moving water habitat (riffles, or runs/glides if no riffle is present) once per year during summer/low flow conditions. Eight separate one-foot square (1 ft²) samples will be collected using a 500 µm kick net from riffle habitat over a reach length of 40 times the average wetted stream width.

5.5.2 Handling and Custody Procedures

The 8-part composite sample is collected following DEQ's 9-cell grid method, moving from downstream to upstream in the fast water habitat from bottom left to center then right for the first three samples, and then moving in the same sequence from left to right upstream until all 8-parts of the composite sample have been collected.

A two-person team is used, where one person holds the D-frame net securely against the bottom of the streambed substrate, while the second person dislodges insects by rubbing rocks and disturbing substrate using their hands, brush or garden tool. Each of the 8 separate 1 ft² samples is placed into a sieve bucket with a 500 µm grid. The entire 8-part composite is transferred to Nalgene jars prior to being preserved using 70-95% ethanol or isopropyl alcohol. A Rite-in-the-Rain label with sample information written in pencil will be added inside the sample jar and the alcohol is added to the sample before the jars are sealed. A second label will be added to the outside of the jar before being sent to a professional entomologist for identification.

The label contained in each sample contains the following information:

- Date of sample collection
- Location of sample collection

- Name of sample collectors
- Number of jars used for sample from each site (Jar # __ of __)

Samples held for more than a week prior to shipment to the taxonomist may have the alcohol replaced with fresh ethanol or isopropyl alcohol. This step is most important for samples containing large amounts of organic material. A list of sample details, including site code, stream name, site location, sample date, and number of jars, is provided to the taxonomist to aid in data reporting.

5.6 Constituents and Methods

Macroinvertebrate samples will be collected according to DEQ's Field Methods for the Collection of Macroinvertebrates in Wadeable Streams (DEQ 2009). In order to get samples identified to the taxonomic level required to conduct the data analyses listed in **Section 5.2.2**, specimens will be sent to a professional entomologist for identification.

5.7 Quality Control Procedures

5.7.1 Quality Assurance

A field duplicate will be collected at a minimum of 10% of the total number of monitoring locations (1 duplicate for every 10 sites). The identification results from the field duplicate data will be compared to the results for the site it was collected from to determine the precision of the taxonomists' identification. A lab duplicate is also performed for each sampling period. A lab duplicate differs from a field replicate in that the taxonomist takes a second random subsample from the composite sample for determining precision and representativeness of the subsampling procedure. The accuracy target for field duplicates is to have less than 10% variability between organisms identified and relative abundance of each taxa.

5.7.2 Representativeness

Macroinvertebrate samples are collected from 8 separate locations within riffles or the best available fast water habitat. Based on procedures published by EPA and DEQ, these habitat conditions are believed to be well mixed and provide the most diverse biological community for comparing sites within the same watershed or around the ecoregion or state.

5.7.3 Comparability

The objective is to ensure that collected data are either directly comparable, or comparable within defined limitations, to literature data or other applicable criteria. Macroinvertebrate samples are collected and identified using the same method used by DEQ and other jurisdictions, so data should be comparable among the instream locations monitored as part of this plan, as well as comparable with other macroinvertebrate data collected from sites around the state.

5.7.4 Completeness

The goal for macroinvertebrate monitoring is to achieve a 100 percent complete data set. It is anticipated that over the 5 year permit term, annual sampling at 8 sites will result in 40 data points being collected. Due to unforeseen circumstances some results may be lost. Field and Laboratory staff will attempt to minimize data loss to the best of their ability by carefully following all protocols and procedures. If data sets are not 100 percent complete for this study, analyses will be

evaluated on a case by case basis to determine whether the project needs to collect additional samples.

5.7.5 Equipment Inspection and Maintenance

Prior to field data collection, all equipment is cleaned and visually inspected to ensure that the net and sieve bucket do not contain any openings that might allow organisms through during sample collection.

5.7.6 Equipment Calibration

No equipment involved in collection of macroinvertebrates requires calibration.

5.8 Data Management, Review, Validation and Verification

5.8.1 Data Management

All macroinvertebrate data will be stored in an annual summary spreadsheet stored on Gresham's server. Once data is received from the taxonomist, it will be reviewed and analyzed using an analysis tool (B-IBI, PREDATOR or other). Data analysis will occur as soon as practicable, with data summarization being shared with Fairview and summarized in the NPDES MS4 Annual Report. Additional analysis will be conducted for the permit renewal to assess instream trends. Periodic analysis of data may also occur to assess whether adaptive management of the Monitoring Plan or program is appropriate.

5.8.2 Data Review, Validation and Verification

Once the macroinvertebrate data from the taxonomist has been analyzed, the results will be compared to other sites and past data from the same site to check for consistency. Raw data from the field and lab duplicate measurements will be assessed against the quality assurance objectives listed in **Section 5.7.1** to determine if the collection and identification results meet the 10% target. Calculations and determinations for completeness and accuracy will be made and corrective action implemented if needed. If data quality indicators do not meet the monitoring program's specifications, data may be discarded and re-sampling may occur. The cause of the failure will be evaluated. If the cause is found to be collection method, techniques will be reassessed and staff will be retrained. If the problem is found to be identification, the taxonomist utilized by the Co-permittees will be assessed and a new taxonomist will be rehired as needed.

6.0 WET WEATHER STORMWATER MONITORING

6.1 Project/Task Organization

The WPCF permit requires the City to develop a monitoring plan for stormwater entering City-owned or operated UICs. The Wet Weather Stormwater Monitoring described in this section was prepared to meet the stormwater monitoring conditions established in the WPCF permit, while also meeting the “Stormwater Monitoring – Storm Event” requirement in Schedule B, Table 2 of the NPDES MS4 permit. For ease of implementing the monitoring requirements in both permits, the stormwater monitoring elements have been combined.

Wet Weather Stormwater Monitoring refers to the monitoring of stormwater runoff from roads and other paved surfaces. While the majority of monitoring is conducted within the City of Gresham, the drainage characteristics (land uses and vehicle trips per day) are also representative of the City of Fairview. Land use based wet weather outfall monitoring was conducted at four locations throughout the permit boundary, including an ACWA study conducted between 1990-1996 (ACWA 1997), and monitoring conducted by the Co-permittees between 1996-2011 as part of the monitoring requirements in the NPDES MS4 permit. This data, along with other regional jurisdictions’ data, was compiled and analyzed through a study managed by the Oregon Association of Clean Water Agencies (ACWA 2009). The 2009 ACWA data analysis provided statewide stormwater characterization and compared the influence of land use and vehicle trips on runoff quality.

The findings from the ACWA (2009) stormwater analysis indicated that stormwater data is highly variable and that vehicle trips per day may be more strongly correlated to differences in the data than land use. Some of the data included in the ACWA (2009) report was collected for compliance with a Water Pollution Control Facility (WPCF) permit for Underground Injection Control systems (UICs). Stormwater data related to UICs showed lower variability, which may be related to the smaller scale drainage basins, or the fact that sites were selected using a spatially balanced and random (“probabilistic”) site selection protocol (see **Section 6.4.1**). In an effort to reduce bias in sample site selection, eliminate variability that may be related to large drainage areas and produce stormwater data with greater statistical power, the Co-permittees changed their monitoring approach from looking at outfalls from large drainage areas to evaluating smaller drainages selected using the probabilistic monitoring design starting in 2011.

6.2 Monitoring Objectives

6.2.1 Monitoring Question and Background

Wet weather stormwater monitoring is intended to characterize the status and, if possible, determine trends in stormwater quality by focusing on the question “What are typical/average concentrations of pollutants in stormwater runoff?” Through evaluation of data that has already been collected (e.g. ACWA 1997 and ACWA 2009), and assessing monitoring approaches used for other stormwater monitoring programs (e.g. Portland’s UIC monitoring program), the Co-permittees plan to continue characterizing stormwater and augment with additional monitoring where data are lacking (specifically for mercury and toxics, especially pesticides). To meet monitoring Objectives 1, 3, and 6 from the NPDES MS4 permit, the Co-Permittees will collect stormwater samples from representative locations.

- Objective 1. Evaluate the source(s) of and means for reducing the pollutants of concern applicable to the co-permittees' permit area, including 2018/2020 303(d) listed pollutants, as applicable;*
- Objective 2. Evaluate the effectiveness of Best Management Practices (BMPs) to assist in identifying BMP priorities;*
- Objective 3. Characterize stormwater runoff discharges based on land use, seasonality, geography or other catchment characteristics;*
- Objective 6. Assess progress towards reducing TMDL pollutant loads.*

6.2.2 Data Analysis Methodology and Quality Criteria

Wet weather stormwater monitoring data will be assessed by comparing sites selected using the probabilistic Generalized Random Tessellation Stratified (GRTS) survey design described in **Section 6.4.1**. After randomly selecting sites with small drainage areas, the characteristics of each drainage area will be assessed, and a nonparametric statistical measure of difference between groups (e.g. Mann-Whitney) will be used to determine if stormwater is significantly different between sites based on land use, traffic patterns, power pole density, or other drainage characteristics. The significance of any difference would be evaluated against an alpha (α) value of at least 0.1, with a goal to demonstrate significance at $\alpha=0.05$.

6.2.3 Assumptions and Rationale

Because patterns of development and management of stormwater are the generally the same across the City, stormwater draining to UICs should not be different from that draining to the MS4. Both the UIC and MS4 areas are comprised of a mixture of residential, commercial, and industrial land uses, and a mixture of high volume and low volume traffic patterns and are therefore also representative of Fairview. The UIC monitoring approach used by Portland has demonstrated lower variability in stormwater data than the historic MS4 data that focused on outfalls from larger drainage areas.

It is assumed that by conducting stormwater monitoring in smaller UIC drainages that can be entirely characterized, versus the larger land use based outfall monitoring conducted in the past, the stormwater data will be less variable and more representative of specific land uses and factors that have the potential to affect stormwater quality. Using a probabilistic approach for selecting monitoring locations removes any bias associated with site selection, and selecting a large enough number of sites allows for meaningful analysis of the stormwater data regardless of the strata (land use, vehicle trips, etc.) being assessed.

The ACWA evaluation of statewide stormwater data (ACWA 2009) indicated that vehicle trips per day more closely correlates with pollutant concentrations than does land use. It is assumed that the statewide data is relevant to Gresham, and the effect of vehicle trips per day will be a primary factor for further analysis.

6.2.4 Relationship to Long-term Monitoring Program Strategy

Wet Weather Stormwater Monitoring provides a direct measure of the water quality of stormwater within the permit area. Using a probabilistic monitoring design that allows assessment of stormwater within the permit area provides the Co-permittees with useful management information

for both the MS4 and UIC system management. The long-term strategy for stormwater monitoring will likely involve keeping a long-term “fixed” panel of 5 sites monitored annually to allow for assessment of long-term trends, while also monitoring a rotating panel of 5 random sites each year to allow for greater assessment of stormwater status within the permit area.

6.3 Documentation and Record-keeping Procedures

Consistent with permit requirements specified in NPDES MS4 permit Schedule F, Section C.8., the Co-Permittees will retain records of all monitoring information, including: all calibration, major maintenance records, all original lab and field data (see **Appendix C** for example of field data sheet), copies of all reports required by the NPDES MS4 permit, and records of data used to complete the application for the NPDES MS4 permit for a period of at least 5 years from the date of the sample, measurement, report, or application.

Records will contain:

1. The date, exact place, time, and methods of sampling or measurements;
2. The individual(s) who performed the sampling or measurements;
3. The date(s) analyses were performed;
4. The individual(s) who performed the analyses;
5. The analytical techniques or methods used; and
6. The results of such analyses.

