



City of Oregon City

National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) Permit Renewal Application

PERMIT NO.: 101348

FILE NO.: 108016

February 28, 2017

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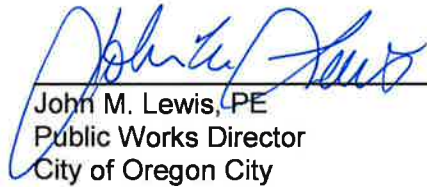
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City of Oregon City

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) MUNICIPAL SEPARATE STORM SEWER SYSTEM (MS4) PERMIT RENEWAL APPLICATION

February 28, 2017

The undersigned hereby submits this permit renewal application package in accordance with NPDES Permit Number 101348. I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person, or persons, who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.



John M. Lewis, PE
Public Works Director
City of Oregon City

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Section 1

Introduction and Overview

In the early 1990s, the Federal Clean Water Act required municipalities with populations greater than 100,000 to apply for and obtain a National Pollutant Discharge Elimination System (NPDES) permit for their stormwater discharges. In Oregon, this program was delegated to the Oregon Department of Environmental Quality (DEQ). As a result, DEQ directed six Oregon jurisdictions and associated co-permittees to apply for and obtain a NPDES municipal separate storm sewer system (MS4) permit (permit). Clackamas County was one of the jurisdictions required to obtain a NPDES MS4 permit, and the City of Oregon City is one of the 13 co-permittees on the Clackamas County NPDES MS4 permit.

1.1 Permit Overview

For Part 1 of the original NPDES MS4 permit application (1993), Clackamas County and its co-permittees performed a review of their stormwater systems including mapping, outfall inventories, monitoring of stormwater quality, etc. The second part of the application (1995) required the development of Stormwater Management Plans (SWMPs) including specific categories of Best Management Practices (BMPs) to address specific sources of pollutants. However, the requirements did not specify the number or type of BMPs that should be implemented. Instead, the requirement states that BMPs should be implemented to reduce the discharge of pollutants to the “maximum extent practicable”. The City of Oregon City received their first NPDES MS4 permit from DEQ in 1995.

The permit period for the 1995 NPDES MS4 permit was five years during which time jurisdictions were responsible for implementation of their SWMPs. The permit required renewal at the end of the five-year permit period. In March 2004, the reissued NPDES MS4 permits were issued to the six larger Oregon jurisdictions, including Clackamas County and its co-permittees. The 2004 permit included some additional requirements that were not in the earlier permit including requirements to evaluate and refine the SWMPs, incorporate more specific monitoring elements and include additional information with the annual reports.

Third-party groups requested DEQ to reconsider the 2004 permit to address total maximum daily load (TMDL) obligations. DEQ agreed to reconsider the permit, and as a result, some additional changes were made. The changes included more specific reporting of SWMP commitments, additional public involvement, and a six-month extension for developing the revised SWMP.

In 2008, Oregon City submitted their third term permit renewal application to DEQ. The City and other Clackamas co-permittees received their third (current) NPDES MS4 permit on March 16, 2012. This permit expires on March 1, 2017. During this permit period, the City’s SWMP has been updated and improved through adaptive management and remains as the central element of the permit.

This document represents Oregon City’s NPDES MS4 permit renewal application for the next permit term. It is being submitted to DEQ in accordance with Schedule F, Section A.4.

1.2 Description of Permit Area and Co-Permittees

The following section outlines the City of Oregon City's NPDES MS4 permit area and describes the City's coordination and responsibilities as a co-permittee with other Clackamas County jurisdictions.

1.2.1 Description of City of Oregon City Permit Area

The City of Oregon City is located in Clackamas County, 13 miles south of Portland. It has a rich history as Oregon's first capital and incorporated city. Oregon City has a population of approximately 33,940 residents (Oregon City website). The City occupies a total of 5,964 acres within its City limits. Urbanization at the edge of Oregon City is constrained by the Willamette River and the City of West Linn to the west, the Clackamas River and the City of Gladstone to the north, and steep topography to the south and east. The City is comprised of mostly low density residential land use, with commercial and industrial land in the southeast portion of the City.

The City is divided into multiple watersheds that drain to the Willamette and Clackamas Rivers. Several smaller tributaries flow through the City, creating the City's physical configuration and providing unique topographic and ecologic areas within the City. The Willamette River and tributaries (including the Clackamas River) currently have a TMDL in place for temperature, bacteria, and mercury.

1.2.2 Summary of City Coordination with Co-Permittees

The City of Oregon City is a co-permittee on the Clackamas County permit, along with a number of other jurisdictions including the cities of West Linn, Milwaukie, Lake Oswego, Gladstone, Wilsonville, Happy Valley, Johnson City, Rivergrove, the Clackamas County Department of Transportation and Development (DTD), as well as three districts: Oak Lodge Water Services District, Clackamas County Service District #1 (CCSD#1), and the Surface Water Management Agency of Clackamas County (SWMACC).

Per the Clackamas County NPDES MS4 permit, the co-permittees are responsible for meeting the same permit requirements as other individual Phase 1 jurisdictions (e.g., the City of Portland, the City of Salem, etc.). However, with the limited resources, it is unlikely that even the most ambitious co-permittee will be able to match efforts of the larger Phase 1 jurisdictions. Therefore, Clackamas County co-permittees have coordinated selected efforts (intergovernmental agreements, comprehensive programs) when possible to meet the permit objectives. Specifically, coordinated efforts include the development and implementation of a comprehensive stormwater monitoring plan, implementation of consistent erosion and sediment control standards, and public outreach and education. Oregon City plans to continue this coordinated effort throughout the new permit period.

1.3 Organization of Document

Table 1-1 below, summarizes the permit renewal submittal requirements as outlined in Schedule B.6. of the permit and provides the corresponding component's location within this document.

Table 1-1. Permit Renewal Submittal Components

Submittal component	Permit requirement	Permit application section
Introduction	-	Section 1.0
MEP Evaluation Information and analysis related to: • How the City's existing program addressed requirements of the 2012 permit. • How the City's proposed program will meet maximum extent practicable (MEP) criteria.	B.6.b	Section 2.0
Proposed SWMP Modifications Narrative summary of proposed SWMP revisions and measurable goals, including rationale for revisions.	B.6.a	Section 3.0 and Appendix A
Service Area Expansions Description of any service area expansions anticipated to occur during the next permit term and a finding as to whether or not the expansion is expected to result in a substantial increase in area, intensity, or pollutant loads.	B.6.e	Section 4.0
Total Annual Pollutant Loading Updated estimate of total stormwater pollutant loads for applicable TMDL pollutants and other identified pollutants.	B.6.c	Section 4.0
Wasteload Allocations (WLAs) and Benchmarks • List of WLAs met • New benchmarks	B.6.h D.3.d	Section 5.0 and Appendix B
Fiscal Evaluation Current permit term expenditures summary and projected program allocations for next permit cycle.	B.6.f	Section 6.0
Monitoring Program Objectives Matrix Including an updated Monitoring Plan	B.6.d	Section 7.0 and Appendix C
MS4 Maps	B.6.g	Appendix D

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Section 2

Maximum Extent Practicable Evaluation

Permit Requirements

Schedule B.6: MS4 Permit Renewal Application Package

...The application package must include an evaluation of the adequacy of the proposed SWMP modifications in reducing pollutants in discharges from the MS4 to the MEP. The application package must contain:

- b. The information and analysis necessary to support the Department's independent assessment that the co-permittee's stormwater management program addressed the requirements of the existing permit. Co-permittees must also describe how the proposed management practices, control techniques, and other provisions implemented as part of the stormwater program were evaluated using a co-permittee-defined and standardized set of objective criteria relative to the following MEP general evaluation factors:
 - i. Effectiveness – program elements effectively address stormwater pollutants.
 - ii. Local Applicability – program elements are technically feasible considering local soils, geography, and other locale specific factors.
 - iii. Program Resources – program elements are implemented considering availability to resources and the co-permittee's stormwater management program priorities.

This section of the permit renewal application provides information to support the Oregon Department of Environmental Quality's (DEQ's) assessment that the City of Oregon City's (City) Stormwater Management Plan (SWMP) reduces pollutants in discharges from the municipal separate storm sewer system (MS4) to the maximum extent practicable (MEP).

To address this requirement, this MEP evaluation includes two parts:

Section 2.1 How the Existing Stormwater Management Program Addressed 2012 Permit Requirements

Section 2.2 How the Proposed Stormwater Management Program Meets the MEP Requirement

2.1 How the Existing Stormwater Management Program Addressed 2012 Permit Requirements

The City's stormwater management program is composed of activities outlined in its SWMP, environmental monitoring, and additional permit-defined regulatory programs and submittals. The following sections summarize how the SWMP (as a subset of the City's overall program) was adaptively managed during the permit term, and how the overall stormwater management program met the permit requirements.

2.1.1 Annual Adaptive Management Permit Requirements

The SWMP is assessed on an annual basis through an adaptive management process. SWMP modifications are made as necessary to achieve a reduction of pollutants in stormwater discharges to the MEP. This requirement is outlined in Schedule D.4 of the permit:

The co-permittee must follow an adaptive management approach to assess and modify, as necessary, any or all existing SWMP components and adopt new or revised SWMP components to achieve reductions in stormwater pollutants to the MEP...

A description of the City's adaptive management approach was submitted to DEQ as required in Schedule D.4 by November 1, 2012. Historically, the City has implemented adaptive management principles to annually refine implementation methods and data collection activities in conjunction with its effective SWMP and best management practices (BMPs). More significant modifications to SWMP activities occur every 5 years, in conjunction with the permit renewal application and updated permit requirements.

As the City prepares its National Pollutant Discharge Elimination System (NPDES) MS4 annual report, it reviews SWMP implementation through BMP-specific measurable goals and tracking measures. The City collects data and feedback from staff responsible for implementing and reporting on each BMP to gauge whether implementation was deemed effective or whether there are suggested improvements to be made. Suggested adjustments to BMP implementation include consideration of resource availability, budget/funding, and overall need.

Each annual report submitted to DEQ includes a section to summarize implementation of the adaptive management process and any resulting proposed SWMP changes. During this permit term, and given the maturity of the stormwater program, no refinements were made to 2012 BMPs that were at a level of detail requiring a formal modification of the SWMP. Minor BMP refinements that were made during the permit term included:

- Dry weather field screening was conducted on August 20, 2015, per BMP 1-2. Staff expressed safety concerns at two locations. The City's *Illicit Discharge Detection and Elimination Standard Operating Procedure* was updated to address the safety concerns.
- Additionally, an illicit discharge was reported on May 9, 2016 at an outfall not currently being monitored annually. An investigation yielded no evidence of an illicit discharge, but the City's *Illicit Discharge Detection and Elimination Standard Operating Procedure* was updated to incorporate the additional location for future screening.

2.1.2 Stormwater Program Compliance with Permit Requirements

Per Schedule A.2 of the permit:

Compliance with this permit and implementation of a stormwater management program, including the Department-approved Stormwater Management Plan, establishes this MEP requirement...

The City met all of its 2012 permit requirements, as shown in Table 2-1 below. In addition, the City supplied information in each annual report related to tracking measures and meeting SWMP measurable goals. The City's existing, overall program met the MEP requirement.

Table 2-1. 2012 Permit Requirements

Requirement	Permit section	Due date	Status of meeting permit requirements
Illicit Discharge Detection and Elimination			
Document an enforcement response plan for responding to illicit discharges	A.4.a.ii	11/1/2012	The <i>Enforcement Response Plan</i> was submitted to DEQ by 11/1/2012 as part of the City's <i>Illicit Discharge Detection and Elimination Standard Operating Procedure</i>.
Document pollutant parameter action levels and report them to DEQ in an enforcement response plan	A.4.a.iii	11/1/2012	Pollutant parameter action levels were documented in the City's <i>Illicit Discharge Detection and Elimination Standard Operating Procedure</i>.
Annual dry weather field screening activities must include identified priority locations, which are identified on a map	A.4.a.iv and xi	11/1/2012	Dry weather field screening locations are mapped and referenced in the City's <i>Illicit Discharge Detection and Elimination Standard Operating Procedure</i>.
Industrial and Commercial Facilities			
Implement an updated strategy to reduce pollutants to the MS4 from industrial and commercial facilities identified as sources that contribute significant pollutant loads to the MS4	A.4.b.iii	7/1/2013	A strategy was completed and implementation was initiated.
Construction Site Runoff Control			
The construction site runoff control program must apply to activities that result in a land disturbance of 1,000 square feet or greater	A.4.c.i	11/1/2014	The City adopted the Clackamas County Erosion Prevention Planning and Design Manual.
Education and Outreach			
Conduct or participate in an effectiveness evaluation to measure the success of public education activities	A.4.d.vi	7/1/2015	Participated in a regional public education effectiveness evaluation and submitted it to DEQ by 7/1/2015.
Public Involvement and Participation			
Provide opportunities for public comments on the 2012 monitoring plan, annual reports, SWMP revisions, and the TMDL pollutant load reduction benchmark development	A.4.e	9/1/2012 (monitoring plan)	The monitoring plan was provided for public review and comment and submitted to DEQ by 9/1/2012. Annual reports, proposed SWMP revisions, and pollutant load reduction benchmarks have also been provided to the public for review and comment.

Table 2-1. 2012 Permit Requirements

Requirement	Permit section	Due date	Status of meeting permit requirements
Post-construction Site Runoff			
Implement a post-construction site runoff program that meets designated permit conditions	A.4.f	11/1/2014	The City developed <i>Stormwater Grading and Design Standards</i>. Guidance for the standards is provided in a manual.
Identify, minimize, or eliminate barriers in ordinances, code, and development standards that inhibit LID/green infrastructure	A.4.f.ii	11/1/2014	The City's <i>Stormwater Grading and Design Standards</i> prioritize the use of LID and include design requirements that address flow duration. Barriers to LID were identified and eliminated with the adoption of this manual.
Develop or reference an enforceable post-construction stormwater management manual or equivalent document	A.4.f.iii	11/1/2014	See above bullets.
Pollution Prevention for Municipal Operations			
Inventory, assess, and implement a strategy to reduce the impact of stormwater runoff from municipal facilities that treat, store, or transport municipal waste	A.4.g.iii	7/1/2013	Submitted a document titled <i>Stormwater Pollution Prevention Strategies for Municipal Operations</i> to DEQ on 7/1/2013. Initiated implementation of the strategies in 2013.
Stormwater Management Facilities O&M Activities			
Inventory and map stormwater management facilities and controls and implement a program to verify that stormwater management facilities and controls are inspected, operated, and maintained	A.4.h.i	7/1/2013	Submitted a document to DEQ on 7/1/2013 titled <i>Private Water Quality Facilities Inspection and Maintenance Program</i> . Initiated implementation of the program in 2013.
Hydromodification Assessment			
Conduct assessment and submit report	A.5	7/1/2015	Submitted the <i>Hydromodification Assessment</i> report to DEQ on 7/1/2015.
Stormwater Retrofit Strategy Development			
Identify 1 stormwater quality improvement project	A.6.c	7/1/2014	The retrofit project was identified by 7/1/2014 as described in the following bullet.
Initiate, construct, or implement the project	A.6.c	Permit expiration	Participated in the design and construction of a project in partnership with ODOT to construct a rain garden, sedimentation manhole, and sumped catch basins along Dunes Drive to treat some runoff from OR99E.
Develop a retrofit strategy and submit plan to DEQ	A.6.b	7/1/2015	Submitted the <i>Stormwater Retrofit Plan</i> to DEQ on 7/1/2015.