6.4 Monitoring Process/Study Design

6.4.1 Study Design

Compared to the historic stormwater data collected at outfalls, the data collected during a one year (2009-2010) wet-weather study of 60 sites conducted by the City of Gresham, as well as the City of Portland’s UIC monitoring program data (2007 to 2021) shows much lower variability and greater consistency than stormwater data collected during the previous decade at outfalls. The wet weather stormwater monitoring approach and locations listed in this plan seeks to continue to build upon those efforts and combine stormwater monitoring requirements, to the extent practicable in order to meet the requirements of both the NPDES MS4 and WPCF permits in order to protect local water resources using the public’s rates in the most efficient and scientific manner possible given limited resources.

A major benefit to using a combined stormwater monitoring approach to address both the MS4 and WPCF permit requirements is that rather than using the three large MS4 drainage outfalls, stormwater monitoring is conducted annually at a greater number of small UIC drainages (0.5 to 5 acres). Sites are selected using a spatially-balanced and random probabilistic approach, which is described below. The greatest benefit to using the Generalized Random Tessellation Stratified (GRTS) survey design (probabilistic approach; see Stevens and Olsen 2004) is that the small drainage areas are typically composed of a single land use, versus the mixed use inherent in the past stormwater outfall monitoring approach that focused on drainage areas that were hundreds of acres in size. Based on findings from Portland and Gresham stormwater sampling summarized in ACWA (2009), and from 2007-2021 monitoring results, stormwater data is generally affected more by vehicle trips per day than land use. Therefore, monitoring locations are stratified by

vehicle trips (< and > 1000 trips per day), which allows data to be comparable to similar sampling locations in nearby Portland.

The GRTS survey design developed by Dr. Don L. Stevens Jr. (Department of Statistics, Oregon State University) and Dr. Anthony R. Olsen (EPA National Health and Environmental Effects Research Laboratory) is specifically designed to efficiently characterize a large system with many potential sampling locations, such as a stream network or stormwater system. It randomly selects sampling locations from a population of potential locations whose members (stormwater structures for potential sampling) are distributed over a large space in a manner that produces a spatially balanced sample. Since the Co-Permittees have a large number of major and minor outfalls draining areas that range from a few acres up to nearly 1000 acres, it is not technically practicable or financially feasible to routinely collect and analyze stormwater from each of these outfalls during every storm event. Due to the large drainage areas and therefore large number of potential confounding factors, the Co-Permittees will monitor smaller stormwater catchments (0.5 to 5 acres) associated with UICs that can be accurately characterized according to land use, vehicular trips, and other characteristics that may influence the water quality of the stormwater effluent. In order to identify small catchments consisting of 1 to 4 catch basins, statistical methods will be applied to select a subset of points for monitoring so that there will be a high degree of confidence that the subset chosen is appropriately representative of stormwater within the permit area.

Stratification

Of the roughly 1100 small City-owned and operated UIC catchments, approximately 60% are in residential areas, and have <1000 vehicle trips per day (TPD), while the other 40% have >1000 TPD and surrounding land use is primarily commercial and multi-family residential with some industrial. In order to ensure that data is collected from a greater number of high vehicle trip sites, each yearly rotating panel of five sites will include three sites with >1000 TPD and two sites with <1000 TPD.

6.4.2 Monitoring Locations

Selection of stratified, spatially-balanced and random sampling locations using the GRTS procedure was accomplished by:

- Determining the exact geographic locations (latitude-longitude) of all UICs within the permit boundary that are owned and operated by the City of Gresham;¹
- Running the GRTS selection tool, which places nested random grids over the City's entire UIC system. Each grid is further divided into smaller nested grids until the smallest grid scales contain only a single UIC;
- In order to have a disproportionately greater number of >1000 TPD sites selected, a weighting factor was applied to the GRTS selection run. For the initial selection run, where a higher number of sites was selected than will be needed to account for sites eliminated after field screening for determining whether the sampling location is feasible/suitable, 390 locations (188 <1000 TPD and 202 >1000 TPD) were selected using weighting factors of 6.78 for <1000 TPD and 10.25 for >1000 TPD;
- The program systematically selected a random and evenly spaced sample from the UIC locations within the nested grids. Output is a ranked list of locations;

¹ Sites selected from UIC Systemwide Assessment conducted October 2011.

- In order to end up with an equal number of sites in the two traffic strata each year (5 sites in both the <1000 and >1000 TPD), the number of sites randomly selected within each traffic strata were evaluated. Since a fixed panel of 5 locations will be monitored each year (consisting of the top 3 ranked sites with <1000 TPD and the top 2 ranked sites with >1000 TPD), the rotating panel for each year was determined by selecting the next 2 locations with <1000 TPD and 3 locations from >1000 TPD. Having slightly more sites in the higher traffic strata of the rotating panel was made purposely so that a disproportionately large number of these sites would be sampled over the permit term.
- Before sampling the 5 rotating sites selected for each year, field reconnaissance will be performed to determine if the randomly selected sites were unsuitable for sampling (e.g., unsafe or inaccessible due to design). Replacement sites will be selected in ranked order from the list of oversample panel locations.

The proposed sampling locations for Wet Weather Stormwater Monitoring are listed in **Tables 10 and 11**. Since exact sampling locations to be monitored each year may vary based on changes to the stormwater system, **Table 10** lists the number of fixed and rotating sites that will be monitored in each year. Each year, monitoring will occur at one panel of 5 fixed locations (described in **Table 11**) and one panel of 5 rotating locations that will be monitored once during the permit term (specific list of rotating panel locations detailed in the separate “Stormwater Monitoring Plan” created to meet the requirements of the WPCF permit). There are 5 panels of 5 sites each which were chosen from the randomized list to be representative of land use and have historically provided adequate flow and safety for sampling. Each panel will be monitored once during the permit term. The goal of including fixed and rotating sample locations is to assess status and trends in stormwater – status being evaluated by covering a large random sample of the permit area, and trends being evaluated by long-term assessment of the same locations.

Table 10: Stormwater Sampling Locations to be Monitored During Permit Term

Permit Year	Fixed Locations*	Rotating Locations	Wet Season
1	5	5 – Panel 1	2022-2023
2	5	5 – Panel 2	2023-2024
3	5	5 – Panel 3	2024-2025
4	5	5 – Panel 4	2025-2026
5	5	5 – Panel 5	2026-2027

* One panel of five fixed sampling locations will be monitored each year. The 5 rotating sampling locations monitored each year will consist of 3 UICs on >1000 TPD and 2 locations on <1000 TPD locations.

Both the panel of 5 fixed monitoring locations and the rotating panel of 5 sites consist of sites selected probabilistically using the GRTS survey design described previously. The rotating panel locations to be monitored each year are subject to change as a result of field reconnaissance or system changes, so the list of locations monitored will be reported to DEQ each year as part of the required annual report. The random panel of sites will be representative of any UICs constructed or discovered during the permit term since it was selected from the 1100 active UICs owned and operated by the City of Gresham. The current probability of randomly selecting a single site from a population of 1100 UICs is 1 in 1100 or 0.091%. While new UICs may be constructed or

discovered over the permit term, it is anticipated that only 5 new UICs would likely be added annually. Over a 5 year period, this would mean 25 potential new sampling locations could be added. The probability of selecting a single site after those 25 sites were added to the system would be 1 in 1125 or 0.088%. The probability that any of the 25 newly added sites would be selected would be 5 in 1125 or 0.44%. Based on a similar criteria used by Portland in their Sampling and Analysis Plan (Portland 2006), sampling locations will not be re-selected using GRTS unless the probability for selecting a newly constructed or discovered sampling site becomes greater than 5% (more than 55 UICs added over 5 year period). The inventory of UICs will be evaluated annually and a determination will be made prior to the beginning of each wet weather sampling season.

Table 11: Wet Weather Stormwater Monitoring Fixed Locations*

Basin**	System ID	Functional Class	Trips per Day	Land Use
Fairview	3151-F-064	Collector	>1000	MRES
Fairview	3251-F-013	Residential	<1000	SFR
Columbia Slough	3148-W-014	Community	>1000	SFR/COM
Fairview	3150-F-030	Residential	<1000	SFR
Fairview	3153-F-040	Residential	<1000	SFR

* Sites and frequency subject to change contingent upon pending WPCF permit. No decrease in effort or resource allocation will be made should changes be proposed.

**Nonstructural BMPs and requirements for new and redevelopment are consistent throughout the City. Land use and trips per day are considered a better indicator of pollutants than surface water drainage basin.

6.4.3 Sampling Event Criteria

Prior to initiating a sampling event, the storm will be predicted and evaluated against the criteria listed below to assess whether the predicted storm should be targeted as Wet Weather Stormwater Monitoring event. Storm event criteria are as follows:

- Predicted rainfall amount of ≥ 0.2 inches per storm [NPDES MS4 permit B 1.d.ii(A) requires sampling to occur during storms > 0.1 ”];
- Predicted rainfall duration ≥ 6 hours; and
- Antecedent dry period ≥ 12 hours (as defined by < 0.1 inches of precipitation over the previous 12 hours; NPDES MS4 permit B.1.d.ii). When possible, samples will be collected after an antecedent dry period of 24 hours.

Based on experience and review of historic weather data related to stormwater monitoring in this region, storms meeting these criteria are expected to provide the volume of runoff necessary to implement sampling. Smaller storms, or storms of shorter duration, are considered to have a low probability of producing sufficient runoff to warrant the extensive preparation and mobilization time required for Wet Weather Stormwater Monitoring. It is likely that a sampled storm may not meet the target criteria listed above when the sampling event is completed, or that unpredicted events will occur that do meet the criteria. Thus, the criteria will be used as general guidance to determine when forecasted storms should be targeted for sampling.

Hourly and daily rainfall records are maintained and available on the HYDRA Data Report System. This data is available on the web at:

http://or.water.usgs.gov/non-usgs/bes/raingage_info/clickmap.html.

6.4.4 Frequency and Duration

As listed in **Section 6.4.2, Table 10**, a single sample will be collected annually for each of the 10 sites per year. As described in Section 6.4.3, storms not likely to result in enough runoff for samples from 5 sites to be collected will not be targeted. This will likely result in average pollutant concentrations that are slightly higher than the true average, because pollutant loads correlate with rainfall intensity.

6.4.5 Responsible Sampling Coordinator

This monitoring task is coordinated by the City of Gresham, who target events, calibrate equipment, perform in-situ field measurements, collect samples for lab analysis, and coordinate delivery to the lab. Laboratory analysis for instream samples is conducted by Portland's Water Pollution Control Laboratory under an IGA with the City of Gresham for laboratory services (see **Appendix F**).

6.5 Sample Collection and Handling

6.5.1 Sample Collection Method

As described in the NPDES MS4 permit Schedule B 1.d.ii(D), Co-permittees have selected grab samples for Wet Weather Stormwater Monitoring. The samples will be collected at each of the 10 locations to be sampled in a given year. Because of the spatial extent of this sampling effort (i.e., sites are distant from one another), composite sampling is infeasible. By focusing on a larger spatial area of the stormwater system sampled in a probabilistic manner over a period of hours, the large number of samples should reflect average conditions as well or better than collecting composite samples from fewer sites. Thus, the Co-permittees concluded that flow-weighted composites are scientifically unwarranted and are financially infeasible. To this end, the selection of smaller drainages for sampling allows for the evaluation of the influence of a variety of watershed characteristics, including, but not limited to land use, traffic patterns, and presence of utility poles which are known to leach pentachlorophenol.