Table 2-1. 2012 Permit Requirements

Requirement	Permit section	Due date	Status of meeting permit requirements
Monitoring and Reporting Requirements			
• Submit draft plan to DEQ for review	B.2	9/1/2012	• The <i>updated Comprehensive Clackamas County NPDES MS4 Stormwater Monitoring Plan</i> was submitted to DEQ on 9/1/2012.
• Implement the approved plan	B.2	10/1/2012	• Implementation of the <i>updated Comprehensive Clackamas County NPDES MS4 Monitoring Plan</i> was initiated on 10/1/2012.
Annual Reporting Submit annual reports each year from the time frame 7/1 of the previous year through 6/30 of the same year	B.5	11/1 (annually)	All annual reports for the permit term were submitted to DEQ by 11/1 each year.
Permit Renewal Application Package Submit permit renewal application package	B.6	9/2/2016 (180 days before permit expiration)	Will be submitted by 2/28/2017 (at permit expiration) in accordance with NPDES MS4 permit, Schedule F, Section A.4. and per the DEQ approval letter dated 6/17/2016.
303(d) Listed Pollutants Submit evaluation report in the 4th annual report	B.5.k D.2	11/1/2015 (4th annual report)	Submitted with FY 2014–15 annual report.
Total Maximum Daily Loads			
• Submit a wasteload allocation attainment assessment	B.5.k D.3.b	11/1/2015 (4th annual report)	• Submitted with FY 2014–15 annual report.
• Submit a TMDL pollutant load reduction evaluation	B.5.k D.3.c	11/1/2015 (4th annual report)	• Submitted with FY 2014–15 annual report.
• Submit TMDL benchmarks	D.3.d	9/2/2016 (180 days before permit expiration)	• Provided in Section 5 of this permit renewal application (see above bullet regarding the permit renewal package deadline).
Adaptive Management Submit an adaptive management approach	D.4	11/1/2012	Submitted to DEQ on 11/1/2012.
SWMP Revisions Revise to include new permit requirements	D.5 and D.8	5/1/2012	Revised the SWMP accordingly and submitted it to DEQ on 5/1/2012.

2.2 How the Proposed Stormwater Management Program Meets the MEP Requirement

The City's adaptive management process requires the City to conduct a comprehensive assessment of the stormwater management program at the end of the permit term, with the results used to identify proposed program modifications to be submitted as part of this permit renewal package.

This section provides background information related to the City's long-term and ongoing compliance with the MEP standard and provides results of the comprehensive assessment of the current program resulting in proposed SWMP modifications. Proposed SWMP modifications are detailed in Section 3 of this permit renewal application and reflected in the proposed SWMP, included as Appendix B.

2.2.1 Maximum Extent Practicable Background

MS4 permittees initially developed and established SWMPs that met the MEP requirement as part of the original 1993 permit applications. Those SWMPs have become the foundation for each permittee's program—a foundation that has been continuously evaluated and improved through adaptive management since the first permit was issued in 1995. As a result, the BMPs described in the permittee's current and proposed SWMP are the result of the cumulative effect of implementing, continuously evaluating, and making corresponding changes (i.e., adaptive management) to a variety of technically and economically feasible BMPs, which ensures that the most appropriate controls are implemented in the most effective manner based on site-specific conditions.

Up until submittal of this permit renewal application, the City adhered to the following process to ensure that its SWMP met the MEP standard. A more detailed summary can be found in the City's 2008 NPDES MS4 permit renewal application:

- **Original development of the SWMP submitted with the permit application (1993):** All Phase I NPDES MS4 permit applicants were encouraged by the U.S. Environmental Protection Agency (EPA) to design programs tailored for local problems, priorities, resources, and objectives. Part 1 of the application required the compilation of information related to the stormwater system within the permit area, including outfall investigation results, maps, and monitoring data. Part 2 of the application required the development of a SWMP.

Clackamas County and co-permittees employed a coordinated, comprehensive, and structured approach to develop its original SWMPs. Committees were formed to coordinate technical-, public-, and policy-related issues. The process included monthly meetings open to all co-permittees to discuss general issues, and a series of meetings with each co-permittee to discuss issues specific to each jurisdiction. Co-permittee coordination meetings were used to discuss permit application and implementation requirements, scheduling, sharing information on SWMP program elements, and sharing issues and concerns. Individual meetings were used to identify specific issues, concerns, and water quality problems identified for each agency, and to develop BMPs and an individual SWMP that each co-permittee could implement. The individual actions considered for inclusion in the SWMPs were referred to as BMPs. General categories of BMPs were discussed during the monthly co-permittee meetings, and agency- or City-specific BMP selection occurred during the individual co-permittee meetings.

The specific steps in the process to select BMPs for the SWMPs included the following:

- Step 1: Identify local stormwater quality problems
- Step 2: Define objectives of the SWMPs
- Step 3: Identify BMPs to address objectives and permit requirements
- Step 4: Tailor implementation of BMPs to each co-permittee

Issuance of the first NPDES MS4 permit by DEQ, which included implementation of the SWMPs, was considered acceptance that the SWMPs met the MEP standard. The first 5-year permit term was 1995 to 2000.

- **Overall SWMP review conducted for the *Interim Evaluation Report* (2006):** DEQ issued the second-term Clackamas County NPDES MS4 permit in March 2004. The 2004 permit required a SWMP evaluation to be submitted to DEQ as part of the *Interim Evaluation Report* due in 2006. As a result of this requirement, the City of Oregon City developed a process to evaluate its stormwater program. The process included an internal audit of the effectiveness of SWMP elements (based on best professional judgment regarding the state of the practice), financial allocations, and public acceptance. A table was prepared to summarize SWMP changes and the rationale for those changes. Drafts of the resulting updated SWMP were made available to the public and interested stakeholders. The updated SWMP was advertised to the public, made available on the City's website, and left open to public comment for 30 days. Copies of the SWMP were also available upon request, and comments that were received were addressed. Based on the results of the program analysis, a number of changes and updates were proposed and implemented for the new SWMP. Most revisions were general and applied to most or all BMPs; however, a few specific modifications were made as well.
- **Overall SWMP review conducted for the permit renewal application (2008):** As part of the adaptive management process, the City prepared a revised SWMP for its permit renewal application in 2008. The revised SWMP was intended to synthesize the implementation and findings from the permit cycle, and reflect an evaluation of the adequacy of the SWMP in reducing pollutants to the MEP based on three evaluation criteria as required by DEQ: (1) program effectiveness, (2) local applicability, and (3) program resources. The City reviewed the SWMP in conjunction with federal regulations and guidelines under the technical documents *MS4 Program Evaluation Guidance*, and *Protocol for Conducting Environmental Compliance Audits under the Stormwater Program* (EPA 2005). Some changes related to adaptive management were made and submitted to DEQ at that time. The updated SWMP was approved by DEQ in September 2012 in conjunction with issuance of this (third-term) permit.
- **Annual reports (ongoing since 1995):** To ensure that the SWMPs continued to meet the MEP standard, the effectiveness of the SWMPs was revisited annually. Each year, Clackamas County and co-permittees including the City of Oregon City are required to submit an annual compliance report for NPDES MS4 permits. Each year, each jurisdiction examines work performed during the previous year, monitoring results, and information shared during ongoing co-permittee meetings and adjusts its programs accordingly. The City has used this adaptive management process since receiving its first permit in 1995 to meet the MEP standard.

2.2.2 Maximum Extent Practicable Evaluation Factors and Criteria

The purpose of this section is to address the permit requirement in Schedule B.6.b to describe how the proposed management practices, control techniques, and other provisions implemented as part of the stormwater program were evaluated using a permittee-defined and standardized set of objective criteria relative to the following MEP general evaluation factors:

- i. *Effectiveness – program elements effectively address stormwater pollutants.*
- ii. *Local Applicability – technically feasible considering local soils, geography, etc.*
- iii. *Program Resources – program elements are being implemented considering availability to resources and the co-permittee's stormwater management program priorities.*

As described above, the SWMP was initially developed in the early 1990s and has continuously evolved through an adaptive management process.

As part of this 2017 MEP evaluation and demonstration, City staff defined objective criteria related to the three MEP evaluation factors listed above. In general, the City's program assessment—as described in Section 2.2.3—was conducted and modified (i.e., adaptively managed) with the goal of meeting/addressing the following criteria (listed by evaluation factor):

- Program effectiveness:
 - The program includes a range of BMPs that encompass pollution prevention, source control, and treatment approaches
 - The program includes BMPs that are technically feasible, effective, and implementable
- Local applicability:
 - The program is consistent with local ordinances and current legal authority
 - Stormwater design standards implemented as part of the program reflect local conditions specific to soils, rainfall, infiltration rates, and stream conditions
- Program resources:
 - The program is included in the current budget allocations
 - The program considers implementation costs and practicability within the overall context of permittee priorities and resources

2.2.3 Program Assessment and Results for the Permit Renewal

Using the MEP factors and criteria described in Section 2.2.2 above, the City conducted a review of its stormwater program to identify proposed changes to the SWMP. As described in the City's adaptive management approach, the 5-year permit cycle adaptive management process includes a review of annual assessments, permit term trends, and evaluations/reports produced during the permit term. Results are summarized below:

- 1) **Review of annual assessments:** A summary of the annual adaptive management approach and results from the annual adaptive management process is provided in Section 2.1.1 above. While several refinements to BMP implementation were made during the permit term (as reported in annual reports), the refinements were not at a level of detail to warrant formal adjustments to the SWMP.

- 2) **Review of monitoring information (i.e., trends results):** In 2015, a summary of water quality trends was submitted to DEQ based on the results of environmental monitoring conducted under this permit. The City has been collecting instream water quality monitoring data since 2007 from six sites representing four creeks (some data have been collected since 2002 from Singer Creek). The trends analysis is provided as an appendix to the *TMDL Pollutant Load Evaluation and TMDL Benchmarks* report, which is provided as Appendix B to this permit renewal application.

Based on the results from this trends analysis, the majority of pollutants that were analyzed revealed improving trends (at a significance level of 10 percent) or no trends. Approximately 8 percent of the trends analyses showed declining trends, and of those, 83 percent were for dissolved zinc. The result was similar when combining the trends analyses from all co-permittees. The majority of negative trends that were detected were for zinc. This prompted discussion among co-permittees during meetings to update the monitoring plan. No changes were made to the monitoring plan or SWMP as a result; however, it is anticipated that further discussions will continue through co-permittee and Association of Clean Water Agencies (ACWA) meetings regarding the identification of likely sources and causes for this trend.

- 3) **Evaluations and reports:** As stated in the City's adaptive management process, specific deliverables required under the current permit were reviewed and considered with respect to stormwater program updates. The permit deliverables that were reviewed and submitted in 2015 included the following:

- A hydromodification assessment (Schedule A.5),
- A stormwater retrofit strategy (Schedule A.6),
- A 303(d) list evaluation (Schedule D.2),
- A total maximum daily load (TMDL) wasteload allocation attainment assessment (Schedule D.3.b),
- A TMDL pollutant load reduction evaluation and establishment of benchmarks (Schedule D.3.c and D.3.d),
- A public education program effectiveness evaluation (Schedule A.4.d).

As a result of the preparation of these permit-required deliverables, those that resulted in a change to the City's overall stormwater program were the hydromodification assessment and the retrofit strategy. The hydromodification assessment identified a number of stream reaches that were observed to suffer from the effects of hydromodification including erosion, incision, widening, and degraded habitat conditions. The assessment included a list of potential instream projects to address some of the problems that were observed. The City has already embarked on the implementation project that was identified for a tributary to Newell Creek (Scatter Canyon). A 30 percent design has been completed for this project and the City anticipates completion of final design and construction during the upcoming permit term.

A primary outcome from the City's retrofit strategy was the goal to complete a City-wide stormwater master plan to include the identification of potential stormwater quality retrofit projects. The City contracted and initiated the master planning effort, and its updated stormwater master plan is scheduled for completion in 2017. A capital project implementation schedule will be developed as part of the master plan.

SWMP modifications were not made as a result of the other deliverables required by the permit as listed above.

- 4) **End of permit term SWMP review process:** For this permit renewal application, the City implemented an inter-department process to review the 2012 SWMP in conjunction with results of the annual adaptive management and findings from evaluations and reports completed over the permit term. The resulting summary of SWMP modifications is provided in Section 3 of this application.
- 5) **Public comment:** After a 30-day public comment period (from January 13, 2017, to February 13, 2017), no comments were received on the proposed SWMP revisions.

Some modifications to the City's SWMP are proposed as a result of the permit renewal program assessment. Proposed SWMP modifications are summarized in Section 3 of this permit renewal application. The updated and reformatted SWMP—reflecting the proposed SWMP modifications—is provided in Appendix A.

Section 3

Summary of Proposed SWMP Modifications

Permit Requirements

Schedule B.6: MS4 Permit Renewal Application Package

...The application package must include an evaluation of the adequacy of the proposed SWMP modifications in reducing pollutants in discharges from the MS4 to the MEP. The application package must contain:

- a. Proposed program modifications including the modification, addition, or removal of BMPs incorporated into the SWMP, and associated measurable goals.

As part of the permit renewal process, the City of Oregon City reviewed the current (2012) Stormwater Management Plan (SWMP) with respect to the need for updates and prepared an updated 2017 SWMP. The 2017 SWMP does not include substantive changes. The majority of changes are related to removing tasks that had a scheduled end date and have been completed. A summary of proposed changes to the 2012 SWMP is as follows:

BMP 1-1. Implement the Illicit Discharge Elimination Program. This BMP required the development of IDDE standard operating procedures (SOP) by November 2012. Development of the SOP was completed. This BMP language has been changed to reflect ongoing implementation of the SOP, as opposed to SOP development.

BMP 1-2. Conduct Annual Dry Weather Field Screening: The dry weather field screening procedures are included in the City's IDDE SOP. This BMP was modified to reference the updated procedures in the IDDE SOP.

BMP 1-3. Implement the Spill Response Program: Enhance the existing BMP adding a measureable goal to publicize spill response phone numbers.

BMP 2-1. Screen Existing and New Industrial Facilities: Enhance the existing BMP. The 2012 SWMP indicated that business licenses would be reviewed once during the permit term. The proposed SWMP increases the frequency to an annual review.

BMP 2-2. Implement an Industrial/Commercial Inspection Program for High Priority Facilities: This BMP required the development of a commercial/industrial facility inspection program by July 2013. The City completed the development of this program, so the BMP has been updated to reflect ongoing implementation. In addition, this BMP has been modified. During the last permit term, the City identified that other types of industrial and commercial facilities have the potential to contribute significant pollutant loads to the MS4. As a result, this BMP has been modified to extend the inspection program beyond only manufacturing facilities. The City's screening procedures (BMP 2-1) identify high priority industrial and commercial facilities. Those facilities will be the focus of the City's inspection program.

BMP 3-1. Implement the Erosion Control Ordinance: This BMP required adoption of an erosion and sediment control manual by November 1, 2014. The BMP has been updated to reference the adopted municipal code and manual. In addition, editorial changes were made to clarify which activities are part of BMP 3-1 and 3-2.

BMP 3-2. Provide Educational Information to Construction Site Operators: The BMP included reference to a previously offered class at Clackamas Community College. This BMP has been updated to reflect current educational opportunities. In addition, the City will conduct a review of the current incentive program for erosion control contractors and evaluate whether changes could be made to improve program effectiveness.