6.5.2 Handling and Custody Procedures

For grab samples, samples are collected directly into the appropriate containers from the center of flow, when possible. If needed, samples will be collected using a clean stainless steel bailer attached to an extension rod. A separate laboratory-cleaned stainless steel bailer is used for each sampling location. Field measurements are made by collecting a representative sample using the stainless steel bailer and then pouring the sample into the measurement/storage cup of the multi-meter probe. Two bottles are field-filtered for ortho-phosphorus and dissolved organic carbon analyses.

Two-person clean sample collection techniques are followed to minimize the potential for contamination of samples: one person acts as “dirty hands” to move equipment, document field measurements, grab samples using the bailer and remove manhole lids; and one person acts as “clean hands” to fill sample bottles. The “clean hands” person wears powder-free nitrile gloves to avoid contamination of the sample and protect staff from possible health risks. If field blanks are

shown to demonstrate any contamination, then field protocols will be amended to reduce contamination.

All samples collected for laboratory analysis are immediately placed into a cooler containing ice and transported to the lab immediately following sample collection. **Table 12** lists the volume of sample collected, the container used and maximum holding time. Once samples are delivered to Portland’s Water Pollution Control Laboratory, they have their own QAPP to ensure that samples are analyzed within the proper holding time and preservation methods are employed.

For total Hg sampling, a version of field method 1669 is used (EPA 1996). This method is performance-based and allows for modification if contamination does not occur. Grab samples are collected as described below and will include field blanks. If field blanks are shown to demonstrate any contamination, then field protocols will be amended to reduce contamination. Samples are collected directly into the container when possible. If needed, samples will be collected using a clean stainless steel bailer attached to an extension rod. The stainless steel bailer is cleaned prior to each site using laboratory-grade soap and distilled water or rinsed 3 times with the water to be sampled at each site prior to sampling. Two-person clean sample collection techniques are followed to minimize the potential for contamination of samples: one person acts as “dirty hands” to move equipment, document field measurements, grab samples using the bailer and remove manhole lids; and one person acts as “clean hands” to fill sample bottles. The “clean hands” person wears powder-free nitrile gloves to avoid contamination of the sample and protect staff from possible health risks.

Table 12: Sample Containers and Holding Times for Wet Weather Stormwater Monitoring

Constituent	Minimum Sample Volume	Bottle Type	Holding Time
Conventional Constituents			
Biochemical Oxygen Demand (BOD ₅)	250 mL	Plastic	24 hours
Dissolved Organic Carbon (DOC)	125 mL	Amber Glass	28 days
Total Suspended Solids	500 mL	Plastic	7 days
Hardness/Total Alkalinity	250 mL	Plastic	6 months
<i>E. coli</i>	100 mL	Sterile Plastic	6 hours (max 24 hrs.)
Nutrients			
Nitrate Nitrogen	100 mL	Plastic	48 hours
Total Kjeldahl Nitrogen (TKN)	100 mL	Plastic	28 days
Ammonia Nitrogen	100 mL	Plastic	28 days
Total Phosphorus	100 mL	Plastic	28 days
Ortho-phosphorus	250 mL	Plastic	48 hours
Total Recoverable Metals			
Copper	400 mL	Plastic	6 months if preserved
Lead			
Zinc			

Mercury	250 mL	Plastic	28 days
Dissolved Metals			
Copper	400 mL	Plastic	6 months if preserved
Lead			
Zinc			
Pesticides			
2,4-D	250 mL	Amber Glass	14 days
Pentachlorophenol			

After samples have been obtained and the collection procedures properly documented, a written record of the chain of custody for each sample requiring laboratory analysis is completed. Information included on the chain of custody includes:

- Name of the persons collecting the sample(s)
- Date and time of sample collection
- Location of sample collection
- Names and signatures of all persons handling the samples in the field and in the laboratory
- Laboratory analysis requested and control information (e.g., duplicate or spiked samples etc.) and any special instructions (e.g., time sensitive analyses).

To ensure that all necessary information is documented, a chain of custody form will accompany each sample or set of samples and a copy of the form is retained. Each person who takes custody will sign and date the appropriate portion of the chain of custody documentation.

6.6 Constituents and Methods

The analytical methods and method reporting limits (MRLs) for constituents monitored for wet weather stormwater monitoring are listed in **Table 13**.

Table 13: Wet Weather Stormwater Monitoring Constituents, Methods, and MRLs

Field Constituents	Analytical Method	MRL**	Units
Temperature	SM 2550 B	-5	Degrees C
DO	SM 4500-OG	0.1	mg/L
Conductivity	EPA 120.1	1.0	µs/cm
pH	EPA 150.1	3.0	S.U.
Turbidity	EPA 180.1	0.05	NTU
Conventional Constituents			
Biochemical Oxygen Demand (BOD ₅)	SM 5210 B	2	mg/L
Total Suspended Solids	SM 2540 D	2	mg/L
Hardness/Total Alkalinity	SM 2340 B	0.5	mg/L as CaCO ₃
<i>E. coli</i>	COLILERT QT	10	MPN/100 mL
Dissolved Organic Carbon (DOC)	SM 5310B	1	mg/L
Nutrients			
Nitrate Nitrogen	EPA 300.0	1.10	mg/L

Total Kjeldahl Nitrogen*	PAI-DK03 ¹	0.20	mg/L
Ammonia Nitrogen	EPA 350.1	0.02	mg/L
Total Phosphorus	EPA 365.4	0.02	mg/L
Ortho-phosphorus	EPA 365.1	0.02	mg/L
Total Recoverable Metals			
Copper	EPA 200.8	0.2	µg/L
Lead	EPA 200.8	0.1	µg/L
Zinc	EPA 200.8	0.5	µg/L
Mercury	EPA 1631E or WPCLSOP M-10-02* ²	0.0005	µg/L
Dissolved Metals			
Copper	EPA 200.8	0.2	µg/L
Lead	EPA 200.8	0.1	µg/L
Zinc	EPA 200.8	0.5	µg/L
Pesticides			
2,4-D	EPA 515.3	0.2	µg/L
Pentachlorophenol	EPA 515.3	0.08	µg/L

* TKN is not required in Table 2 of the NPDES MS4 permit, so is subject to the Adaptive Management process described in **Section 1.4**.

** Method Reporting Limit

¹ The PAI-DK03 method for TKN is a 40 CFR 136 method (flow injection gas method, see footnote 41, Table 1B, 40 CFR Part 136.3).

² The WPCLSOP M-10.02 method cited for total Hg is EPA 200.8 w/CEM digestion (footnote 4, Table 1B, 40 CFR Part 136.3).

6.6.1 Pesticides

The list of pesticides in the NPDES MS4 permit, Schedule B, Table 2, Special Condition 9 has been considered for Wet Weather Stormwater monitoring. Due to previous analysis and past results, 2,4-D and pentachlorophenol will continue to be monitored at all sites and events. Three additional pesticides will each be monitoring at a minimum of 10 sites and one event during the permit term: bifenthrin, fipronil, and triclopyr. These three pesticides may be used throughout the year and are either highly toxic to aquatic organisms (bifenthrin and fipronil) or are used frequently and detected in past stormwater samples (triclopyr).

Due to the sample collection timing and drainage area characteristics for Wet Weather Stormwater monitoring, it is likely that all or most of the other pesticides listed in the NPDES MS4 permit, Schedule B, Table 2, Special Condition 9 would not be detected in Gresham's Wet Weather Stormwater monitoring, as described below. However, these pesticides do have the potential to enter waterways in harmful amounts through stormwater runoff, and data on prevalence of these pesticides in surface water would be valuable. Therefore, these pesticides will be monitored at Instream locations during either the spring Instream event or a separate instream storm event, as described in section 3.6.1. It is anticipated that this approach will provide more

useful information regarding pesticides than the likely results of including it in the Wet Weather Stormwater monitoring.

Wet Weather Stormwater monitoring in Gresham is designed to capture runoff from a fall flushing event at sites with very small drainages. This allows for analysis of differences between sites with very specific characteristics, such as a single land-use, or traffic volume. The major differences found 2009-2021 have been between high traffic and low traffic roads. The sampling locations often comprise only one or two catch basins, meaning the catchment areas are typically only a few properties with the same land-use. The small catchment areas make it statistically unlikely that one of those properties applied a pesticide in the days before the sampling, particularly when the timing for fall sampling is generally out of sync with the application of many of the target pesticides. The 2009-2021 Wet Weather Stormwater data indicated that the majority of detections occurred when samples were collected in the spring after a warm, dry period where pesticides were likely applied. Because the current sampling plan for Wet Weather Stormwater monitoring is to sample a large storm in the fall, it is likely to miss most pesticide applications.

Some of the target pesticides listed in the NPDES MS4 permit, Schedule B, Table 2, Special Condition 9 are principally agricultural pesticides which are unlikely to be generated by urban land uses, such as atrazine, simazine, and chlorpyrifos. Restricted use pesticides with uses that are primarily agricultural are unlikely to be detected in Wet Weather Stormwater samples of small urban catchments, but data on their presence in streams with mixed urban/agricultural inputs would be valuable.

6.7 Quality Control Procedures

6.7.1 Quality Assurance

The data quality objectives for field measurements are listed in **Table 14**. Precision and accuracy are referenced from the DEQ Data Quality Matrix. Because field measurements for temperature, pH, DO and conductivity are made using a multi-meter probe, precision between replicates is usually not assessed since meter values are continuously assessed and not documented until they stabilize. Accuracy for field measurements is determined by measuring standards before and after each sampling event and assessing deviation from the standard in comparison to accuracy ranges in **Table 14**.

Table 14: Accuracy and Precision Targets for Stormwater Field Measurements

Parameter	Precision	Accuracy	Measurement Range
Temperature	± 1.0 °C	± 0.5 °C	-5 to 45 °C
pH	± 0.3 SU	± 0.2 SU	0 to 14 SU
Dissolved Oxygen	± 0.3 mg/L	± 0.2 mg/L	1 to 50 mg/L
Conductivity	± 10% of Std. Value	± 7% of Std. Value	0 to 200 mS/cm
Turbidity	± 5% of Std. Value ± 1 NTU if NTU <20	± 5% of Std. Value	0 to 1000 NTU

Analytical methods for grab samples analyzed at Portland's Water Pollution Control Laboratory use an appropriate balance of quality assurance/quality control measures, including replicates, blanks, spiked samples and other measures approved under 40 CFR 136 to ensure that data meet quality objectives appropriate for compliance with state and federal regulatory requirements. A copy of the WPCL's QAPP is included in **Appendix G**.

Field duplicate samples will be collected at a minimum of 10% of the total number of monitoring locations (1 duplicate for every 10 sites). For wet weather stormwater sampling, one lab replicate will be collected from one of the 10 stormwater sampling sites. Any data or sample values outside of the expected range for the constituent being measured will be rechecked for validity with the laboratory or in the field by the field team as appropriate. Data that continue to be outside the expected values will be further investigated to determine the cause.

Duplicate measurements are not collected for field constituents (DO, pH, temperature, conductivity, turbidity). Instead, quality assurance for field constituents will be assessed by calibrating the equipment prior to mobilization on the day of the monitoring event and by measuring equipment with a known standard after each monitoring event to measure how accurately the equipment can still read the standard within the accuracy ranges specified in **Table 14**.

Field blanks will also be collected for 10% of sampling mobilization events. Equipment blanks will be generated annually by the City of Portland WPCL to ensure that equipment and bottles provided by the lab are not producing false positive readings.

6.7.2 Representativeness

Stormwater samples are collected from the center of the flow to obtain a well-mixed sample representative of the stormwater conditions. Sampling sites are selected using the GRTS study design, so data collected using this random and spatially balanced approach is assumed to be representative of conditions within the entire permit area.

6.7.3 Comparability

The objective is to ensure that collected data are either directly comparable, or comparable with defined limitations, to literature data or other applicable criteria. Wet Weather Stormwater samples are collected and analyzed in the same manner as those collected for Instream Monitoring and Structural Best Management Practice Monitoring. Grab samples are analyzed at Portland's Water Pollution Control Laboratory to minimize variability and increase comparability of data collected on streams flowing through both jurisdictions. Portland utilizes the GRTS approach in the selection of their stormwater sampling locations, so regional assessment of stormwater data will be possible based on using a similar study design.

6.7.4 Completeness

Completeness is a measure of the amount of valid data obtained from the analytical measurement system compared to the amount that was expected to be obtained. It is defined as the total number of samples taken for which valid analytical data are obtained divided by the total number of samples collected and multiplied by 100.

Based on QA/QC procedures outlined in this Stormwater Monitoring Plan, the Wet Weather Stormwater monitoring goal is to achieve a 100 percent complete data set for all analyses. It is anticipated that 10 samples will be collected annually. Over the 5-year permit term, 50 samples will be collected consisting of 5 monitoring locations being “fixed” sites monitored each year and 25 spatially balanced and random sites selected probabilistically that are each monitored once. It is understood that due to unforeseen circumstances some results may be lost. Field and Laboratory staff will attempt to minimize data loss to the best of their ability by carefully following all protocols and procedures. If data sets are not 100 percent complete for this study, analyses will be evaluated on a case by case basis to determine whether the project needs to collect additional samples.

6.7.5 Instrument Inspection and Maintenance

Field sampling equipment is inspected before and after each monitoring event. The multi-meter and turbidimeter will be cleaned and maintained according to the manufacturer’s guidelines. Multi-meters will be professionally inspected, maintained and calibrated annually by Quality Control Services (2340 SE 11th Ave, Portland, OR. 503-236-2712).

Portland’s Water Pollution Control Laboratory performs inspection and maintenance of laboratory instruments used for analysis of grab samples. A copy of the WPCL’s QAPP is included in **Appendix G**.

6.7.6 Instrument Calibration

The multi-meter probe used to collect field measurements (temperature, pH, DO, and conductivity) will be calibrated prior to each event at mobilization. pH will be calibrated using a 3-point calibration (pH 4, 7 and 10 buffers). Conductivity will be calibrated using a standard within the range of expected measurement (typically 100 $\mu\text{S}/\text{cm}$). DO will be calibrated using percent saturation at the current barometric pressure. Meter calibration will be recorded in an electronic calibration log. Meters will be calibrated halfway through the monitoring event if the accuracy of the meter drifts during the monitoring event. After each sampling event the meter will be measured against known standards to check measurement accuracy.

The turbidimeter will be calibrated annually. Prior to each sampling event, the meter will be measured against known secondary Gelex sample standards to ensure accuracy. Readings will be recorded in the electronic calibration log.

Portland’s Water Pollution Control Laboratory performs calibration of laboratory instruments used for analysis of grab samples. A copy of the WPCL’s QAPP is included in **Appendix G**.

6.8 Data Management, Review, Validation and Verification

6.8.1 Data Management

All analytical results and applicable field measurements including field data sheet information will be stored in Gresham’s master Monitoring Program database. Lab data will be reviewed and entered as soon as practicable, with data entry and analysis always taking place annually for meeting NPDES MS4 annual reporting requirements. Final reporting will be performed in conjunction with the NPDES Annual Report and the permit renewal to assess stormwater status.

Periodic analysis of data may also occur to assess whether adaptive management of the Monitoring Plan or program is appropriate as described in **Section 1.4**.

6.8.2 Data Review, Validation and Verification

The data will be reviewed and input by the sampling team leader within 5 days of receipt from the lab. Values are compared against water quality standards, as well as the Pollutant Parameter Action Levels described in section 6.8.3. Once the data has been entered in the monitoring program database, the Monitoring Program Coordinator will proofread it against the original field data sheets. Statistical and graphical analysis may be used to reveal whether keystroke errors occurred during data entry. Potential errors in the database will be checked against field data sheets and lab reports. Once verified, errors in data entry will be corrected at that time. Outliers and inconsistencies will be flagged for further review, investigation, and if appropriate, discarded. Data quality problems will be discussed as they occur and in the final report to data users.

Reconciliation with data quality objectives as noted above will be performed as soon as possible after each sampling event. Calculations and determinations for precision, completeness, and accuracy will be made and corrective action implemented if needed. If data quality indicators do not meet the monitoring program's specifications, data may be discarded and re-sampling may occur. The cause of the failure will be evaluated. If the cause is found to be equipment failure, calibration and/or maintenance techniques will be reassessed and improved. If the problem is found to be sampling team error, field techniques will be assessed, revised and retrained, as needed.

6.8.3 Pollutant Parameter Action Levels

In order to more rapidly identify and respond to potential issues, Gresham developed "action levels" to identify when the lab would immediately notify the monitoring coordinator so that staff could respond promptly to potential issues (Table 7). The process of developing the action levels is described in Section 3.8.3.

When a Wet Weather Stormwater monitoring result exceeds an action level, staff will begin investigating potential sources within 48 hours of becoming aware of the exceedance. Investigations may include searching the catchment area for possible sources or collecting additional samples. DEQ will be notified if/when a source is identified that is causing or contributing to stormwater pollution.

7.0 DRY WEATHER FIELD SCREENING

7.1 Project/Task Organization

As required by the NPDES MS4 permit Schedule A 3.c.v, Dry Weather Field Screening is part of an overall Illicit Discharge Detection and Elimination (IDDE) program and refers to the annual inspection of priority outfalls during the dry season. The screening includes documentation of visual observations, uncharacteristic odors and certain field measurements (if sufficient flow is observed). Water quality samples will be collected for laboratory analyses when field screening test values exceed the Co-permittee's protocol.

7.2 Monitoring Objectives

7.2.1 Monitoring Question and Background

The goal for dry weather screening is to identify illicit discharges to the MS4 system. Dry Weather Field Screening seeks to answer the questions "What is the significance of illicit discharges in the permit area?" and "Have illicit discharge elimination programs been successful in reducing problems?" Illicit discharge sources may vary, but of primary interest are wastewater cross connections, floor drains or catch basins capturing wash water or fluids from industrial or commercial facilities, and spills and dumping. Flows from non-stormwater discharges such as landscape irrigation and car washing are addressed by the Co-permittee's education and outreach program and are not a priority for follow-up response given limited staff resources and the limited potential for harm. Note that annual assays are less likely to catch spills and dumping than illicit connections, since the former are typically intermittent.

During permit years 1-10, alternate screening protocols were employed including screening on different days of the week and times of day to see whether discharges due to spills and dumping were more likely to be caught in the evening or on weekends than during the workweek; however no temporal differences were observed. In 2003-2005, Gresham hired contractors to investigate the piped system in industrial and commercial areas using closed circuit television, with the goal of identifying all cross connections. No illicit cross connections were identified. As part of the City's ongoing asset management work which uses small, closed circuit television equipment (CCTV) to inspect pipes throughout the city, camera operators look for potential cross connection and then work on investigative follow up.

Dry weather screening will address the following four monitoring objectives from the permit, in addition to other dry weather field screening requirements that are listed in the permit under Schedule A 3.c.v.

- Objective 1. Evaluate the source(s) of and means for reducing the pollutants of concern applicable to the co-permittees' permit area, including 2018/2020 303(d) listed pollutants, as applicable*
- Objective 2. Evaluate the effectiveness of Best Management Practices (BMPs) to assist in identifying BMP priorities;*
- Objective 3. Characterize stormwater runoff discharges based on land use, seasonality, geography or other catchment characteristics;*

Objective 5. Assess the chemical, biological and physical effects of MS4 stormwater discharges on receiving waters;

7.2.2 Data Analysis Methodology and Quality Criteria

Dry Weather Field Screening data is continually evaluated to determine the range of values typically present in non-stormwater discharges found in the MS4 during the dry season. After 15 years of screening values, follow up laboratory testing, and tracing sources back to permitted, natural, or illicit sources, the outliers in the field screening data were used to establish the evaluate where Pollutant Parameter Action Levels described in **Section 7.5.3**.

7.2.3 Assumptions and Rationale

Dry Weather Field Screening is most likely to detect illicit connections to the storm system rather than identify pollutants related to spills or dumping. In the past, Gresham used closed circuit television (CCTV) equipment to inspect high priority commercial and industrial areas, including some major arterials and the downtown area for cross connections with the wastewater system. In addition to high priority outfall dry weather screening for Gresham and Fairview, currently, Gresham conducts periodic camera inspections of pipes, and video inspects all new piped systems that will become publicly owned to the point of the private connection within its boundary and the City of Fairview conducts inspections within its boundary of additional outfalls annually. Conducting dry weather screening following a sufficient dry period will allow for the identification of any additional on-going discharges that result in discoloration, odor or changes over background in field screening tests.

7.2.4 Relationship to Long-term Monitoring Program Strategy

Dry Weather Field Screening provides an opportunity for monitoring staff to evaluate the Co-permittee's major pipesheds on an annual basis. This monitoring activity helps the Co-permittees identify potential sources of pollutants that exist within the storm system that could potentially be contributing to pollutant loads observed during Wet Weather Stormwater Monitoring (**Section 6.0**). Since the IDDE Program's inception in 1995, Gresham has identified very few illicit discharges, and as such prefers to limit the amount of staff time devoted to this activity in order to balance competing permit requirements and given the resource limitations with regard to staff and financial resources.

7.3 Documentation and Record-keeping Procedures

Consistent with permit requirements, the Co-Permittees will retain records of all monitoring information, including: all calibration, major maintenance records, all original data, copies of all reports required by the NPDES MS4 permit, and records of data used to complete the application for the NPDES MS4 permit for a period of at least 5 years from the date of the sample, measurement, report, or application.

7.4 Monitoring Process/Study Design

7.4.1 Study Design

The Co-permittees have identified all priority outfalls within the permit area based on more inclusive criteria than the original description in the code of federal regulations. The original program identified major outfalls as 36" or greater, but the Co-Permittees have also selected some

outfalls that are smaller. The goal of dry weather screening is to determine whether any illicit discharges are present at the outfalls as illustrated in **Figure 2**. A combination of visual observations and field measurements is used to determine the source of any non-stormwater discharge present. The Co-permittees have a process for tracing sources and following up on any suspected illicit discharges identified through the screening process that is described in **Section 7.6.2**.

7.4.2 Monitoring Locations

The Co-Permittees will continue to perform dry-weather outfall monitoring at a revised list of priority outfalls originally identified in the Part II NPDES MS4 Application dated May 17, 1993. Revisions to the original outfall list account for upgrades to the MS4 system which have been made since 1993. The Co-permittee’s proposed list of priority outfalls to be screened during this permit term is provided in Table 15. The eight priority locations are located at the outfall or at the most accessible downstream location from any potential source of suspected illegal or illicit activity that might occur within major pipesheds. Twenty-two sites/year will be from a rotating panel of outfalls >12”. There are five panels and therefore each outfall in the City >12” will be visited at least once every five years.