BMP 4-1. Provide Public Education and Outreach Materials Regarding Stormwater Management: The City is making an adaptive management change to better target public outreach activities to TMDL pollutants of concern, namely bacteria. As a result, the City will target outreach efforts to pet waste clean-up at City parks and recreational areas.

BMP 4-2. Participate in a Public Education Effectiveness Evaluation: This BMP was removed as it was completed as required by the permit.

BMP 4-3. Conduct Staff Training for Pest Management: This BMP was modified to align educational activities with OSHA certification requirements.

BMP 5-1. Provide for Public Participation with Submittal Efforts: Public involvement is required by the permit for the updated 2017 SWMP and benchmarks that are prepared for the permit renewal package that is due to DEQ February 28, 2017. This BMP specified that a 30-day public review would be provided for these documents. The 30-day review period is not specified by the permit and has not historically resulted in substantial edits or changes to documents provided for public review. Therefore, this timeframe is proposed for removal from the BMP. The City will continue provide the documents for public review for a shorter, unspecified time period, likely one to two weeks. In addition, a tracking measure was added to track comments received through public participation activities.

BMP 6-1. Implement Municipal Stormwater Construction Standards: Editorial changes to reflect the stormwater construction standards adopted under BMP 6-2.

BMP 6-2. Code and Development Standards Related to Stormwater Quality Control: The permit required stormwater development standards to be updated by November 2014, in order to meet new conditions in the permit. The City adopted the updated *Oregon City Stormwater and Grading Design Standards* during the permit term. This BMP has been updated to reflect review and updates (if needed) to the adopted standards.

BMP 7-3. Program to Reduce the Impact of Stormwater Runoff from Municipal Facilities: This BMP required the development of a strategy for reducing the impact of runoff from municipal facilities by July 2013. The BMP has been changed to reflect ongoing implementation of the strategy.

BMP 7-4. Control Infiltration and Cross-Connections to the City's Stormwater Conveyance System: This BMP required the City to develop high priority inspection areas by June 30, 2013. Those areas were identified, so the BMP has been updated to reflect ongoing inspections.

BMP 7-5. Coordinate with the Local Fire Department related to Pollutant Discharge from Firefighting Training Activities: During the permit term, the City met with Clackamas County Fire District #1 to determine whether firefighting training activities have the potential to discharge pollutants to the City's MS4. As a result of that meeting, it was determined that the fire district only conducts training with water within Oregon City. As a result, this BMP has been removed.

BMP 7-6 (renamed to 7-5). Conduct Master Planning and Implement Capital Projects for Stormwater Quality Enhancement: The City is currently developing an updated stormwater master plan that includes capital projects to address water quality. The updated plan is expected to be complete in 2017. This BMP has been renamed and updated to reflect ongoing implementation of capital projects related to stormwater quality enhancement.

BMP 8-4. Private Structural Control Facility Cleaning and Maintenance: The permit required the development of a private facility inspection program by July 1, 2013. This BMP was updated to reflect implementation rather than development of the program. In addition, a tracking measure was added to track the number of facility maintenance records returned to the City each year.

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Section 4

Service Area Expansions and Total Annual Pollutant Load Estimate

Permit Requirements

Schedule B.6: MS4 Permit Renewal Application Package

...The application package must include an evaluation of the adequacy of the proposed SWMP modifications in reducing pollutants in discharges from the MS4 to the MEP. The application package must contain:

- c. An updated estimate of total annual stormwater pollutant loads for applicable TMDL pollutants or applicable surrogate parameters, and the following pollutant parameters: BOD₅, COD, nitrate, total phosphorus, dissolved phosphorus, cadmium, copper, lead, and zinc. The estimates must be accompanied by a description of the procedures for estimating pollutant loads and concentrations, including any modeling, data analysis and calculation methods.
- e. A description of any service area expansions that are anticipated to occur during the following permit term and a finding as to whether or not the expansion is expected to result in a substantial increase in area, intensity or pollutant loads.

As part of the City's renewal application for the NPDES MS4 permit, the City is required to provide a description of anticipated service area expansions and an updated estimate of total annual stormwater pollutant loads for applicable TMDL pollutants.

Based on the methodology and assumptions detailed in the City's previous permit renewal application (2008), the updated estimate of total annual stormwater pollutant loads needs to account for projected annexations through the end of the anticipated permit term. Therefore, evaluations to address both c. and e. above have been provided together in this report.

To address these requirements, this report is organized as follows:

- Section 4.1 Description of Service Area Expansions
- Section 4.2 Updated Estimate of Total Annual Pollutant Loads
- Section 4.3 Qualitative Evaluation of Impacts

4.1 Description of Service Area Expansions

This section outlines the process and results of the evaluation of the expansion of the City's NPDES MS4 service area anticipated over the next permit term.

4.1.1 Definition of the City's NPDES MS4 Permit Area

The City's NPDES MS4 permit area or "service area" is defined as the area included within its city limits for which the City has responsibility for implementing a stormwater management

program. Historically, this area has excluded open water bodies and waterways and areas operated by another NPDES MS4-permitted entity.

The Oregon Department of Transportation (ODOT) has its own NPDES MS4 permit covering rights-of-way (ROW) associated with state highways and freeways. Therefore, the City's service area excludes ODOT ROW.

As of July 2016, the Oregon City NPDES MS4 permit area was calculated to be 5,964 acres.

4.1.2 Identification of Projected Service Area Expansions

In Oregon City, annexations are typically applicant-driven. The City and City Commission do not typically initiate annexation of property outside of the city limits into the city. It should be noted that the City's current annexation process is under review due to passage of House Bill 1573 and may be subject to change.

The process for annexation begins with a mandatory pre-application conference between the applicant and city planner to discuss eligibility and potential time frame for annexation. After the application for annexation is submitted, the city planner conducts a completeness review. Within 30 days of deeming an application complete, public hearings are scheduled with the Planning Commission and City Commission. City staff prepare a staff report to compare the annexation application to the requirements of state statutes and local codes, including the seven annexation factors in Oregon City Municipal Code 14.04060. Following a public hearing, the Planning Commission makes a recommendation to the City Commission, and the City Commission holds a second public hearing to review the annexation application.

If the City Commission approves the annexation, it is placed on the ballot for city-wide vote on one of the four regular state election dates (March, May, September, and November). A City Commission vote that does not support the annexation would terminate the application, and the application would not be subject to a city-wide vote.

To identify areas projected to be annexed into Oregon City's city limits over the next permit term (through 2022), city planning staff reviewed current applicant-initiated annexation applications and pending large development activities that may result in the annexation of adjacent property during construction of infrastructure. Given the time frame and potential need for a public vote, annexation applications may require up to 1 year from submittal until they are approved.

A total of fifteen parcels have been identified for potential future annexation, totaling approximately 289 acres, and bringing the City's total anticipated NPDES MS4 permit service area to 6,253 acres. Several identified parcels have applications submitted and are currently awaiting land use decisions and an annexation review. City planning staff anticipate that the likelihood of annexation of these parcels in the next 5 years is high.

The future annexation areas are currently larger tax lots located within the urban growth boundary, adjacent to the outer city boundary. Several smaller tax lots within pockets of unincorporated areas surrounded by the city are also included. The majority of the area (over 200 acres) is zoned for, or expected to be zoned for single-family residential (SFR) development with either a low density or medium density residential zoning designation. All parcels have the potential to subdivide and be developed in accordance with the City Commission-approved zoning designation.

Locations of anticipated service area expansions are shown on the MS4 maps, included in Appendix D of the permit renewal application.

4.2 Updated Estimate of Total Annual Pollutant Loads

This section outlines the modeling methods, assumptions, and results associated with developing an updated estimate of total annual pollutant loads.

The City submitted its original estimate of total annual pollutant loads in Part 2 of its 1993 NPDES MS4 permit application. The City provided its most recent updated estimate of total annual pollutant loads with its NPDES MS4 permit renewal application in 2008. The total modeled MS4 permit area in 2008 was 5,969 acres, which included area within the city limits as of 2008 and projected annexations through 2014. A spreadsheet loads model, using the U.S. EPA simple method equation, was developed and used for the 2008 analysis.

Modeling methods and assumptions used for this estimate of total annual pollutant loads are detailed below and are generally consistent with the approach used in 2008.

4.2.1 Modeling Methods and Assumptions

Total annual pollutant loads were calculated for the City's current NPDES MS4 service area and annexations anticipated to occur through the end of the permit term (expected to be 2022). The total modeled MS4 permit area is 6,253 acres, consistent with the City's anticipated NPDES MS4 service area expansions outlined in Section 4.1.

Total annual pollutant loads are required to be calculated for TMDL pollutants, or applicable pollutant surrogates, and additional parameters as listed in Schedule B.6.c. For the City, the Willamette Basin TMDL includes waste load allocations (WLAs) for bacteria (*E. coli*) in the Middle Willamette and Clackamas River (as part of the Lower Willamette) watersheds.

A spreadsheet pollutant loads model using the EPA simple method was used for the pollutant load calculations. The spreadsheet loads model is consistent with the model used in 2008 and contains baseline land use event mean concentrations (EMCs), which were developed in 2008 based on regionally collected data as part of a coordinated effort between the Oregon Association of Clean Water Agencies (ACWA) and Oregon Phase I jurisdictions. Land use EMCs are calculated as a range reflecting the upper and lower 95 percent confidence limit and reflect general (commercial [COM], residential, industrial [IND], parks and open space [POS]) land use categories. Table 4-1, below, summarizes the land use EMCs used in the model.

The spreadsheet loads model and land use EMCs per Table 4-1 were also used to conduct the 2015 PLRE and calculate the TMDL benchmarks (see Section 5 and Appendix B of the permit renewal application).

Table 4-1. Land Use EMC Values used in the Total Annual Pollutant Load Estimate

Parameter	Land use	Count ^a	Bootstrapped values		
			95% LCL	Mean	95% UCL
TSS, mg/L	COM	72	64	82	103
	IND	48	117	184	284
	POS	10	16	31	50
	Residential ^b	65	44	66	99
E. coli, CFU/100 mL (geomean)	COM	52	573	1,247	2,409
	IND	58	154	438	1,004
	POS	9	57	87	124
	Residential ^b	65	970	1,656	2,651

Table 4-1. Land Use EMC Values used in the Total Annual Pollutant Load Estimate

Parameter	Land use	Count ^a	Bootstrapped values		
			95% LCL	Mean	95% UCL
BOD ₅ , mg/L	COM	22	8.5	11.9	16.6
	IND	23	26.1	39.6	56.1
	POS	3	2.4	3.3	4.2
	Residential ^b	28	5.9	8.1	10.8
COD, mg/L	COM	26	51.8	65.1	81.5
	IND	25	76.8	102.6	134.1
	POS	9	11.1	19.6	27.6
	Residential ^b	36	37.4	50.9	66.0
Nitrate, mg/L	COM	46	0.27	0.38	0.53
	IND	22	0.18	0.24	0.31
	POS	263	1.36	1.51	1.66
	Residential ^b	32	0.60	0.91	1.33
Total phosphorus, mg/L	COM	26	0.280	0.380	0.500
	IND	25	0.400	0.510	0.640
	POS	8	0.095	0.120	0.150
	Residential ^b	36	0.230	0.340	0.480
Dissolved phosphorus, mg/L	COM	46	0.09	0.11	0.14
	IND	21	0.10	0.17	0.27
	POS	261	0.04	0.04	0.04
	Residential ^b	30	0.08	0.11	0.15
Cadmium, total, µg/L	COM	53	0.75	1.11	1.56
	IND	23	2.27	3.47	5.00
	POS	131	0.10	0.11	0.13
	Residential ^b	45	0.41	0.53	0.66
Copper, total, µg/L	COM	26	20.8	28.6	38.2
	IND	26	33.8	45.5	58
	POS	10	2.0	2.5	3.0
	Residential ^b	33	10.5	13.4	17.1
Lead, total, µg/L	COM	25	37.8	54.0	72.7
	IND	22	32.7	48.3	67.0
	POS	9	0.6	0.8	1.1
	Residential ^b	28	11.0	17.7	27.6
Zinc, total, µg/L	COM	28	130.0	170.0	217.0
	IND	24	283.0	674.0	1,353.0
	POS	9	6.3	7.8	9.5
	Residential ^b	39	77.0	104.0	134.0

Note: Data range (+/- 95%) provided by the City of Portland; based on modified ACWA data set (see 2015 PLRE).

a. Count refers to the number of samples used to calculate the land use EMC.

b. Land use EMCs for residential are used to simulate runoff concentrations from both SFR and MFR land use.

Full buildout conditions (i.e., no remaining vacant lands) were simulated in the spreadsheet loads model, consistent with the 2008 assumptions. As the City does not maintain a current condition land use coverage map, the modeled land use categories are based instead on City zoning. Zoning categories were reviewed and consolidated into those categories for which land use concentration information (Table 4-1) exists. Compared to the 2008 analysis, one new land use category (public facilities) was added to separately categorize schools, hospitals, and other public areas.

Calculation of pollutant loads using the EPA simple method requires runoff coefficients reflective of each land use category. Consistent with assumptions and methodology described in the 2015 PLRE, the runoff coefficients are calculated from estimated impervious percentages for each land use category. Impervious percentages were calculated for each land use category as part of the Oregon City, *TMDL Pollutant Load Reduction Evaluation*¹ (2015 PLRE). These values were updated from the 2008 assumptions to account for the added public facilities land use category. Table 4-2 below, summarizes the modeled area by land use category and associated impervious percentages used for this estimation of total annual pollutant loads.

Table 4-2. Modeled Area by Land Use Category and Impervious Percentage

Modeled land use category	Model area (ac)	Modeled impervious percentage (%)
Single-family residential	3,800.8	45
Multifamily	298.6	57
Commercial	708.9	74
Industrial	437.4	63
Public facility	581.9	34
Parks and open space	309.1	19
Agriculture	115.9	48
Total permit area (includes anticipated annexations through the permit term)	6,252.6	

The annual pollutant load estimates are based on an average annual rainfall volume of 47.06 inches, consistent with the rainfall volume assumed in the 2008 NPDES MS4 permit renewal and the 2015 PLRE.

4.2.2 Updated Estimate of Total Annual Pollutant Loads

Total annual pollutant loads, reflective of full-buildout conditions and the anticipated City permit area through the end of the permit term, are summarized in Table 4-3 below, for the applicable parameters. This updated estimate is presented in terms of a pollutant load range because of the inherent variability in stormwater runoff quality. Pollutant loads are shown in pounds (lb) per year, with the exception of *E. coli*, which is shown as total counts per year.

¹ City of Oregon City, *TMDL Pollutant Load Reduction Evaluation*. Brown and Caldwell, October 2015. Amended to include Benchmarks, November 2016.

Table 4-3. Updated Annual Estimate of Pollutant Loads for the City

Pollutant load parameter	LCL (lb or counts)	Mean (lb or counts)	UCL (lb or counts)
TSS	1,588,603	2,305,947	3,333,985
<i>E. coli</i> (counts)	1.01x10 ¹⁴	1.84x10 ¹⁴	3.12x10 ¹⁴
BOD ₅	239,553	340,349	467,642
COD	1,270,755	1,687,485	2,170,734
Nitrate	14,285	21,000	30,040
Total phosphorus	7,360	10,405	14,199
Dissolved phosphorus	2,408	3,284	4,494
Cadmium, total	19.0	26.9	36.6
Copper, total	434	575	746
Lead, total	565	848	1,215
Zinc, total	3,102	4,903	7,558

4.3 Qualitative Evaluation of Impacts

This section provides a qualitative evaluation of the potential increases to area, intensity, and pollutant loads due to the proposed service area expansions discussed in Section 4.1. This discussion is required per Schedule B.6.e of the City's NPDES MS4 permit.