Eight fixed Dry Weather Screening Locations are listed in **Table 15** and in **Figure 2**. Sites were selected from the 30 priority outfalls previously monitored after data analysis. These outfalls were the most likely to have illicit discharges due to land use within the drainage area and findings from past years. These fixed sites are distributed between the Columbia Slough, Fairview Creek, and Johnson Creek watersheds. Staff will monitor 22 additional outfalls each year. These outfalls will consist of panels containing all outfalls >12”. Experience has shown that smaller outfalls typically drain only a handful of properties and are unlikely to produce illicit discharges. By focusing on outfalls >12”, all areas of the City will be assessed throughout the permit term.

Figure 3 shows locations where groundwater discharge has been observed as of 2021 at Dry Weather Screening locations. Sites listed as Chronic have frequently had parameters outside of the action levels. Both locations identified as chronic are situated at historic landfills which are suspected of contributing to the parameter values.

Table 15: Fixed Illicit Discharge Monitoring/Dry Weather Screening Locations

Site ID	Location	Watershed	Channel Type	Land Use
D2A	MH south of NE 181st Ave Bridge (CSO1) (Drains 181st St)	Columbia	MH	I/C
F2	OF @ Sandy (open channel) north of Boeing (Stormdrain Cr)	Columbia	MH	I/C
G1	Boeing Outfall (east outfall entering CSWQF)	Columbia	OF	I/Ag
3250-F-004	Manhole at inlet to Fairview Creek facility	Fairview	MH	C/R
N15B	NE Elliott & Powell, north bank of trib to Johnson	Johnson	OF	R/C
J18A	OF @ Eastman/Towle on South side of Johnson Creek	Johnson	OF	R
M16	West OF in Main City Park (JCOS1)	Johnson	OF	C
N16	East OF in Main City Park (JCO3)	Johnson	OF	C/R

Channel Types

OF = outfall

MH = manhole

Land Uses

R = residential

I = industrial

C = commercial

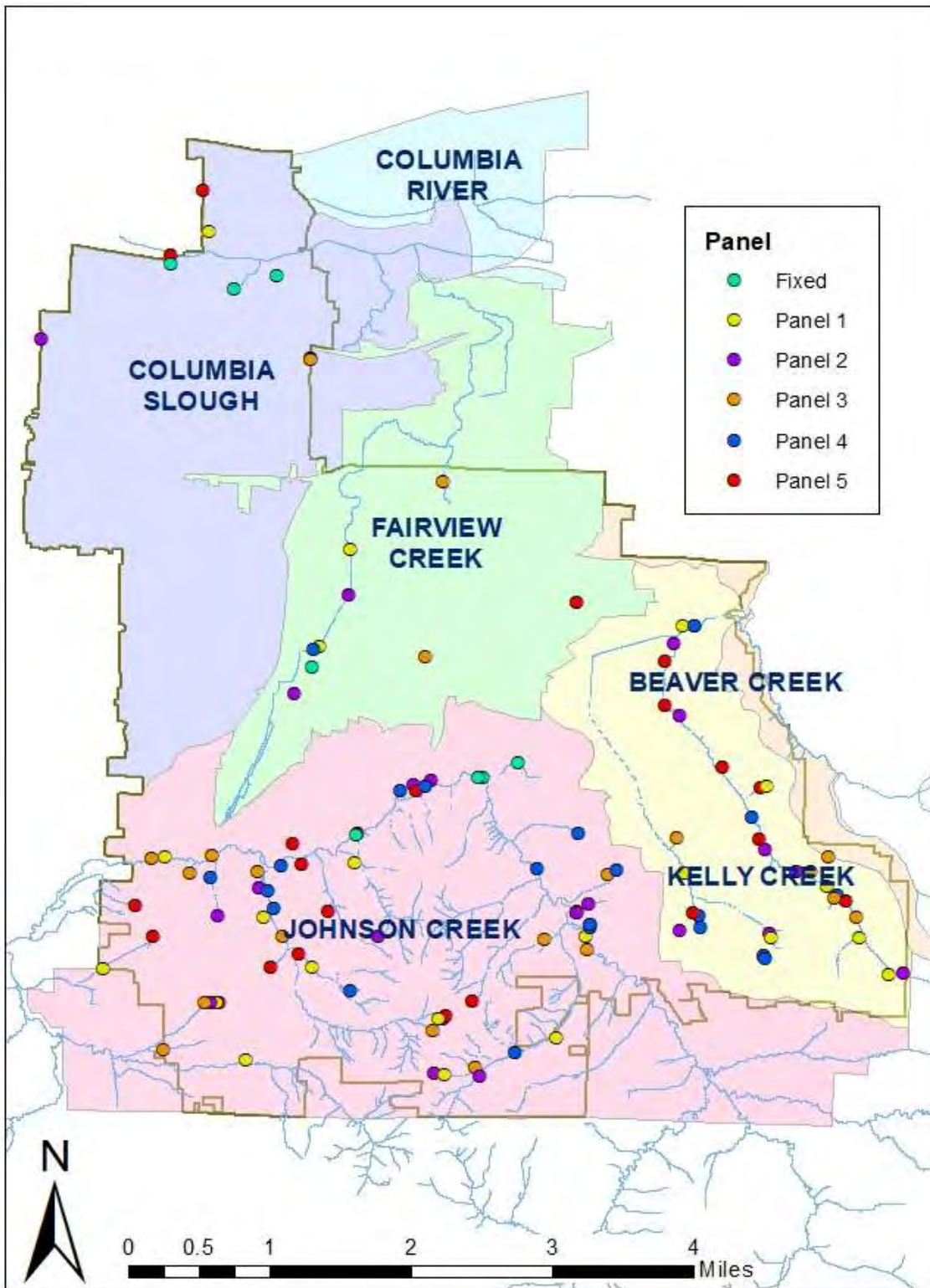


Figure 2. Dry Weather Screening Locations

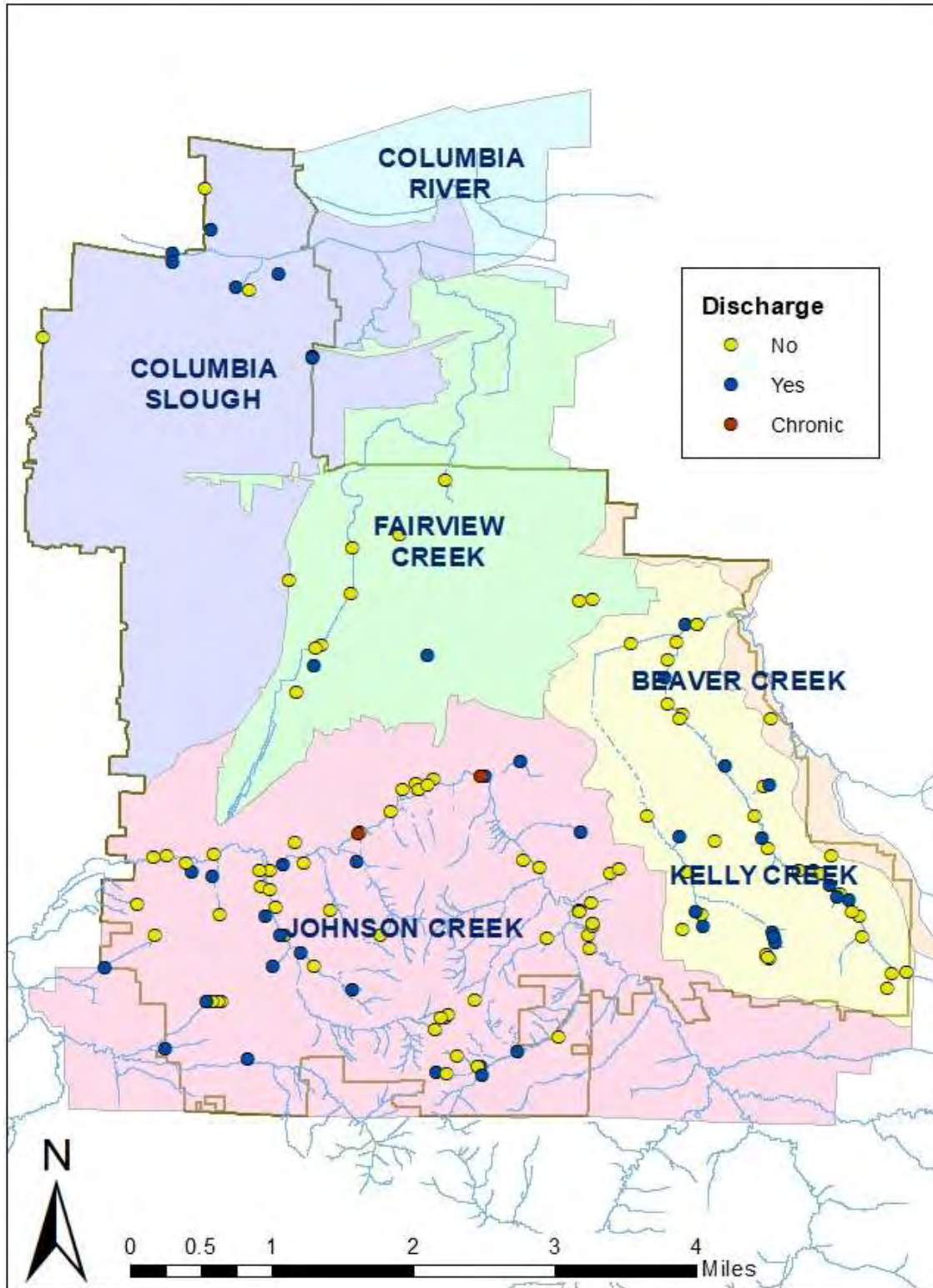


Figure 3. Dry Weather Screening Discharge History.

7.4.3 Sampling Event Criteria

Dry weather screening will be conducted during the dry summer months, typically during July, August or September. As required by the permit, dry weather screening will be conducted following at least a 72-hour antecedent dry period.

7.4.4 Frequency and Duration

Dry weather field screening will be conducted one time annually at each of the locations listed in **Table 15**. Sampling frequency may be adaptively managed as additional outfalls are assessed.

7.4.5 Responsible Sampling Coordinator

This monitoring task is coordinated by the City of Gresham's Water Resources Division on behalf of Gresham, who target proper dry weather conditions, calibrate equipment, perform field observations and screening, collect samples for lab analysis, and coordinate delivery to the lab. Laboratory analysis for any sample collected for laboratory analysis is conducted by Portland's Water Pollution Control Laboratory under an IGA with the City of Gresham for laboratory services (see **Appendix F**).

7.5 Dry Weather Screening Activities

7.5.1 General Observations

For each of the sites listed in **Section 7.4.2.**, **Table 15**, the following conditions are noted – odor, color, clarity, floatable, deposit/stains, vegetative condition (if applicable), structural condition, biological, and other observations that may indicate presence of non-stormwater or illicit discharges.

7.5.2 Field Screening

When flow is present, a sample will be collected and screened for illicit discharges using field measurements of temperature, pH, conductivity, turbidity, ammonia, and chlorine. If any of the observations or screening data indicate an illicit discharge may be present, the source is investigated within the drainage system. If a source cannot be identified or the pollutant parameter action level indicates there is a need for additional information, a sample may be collected and sent to the laboratory for analysis.

7.5.3 Pollutant Parameter Action Levels

As described in **Section 7.2.2**, field observations and screening values are compared against historic information for each monitoring location and the system. Screening values which indicate that an illicit discharge may be present will be investigated using the process described in **Section 7.6**. **Table 16** contains the pollutant parameter action levels and suspected sources the Co-permittees will investigate based on action levels.