Outcomes from this evaluation are intended to support the Oregon DEQ determination as to whether the permit renewal will involve a substantial modification or intensification of the permitted activity, as referenced in Oregon Administrative Rule (OAR) Chapter 340, Division 18 regarding completion of a Land Use Compatibility Statement (LUCS). Specifically, OAR 340-018-0050(2)(b) states:

(b) An applicant's submittal of a LUCS is required for the renewal or modification of the permits identified in OAR 340-018-0030 if the Department determines the permit involves a substantial modification or intensification of the permitted activity.

The City expects to expand the service area by approximately 5 percent during the next (2017-22) permit term. However, the expansion should not result in substantial increases in runoff intensity or pollutant loads. As described in Section 4.3.2, the City has stormwater design standards in place to mitigate the impacts from new development and service area expansions.

4.3.1 Service Area Expansion

The City anticipates approximately 289 acres of service area expansion over the next 5 year permit term. This service area expansion represents less than 5 percent of the City's current NPDES MS4 permit area. All areas identified for potential annexation are within the City's designated urban growth boundary (UGB), which represents the land area needed to support the growth in the Portland Metro area forecast over the next 20 years. The Portland Metro UGB is reviewed every 6 years, and the last update around Oregon City occurred in 2004. Even if city limits expand by 5 percent during the next permit term, Oregon City will still have substantial area within the UGB available for future growth.

A majority of the proposed service area expansion will be zoned as single family residential, with smaller areas zoned as multifamily residential or parks/open space. In Oregon City, the service area expansions or annexations are typically applicant-initiated annexations of parcels adjacent to existing City utility services. Current development of these parcels is typically single family homes on large parcels of land, where native vegetation has already been cleared to support hobby farms. One area anticipated for annexation is the Oregon City Golf Course and adjacent forested areas along Thimble Creek. As described in Section 4.1, the majority of areas anticipated for annexation are expected to be subdivided to support single-family or multifamily housing. As outlined in Table 4-2, above, the anticipated, developed impervious percentage for single family residential is 45 percent and multifamily residential is 57 percent. With annexation and development, the imperviousness (or intensity per the NPDES MS4 permit language) of these areas is anticipated to increase from current use, but the magnitude would vary depending on the nature of the current and proposed site usage.

At the present time, there is no proposed adjustment to the UGB that would further promote annexation of area outside the current UGB.

4.3.2 Pollutant Load Discharge

With expansion of the service area, the pollutant load permitted under the City's NPDES MS4 permit would increase. However, the incremental increase in pollutant load generation would be mitigated by programmatic and structural stormwater best management practices implemented by the City. Some pollutant load is likely already being generated by these properties. With annexation, the pollutant load will now be included under the City's NPDES MS4 service area boundary and subject to additional controls that would not otherwise be implemented.

Since 1995, the City has adaptively managed its stormwater program as detailed in both the City's Stormwater Management Plan (Oregon City 2012)² (SWMP) and in the City's process outlined in the maximum extent practicable evaluation, included as Section 2 of this permit renewal application. The SWMP includes a variety of source control measures targeting typical stormwater pollutants of concern. Newly annexed properties will be subject to control measures outlined in the SWMP.

The City adopted updated stormwater design standards in 2015, which require water quality treatment and flow controls for new development and redevelopment projects. Structural stormwater controls are required to mitigate pollutant discharges from new or redeveloping areas impacting 5,000 square feet or more of impervious surface. Proposed development of newly annexed parcels will be subject to the installation of these stormwater controls to offset the increase in impervious surface and associated pollutant discharge. Typical structural stormwater controls include planter boxes, rain gardens, vegetated swales, and detention ponds that are designed to infiltrate stormwater runoff to the maximum extent practicable. In addition to direct treatment of stormwater runoff, these structural facilities also limit pollutant load discharges through volume reduction.

As part of the City's 2015 PLRE, a water quality trends analysis was conducted to determine whether instream water quality conditions, as reflected through instream water quality monitoring efforts, were improving or degrading in conjunction with MS4 discharges. A trends analysis was previously conducted in 2008. The most recent water quality trends indicate that instream water quality for analyzed parameters (total phosphorus, total and dissolved zinc, total

² *Stormwater Management Plan*, City of Oregon City, 2012.

and dissolved copper, bacteria, and TSS) in the City is generally the same or improving during precipitation events, even in consideration of service area expansions that have increased the City's population by approximately 25 percent during the trends analysis timeframe. For most sites and parameters evaluated, results indicated either no trend observed or trends toward decreasing pollutant concentrations, indicating improved water quality. Dissolved zinc and *E. coli* were the only parameters shown to have trends towards increasing pollutant concentration during precipitation events, and those trends were not observed at all monitoring locations.

4.3.3 Conclusion

At present time, annexation into the City's service area is limited to parcels adjacent to the existing City limits. Annexation is based on applications from private land owners and subject to approval from the City Commission and public vote. There is no proposed adjustment to the UGB.

Given the extensive efforts in implementing an effective stormwater program including stormwater design standards, source controls and structural stormwater controls, the City's pollutant loads are not anticipated to significantly increase as a result of service area expansions. Historical service area expansions and development have not resulted in significant impacts to instream water quality, as indicated through the water quality monitoring data and trends analysis.

Section 5

Benchmarks

Permit Requirements

Schedule B.6: MS4 Permit Renewal Application Package

...The application package must include an evaluation of the adequacy of the proposed SWMP modifications in reducing pollutants in discharges from the MS4 to the MEP. The application package must contain:

- h. If applicable, the established TMDL pollutant load reduction benchmarks, as required in **Schedule D.3.d.**

In accordance with the City of Oregon City's (City's) 2012 National Pollutant Discharge Elimination System (NPDES) municipal separate storm sewer (MS4) permit, Schedule D.3.d, the City must develop total maximum daily load (TMDL) pollutant load reduction benchmarks. Benchmarks must be developed for each TMDL parameter where existing best management practice (BMP) implementation is not estimated to achieve the wasteload allocation (WLA). The TMDL benchmarks must be submitted to the Oregon Department of Environmental Quality (DEQ) with the City's NPDES MS4 permit renewal application, due February 28, 2017.

The City is a designated management agency (DMA) in the Willamette Basin TMDL due to urban stormwater discharges. The City's MS4 discharges runoff either directly or via tributaries to the Willamette River. The applicable TMDL parameters and waterbodies are summarized in Table 5-1.

Table 5-1. Oregon City Applicable WLAs			
TMDL waterbody	Parameter	WLA	Anticipated to meet WLAs (based on the PLRE 2015)
Clackamas River	Bacteria (<i>E. coli</i>)	78% (annual reduction)	No
Middle Willamette (via tributaries)	Bacteria (<i>E. coli</i>)	88% (summer seasonal reduction) 75% (fall, winter, spring seasonal reduction)	No
Middle Willamette (direct)	Bacteria (<i>E. coli</i>)	75% (annual reduction)	No

The City conducted a pollutant load reduction evaluation (PLRE) in 2015. Based on results of the PLRE, the City is not estimated to be meeting TMDL WLAs for bacteria. As a result, the City is required to establish TMDL pollutant load reduction benchmarks for bacteria for the next permit term.

This summary outlines the City's plans for implementation of additional BMPs that will result in further reductions of bacteria over the next permit term and presents the associated TMDL benchmarks. Detailed information with regards to modeling methods, assumptions, and results are provided in the City's *TMDL Pollutant Load Reduction Evaluation and Benchmarks* report (January 2017), which is included as Appendix B to this NPDES MS4 permit renewal application.

5.1 BMP Identification

By definition, TMDL benchmarks are estimates of pollutant load reductions in the future. They reflect current BMP implementation and projected BMP implementation over the next permit term (i.e., through 2022).

City Engineering, Planning, and Public Works staff identified stormwater facility installations associated with upcoming public works projects. They also identified pending and constructed private stormwater facility installations associated with recent or in-progress development activities since the PLRE was completed in October 2015. In total, 24 new structural stormwater BMPs are anticipated, representing the City's projected stormwater facility installations through 2022.

City staff identified the location, type(s), and anticipated drainage area(s) for these projected stormwater facility installations. Table 5-2 lists the anticipated stormwater facility installations by TMDL watershed, facility type, and drainage area.

Additional public and private stormwater facility installations beyond those listed in Table 5-2 are likely but have not been projected. This conservative assumption is due to the variable schedules of private development activities and the unknown content and issuance date for the City's reissued NPDES MS4 permit.

Table 5-2. TMDL Benchmark Status and Projected Future Stormwater Facility Installations

TMDL watershed	Model time frame	Parameter	2016 TMDL benchmark development	
			Projected BMP installations	Estimated future BMP drainage area addition (ac) ^a
Clackamas River	Annual	Bacteria	• Dry ponds • Flow through swales	19.25
Middle Willamette tributary	Summer Season	Bacteria	• Underground filter systems • Dry ponds • Infiltration rain gardens • Flow through swales	118.47
	Fall, Winter, Spring Season	Bacteria		
Middle Willamette direct	Annual	Bacteria	• Infiltration rain gardens	0.65

a. The future BMP drainage area includes 1) potential areas to be treated by new BMPs, and 2) area currently being treated by a structural BMP, but expected to receive treatment by a more effective BMP (through retrofit of existing systems or installation of downstream BMPs).

5.2 TMDL Benchmark Results and Discussion

The spreadsheet loads model used for the PLRE in 2015 was used to simulate predicted future BMP implementation and calculate future pollutant load reduction estimates (i.e., TMDL benchmarks).

TMDL benchmarks are calculated as the difference between the modeled loads associated with the no-BMP scenario and the (future) with-BMP scenario. This load reduction is presented as a range to reflect the wide variability in stormwater data. Table 5-3 provides TMDL benchmarks as a load reduction and as a percentage load reduction. Calculation of the TMDL benchmarks as a percentage load reduction allows for direct comparison with the WLAs established for bacteria.

Table 5-3. TMDL Benchmarks for Bacteria (2017–2022)

TMDL watershed	Time frame	Pollutant (units)	WLA (% reduction)	TMDL benchmarks (load reduction) ^a , range	TMDL benchmarks (% load reduction) ^a , range
Clackamas River	Annual	Bacteria (counts)	78%	1.47×10^{11} to 9.05×10^{11}	4.6 to 7.5
Middle Willamette tributary	Summer season	Bacteria (counts)	88%	1.69×10^{12} to 7.76×10^{12}	15.3 to 23.4
	Fall, Winter, Spring Season	Bacteria (counts)	75%	9.98×10^{12} to 4.58×10^{13}	15.3 to 23.4
Middle Willamette direct	Annual	Bacteria (counts)	75%	1.20×10^{10} to 6.30×10^{10}	0.8 to 1.0

a. The TMDL benchmarks are a load reduction, calculated as the difference between the current no-BMP scenario load and the future with-BMP scenario load. The benchmarks have also been calculated as a percent reduction for direct comparison with the WLA.

The City's benchmarks reflect the projected installation of 24 new structural BMPs, covering approximately 138 acres of drainage area. Approximately 132 acres will be new treatment for drainage areas that are not currently treated. The remaining 6 acres reflects a drainage area that is currently treated by a structural BMP, but is expected to be managed by a more effective structural BMP in the future.

While the projected BMP coverage area and resulting bacteria load reductions are significant, the resulting pollutant load reductions fall short of achieving the WLAs. Large areas of the City have already developed without structural BMPs and structural stormwater BMPs are not 100 percent effective in removing bacteria. The City prepared a WLA attainment assessment for DEQ in February 2016, which indicated that achieving the WLAs would require construction of facilities and associated maintenance costs that far exceed the City's definition of maximum extent practicable. Progress toward the WLA, and not achievement of the WLA, is the City's goal in setting benchmarks. Such progress is reflected in Table 5-3 and Appendix B of this NPDES MS4 permit renewal application.

The proposed benchmarks are conservative estimates of the pollutant load reduction anticipated during the next permit term with the use of structural BMPs alone. The load reduction estimates do not account for:

- Non-structural BMPs.
- Future stormwater program enhancements to target TMDL parameters as pollutants of concern, to be identified in future SWMP updates.
- Additional structural BMPs installed in conjunction with future development and redevelopment projects that have not yet submitted land use applications to the City.
- New water quality capital projects, identified through the development of the City's new Stormwater Master Plan, which is anticipated to be completed in 2017.

Each of these efforts is expected to further reduce the bacteria pollutant loads in runoff from the City's watersheds to below the levels indicated in these benchmark projections.

Section 6

Fiscal Evaluation of Stormwater Expenditures

Permit Requirements

Schedule B.6: MS4 Permit Renewal Application Package

...The application package must include an evaluation of the adequacy of the proposed SWMP modifications in reducing pollutants in discharges from the MS4 to the MEP. The application package must contain:

- f. A fiscal evaluation summarizing program expenditures for the current permit cycle and projected program allocations for the next permit cycle.

The City spent approximately \$11.43 million on stormwater management services and facilities during the first 5 years of the current permit term (FYs 2012 through 2016) as shown in Table 6-1. The stormwater revenue requirements for FY 2017 total approximately \$2.8 million. Table 6-2 shows the City's forecasted stormwater revenue requirements of approximately \$14.6 million during FYs 2018 through 2022.

Table 6-1. Actual/Adopted Expenditures

Expenditure type	Current permit term, 2012-2017					
	Actual					Budget
FY	2012	2013	2014	2015	2016	2017
Personal services	\$ 978,421	\$ 968,984	\$ 970,208	\$1,046,529	\$1,085,946	\$1,211,458
Material and services	548,153	690,828	752,416	728,700	773,861	648,685
Capital outlay	121,308	85,919	96,537	207,969	401,712	321,000
Transfers out	407,123	378,000	325,346	335,000	405,000	585,011
Total stormwater	\$2,055,005	\$2,123,731	\$2,144,507	\$2,318,198	\$2,666,519	\$2,766,154

Table 6-2. Forecasted Requirements

Expenditure type	Next permit term, 2018-2022				
	Forecast				
FY	2018	2019	2020	2021	2022
Personal services	\$1,247,802	\$1,272,758	\$1,298,213	\$1,337,160	\$1,363,903
Material and services	650,000	669,500	689,585	710,273	731,581
Capital outlay	215,000	349,000	359,470	370,254	381,362
Transfers out	584,000	584,000	584,000	584,000	584,000
Total stormwater	\$2,696,802	\$2,875,258	\$2,931,268	\$3,001,686	\$3,060,845

The City relied on stormwater utility user fees to pay for an average of 96 percent of the total annual utility requirements during FYs 2012 through 2016. Utility user fees will finance approximately 97 percent of total stormwater utility requirements in FY 2017. During FYs 2018 through 2022, the City expects to rely on stormwater utility user fees for 97 percent of the total utility revenue requirements. Table 6-3 lists the adopted (FY 2012-2017) and forecasted (FY 2018-2022) stormwater utility user rates for the current permit term.