The Co-permittees have evaluated field screening constituents listed in **Section 7.5.2** as required in Schedule A 3.c.v. The values in Table 15 are based on evaluation of Dry Weather Screening data and Herrera's 2013 Illicit Discharge Indicator Thresholds Memo which reviewed the literature as well as jurisdictional levels.

Table 16: Pollutant Parameter Action Levels

Parameter	Action level	Suspected Source and Action
Ammonia nitrogen	> 0.5 mg/L	Presence of ammonia >0.5 mg/L likely indicates sewage, industrial waste or pets/wildlife. Action: conduct source identification investigation looking for upstream bacteria or waste source.
Total chlorine	> 0.5 mg/L	Presence of chlorine, absent other parameters that exceed action levels, likely indicates municipal treated water, a discharge of municipal water, residential car washing, or pool/hot tub water. If greater than action level, conduct source identification investigation looking for pool or nearby irrigation discharge to system.
Turbidity	> 15 NTU	Turbidity is a supplemental measurement that is not conclusive by itself, but may help identify problem outfalls that merit follow-up. Turbidity above the action level may indicate whether discharge consists of something other than tap water or groundwater. Action: conduct source identification investigation looking for upstream sediment source.
Conductivity	> 300 μ S/cm	Conductivity is a supplemental measurement that is not conclusive by itself, but may help identify problem outfalls that merit follow-up. If turbidity is high, conductivity may indicate whether the turbidity is due to dissolved substances rather than fine particulates. Groundwater typically has higher conductivity than clean stormwater, so conductivity will rarely be indicative of pollution on its own. Action: conduct source identification investigation and, if needed, collect lab sample for appropriate pollutants based on suspected pollutants.
pH	Outside 6.5-8.5	pH is a supplemental measurement that is not conclusive by itself, but may help identify problem outfalls that merit follow-up. In combination with other screening levels, actions may include conduct source tracing and, if source not found, collect lab sample for pollutants suspected to cause or be associated with pH levels. Discharge sources that may cause high or low pH include among others: natural sources (bacteria, algae) and certain industrial discharges.
Temperature	> ambient air temperature	Water warmer than ambient air temperature may indicate a human-caused heat source.
Flow	Water level above base flow level indicated by pipe staining	Conduct source identification investigation within upstream pipeshed, by lifting manhole lids and checking flow volume against pipe staining level.

7.5.4 Laboratory Analysis

Water quality samples will be collected for additional analysis when visual observations or field screening tests indicate a potential pollutant for which the source cannot be identified through source identification investigation (Section 7.6). Typically, this will be determined after source identification investigation has occurred, and no discharge source has been identified. However, there can be cases in which none of the field measurements exceed action levels, but sensory observation indicates the presence of pollutants. Additional analyses may consist of bacteria, metals, nutrients, phenols, hydrocarbons or other analyses deemed appropriate based on observations and field screening. Analyses are deemed appropriate if the pollutant relates to a suspected type of source or discharge; or known land uses or activities in the pipeshed. Once water quality results are received from the lab—which is typically several days to weeks after samples were taken, additional source identification investigation may occur.

7.6 Source Identification Investigation

7.6.1 Source Tracing

If any of the observations or field screening outlined in **Section 7.5** indicate an illicit discharge may be present, the source is investigated within the drainage system using GIS mapping to illustrate the stormwater system and corresponding tax lots and follow the system upstream to investigate. Upstream points such as manholes and catch basins will be observed visually for connections to the system. Based upon experience, staff generally investigate a minimum of ¼ mile and up to ½ a mile from the screening location or until flow is no longer observed and/or no probable source can be identified for further investigation, which are described below in **Section 7.6.2**.

If general observations, field screening action levels, or source tracing indicate that the flow present is a non-stormwater discharges as described in the NPDES MS4 permit Schedule A 3.c.v, an illicit discharge investigation (**Section 7.6.2**) will not be conducted. Some of the most commonly occurring non-stormwater discharges include: landscape irrigation, lawn watering, discharges from potable water sources, residential car washing, charity car washing, flows from diverted streams or wetlands, springs, infiltration or pumping of groundwater, foundation drains, and footing drains.

7.6.2 Illicit Discharge Investigation

When field screening indicates there may be an illicit discharge to the MS4, the upstream area will be inspected in an attempt to identify the pollutant(s) source. The level of effort staff spend investigating potential illicit discharges will be evaluated on a case-by-case basis, but will consider the following factors:

- Volume and extent of discharge (detectable at outfall to waters of state, or only in localized area within pipe system);
- Frequency and duration of discharge (isolated episode, intermittent, or ongoing);
- Suspected type of discharge (determined by screening criteria – color, smell, water quality measurements); and
- Risk and potential to impact surface water quality or harm human health or aquatic life.

Some discharges detected during dry weather screening may be deemed to be low risk to the MS4 based on the above listed criteria. If a source cannot be identified with a reasonable amount of effort, it may be determined that the risk from the discharge is low enough that the effort needed to identify the source is not cost-effective, and that other measures (e.g., inspections or outreach programs to educate and prevent against dumping and spills) are a better expenditure of program resources. Small or episodic contributions to the MS4 can be deemed *de minimus* after city staff have expended a reasonable amount of investigational effort with no positive results.

Sources that are deemed to pose a moderate or high level of risk to the MS4 or waters of the state due to either the quantity or type of pollutant will be investigated immediately and will receive a high level of effort. In addition to visual investigation of the upstream system, water flushing, dye testing, closed circuit television, or other such methods may be used to aid in source identification. Additionally, if any field screening action level indicates a need for additional information, a sample may be collected and sent to the laboratory for analysis.

If the suspected illicit discharge is deemed to be a threat to water quality and originates from private property, permission for inspection may be required from the property owner or tenant; if denied, an Administrative Inspection Warrant can be obtained within 3-5 days.

Once a source has been identified, an initial evaluation to eliminate the discharge will be completed within 5 working days. If the elimination of the illicit discharge will take more than 15 working days due to technical, logistical or other reasonable issues, an action plan to eliminate the discharge in an expeditious manner will be created. The action plan will be completed within 20 working days of determining the source of the illicit discharge and submitted to DEQ as required by the permit. City Code allows for the use of civil penalties and/or abatement for stormwater violations where a responsible party has been identified and provided with direction from the City with regard to gaining compliance, but has not complied within the specified timeframe.

To this end, the permit further requires that illicit discharges entering or exiting one Co-permittee's area into the other requires notification to the affected jurisdiction within one working day.

7.7 Data Management, Review, Validation and Verification

7.7.1 Data Management

All applicable field observations and measurements will be stored in Gresham's dry weather screening database. Field observations and screening data are typically entered directly into the database during dry weather field screening activities. When laboratory analysis is conducted, data will be reviewed and entered as soon as practicable so that follow up source identification investigation can take place.

Dry weather field screening data entry and analysis will occur annually and will be reported to DEQ with the NPDES MS4 Annual Report. Periodic analysis of data may also occur to assess whether adaptive management of the Monitoring Plan or program is appropriate.

7.7.2 Data Review, Validation and Verification

Once the data has been entered in the monitoring program database, the Monitoring Program Coordinator will review the data to determine if all values are within the expected range, and detect any outliers due to keystroke errors during data entry. If the error can be identified, errors in data entry will be corrected at that time. Outliers and inconsistencies will be flagged for further review, investigation, and if appropriate, discarded. Data quality problems will be discussed as they occur and in the final report to data users.

8.0 STRUCTURAL BEST MANAGEMENT PRACTICE MONITORING

8.1 Project/Task Organization

Structural Best Management Practice Monitoring refers to the effectiveness monitoring of structural BMPs recently constructed by the City of Gresham. The city currently has numerous “centralized facilities” that manage stormwater at a neighborhood or regional scale. Since the City allows centralized facilities (typical dry and wet ponds) in the Stormwater Management Manual, so assessing the effectiveness of these facilities is important for the adaptive management of Gresham’s stormwater program, as well as for refining the values used in TMDL pollutant reduction benchmarks. The City also allows other structural BMPs in the Stormwater Management Manual, such as pervious pavement and media options for stormwater planters, where additional data would help inform the City’s policies and requirements.

Some of the Structural BMPs and facilities that have been monitored, or will continue to be evaluated, through the Structural BMP Monitoring effort include:

The **Fairview Creek Water Quality Facility (FCWQF)** provides stormwater treatment for a combined drainage area of approximately 959 acres of residential, commercial, and industrial development that previously discharged partially treated stormwater (e.g., catch basin filters and street sweeping) directly to Fairview Creek. The single large outfall, which is now the inlet to this BMP, was previously monitored as part of the land use based monitoring performed in permit years 1, 2 and 3 during the first 5-year permit cycle, and continued as a stormwater outfall monitoring site (mixed land use) in permit years 7, 8, 9, and 10.

The **Columbia Slough Water Quality Facility (CSWQF)** provides stormwater treatment for a combined drainage area of approximately 709 acres of primarily commercial and industrial development that previously discharged partially treated stormwater (e.g., catch basin filters and street sweeping) directly to the Columbia Slough. There are 2 major outfalls that drain similar land uses that discharge to this facility. Since the facility contains multiple components, including sedimentation forebays, vegetated swales and holding cells for base and low flows, as well as wetland detention with emergent vegetation, and riparian forest for periodic inundation, monitoring of the facility would provide pollutant removal effectiveness for this specific large-scale facility. Additionally, this facility has changed greatly through time as a population of beavers has moved in and altered flow paths. Monitoring throughout these changes has demonstrated that the beaver activity has improved pollutant removal performance of this facility and has informed management actions.

The **Kelly Creek Regional Water Quality Facility** is an in-line facility in Kelly Creek that drains into Beaver Creek. It was retrofitted in 2013-2014 to improve water quality in a stream that receives water from mostly residential use. Monitoring from before and after the retrofit indicated that water quality was generally improved.

The **Brookside Regional Facility** was constructed at the base of a new housing sub-division project in Pleasant Valley area. It contains a meandering swale within a detention pond that was designed to slow water and allow for longer contact time with plants and soil before entering Kelley Creek.

Between 2015 and 2021 several new regional or neighborhood-scale facilities have been constructed in the Pleasant Valley (Sunset Village and Ponza) and Springwater (Brickworks and Skyliner) areas. Each of these facilities has a unique design; therefore, collecting monitoring data that allows for an evaluation of each facility’s effectiveness for stormwater pollutant removal will inform future design and management policies.

In addition to regional constructed wetlands, the City of Gresham is interested in understanding the pollutant removal capabilities of other structural BMPs such as pervious pavement and stormwater planters with various media types.

Kane Road Pervious Pavement retrofit. Kane Road is a major arterial road which drains into Kelly Creek. It is a truck route with ~30,000 vehicle trips per day. In 2008 a ½-mile section of the road was paved with a pilot project of pervious pavement. One section was full-depth pervious with an underdrain while another section was a 3” pervious overlay on top of conventional asphalt. BMP monitoring of this road has demonstrated remarkable pollutant removal capabilities, especially of suspended solids, total phase metals, and poly-cycle aromatic hydrocarbons (PAHs). Continuing to monitor this and other pervious pavement installations will help to inform where this technology may provide pollution reduction.

Streetside stormwater planters are common throughout new and redevelopment in Gresham. The media used in these facilities can affect drainage, plant health, and pollutant removal. BMP monitoring of various media types has informed media specifications to allow for multiple benefits.

8.2 Monitoring Objectives

8.2.1 Monitoring Question and Background

Structural BMP effectiveness monitoring is intended to answer the question “How effective are the various structural BMPs that are being implemented throughout the permit area at reducing pollutants?” The City of Gresham plans to examine the performance of at least one of the structural BMPs recently constructed to enhance water quality. As shown in **Appendix A**, Structural BMP monitoring contributes to meeting NPDES MS4 monitoring objectives 1, 2, 3, and 6.

- Objective 1. Evaluate the source(s) of and means for reducing the pollutants of concern applicable to the co-permittees’ permit area, including 2018/2020 303(d) listed pollutants, as applicable;*
- Objective 2. Evaluate the effectiveness of Best Management Practices (BMPs) to assist in identifying BMP priorities;*
- Objective 3. Characterize stormwater runoff discharges based on land use, seasonality, geography or other catchment characteristics;*
- Objective 6. Assess progress towards reducing TMDL pollutant loads.*

8.2.2 Data Analysis Methodology and Quality Criteria

Structural BMP Effectiveness Monitoring requires a paired sampling design, with the event mean concentrations being compared for influent and effluent. Because stormwater data typically

doesn't follow a normal distribution, a nonparametric statistic, such as Mann-Whitney, will be used to compare the influent and effluent concentrations to determine if there is a significant change in stormwater quality. The current TMDL benchmark approach requires calculation of an effluent concentration for specific BMPs, so the effluent concentrations from various events will be evaluated for central tendency and variability. To capture both averages and variability, staff will collect a minimum of three grab samples spread throughout the storm at each site during each event.

8.2.3 Assumptions and Rationale

Based on other BMP effectiveness studies (see International BMP Database), influent concentrations are more variable than effluent concentrations. Based on this assumption, enough data may be collected to accurately represent the mean effluent concentration after monitoring 2 events per year for 3-5 years (6-10 events total).

8.2.4 Relationship to Long-term Monitoring Program Strategy

The structural BMP Effectiveness Monitoring described in this section provides a direct measure of innovative regional CIP projects constructed to treat stormwater within the permit area. The two facilities described in this section are each composed of a different series of BMPs (FCWQF has sedimentation forebay → wet detention pond → constructed wetland; CSWQF has sedimentation manhole → sedimentation forebay → series of terraced wetland swales → wet detention pond) that will be evaluated to determine overall effectiveness of the different combination of these BMPs. Gresham includes centralized facilities in the Stormwater Management Manual, so assessing the effectiveness of these facilities is important for the adaptive management of Gresham's stormwater program; specifically, determining what components of a BMP "treatment train" will be incorporated into future regional facilities. Data collected for the two regional facilities described in this section will provide values to be used in future TMDL pollutant load reduction benchmark calculations.

8.3 Documentation and Record-keeping Procedures

Consistent with permit requirements specified in NPDES MS4 permit Schedule F, Section C.8., the Co-Permittees will retain records of all monitoring information, including: all calibration, major maintenance records, all original lab and field data (see **Appendix C** for example of field data sheet), copies of all reports required by the NPDES MS4 permit, and records of data used to complete the application for the NPDES MS4 permit for a period of at least 5 years from the date of the sample, measurement, report, or application.

Records will contain:

1. The date, exact place, time, and methods of sampling or measurements;
2. The individual(s) who performed the sampling or measurements;
3. The date(s) analyses were performed;
4. The individual(s) who performed the analyses;
5. The analytical techniques or methods used; and
6. The results of such analyses.

8.4 Monitoring Process/Study Design

8.4.1 Study Design

The study design for Structural BMP Effectiveness Monitoring is a paired study looking at influent and effluent concentrations. Because the facilities are designed to provide detention time, as well as water quality treatment, obtaining representative samples involves collecting several grab samples throughout the duration of the event as stormwater enters and leaves the facility. Flow and rainfall data are used to determine representativeness of the water quality data collected.

8.4.2 Monitoring Locations

Monitoring locations will consist of the inlets and outlets of stormwater facilities. The type of facilities include centralized facilities, street-side stormwater planters, pervious pavement, and stormwater retrofits. For facilities without an inlet, control samples will be used, such as an impervious section of road or pre-project sampling of a retrofit location.

8.4.3 Sampling Event Criteria

Prior to initiating a sampling event, the storm will be predicted and evaluated against the criteria listed below to assess whether the predicted storm should be targeted as a potential sampling event. Storm event criteria are as follows:

- Predicted rainfall amount of ≥ 0.5 inches per storm;
- Predicted rainfall duration ≥ 6 hours; and
- Antecedent dry period ≥ 24 hours (target is <0.1 inches of precipitation).

Since the goal for Structural BMP Effectiveness Monitoring is to determine how effective regional facilities are at pollutant removal, longer antecedent dry periods may be required to ensure that stormwater from previous wet weather events is no longer being detained in the facility. Discrete precipitation events with greater than 24 hours meeting the antecedent dry period condition listed above preceding and following the wet weather event will be targeted when feasible, as described in section 2.0.

Hourly and daily rainfall records are maintained and available on the HYDRA Data Report System. This data is available on the web at:

http://or.water.usgs.gov/non-usgs/bes/raingage_info/clickmap.html.

8.4.4 Frequency and Duration

A minimum of two “facility events” will be sampled per year; for example, one facility may be sampled for each of two storms, or two facilities may be sampled during one storm each. The decision of which BMPs to monitor will depend on the results of the sampling, the status of the facilities, and the related management objectives. If fewer than four “facility events” are sampled, the remaining events will be sampled for special projects regarding particular pollutants. For example, these events may focus on better understanding emerging pollutants of concerns such as 6ppd-quinone from tires, styrene export from new cast-in-place stormwater pipe repair technologies, pesticides, or perfluoroalkyl and polyfluoroalkyl substances (PFAS).

8.4.5 Responsible Sampling Coordinator

This monitoring task is coordinated by the City of Gresham’s Water Resources Division on behalf of Gresham, Fairview Gresham will target events, calibrate equipment, perform in-situ field measurements, collect samples for lab analysis, and coordinate delivery to the lab. Laboratory analysis for instream samples is conducted by Portland’s Water Pollution Control Laboratory under an IGA with the City of Gresham for laboratory services (see **Appendix F**).

8.5 Collection Method and Handling

8.5.1 Sample Collection Method

The four regional facilities described above have continuous flow monitoring equipment installed at the inlets and outlets. Data from past events is used to determine when to take representative grab samples.

Table 17: Sample Collection Method and Timing for Structural BMP Monitoring

Constituents	Number of Samples	Collection Method	Timing
Field			
Temperature, Conductivity, pH, Turbidity	≥3	Grab/in situ	Periodic
Conventional			
<i>E. coli</i>	1-3	Grab	Rising Limb, Middle**, Falling Limb
Biochemical Oxygen Demand (BOD ₅), Total Suspended Solids, Hardness, Particle Size Distribution	≥3	Grab	Rising Limb, Middle, Falling Limb
Total Recoverable Metals			
Copper, Lead, Mercury, Zinc	≥3	Grab	Rising Limb, Middle, Falling Limb
Dissolved Metals			
Copper, Lead, Zinc	≥3	Grab	Rising Limb, Middle, Falling Limb
Nutrients			
Nitrate + Nitrite Nitrogen, Total Kjeldahl Nitrogen, Ammonia Nitrogen, Total Phosphorus, Ortho-phosphorus	≥3	Grab	Rising Limb, Middle, Falling Limb

** When the decision is made to collect only a single bacteria sample, the sample is typically collected 1/3 of the way through sample collection. Based on sampling history, the rising limb of an event hydrograph is usually well represented by a sample collected 1/3 of the way into an event, and a falling limb sample collected approximately 2/3 of the way through an event.

8.5.2 Handling and Custody Procedures

For grab samples, samples are collected directly into the appropriate containers directly from the center of flow, when possible. If needed, samples will be collected using a clean stainless steel

bailer attached to an extension rod. The stainless steel bailer is cleaned prior to each site using laboratory-grade soap and distilled water or rinsed 3 times with the water to be sampled at each site prior to sampling. Field measurements are made by collecting a representative sample using the stainless steel bailer and then pouring the sample into the measurement/storage cup of the multi-meter probe.

Two-person clean sample collection techniques are followed to minimize the potential for contamination of samples: one “dirty hands” to move equipment, document field measurements, grab samples using the bailer and remove manhole lids; and one “clean hands” to fill sample bottles. The “clean hands” member wears powder-free nitrile gloves to avoid contamination of the sample and protect the sampler from possible health risks. If field blanks are shown to demonstrate any contamination, then field protocols will be amended to reduce contamination.

All samples collected for laboratory analysis are immediately placed into a cooler containing ice and transported to the lab immediately following sample collection. **Table 18** lists the volume of sample collected, the container used and maximum holding time. Once samples are delivered to Portland’s Water Pollution Control Laboratory, they have their own QAPP to ensure that samples are analyzed within the proper holding time and preservation methods are employed.

For total Hg sampling, a version of field method 1669 is used (EPA 1996). This method is performance-based and allows for modification if contamination does not occur. Grab samples are collected as described below and will include field blanks. If field blanks are shown to demonstrate any contamination, then field protocols will be amended to reduce contamination. Samples are collected directly into the container when possible. If needed, samples will be collected using a clean stainless steel bailer attached to an extension rod. The stainless steel bailer is cleaned prior to each site using laboratory-grade soap and distilled water or rinsed 3 times with the water to be sampled at each site prior to sampling. Two-person clean sample collection techniques are followed to minimize the potential for contamination of samples: one person acts as “dirty hands” to move equipment, document field measurements, grab samples using the bailer and remove manhole lids; and one person acts as “clean hands” to fill sample bottles. The “clean hands” person wears powder-free nitrile gloves to avoid contamination of the sample and protect staff from possible health risks.

Table 18: Sample Containers and Holding Times for Structural BMP Monitoring

Constituent	Minimum Sample Volume	Bottle Type	Holding Time
Conventional Constituents			
Biochemical Oxygen Demand (BOD ₅)	250 mL	Plastic	24 hours
Total Suspended Solids	500 mL	Plastic	7 days
Hardness	250 mL	Plastic	6 months
<i>E. coli</i>	100 mL	Sterile Plastic	6 hours (max 24 hrs)
Particle Size Distribution	1 liter	Plastic	28 days
Nutrients			

Nitrate Nitrogen	100 mL	Plastic	48 hours
Total Kjeldahl Nitrogen	100 mL	Plastic	28 days
Ammonia Nitrogen	100 mL	Plastic	28 days
Total Phosphorus	100 mL	Plastic	28 days
Ortho-phosphorus	250 mL	Plastic	48 hours
Total Recoverable Metals			
Copper	400 mL	Plastic	6 months if preserved
Lead			
Zinc			
Mercury	250 mL	Plastic	28 days
Dissolved Metals			
Copper	400 mL	Plastic	6 months if Preserved
Lead			
Zinc			

After samples have been obtained and the collection procedures properly documented, a written record of the chain of custody for each sample requiring laboratory analysis is completed (see **Appendix C**). Information included on the chain of custody includes:

- Name of the persons collecting the sample(s)
 - Date and time of sample collection
- Location of sample collection
- Names and signatures of all persons handling the samples in the field and in the laboratory
- Laboratory analysis requested and control information (e.g., duplicate or spiked samples etc.) and any special instructions (e.g., time sensitive analyses).

To ensure that all necessary information is documented a chain of custody form will accompany each sample or set of samples and a copy of the form is retained. Each person who takes custody will sign and date the appropriate portion of the chain of custody documentation.

8.6 Constituents and Methods

The analytical methods and method reporting limits (MRLs) for constituents monitored for structural BMP monitoring are listed in **Table 19**.