Table 6-3. Stormwater Utility User Rates, Adopted and Forecasted
(per month, per EDU)

Current permit term, 2012-2017	Actual					Budget
	2012	2013	2014	2015	2016	
FY						
Rate	7.40/8.30	8.30/8.55	8.55/8.80	8.80/9.05	9.05/9.35	9.35/9.65
Next permit term, 2018- 2022	Forecast					
	2018	2019	2020	2021	2022	
Rate	9.65/9.94	9.94/10.24	10.24/10.54	10.54/10.86	10.86/11.19	

Section 7

Monitoring Objectives Matrix

Permit Requirements

Schedule B.6: MS4 Permit Renewal Application Package

...The application package must include an evaluation of the adequacy of the proposed SWMP modifications in reducing pollutants in discharges from the MS4 to the MEP. The application package must contain:

- d. A proposed monitoring program objective matrix and proposed monitoring plan including the information required in Schedule B.2.d for each proposed monitoring project/ task.

This section of the permit renewal provides a summary of the City's stormwater monitoring program and an updated monitoring objectives matrix.

The City's monitoring plan and information required in Schedule B.2.d. of the NPDES MS4 permit is provided in the *Comprehensive Clackamas County NPDES MS4 Stormwater Monitoring Plan* (CCCSMP), dated January 2017 (scheduled for implementation July 1, 2017). The CCCSMP is provided in Appendix C of this permit renewal application. The CCCSMP was updated as a joint effort with other participants including: Clackamas County, Clackamas County Service District #1 (CCSD#1), the Surface Water Management Agency of Clackamas County (SWMACC), Oak Lodge Water Services District (OLWSD) and the cities of Gladstone, Milwaukie, West Linn, Wilsonville, Happy Valley, and Rivergrove, Oregon.

Per Schedule B.2.e of the NPDES MS4 permit, the co-permittees were allowed to modify their monitoring plans on the condition that a 30-day notice was provided to the Oregon DEQ for review and approval. Participating co-permittees submitted a modified CCCSMP to DEQ on December 16, 2016 and did not receive comments back from DEQ within the 30-day window. Therefore, participating co-permittees intend to implement the 2017 CCCSMP beginning July 1, 2017. Adaptive management changes that were made to the monitoring plan are summarized in Section 3 of the CCCSMP.

The monitoring objectives matrix is provided in Table 7-1, below. This matrix summarizes the stormwater-related monitoring activities described in the 2017 CCCSMP including: instream water quality, instream biological, instream physical, stormwater quality, BMP effectiveness, and MS4 program monitoring. The matrix provides a summary of how each of the listed monitoring activities is used to address the monitoring objectives that are specified in the permit in Schedule B.1.a.

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Table 7-1. Monitoring Objectives Matrix for 2017 Permit Renewal							
Stormwater-related monitoring activity/program	Stormwater-related monitoring activity/program description	DEQ MS4 Monitoring Objectives - Schedule B.1.a.					
		i. Evaluate the sources of the 2004/ 2006 303(d) listed pollutants as applicable.	ii. Evaluate the effectiveness of BMPs in order to help determine BMP implementation priorities.	iii. Characterize MS4 runoff discharges based on land use, seasonality, geography or other catchment characteristics.	iv. Evaluate long-term trends in receiving waters associated with MS4 stormwater discharges.	v. Assess the chemical, biological, and physical effects of MS4 discharges on receiving waters.	vi. Assess progress towards meeting TMDL pollutant load reduction benchmarks.
Environmental Monitoring Activities							
In-Stream Water Quality	• Instream samples will be collected from 25 locations. • Sampling frequencies vary from 3 to 9 times per year depending on the sampling location. • A total of 147 data points will be collected per year. • Depending on the jurisdiction and sampling location, samples will be collected as: 1) ambient scheduled grabs and timed composite grabs if it is raining on the scheduled sampling day, or 2) targeted dry weather grabs and targeted storm event time composites. • Samples will be analyzed for both field and lab parameters (see Table 9 of the CCCSMP).	N/A	There are some paired instream sampling locations that will be used to evaluate and compare upstream and downstream water quality. Results will assist in evaluating effectiveness of the co-permittees overall SWMPs in terms of implementing BMPs.	N/A	Trends will be assessed for each location, based on available data. Trends may be assessed for both dry weather and wet weather data.	Chemical effects of MS4 discharges may be assessed by comparing dry weather and wet weather instream water quality sampling results.	N/A
In-Stream Biological	• Biological samples will be collected from 21 instream locations. • The sampling frequency will be once per permit term. • Samples will be evaluated for the type and number of macroinvertebrates present. Water quality and physical condition monitoring is also conducted at the same locations to help inform results.	N/A	N/A	N/A	N/A	Biological effects may be assessed based on macroinvertebrate sampling results with respect to MS4 discharge locations.	N/A
In-Stream Physical Conditions	• During biological sampling activities, physical conditions are assessed using the modified Rapid Assessment Technique. Physical attributes include stream width/ depth, riparian vegetation, tree canopy, and bank erodibility.	N/A	N/A	N/A	N/A	Physical effects (erodibility) may be assessed through geomorphic monitoring with respect to MS4 discharge locations.	N/A
Stormwater Quality	• Stormwater samples will be collected from 11 locations representing 5 land uses. • Samples will be collected during 3 storm events per year. • A total of 33 data sets will be collected per year (3 events from each of 11 sites). • Samples will be collected as timed composites. • Samples will be analyzed for both field and lab parameters (see Table 9 of the CCCSMP).	The 303(d) parameters bacteria and organics (via TSS as a surrogate) are monitored. Results may provide an indication of the predominant sources of these parameters in terms of general land uses.	As BMP implementation progresses, results of stormwater monitoring over time may help to indicate whether BMPs are effective for the range of parameters.	Stormwater sampling results may be used to characterize runoff quality for the respective contributing land use categories.	N/A	Chemical effects of MS4 discharges on receiving waters may be assessed by comparing MS4 runoff concentrations with instream concentrations.	Land use event mean concentrations (EMCs) are used to model pollutant loads for developing pollutant load reduction benchmarks. EMCs that are used in the model are evaluated periodically to determine whether updates are needed.
BMP Monitoring (Effectiveness)	• Stormwater samples will be collected from a regional water quality facility during 1 storm event per year. Samples will be evaluated for both field and lab parameters (see Table 9 of the CCCSMP).	N/A	Sampling results may be used to understand the effectiveness of this regional water quality/ detention facility.	N/A	N/A	N/A	Sampling results may be used to refine/update BMP effluent concentrations included in the pollutant loads model used to develop benchmarks.
Program Monitoring Activities							
BMP Monitoring (Programmatic)	• Measurable goals and tracking measures are evaluated annually for BMPs listed in the co-permittee's stormwater management plans (SWMPs).	Tracking measures associated with commercial/industrial inspections, illicit discharge investigations, dry weather field screening, and private water quality facility inspections may indicate potential sources of 303(d) pollutants.	Measurable goals and tracking measures are assessed annually to assist in evaluating the effectiveness of SWMP BMPs.	N/A	N/A	N/A	Tracking measures for pollution prevention and operations and maintenance activities will require tracking of water quality facility installations and retrofits. Information will be used to help develop benchmarks.

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Appendices

- A Stormwater Management Plan
- B TMDL Pollutant Load Reduction Evaluation and Benchmarks
- C Updated Monitoring Plan
- D MS4 Maps

Appendix A: Stormwater Management Plan

CITY OF OREGON CITY STORMWATER MANAGEMENT PLAN (2017)

Overview

This 2017 version of the City of Oregon City's Stormwater Management Plan ("SWMP") reflects updates to the City's effective (2012) SWMP and was developed based on a review and evaluation of the City's stormwater management program implemented during the 2012 – 2017 NPDES MS4 permit term. This proposed SWMP was prepared for the City's NPDES MS4 permit renewal application, due February 28, 2017.

NPDES MS4 permit language associated with the next reissuance of the permit has not yet been drafted by the Department of Environmental Quality (DEQ). As such, this (2017) SWMP continues to address and include the permit language from the City's current NPDES MS4 permit (permit number 101348, issued March 16, 2012). Future updates are anticipated to address any new requirements associated with the next reissuance of the NPDES MS4 permit.

City of Oregon City SWMP (2017)

The SWMP is organized into the eight major stormwater program elements listed below. The eight major elements correspond to those outlined in the NPDES MS4 permit (i.e., Schedule A(4)(a-h)).

Element #1:	Illicit Discharge Detection and Elimination
Element #2:	Industrial and Commercial Facilities
Element #3:	Construction Site Runoff Control
Element #4:	Education and Outreach
Element #5:	Public Involvement and Participation
Element #6:	Post-Construction Site Runoff
Element #7:	Pollution Prevention for Municipal Operations
Element #8:	Stormwater Management Facilities Operations and Maintenance Activities

SWMP Element #1

Illicit Discharge Detection and Elimination

NPDES permit requirements are listed below, followed by Oregon City's relevant BMPs that address the permit requirement. Applicable provisions are outlined under Schedule A.4.a of the City's NPDES MS4 Permit. See **Table 1** for the City of Oregon City's BMP fact sheets that address the permit requirements that are listed below.

SWMP Element #1: Illicit Discharge Detection and Elimination			
Schedule A.4.a Permit Requirement (permit requirements to be updated with subsequent permit issuance)	Applicable BMPs		
	Implement the Illicit Discharges Elimination Program	Conduct Annual Dry Weather Field Screening	Implement the Spill Response Program
i. Prohibit, through ordinance or other regulatory mechanism, illicit discharges into the co-permittee's MS4.	■		
ii. Describe enforcement response procedures by November 1, 2012.	■		
iii. Develop or identify pollutant parameter action levels that will be used as part of the field screening to identify the source of an illicit discharge or other type of discharge.... by November 1, 2012.		■	
iv. Conduct annual dry-weather inspection activities during the term of the permit. The dry-weather inspection activities must be documented and include: 1) General observations; 2) Field Screening; and 3) Laboratory Analysis.		■	
v. Identify response procedures to investigate portions of the MS4 that, based on the results of general observations, field screening, laboratory analysis...indicates the likely presence of an illicit discharge.		■	
vi. Maintain a system for documenting illicit discharge complaints or referrals and suspected illicit discharge investigation activities.	■		

SWMP Element #1: Illicit Discharge Detection and Elimination			
Schedule A.4.a Permit Requirement (permit requirements to be updated with subsequent permit issuance)	Applicable BMPs		
	Implement the Illicit Discharges Elimination Program	Conduct Annual Dry Weather Field Screening	Implement the Spill Response Program
vii. <i>Take appropriate action to remove illicit discharges from the MS4 within 5 working days of detection...If elimination will take more than 15 days... the co-permittee must develop and implement an action plan in an expeditious manner. The action plan must be completed within 20 working days of determining the source of an illicit discharge. The action plan, response procedures, response plan or similar document must include a timeframe for elimination as soon as practicable.</i>	■		
viii. <i>Describe and implement procedures to prevent, contain, respond to and mitigate spills that may discharge into the MS4....</i>			■
ix. <i>In the case of a known illicit discharge that originates within the co-permittees MS4 regulated area and that discharges directly to a storm sewer system or property under the jurisdiction of another municipality, the co-permittee must notify the affected municipality as soon as practicable, and at least within one working day of becoming aware of the discharge.</i>	■		
x. <i>In the case of a known illicit discharge that is identified within the co-permittee's MS4 regulated area, but is determined to originate from a contributing storm sewer system or property under the jurisdiction of another municipality, the City must notify the contributing municipality or municipality with jurisdiction as soon as practicable, and at least within one working day of identifying the discharge.</i>	■		
xi. <i>Maintain maps identifying known co-permittee owned MS4 outfalls discharging to waters of the State. The dry-weather screening priority locations must be identified on maps by November 1, 2012.</i>		■	
xii. <i>Unless identified as a significant source of pollutants to waters of the State by a co-permittee or the Department, the following non-stormwater discharges are not considered illicit discharges: (see Schedule A.4.a.xii for list of discharges). If any of these non-stormwater discharges under the co-permittee's jurisdiction is a significant source of pollutants, the co-permittees must develop and require implementation of appropriate BMPs to reduce the discharge of pollutants associated with the source.</i>	■		

BMP 1-1

Implement the Illicit Discharge Elimination Program

BMP Implementation	Measurable Goals	Tracking Measures
BMP Owner: Oregon City Public Works Department Permit Year: Ongoing Implementation Activities: The City of Oregon City prohibits illicit discharges to their MS4 system in conjunction with the stormwater management chapter of their City code (Section 13.12). The City has the authority to conduct appropriate response procedures and enforce against responsible parties per Section 13.12.150 of City code. If an illicit discharge is discovered, the City will conduct appropriate actions to remove the illicit discharge in accordance with the City's Illicit Discharge Detection and Elimination Standard Operating Procedures (IDDE SOP). These standard operating procedures have been implemented in accordance with NPDES MS4 permit requirements for illicit discharges. Illicit discharges suspected and/or identified by City staff (either independently or in conjunction with public reporting) are currently recorded in paper files, and will be incorporated into the City's asset management program to track results for annual reporting.	• Implement updated Standard Operating Procedures for the IDDE program. • For identified illicit discharges, conduct appropriate actions to remove the discharge in conjunction with time frames outlined in the City's NPDES MS4 Permit. • Track and record all identified illicit discharges and how such discharges were removed.	• Track updates to the IDDE standard operating procedures. • Track the number, location, type of discharge, resolution and enforcement activities related to any illicit discharge investigation conducted.

BMP 1-2

Conduct Annual Dry Weather Field Screening

BMP Implementation	Measurable Goals	Tracking Measures
BMP Owner: Oregon City Public Works Department Permit Year: Ongoing Implementation Activities: Oregon City conducts illicit discharge inspections (i.e., dry weather field screening) at least once annually during dry-weather conditions (typically between July and September) at major and select minor outfalls previously approved by DEQ. Trained personnel complete data inspection forms while inspecting each of the outfalls. Dry weather flows are inspected for a variety of visual characteristics, and sources of flows are characterized as either permissible (listed in Schedule A3 of the NPDES MS4 permit), non-permissible or unknown. If non-permissible or unknown discharges are observed, sampling, analysis, and investigation are conducted according to the following procedures: 1. General field observations are documented including the visual presence of flow, turbidity, oil sheen, etc. that indicates the presence of illicit discharges. 2. A water sample is collected and analyzed for general field parameters based on the known information regarding the discharge such as source, color, odor, etc. 3. If the source of the illicit discharge cannot be verified at the time of the initial investigation, laboratory analysis will be conducted for the suspected contaminant group. 4. Using a drainage map and other source identification data, an attempt is made to locate the potential sources upstream of the discharge location. Additional source investigations may be conducted using one or more of the following techniques: onsite inspections, dye-testing, smoke testing, and/or TV inspection of lines. The Public Works Operations Manager will be notified of all positive identifications of illicit discharges and will take all necessary steps to eliminate them. Typically, code enforcement is sent to the site and the site owner is given a notice of violation and a time frame with which to correct the problem. A follow-up inspection will occur to ensure the illicit discharge has been removed, and if the illicit discharge still exists, the site owner will face further enforcement action.	• Conduct dry-weather field screening once per year, at a minimum, at major outfalls (approximately 9) using data inspection forms. • Characterize dry weather flows as permissible, non-permissible or unknown. • Conduct sampling, analysis, and investigations for non-permissible and unknown dry-weather discharges. • Maintain maps of major outfalls and dry weather field screening locations on an annual basis. • Notify the Public Works Operations Manager of all positive identifications of illicit discharges and take necessary steps to eliminate them.	• Track the number and location of outfalls inspected annually. • Summarize inspection results and track the number and location of outfalls requiring monitoring (sampling) and/or investigations. • Report the outcome and resolution of any investigation activities conducted. • Report the outcome and resolution of any code enforcement actions.

BMP 1-3

Implement the Spill Response Program

BMP Implementation	Measurable Goals	Tracking Measures
BMP Owner: Clackamas Fire District #1 (Hazardous Materials Team), and Oregon City Public Works Department Permit Year: Ongoing Implementation Activities: Clackamas Fire District #1, Hazardous Materials Team initially responds to all phone calls and reports regarding chemical and hazardous waste spills within the City limits. Procedures for spill response are outlined in the Fire Department's "Emergency Operations Plan". The Fire Department reports the spill to DEQ, and if necessary may rely on DEQ for technical assistance on clean-up, sampling, restoration, disposal, enforcement and coordination of state agency resources. For non-hazardous material spills (oil and grease, paint, sewage), the Public Works Department responds to reports by citizens or as observed by Public Works staff. Public Works staff follows the City of Oregon City Spill Response Plan, which references DEQ's spill response procedures. When Public Works responds to spills, they stop the source, and then use absorbent pads and booms to prevent any contaminated runoff from entering the stormwater conveyance system. Following initial site cleanup, the catch basins are cleaned to remove any residual pollutants that may have discharged into the system. Spill reports are completed and faxed to DEQ and are maintained on file at the Public Works office. Appropriate City staff is trained annually on spill response. This is covered in more detail in the BMP titled, "Conduct Staff Training in Spill Response" in Element #4.	• Respond to reports of spills of non-hazardous materials and follow the Oregon City Spill Response Plan. • Report all hazardous and non-hazardous spills to DEQ as necessary. • Publicize spill response phone numbers.	• Indicate the number of spills reported to Public Works and to DEQ. • Track responses to reported spills. • Indicate sources, causes, and types of discharges resulting from spill activities. • Track any changes made to the Oregon City Spill Response Plan.

SWMP Element #2 Industrial and Commercial Facilities

NPDES permit requirements are listed below, followed by Oregon City's relevant BMPs that address the permit requirement. Applicable provisions are outlined under Schedule A.4.b. **See Table 2** for the City of Oregon City's BMPs that address the requirements that are listed above.

SWMP Element #2: Industrial and Commercial Facilities		
Schedule A.4.b Permit Requirement (permit requirements to be updated with subsequent permit issuance)	Applicable BMP	
	Screen Existing and New Industrial Facilities	Implement an Industrial/Commercial Inspection Program for High Priority Facilities
i. <i>Screen existing and new industrial facilities to assess whether they have the potential to be subject to an industrial stormwater NPDES permit or have the potential to contribute a significant pollutant load to the MS4.</i>	■	
ii. <i>Within 30 days after the facility is identified, notify the industrial facility and the Department that an industrial facility is potentially subject to an industrial stormwater NPDES permit.</i>	■	
iii. <i>Implement an updated strategy to reduce pollutants in stormwater discharges to the MS4 from industrial and commercial facilities...The strategy must include a description of the rationale for identifying commercial and industrial facilities as a significant contributor, and establish the priorities and procedures for inspection of and implementation of stormwater control measures. The strategy must be implemented by July 1, 2013, and applied within one calendar year from the date a new source contributing a significant pollutant load to the MS4 has been identified.</i>		■

BMP 2-1

Screen Existing and New Industrial Facilities

BMP Implementation	Measurable Goals	Tracking Measures
Responsible Department: City of Oregon City Public Works Department Permit Year: Ongoing BMP Description: The City's Business License inventory includes SIC codes for licensed industrial facilities. The City of Oregon City will review the business license inventory annually to determine whether any existing or new facilities would be subject to an industrial stormwater NPDES permit. This determination will occur based on a review of the facilities proposed activities and the applicable SIC codes related to the 1200-series NPDES permit. If a facility is identified that would be subject to an industrial stormwater NPDES permit, the facility and DEQ will be notified within 30 days. During the annual review of the existing business license inventory, the City will also consider whether any industrial or commercial facilities have the potential to contribute a significant pollutant load to the MS4. These facilities will be considered for potential inclusion in the industrial/commercial inspection program (see BMP 2-2).	• Review the business license inventory for 1200Z industries annually. • Notify DEQ of any existing or new industrial facilities within the City of Oregon City jurisdiction that may potentially be subject to an industrial stormwater NPDES permit.	• Track the number of existing or new facilities subject to a stormwater industrial NPDES permit annually.

BMP 2-2

Implement an Industrial/Commercial Inspection Program for High Priority Facilities

BMP Implementation	Measurable Goals	Tracking Measures
BMP Owner: Oregon City Public Works Department Permit Year: Ongoing Implementation Activities: The City relies on DEQ to conduct inspections of 1200-Z permitted facilities, as these are under DEQ's jurisdiction. The City has developed standard operating procedures for conducting industrial/commercial facility inspections. There are over 1200 registered identified industrial or commercial businesses in Oregon City. Through BMP 2-1, the City identifies the industrial and commercial facilities that have the potential to contribute significant pollutant loads to the MS4. The City's goal is to inspect at least 8 of these facilities by the end of the permit term. If, during an inspection, a site is discovered to be contributing excess pollutants to the stormwater system, the City of Oregon City will either work with the site owner to remove the discharge or refer the site to code enforcement and DEQ who may either require sampling and monitoring or removal of a specific source of discharge.	• Pursue approval to hire staff to implement a business inspection program. • Develop a priority list of industrial/commercial facilities for inspection. • Investigate 8 of the City's high priority industrial/commercial facilities once during the permit term.	• Track the number of inspections conducted. • Report on inspection results and follow-up actions. • Track updates to inspection procedures.

SWMP Element #3 Construction Site Runoff Control

NPDES permit requirements are listed below, followed by Oregon City's relevant BMPs that address the permit requirement. Applicable provisions are outlined under Schedule A.4.c. **See Table 3** for the City of Oregon City's BMPs that address the requirements that are listed above.

SWMP Element #3: Construction Site Runoff Control			
Schedule A.4.c Permit Requirement (permit requirements to be updated with subsequent permit issuance)	Applicable BMPs		
	Implement the Erosion Control Ordinance	Provide Educational Information to Construction Site Operators	Conduct Erosion Control Inspections and Enforcement
i. <i>Include ordinances or other enforceable regulatory mechanism that requires erosion and sediment controls to be designed, implemented, and maintained to prevent adverse impacts to water quality and minimize the transport of contaminants to waters of the State. By November 1, 2014, the construction site runoff control program ordinances or other enforceable regulatory mechanism must apply to construction activities that result in land disturbance of 1,000 square feet or greater.</i>	■	■	
ii. <i>Require construction site operators to develop site plans, and to implement and to maintain effective erosion and sediment control best management practices.</i>	■	■	
iii. <i>Require construction site operators to prevent or control non-stormwater waste that may cause adverse impacts to water quality, such as discarded building materials, concrete truck washout, chemicals, litter, and sanitary waste.</i>	■	■	

SWMP Element #3: Construction Site Runoff Control			
Schedule A.4.c Permit Requirement (permit requirements to be updated with subsequent permit issuance)	Applicable BMPs		
	Implement the Erosion Control Ordinance	Provide Educational Information to Construction Site Operators	Conduct Erosion Control Inspections and Enforcement
iv. <i>Describe site plan review procedures to ensure stormwater BMPs are appropriate and address the construction activities being proposed. At a minimum, construction site erosion and sediment control plans for sites disturbing one acre or greater must be consistent with the substantive requirements of the State of Oregon's 1200-C permit site erosion prevention and sediment control plans.</i>	■	■	
v. <i>Co-permittees must perform on-site inspections in accordance with documented procedures and criteria to ensure the approved erosion and sediment control plan is properly implemented.... Inspections must be documented, including photographs and monitoring results as appropriate.</i>			■
vi. <i>Describe in an enforcement response plan or similar document the enforcement response procedures the co-permittee will implement. The enforcement response procedures must use all means necessary to ensure construction activities are in compliance with the ordinances or other regulatory mechanisms.</i>			■

BMP 3-1

Implement the Erosion Control Ordinance

BMP Implementation	Measurable Goals	Tracking Measures
BMP Owner: Oregon City Public Works Department Permit Year: Ongoing BMP Description: Oregon City's erosion control ordinance (Ordinance 99-1013) requires all land development applications to obtain an erosion control permit, issued based on City approval of erosion and sediment control plans submitted for the project. This requirement is consistent with Metro's Urban Growth Management Plan Title 3. Erosion control plans must be submitted and approved prior to issuance of the City's erosion control permit and must show permanent and non-permanent control structures for all developments greater than 1,000 square feet (including those sites greater than 5 acres that are also required to obtain a DEQ 1200-C NPDES permit). Erosion and Sediment Control standards are contained in City Code 17.47 that defines policies, minimum requirements, minimum standards and design procedures for erosion prevention and sediment control in Oregon City. In addition, the City adopted use of the <i>Clackamas County Erosion Prevention and Sediment Control Planning and Design Manual</i> as modified by Oregon City Addendum. The manual and addendum were adopted by the City Commission on May 20, 2015 through Resolution 15-14. During the plan review process, new and redevelopment projects are reviewed for compliance with the erosion control standards. Plans not in compliance are not approved and are required to implement appropriate erosion control techniques prior to approval.	- Require and review erosion control plans with both permanent and non-permanent BMPs for all developments greater than 1,000 sf. The plans must comply with the City of Oregon City Public Works Standards for Erosion and Sediment Control. - Require erosion and sediment control plans not in compliance with standards to be amended and approved prior to construction.	- Record the number of erosion control plan reviews completed and approved. - Track the number of erosion and control permits issued annually.

BMP 3-2

Provide Educational Information to Construction Site Operators

BMP Implementation	Measurable Goals	Tracking Measures
BMP Owner: Oregon City Public Works Department Permit Year: Ongoing BMP Description: The City's erosion control manual is available for download from the City of Oregon City website. The City currently has incentive practices that allow a reduction in fees associated with the erosion control permit if the applicant (contractor) has received formal training in erosion or sediment control per the contractor certification program. This program will be reviewed to identify more effective alternatives.	• Continue to provide the City's most current erosion control manual on the City website. • Research opportunities to enhance contractor education and, if necessary, modify the incentive program that offers discounts on erosion control permits to contractors completing the Erosion Control Certification Program.	• Track the number of contractors receiving a discount on erosion control permit fees.

BMP 3-3

Conduct Erosion Control Inspections and Enforcement

BMP Implementation	Measurable Goals	Tracking Measures
BMP Owner: Oregon City Public Works Department Permit Year: Ongoing BMP Description: Oregon City’s erosion control ordinance requires erosion control permits for construction activities. Prior to receipt of a footing inspection, appropriate erosion control measures must be in place and inspected. A minimum of three inspections are required at all applicable sites: an initial inspection, an unscheduled inspection during construction activity, and a final inspection. However, at the beginning of construction, inspections for residential and commercial development sites generally occur two to three times weekly. Public Works projects are generally inspected weekly for erosion control measures. Erosion and sediment control enforcement procedures are outlined in the Oregon City Municipal Code 17.47. For sites with an erosion control violation or where ineffective erosion control is observed, a Notice of Non-Compliance is issued, and contractors are required to install effective control measures within a specified timeframe (typically 24 hours). A Stop Work Order is in effect until all appropriate measures are in place. If not resolved within the required time frame, a Code Violation Citation may be issued.	• Conduct a minimum of three erosion control inspections at each permitted site. • Conduct appropriate enforcement activities for erosion control violations.	• Record the number of erosion control inspections conducted annually. • Report the number of notices of non-compliance issued during inspections.

SWMP Element #4 Education and Outreach

NPDES permit requirements are listed below, followed by Oregon City's relevant BMPs that address the permit requirement. In some cases, listed permit requirements have been condensed. Applicable provisions are outlined under Schedule A.4.d. See **Table 4** for the City of Oregon City's BMPs that address the requirements that are listed above.

SWMP Element #4: Education and Outreach					
Schedule A.4.d Permit Requirement (permit requirements to be updated with subsequent permit issuance)	Applicable BMPs				
	Provide Public Education and Outreach Materials Regarding Stormwater Management	Participate in a Public Education Effectiveness Evaluation	Conduct Staff Training for Pest Management	Conduct Staff Training in Spill Response	Ensure Municipal Staff Training in Stormwater Pollution Prevention
i. Continue to implement a documented public education and outreach strategy that promotes pollutant source control and a reduction of pollutants in stormwater discharges.... The public education and outreach strategy may incorporate cooperative efforts with other MS4 regulated permittees or efforts by other groups or organizations provided a mechanism is developed and implemented to track the public education and outreach efforts within the MS4 regulated area and the results of such efforts are reported annually.	■				
ii. Provide educational materials to the community or conduct equivalent outreach activities describing the impacts of stormwater discharges on water bodies and the steps or actions the public can take to reduce pollutants in stormwater runoff.	■				
iii. Provide public education on the proper use and disposal of pesticides, herbicides, fertilizers and other household chemicals.	■				

SWMP Element #4: Education and Outreach					
Schedule A.4.d Permit Requirement (permit requirements to be updated with subsequent permit issuance)	Applicable BMPs				
	Provide Public Education and Outreach Materials Regarding Stormwater Management	Participate in a Public Education Effectiveness Evaluation	Conduct Staff Training for Pest Management	Conduct Staff Training in Spill Response	Ensure Municipal Staff Training in Stormwater Pollution Prevention
iv. <i>Provide public education on the proper operation and maintenance of privately-owned or operated stormwater quality management facilities.</i>	See Element #8: Stormwater Management Facilities Operation and Maintenance Activities BMP: Private Structural Control Facility Cleaning and Maintenance (BMP 8-4)				
v. <i>Provide notice to construction site operators concerning where education and training to meet erosion and sediment control requirements can be obtained.</i>	See Element #3: Construction Site Runoff Control BMP: Provide Educational Information to Construction Site Operators (BMP 3-2)				
vi. <i>Conduct or participate in an effectiveness evaluation to measure the success of public education activities during the term of this permit. The effectiveness evaluation must focus on assessing changes in targeted behaviors. The results of the effectiveness evaluation must be used in the adaptive management of the education and outreach program and reported to the Department no later than July 1, 2015.</i>		■			
vii. <i>Include training for co-permittee employees involved in MS4-related activities, as appropriate. The training should include stormwater pollution prevention and reduction from municipal operations, including, but not limited to, parks and open space maintenance, fleet and building maintenance, new municipal facility construction and related land disturbances, design and construction of street and storm drain systems, discharges from non-emergency firefighting-related training activities, and stormwater system maintenance.</i>	See Element #7: Pollution Prevention for Municipal Operations BMP: Coordinate with the Local Fire Department Related to Pollutant Discharge from Fire Fighting Training Activities (BMP 7-5)				
			■	■	■
viii. <i>Promote, publicize and facilitate public reporting of illicit discharges through the use of newspapers, newsletters, utility bills, door hangers, radio public service announcements, videos, televised council meetings, brochures, signs, posters or other effective methods.</i>	■				

BMP 4-1. Provide Public Education and Outreach Materials Regarding Stormwater Management

BMP Implementation	Measurable Goals	Tracking Measures
BMP Owner: Oregon City Public Works Department Permit Year: Ongoing BMP Description: Oregon City continues to employ a public education strategy aimed at reducing the discharge of pollutants associated with a variety of activities including but not limited to: 1. The application of pesticides, herbicides and fertilizers by citizens. 2. Illicit discharges and dumping of waste materials into the storm drainage system. 3. Disposal of waste oil and toxic materials. The City utilizes newsletter publications, brochures, posters, bill inserts, and various Clackamas County mailings to promote public awareness of water quality issues related to the above-mentioned practices. The City newsletter is distributed to citizens four times per year. The City of Oregon City participates in the Regional Coalition for Clean Rivers and Streams, which implements public educational campaigns on a more regionalized basis. The City also seeks out opportunities to partner in educational programs with organizations such as Clackamas County Water Environment Services, Clackamas River Water Providers, Clackamas Community College Environmental Learning Center, the Lower Columbia River Estuary Partnership, and Oregon State University to educate and promote topics including watershed health and low-impact development. The City also installs signs surrounding local water quality facilities, reminding residents that they are for stormwater quantity and quality control and should not be used for garbage or debris disposal. Periodically, general educational signs are also installed on public vehicles promoting water quality. To aid in public education related to proper disposal of waste materials, the City of Oregon City also sponsors a citywide catch basin stenciling program. Upon the request of volunteers, Public Works staff assist the volunteers with stenciling efforts by providing materials and directions for catch basin stenciling. On a selective basis, staff stencils catch basins after certain catch basins have been cleaned. To address bacteria concerns, the City is evaluating opportunities to increase signage or provide waste stations to promote pet waste clean-up at City parks and recreational areas.	• Include water quality related articles in three City newsletters per year. • Participate in the Regional Coalition for Clean Rivers and Streams or other equivalent partnerships to educate and promote watershed health and low impact development. • Periodically install signs near water quality structures and around the City promoting water quality. • Sponsor the volunteer catch basin stenciling program. • Distribute an annual water quality report to Oregon City residents including stormwater educational information. • Target outreach efforts to encourage pet waste clean-up at City parks and recreational areas.	• Track the number, types, and topics of public educational materials distributed to the public annually. • Report any large-scale public educational campaigns initiated during a given year. • Track coordinated public outreach activities with other permittees.