Table 19: Structural BMP Monitoring Constituents, Methods, and MRLs

Field Constituents	Analytical Method	MRL	Units
Temperature	SM 2550 B	-5	Degrees C
DO	SM 4500-OG	0.1	mg/L
Conductivity	EPA 120.1	1.0	µs/cm
pH	EPA 150.1	3.0	S.U.
Turbidity	EPA 180.1	0.05	NTU
Biochemical Oxygen Demand (BOD ₅)	SM 5210 B	2	mg/L

Total Suspended Solids	SM 2540 D	2	mg/L
Hardness	SM 2340 B	0.5	mg/L as CaCO ₃
<i>E. coli</i>	COLILERT QT	10	MPN/100 mL
Particle Size Distribution	OPTICAL	1000	# Part/100 mL
Nutrients			
Nitrate Nitrogen	EPA 300.0	1.10	mg/L
Total Kjeldahl Nitrogen	PAI-DK03 ¹	0.20	mg/L
Ammonia Nitrogen	EPA 350.1	0.02	mg/L
Total Phosphorus	EPA 365.4	0.02	mg/L
Ortho-phosphorus	EPA 365.1	0.02	mg/L
Total Recoverable Metals			
Copper	EPA 200.8	0.2	µg/L
Lead	EPA 200.8	0.1	µg/L
Zinc	EPA 200.8	0.5	µg/L
Mercury	EPA 1631E or WPCLSOP M- 10.02 ^{*2}	0.002	µg/L
Dissolved Metals			
Copper	EPA 200.8	0.2	µg/L
Lead	EPA 200.8	0.1	µg/L
Zinc	EPA 200.8	0.5	µg/L

* TKN is not required in Table 2 of the NPDES MS4 permit, so is subject to the Adaptive Management process described in **Section 1.4**.

¹ The PAI-DK03 method for TKN is a 40 CFR 136 method (flow injection gas method, see footnote 41, Table 1B, 40 CFR Part 136.3).

² The WPCLSOP M-10.02 method cited for total Hg is EPA 200.8 w/CEM digestion (footnote 4, Table 1B, 40 CFR Part 136.3).

8.7 Quality Assurance

8.7.1 Quality Control Objectives

The data quality objectives for accuracy and precision for field and lab analysis of Structural BMP monitoring are the same as those listed under Wet Weather Stormwater Monitoring. Because Structural BMP monitoring often occurs at the same time as other instream or wet weather stormwater monitoring, and because greater than 10% duplicates are typically collected, duplicates are not typically collected for this monitoring activity, but instead included as part of Wet Weather Stormwater Monitoring. Field duplicates will be collected for a minimum of 10% of the combined BMP and wet weather sampling events. Field blanks will also be collected for 10% of sampling mobilization events. Equipment blanks will be generated annually by the WPCL to ensure that equipment and bottles provided by the lab are not producing false positive readings.

8.7.2 Representativeness

Stormwater samples are collected from the center of the flow to obtain a well-mixed sample representative of the stormwater conditions. Composite sampling is used for most constituents to

ensure that samples collected are representative of conditions that likely occur throughout the entire event.

8.7.3 Comparability

The objective is to ensure that collected data are either directly comparable, or comparable within defined limitations, to literature data or other applicable criteria. Structural Best Management Practice Monitoring samples are collected and analyzed in the same manner as those collected for Instream Monitoring and Wet Weather Stormwater. Samples are analyzed at Portland's Water Pollution Control Laboratory to minimize variability and increase comparability of data collected by both jurisdictions.

8.7.4 Completeness

The Structural BMP monitoring goal is to achieve a 100 percent complete data set for all analyses. It is anticipated that 2 events will be collected annually, so over the 5 year permit term, 10 samples will be collected. It is understood that due to unforeseen circumstances some results may be lost. Field and Laboratory staff will attempt to minimize data loss to the best of their ability by carefully following all protocols and procedures. If data sets are not 100 percent complete for this study, analyses will be evaluated on a case by case basis to determine whether the project needs to collect additional samples.

8.7.5 Instrument Inspection and Maintenance

Field sampling equipment is inspected before and after each monitoring event. The multi-meter and turbidimeter will be cleaned and maintained according to the manufacturer's guidelines. Multi-meters will be professionally inspected, maintained and calibrated annually by Quality Control Services (2340 SE 11th Ave, Portland, OR. 503-236-2712).

Portland's Water Pollution Control Laboratory performs inspection and maintenance of laboratory instruments used for analysis of grab samples. A copy of the WPCL's QAPP is included in **Appendix G**.

8.7.6 Instrument Calibration

The multi-meter probe used to collect field measurements (temperature, pH, DO, and conductivity) will be calibrated prior to each event at mobilization. pH will be calibrated using a 3-point calibration (pH 4, 7 and 10 buffers). Conductivity will be calibrated using a standard within the range of expected measurement (typically 100 μ S/cm). DO will be calibrated using percent saturation at the current barometric pressure. Meter calibration will be recorded in an electronic calibration log. Meters will be calibrated halfway through the monitoring event if the accuracy of the meter drifts during the monitoring event. After each sampling event the meter will be measured against known standards to check measurement accuracy.

The turbidimeter will be calibrated annually. Prior to each sampling event, the meter will be measured against known secondary Gelex sample standards to ensure accuracy. Readings will be recorded in the electronic calibration log.

Portland's Water Pollution Control Laboratory performs calibration of laboratory instruments used for analysis of grab samples. A copy of the WPCL's QAPP is included in **Appendix G**.

8.8 Data Management, Review, Validation and Verification

All analytical results and applicable field measurements including field data sheet information will be stored in Gresham's master NPDES MS4 data spreadsheet. Lab data will be reviewed and entered as soon as practicable, with data entry and analysis always taking place annually for meeting NPDES MS4 annual reporting requirements. Final reporting will be performed in conjunction with the NPDES Annual Report and the permit renewal to assess instream trends. Periodic analysis of data may also occur to assess whether adaptive management of the Monitoring Plan or program is appropriate.

8.8.1 Data Management

All analytical results and applicable field measurements including field data sheet information will be stored in Gresham's Stormwater Database. Lab data will be reviewed and entered as soon as practicable, with data entry and analysis taking place prior to calculating benchmarks due with the permit renewal submittal. Periodic analysis of data may also occur to assess whether adaptive management of the Monitoring Plan or program is appropriate.

8.8.2 Data Review, Validation and Verification

Once the data has been entered in the project database, the Monitoring Program Coordinator will proofread it against the original field data sheets. Statistical and graphical analysis may be used to reveal whether keystroke errors occurred during data entry. Potential errors in the database will be checked against field data sheets and lab reports. Once verified, errors in data entry will be corrected at that time. Outliers and inconsistencies will be flagged for further review, investigation, and if appropriate, discarded. Data quality problems will be discussed as they occur and in the final report to data users.

Reconciliation with data quality objectives as noted above will be performed as soon as possible after each sampling event. Calculations and determinations for precision, completeness, and accuracy will be made and corrective action implemented if needed. If data quality indicators do not meet the project's specifications, data may be discarded and re-sampling may occur. The cause of the failure will be evaluated. If the cause is found to be equipment failure, calibration and/or maintenance techniques will be reassessed and improved. If the problem is found to be sampling team error, field techniques will be assessed and revised as needed.

9.0 SOURCE CONTROL ASSESSMENT AND SOLIDS TRACKING

Each Co-Permittee's source control best management practices are described in their respective Stormwater Management Plans, which include the type of activity, frequency of implementation, and measurable goals. Gross solids are collected during various operations & maintenance activities as described in the SWMP and will be reported in the annual NPDES report to DEQ.

Gresham developed a debris characterization study to attempt to identify specific contaminants that may be related to gross solids and debris (see **Appendix I**). The City continues to collect debris samples annually to inform proper debris disposal.

Objective 2. Evaluate the effectiveness of Best Management Practices (BMPs) in order to help determine BMP implementation priorities;

Objective 6. Assess progress towards reducing TMDL pollutant loads.

9.1 Literature Tracking

Stormwater management is a continually evolving field, covering many disciplines. There is extensive existing and new literature on treatment system performance monitoring conducted by researchers, public entities, and private companies to meet both regulatory and non-regulatory needs. Some of these studies provide estimates of effectiveness of treatment controls. An important part of the Co-Permittees' strategy for collecting information to aid their stormwater management efforts is to track current and developing literature on relevant topics. In particular, literature related to the performance and cost effectiveness of both treatment and source control best management practices will be followed.

The Co-Permittees are currently involved with AWCA, which provides an open forum for stormwater management discussions. Additionally, managers and staff attend local conferences, coordinate with other agencies, and track stormwater management related literature. These activities aid in addressing:

Objective 1. Evaluate the source(s) of and means for reducing the pollutants of concern applicable to the co-permittees' permit area, including 2018/2020 303(d) listed pollutants, as applicable;

Objective 2. Evaluate the effectiveness of Best Management Practices (BMPs) in order to help determine BMP implementation priorities;

The Co-Permittees will track and review the literature in order to keep current with innovations and technological advances that may be utilized to enhance treatment and source controls. Typically, the Co-permittee will review research to determine whether the findings merit changes to their respective SWMPs that will be submitted for DEQ's consideration during the permit renewal submittal. Changes that can be made with adaptive management may occur annually, but the Co-permittees may not always have the resources to do ongoing annual analysis. Examples of resources that provide data relevant to performance monitoring and evaluation for potential tracking are given below. The Co-Permittees also contributed to development of a BMP effectiveness database that ACWA commissioned. The database is available from ACWA in electronic format.

9.2 Literature Search Resources

Technical literature and research that is available for review includes but is not limited to the following sources:

- ASCE and USEPA. 2004. International Stormwater Best Management Practices (BMP) Database. [Online] <http://www.bmpdatabase.org>.
- WERF and NCHRP Stormwater Research Efforts. Both organizations are active in preparing research documents on stormwater runoff and best management practices performance.
- Federal Highway Administration (FHWA). 2000. Stormwater Best Management Practices in an Ultra-Urban Setting: Selection and Monitoring. Prepared by Tetra-Tech, Inc. and Hagler Bailly Services, Inc. FHWA-EP-00-002, Washington, DC.
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- Heyvaert, A.C., Reuter, J.E. and E.W. Strecker. 2003. Selected Results from Monitoring Relevant to the Design and Performance of Stormwater BMPs in the Tahoe Basin, Draft Report Prepared for California Tahoe Conservancy, South Lake Tahoe, California.
- Pitt, R.E. 2002a. "Emerging Stormwater Controls for Source Areas." In Management of Wet Weather Flows in Watershed. Sullivan, D. and Field, R., eds., CRC Press, Boca Raton.
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- Schueler, T. 1987. Controlling Urban Runoff- A Practical Manual for Planning and Designing Urban Best Management Practices. Metropolitan Washington Council of Governments. Washington, DC.
- USEPA. NPDES Urban BMP performance Tool. [online] <http://cfpub.epa.gov/npdes/stormwater/urbanbmp/bmpeffectiveness.cfm>

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- Oregon Association of Clean Water Agencies (ACWA). 2009. Compilation and Evaluation of Existing Stormwater Quality Data from Oregon. Prepared by Kennedy/Jenks, K/J Project No 0891020.00, Dec 16, 2009.
- Portland, 2016. Monitoring Plan: For Stormwater and Surface Water Sampling by the City of Portland in Compliance with MS4 Permit Requirements. Prepared by City of Portland, Bureau of Environmental Services. For MS4 Permit 101314.
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