BMP 4-2

Conduct Staff Training for Pest Management

BMP Implementation	Measurable Goals	Tracking Measures
BMP Owner: Oregon City Public Works Department and Parks Department Permit Year: Ongoing BMP Description: Oregon City requires crews from Public Works and the Parks Department that are conducting pest management activities to be certified and licensed for spraying activities in accordance with OSHA requirements. Licensed staff attend refresher courses as required by the licensing board. During Public Works safety meetings, staff discuss appropriate application measures, techniques, and disposal activities for vegetative and pest management, not specific to spraying activities.	• Ensure Public Works and Parks Department Staff conducting pest management activities are certified for spraying activities according to OSHA requirements. • Ensure licensed staff attend refresher courses as required by the licensing board.	• Track the number of employees licensed for spraying activities. • Report number of employees that attended initial or refresher training for safe pest management application.

BMP 4-3

Conduct Staff Training in Spill Response

BMP Implementation	Measurable Goals	Tracking Measures
BMP Owner: Oregon City Public Works Department Permit Year: Ongoing BMP Description: Oregon City coordinates with the Clackamas County Office of Emergency Management and the Oregon City Police Department for training related to non-hazardous spill response procedures. At least once annually, the City's Public Works Department will utilize its monthly safety meeting format to provide training related to non-hazardous spill response procedures. Oregon City Public Works coordinates training opportunities for staff that initially respond to spills using Occupational Safety and Health Administration (OSHA) hazardous materials educational resources and services.	• Provide non-hazardous spill response training annually through the monthly safety meetings. • Coordinate annual training and refresher courses for staff initially responding to spills using OSHA hazardous materials educational resources.	• Track spill related training and education.

BMP 4-4

Ensure Municipal Staff Training in Stormwater Pollution Prevention

BMP Implementation	Measurable Goals	Tracking Measures
BMP Owner: Oregon City Public Works Department Permit Year: Ongoing BMP Description: A variety of training is provided to City staff associated with stormwater management in the City. Training and advisory committee opportunities are typically made available through state and local agencies and groups involved with a broad range of water quality issues including stormwater. Such training is conducted annually or every other year, depending on the number of employees to train. Oregon City Public Works staff also coordinates with other Clackamas County co-permittees regarding regional water quality efforts through ACWA and APWA on stormwater committees, permit renewal committees, and other local agency work groups interested in water quality improvements. Areas for coordination include monitoring, public education, and BMP effectiveness studies. In addition, the City will conduct regular staff meetings one to two times per year for staff with BMP implementation responsibilities. Meetings will be used to track progress on BMP implementation and to present training type materials related to stormwater quality and the NPDES MS4 permit requirements.	• Conduct municipal training for employees associated with stormwater management in the City. • Coordinate with other Clackamas County co-permittees regarding regional water quality efforts. • Participate in training and advisory committee opportunities available through state, and local agencies and groups associated with water quality. • Conduct regular stormwater staff meetings one to two times per year.	• Track the number of employees receiving training in stormwater management annually. • Track Oregon City staff participation in groups, committees, and organizations relevant to stormwater quality management. • Track regular stormwater staff meetings and staff attendance at those meetings.

SWMP Element #5 Public Involvement and Participation

NPDES permit requirements are listed below, followed by Oregon City's relevant BMPs that address the permit requirement. In some cases, listed permit requirements have been condensed. Applicable provisions are outlined under Schedule A.4.e. **See Table 5** for the City of Oregon City's BMPs that address the requirements that are listed above.

SWMP Element #5: Public Involvement and Participation	
Schedule A.4.e Permit Requirement (permit requirements to be updated with subsequent permit issuance)	Applicable BMP
	Provide for Public Participation with Submittal Efforts
<i>e. Co-permittees must adopt a public participation approach that provides opportunities for the public to effectively participate in the development, implementation and modification of the co-permittee's stormwater management program. The process must include provisions for receiving and considering public comments on the monitoring plan due to the Department September 1, 2012, annual reports, SWMP revisions, and the TMDL pollutant load reduction benchmark development.</i>	■

BMP 5-1. Provide for Public Participation with Submittal Efforts

BMP Implementation	Measurable Goals	Tracking Measures
Responsible Department: City of Oregon City Public Works Permit Year: Ongoing BMP Description: Schedule A.4.e of the City's NPDES MS4 permit requires the City to provide opportunity for public participation in the development, implementation, and modification of the City's stormwater management program. This includes monitoring plan updates, annual reports, SWMP revisions, and pollutant load reduction benchmark development. The monitoring plan and annual reports will be provided to the public for review and comment on the City's website prior to submission to DEQ. SWMP revisions and pollutant load reduction benchmarks are required for submittal to DEQ at the permit renewal submittal (180 days prior to permit expiration). Prior to submittal of these items, the City will provide the public with an opportunity to comment on the revisions to the SWMP and proposed pollutant load reduction benchmarks. Comments on the documents will be collected and considered and response to comments will be publicly provided.	• Provide for public participation with the SWMP and pollutant load reduction benchmarks prior to the permit renewal application deadline. • Provide a public comment period for the updated monitoring plan and annual reports prior to submittal to DEQ.	• Track comments received through public participation activities.

SWMP Element #6 Post-Construction Site Runoff

NPDES permit requirements are listed below, followed by Oregon City's relevant BMPs that address the permit requirement. In some cases, listed permit requirements have been condensed. Applicable provisions are outlined under Schedule A.4.f. **See Table 6** for the City of Oregon City's BMPs that address the requirements that are listed above.

SWMP Element #6: Post-Construction Site Runoff		
Schedule A.4.f Permit Requirement (permit requirements to be updated with subsequent permit issuance)	Applicable BMPs	
	Implement Municipal Stormwater Construction Standards	Review and Update Code and Development Standards related to Stormwater Quality Control
i. <i>By November 1, 2014, the post-construction stormwater pollutant and runoff control program applicable to new development and redevelopment projects that create or replace impervious surfaces must meet the conditions described in this subsection. The minimum project threshold....is identified in Table A-1. The post-construction stormwater site runoff permit conditions are as follows:</i> 1) <i>Incorporate site-specific management practices that target natural surface or predevelopment hydrologic functions as much as practicable. The site-specific management practices should optimize on-site retention based on the site conditions;</i> 2) <i>Reduce site specific post-development stormwater runoff volume, duration, and rates of discharges to the municipal separate storm sewer system (MS4) to minimize hydrological and water quality impacts from impervious surfaces;</i> 3) <i>Prioritize and include implementation of Low-Impact Development (LID), Green Infrastructure (GI) or equivalent design and construction approaches; and,</i> 4) <i>Capture and treat 80% of the annual average runoff volume, based on a documented local or regional rainfall frequency and intensity.</i>	■	■
ii. <i>The co-permittee must identify, and where practicable, minimize or eliminate ordinance, code and development standard barriers within their legal authority that inhibit design and implementation techniques intended to minimize impervious surfaces and reduce stormwater runoff (e.g., Low Impact Development, Green Infrastructure). Such modifications to ordinance, code and development standards are only required to the extent they are permitted under federal and state laws.</i>	■	■

SWMP Element #6: Post-Construction Site Runoff		
Schedule A.4.f Permit Requirement (permit requirements to be updated with subsequent permit issuance)	Applicable BMPs	
	Implement Municipal Stormwater Construction Standards	Review and Update Code and Development Standards related to Stormwater Quality Control
<i>The co-permittee must review ordinance, code and development standards for modification, minimization or elimination, and appropriately modify ordinance, code or development standard barriers by November 1, 2014. If an ordinance, code or development standard barrier is identified at any time subsequent to November 1, 2014, the applicable ordinance, code or development standard must be modified within three years.</i>		
iii. <i>To reduce pollutants and mitigate the volume, duration, time of concentration and rate of stormwater runoff, the co-permittee must develop or reference an enforceable post-construction stormwater quality management manual or equivalent document by November 1, 2014 that, at a minimum, includes the following:</i> 1) <i>A minimum threshold for triggering the requirement for post-construction stormwater management control and the rationale for the threshold.</i> 2) <i>A defined design storm or acceptable continuous simulation method to address the capture and treatment of 80% of the annual average runoff volume.</i> 3) <i>Applicable LID, GI or similar stormwater runoff reduction approaches, including the practical use of these approaches.</i> 4) <i>Conditions where the implementation of LID, GI or equivalent approaches may be impracticable.</i> 5) <i>Best Management Practices, including a description of the following:</i> a. <i>Site-specific design requirements;</i> b. <i>Design requirements that do not inhibit maintenance; and</i> c. <i>Conditions where the Best Management Practice applies.</i> 6) <i>Pollutant removal efficiency performance goals that maximize the reduction in discharge of pollutants.</i>	■	■
iv. <i>The co-permittee must review, approve and verify proper implementation of post-construction site plans for new development and redevelopment projects applicable to this section.</i>	■	■

SWMP Element #6: Post-Construction Site Runoff		
	Applicable BMPs	
	Implement Municipal Stormwater Construction Standards	Review and Update Code and Development Standards related to Stormwater Quality Control
Schedule A.4.f Permit Requirement (permit requirements to be updated with subsequent permit issuance)		
v. <i>Where a new development or redevelopment is characterized by factors limiting use of on-site stormwater management methods to achieve post-construction site runoff performance standards.... the Post-Construction Stormwater Management program must require equivalent pollutant reduction measures, such as off-site stormwater quality management. Off-site stormwater quality management may include off-site mitigation, such as construction of a structural stormwater facility within the sub-watershed, a stormwater quality structural facility mitigation bank or a payment-in-lieu program.</i>	■	■
vi. <i>A description of the inspection and enforcement response procedures the co-permittee will follow when addressing project compliance issues with the enforceable post-construction stormwater management performance standards.</i>	■	■

BMP 6-1

Implement Municipal Stormwater Construction Standards

BMP Implementation	Measurable Goals	Tracking Measures
BMP Owner: Oregon City Community Development Department Permit Year: Ongoing Implementation Activities: Oregon City continues to review new and redevelopment submittals for conformance with the Oregon City Stormwater and Grading Design Standards and associated ordinances that update portions of the Oregon City Municipal Code regarding stormwater drainage and water resources protection for all development. The Oregon City Stormwater and Grading Design Standards (effective August 2015) contain criteria and design standards for stormwater controls, and the Oregon City Municipal Code mandates development restrictions in Water Quality Resource Areas, Steep Slopes (Geologic Hazards), and Flood Plain Overlay Districts. Stormwater requirements, as outlined in the City's Stormwater and Grading Design Standards, prioritize the use of low impact development (LID), address hydromodification, and contain guidelines for both treatment and detention. Per the City's Municipal Code (Chapter 13.12), stormwater quality and quantity need to be addressed for most new development and redevelopment. Per the Municipal Code, stormwater quantity <u>and quality</u> control is required for creation of greater than 500 sf of impervious surface or disturbance of greater than 1,000 sf of existing impervious surface within a designated Water Quality Resource Area (WQRA). For all other areas, stormwater quantity and quality control is required for most activities that create or replace more than 5,000 sf of impervious surface. Flow control exemptions are provided for areas that directly discharge to major waterbodies.	• Per the City's Development Code, review all new development and applicable redevelopment for conformance with current City stormwater design standards and ordinances.	• Track the number of development applications reviewed and approved for compliance with the stormwater regulations. • Track the number, type, and drainage area of treatment facilities constructed annually.

BMP 6-2

Review Code and Development Standards related to Stormwater Quality Control

BMP Implementation	Measurable Goals	Tracking Measures
Responsible Department: Oregon City Community Development Department Permit Year: Ongoing BMP Description: The City of Oregon City updated the Stormwater and Grading Design Standards and Chapter 13.12 of the City's Municipal Code in 2015. The standards aim to: 1) promote the design and implementation of practices to minimize impervious surfaces and reduce stormwater runoff, 2) optimize onsite retention practices, and 3) reduce post-construction stormwater runoff volumes and rates. The current standards have impervious area thresholds and water quality capture and treatment requirements in line with the NPDES MS4 permit requirements. Periodic updates may be needed to clarify and improve implementation of the stormwater standards.	Review and, if necessary, update the City's post-construction stormwater design standards and code language once during the permit term.	Track any code/standards modifications made by ordinance.

SWMP Element #7

Pollution Prevention for Municipal Operations

NPDES permit requirements are listed below, followed by Oregon City's relevant BMPs that address the permit requirement. In some cases, listed permit requirements have been condensed. Applicable provisions are outlined under Schedule A.4.g. See **Table 7** for the City of Oregon City's BMPs that address the requirements that are listed above.

SWMP Element #7: Pollution Prevention for Municipal Operations						
Schedule A.4.g Permit Requirement (permit requirements to be updated with subsequent permit issuance)	Applicable BMPs					
	Conduct Street Sweeping and Roadway Repair Activities	Minimize Pollutant Discharges Associated with Landscape Management Practices	Implement a Program to Reduce the Impact of Stormwater Runoff from Municipal Facilities	Control Infiltration and Cross-Connections to the City's Stormwater Conveyance System	Coordinate with the Local Fire Department related to Pollutant Discharge from Fire fighting Training Activities	Conduct Master Planning and Implement Capital Projects for Stormwater Quality Enhancement
i. Operate and maintain public streets, roads and highways in a manner designed to minimize the discharge of stormwater pollutants to the MS4, including pollutants discharged as a result of deicing activities;	■					
ii. Implement a management program to control and minimize the use and application of pesticides, herbicides and fertilizers on co-permittee-owned properties;		■				
iii. By July 1, 2013, inventory, assess, and implement a strategy to reduce the impact of stormwater runoff from municipal facilities that treat, store or transport municipal waste, such as yard waste or other municipal waste not already covered under a 1200 series NPDES permit, a DEQ solid waste permit, or other permit designed to reduce the discharge of pollutants;			■			
iv. Limit infiltration of seepage from the municipal sanitary sewer system to the MS4;				■		

SWMP Element #7: Pollution Prevention for Municipal Operations

	Applicable BMPs					
	Conduct Street Sweeping and Roadway Repair Activities	Minimize Pollutant Discharges Associated with Landscape Management Practices	Implement a Program to Reduce the Impact of Stormwater Runoff from Municipal Facilities	Control Infiltration and Cross-Connections to the City's Stormwater Conveyance System	Coordinate with the Local Fire Department related to Pollutant Discharge from Fire fighting Training Activities	Conduct Master Planning and Implement Capital Projects for Stormwater Quality Enhancement
Schedule A.4.g Permit Requirement (permit requirements to be updated with subsequent permit issuance)						
v. <i>Implement a strategy to control the release of materials related to fire-fighting training activities;</i>					■	
vi. <i>Assess co-permittee flood control projects to identify potential impacts on the water quality of receiving water bodies and determine the feasibility of retrofitting structural flood control devices for additional stormwater pollutant removal. The results of this assessment must be incorporated and considered along with the results of the Stormwater Retrofit Assessment required by this permit.</i>						■

BMP 7-1

Conduct Street Sweeping and Roadway Repair Activities

BMP Implementation	Measurable Goals	Tracking Measures
BMP Owner: Oregon City Public Works Department Permit Year: Ongoing Implementation Activities: Oregon City conducts road maintenance and repair activities throughout the year to prevent erosion and excessive transport of sediment and organics into the stormwater system. <u>Street Sweeping Activities:</u> The City currently maintains 133 miles of streets. The City currently owns and operates two street sweepers. Streets are swept throughout the year, on average every 3-4 months. High traffic streets within the downtown area and major corridors are swept more frequently. In addition, streets are swept more often seasonally when the leaves are falling. Door hangers are distributed to inform residents not to pile leaf materials in the streets. The City's solid waste provider also collects yard debris from residents on a weekly basis. During the winter, limited sanding and the deicer, calcium magnesium acetate (CMA), are applied to address icy roadway conditions. Routine operation of the sweepers includes one full time sweeper with a second sweeper during the leaf pickup season and at times when winter sanding materials need to be removed. The City currently keeps track of street sweeping by documenting the full routes completed. However, this estimate is a conservative account because there are several non-routine trips that go unreported because they represent less than a full route. <u>Road Maintenance Activities:</u> Major road construction work is generally scheduled during the dry season when possible, to minimize polluted discharges from entering the stormwater conveyance system. For road maintenance and repair work, erosion control activities are implemented as needed and in accordance with the City's erosion control ordinances.	• Sweep city streets every 3-4 months on average, more frequently in high-traffic areas and during leaf pick up and following deicing activities.	• Track the average number of citywide sweeps per year. • Estimate the miles of streets swept per year. • Estimate the volume of debris removed during sweeping activities per year.

BMP 7-2

Minimize Pollutant Discharges Associated with Landscape Management Practices

BMP Implementation	Measurable Goals	Tracking Measures
BMP Owner: Oregon City Public Works Department and Parks Department Permit Year: Ongoing Implementation Activities: Oregon City implements a number of measures to minimize pollutant impacts associated with landscape maintenance activities. The City conducts landscape maintenance activities on all public open space and park areas using herbicides (i.e. Rodeo, Garlon3A, Aqua Master) sparingly. Insecticides are not used. Herbicides are currently applied to only select locations (generally surrounding fence lines). The City only uses approved and low-risk chemicals and makes significant efforts to reduce the need for chemicals entirely through manual weed removal (when feasible) and application of bark dust to reduce weed growth. All chemical applicators, both contractors and city staff, comply with state law regarding licensing. The City maintains copies of all Material Safety Data Sheets (MSDSs), to be made available upon request, to public and commercial pesticide and fertilizer applicators. Spray reports are completed for the application of chemicals. Specific education measures and staff training measures related to landscape maintenance are discussed under Element #4: Public Education BMPs.	• All chemical applicators, both contractors and city staff, must follow state laws related to the use of pesticides. • Applicators will complete spray reports for the application of chemicals.	• Track any program changes regarding chemical application practices used by the City.

BMP 7-3

Implement a Program to Reduce the Impact of Stormwater Runoff from Municipal Facilities

BMP Implementation	Measurable Goals	Tracking Measures
Responsible Department: Oregon City Public Works Department Permit Year: Ongoing BMP Description: The City of Oregon City currently operates various maintenance facilities that have the potential to treat, store, or transport municipal waste. These sites include the temporary storage of wastes collected from line cleaning, street sweeping, tree trimming, and catchbasin cleaning. The City has developed stormwater pollution control plans for these municipal storage facilities.	• Develop stormwater pollution control plans for municipal waste storage facilities added during the permit term. • Once during the permit term, review stormwater pollution control plans for municipal waste storage facilities and update plans, if necessary.	• Track updates to strategies used to minimize pollutant discharges from municipal waste storage facilities.

BMP 7-4

Control Infiltration and Cross-Connections to the City's Stormwater Conveyance System

BMP Implementation	Measurable Goals	Tracking Measures
BMP Owner: Oregon City Public Works Department Permit Year: Ongoing Implementation Activities: Oregon City implements an Inflow and Infiltration (I&I) abatement program. This program investigates sanitary lines using smoke-testing, T.V. techniques, dye-testing, and flow metering for any cracking or breakage that would possibly result in infiltration from the sanitary to the storm system. The City's Community Development Department reviews new and redevelopment plans for possible cross-connections, and if cross-connections are discovered, they are eliminated. The City's illicit discharge program also works to control and prevent any cross-connections during their outfall inspections and dry-weather field screening activities. Stormwater and sanitary sewer cleaning and inspection staff are always attentive to the possibility of cross-connections. This program runs congruent with other conveyance system maintenance activities, including visual inspections during routine catch basin cleaning activities. No new septic systems are permitted in the City. Repairs and enforcement to assure properly functioning septic systems are provided by Clackamas County Water Environment Services.	• Review new and re-development for possible cross-connections. • Eliminate cross-connections upon identification. • Conduct visual inspections for evidence of cross-connections during routine catch basin cleaning activities.	• Report whether any cross-connections were discovered and describe follow-up activities.

BMP 7-6

Implement Capital Projects for Stormwater Quality Enhancement

BMP Implementation	Measurable Goals	Tracking Measures
BMP Owner: Oregon City Public Works Department Permit Year: Ongoing BMP Description: Oregon City conducts Master Planning to update the current City drainage system and prioritize future capital improvement projects for flood control and water quality benefits. The City's Stormwater Master Plan is under development in 2016-2017, to include an evaluation and inventory of proposed capital improvement projects (CIPs) for water quality and flood control. As part of the master plan evaluation process, the City will review existing flood control facilities for retrofit opportunities to address water quality. CIPs are generally prioritized and implemented according to the ability of the City to fund by leveraging other funding sources and by the general magnitude of water quality/flood control benefit. The City implements the CIPs as funding is available. The City's mapping system is updated to reflect CIP improvements.	• Prioritize CIPs by funding availability and water quality/flood control benefit. • Update maps to include location and drainage area of any new stormwater quality CIPs.	• Track the number and associated cost of major CIP projects (exceeding \$100K) implemented each year and describe the added benefit (water quality, habitat restoration, etc.) of each. • Map the location and drainage area of water quality related CIPs.

SWMP Element #8

Stormwater Management Facilities Operation and Maintenance Activities

NPDES permit requirements are listed below, followed by Oregon City's relevant BMPs that address the permit requirement. In some cases, listed permit requirements have been condensed. Applicable provisions are outlined under Schedule A.4.h. See **Table 8** for the City of Oregon City's BMPs that address the requirements that are listed above.

SWMP Element #8: Stormwater Management Facilities Operation and Maintenance Activities				
Schedule A.4.h Permit Requirement (permit requirements to be updated with subsequent permit issuance)	Applicable BMPs			
	Conduct Stormwater Conveyance System Cleaning and Maintenance	Conduct Catch Basin Cleaning and Maintenance	Public Structural Control Facility Cleaning and Maintenance	Private Structural Control Facility Cleaning and Maintenance
<i>i. By July 1, 2013, the co-permittee must inventory and map stormwater management facilities and controls, and implement a program to verify that stormwater management facilities and controls are inspected, operated and maintained for effective pollutant removal, infiltration and flow control. At a minimum, the program must include the following:</i> <i>1. Legal authority to inspect and require effective operation and maintenance;</i> <i>2. A strategy to inventory and map public and private stormwater management facilities as provided under Schedule A.4.h.ii.; and,</i> <i>3. Public and private stormwater facility inspection and maintenance requirements for stormwater management facilities that have been inventoried and mapped as provided under Schedule A.4.h.ii.</i>	■	■	■	■

SWMP Element #8: Stormwater Management Facilities Operation and Maintenance Activities				
	Applicable BMPs			
	Conduct Stormwater Conveyance System Cleaning and Maintenance	Conduct Catch Basin Cleaning and Maintenance	Public Structural Control Facility Cleaning and Maintenance	Private Structural Control Facility Cleaning and Maintenance
Schedule A.4.h Permit Requirement (permit requirements to be updated with subsequent permit issuance)				
ii. <i>As part of the Stormwater Management Facilities Inspection and Maintenance program, the co-permittee must implement a strategy that guides the long-term maintenance and management of all co-permittee-owned and identified privately-owned stormwater structural facilities. At a minimum, the strategy must describe the following:</i> 1. <i>Co-permittee-owned or operated stormwater management facilities</i> a. <i>Inventory and mapping process;</i> b. <i>Inspection and maintenance schedule;</i> c. <i>Inspection, operation and maintenance criteria and priorities;</i> d. <i>Description of inspector type and staff position or title; and,</i> e. <i>Inspection and maintenance tracking mechanisms.</i> 2. <i>Privately-owned or operated stormwater management facilities</i> a. <i>Procedures for and types of stormwater facilities that will be inventoried and mapped. At a minimum, the inventory and mapping must include the following:</i> i. <i>Private stormwater management facilities for new development and redevelopment projects constructed under the permittee's post-construction management manual or equivalent document after January 15, 2012;</i> ii. <i>Private stormwater management facilities identified by the co-permittee and used to estimate the pollutant load reduction as part of the TMDL benchmark evaluation; and,</i> iii. <i>Any major private stormwater management facility or structural control.</i> b. <i>Inspection criteria, rationale, priorities, inspection frequency and procedures for inspecting private stormwater facilities that have been inventoried and mapped;</i> c. <i>Required training or qualifications to inspect private stormwater facilities;</i> d. <i>Reporting requirements; and,</i> e. <i>Inspection and maintenance tracking mechanism.</i>	■	■	■	■

BMP 8-1

Conduct Stormwater Conveyance System Cleaning and Maintenance

BMP Implementation	Measurable Goals	Tracking Measures
BMP Owner: Oregon City Public Works Department Permit Year: Ongoing BMP Description: Oregon City inspects their stormwater conveyance system including manholes, drainage pipes, culverts, and ditches according to historical records of problem areas and/or public complaints. Conveyance system components are inspected for accumulated sediment and debris that may prompt flooding and broken system components in need of repair. Conveyance system components (manholes and pipes) are cleaned when needed, based on inspections. The City manages over 120 miles of public stormwater conveyance systems. The City strives to keep the system clean and free flowing through inspection including catch basin cleaning (see next BMP) emergency response, video inspection and high pressure cleaning. Repair or replacement of public conveyance system components will be scheduled if needed. Public stormwater conveyance systems in need of repair will be repaired as routine maintenance or through the City’s capital improvement programs. The City does not regularly inspect private stormwater conveyance systems. However, if the City notices that repair or replacement of private system components (e.g., culverts) is required, Public Works will inform the owner of the need. Significant culvert failures that may result in flooding or damage to the public rights-of-way would be repaired by the City. The City has over 1.6 miles of roadside ditches within its jurisdiction included in its public conveyance system. Significant ditches (typically those that are 36” in depth or greater, or those ditches along collectors and arterials) are generally cleaned annually and more frequently if needed. A map showing the stormwater conveyance system components and stormwater structural controls is used when conducting maintenance activities. During maintenance, if a mapping discrepancy is discovered, the map is updated accordingly.	• Maintain, repair, and/or replace conveyance system components when needed, based on ongoing inspections. • Update the stormwater system map when discrepancies are found.	• Estimation of the volume of debris removed during public conveyance system cleaning activities is made in conjunction with catch basin cleaning (see BMP “Conduct Catch Basin Cleaning and Maintenance”).

BMP 8-2

Conduct Catch Basin Cleaning and Maintenance

BMP Implementation	Measurable Goals	Tracking Measures
BMP Owner: Oregon City Public Works Department Permit Year: Ongoing BMP Description: Oregon City has an annual catch basin inspection and cleaning program. The City strives to inspect 33% of its approximately 4,300 public catch basins each year. Catch basins are generally inspected for accumulated sediment and debris that may cause flooding. Catch basin cleaning activities occur primarily during the dry weather season. Utility crews utilize tracking forms (computer printouts) to document inspection and maintenance activity for the annual reports. Maintenance, repair or replacement of public catch basins will be scheduled, as needed, following inspection. A map showing the stormwater conveyance system components and stormwater structural controls is used when conducting maintenance activities. Maps are updated if a discrepancy is discovered during maintenance. The City is aware of approximately 855 private catch basins and inlets located within Oregon City. The City does not inspect these facilities as part of its annual catch basin inspection and cleaning program. However, as part of its routine stormwater maintenance program, the City does at times inspect portions of the associated private collection systems. If catch basins are found to be in need of cleaning, the City reports this to the property owner.	• Inspect at least 33% of the public catch basins annually. • Schedule the repair, and replacement of catch basins as needed based on inspections. • Update the stormwater system map when discrepancies are found.	• Track the percent of total public catch basins inspected and/or maintained annually. • Track the volume of sediment removed during cleaning activities conducted annually (this volume reported also includes sediment removed as a result of line and ditch cleaning). • Track the number of catch basin replacements annually. • Track the number of public catch basins added to the City's catch basin inventory annually.

BMP 8-3

Public Structural Control Facility Cleaning and Maintenance

BMP Implementation	Measurable Goals	Tracking Measures
BMP Owner: Oregon City Public Works Department Permit Year: Ongoing BMP Description: Oregon City inspects and/or maintains a variety of public structural water quality facilities annually. Routine inspections and/or maintenance of these public facilities vary depending on the type of facility. The City keeps a map of such facilities. The map is updated periodically to indicate the drainage areas to public structural controls. The process for conducting inspections and maintenance of these public structural water quality control facilities is provided below. A map showing the stormwater conveyance system components and stormwater structural controls is used when conducting maintenance activities. If a discrepancy in the map is discovered during maintenance activities, the map will be updated accordingly. The current structural stormwater management facilities within the City's jurisdictional boundaries, along with associated maintenance procedures and frequencies, consists of: - Public detention/water quality ponds (publicly maintained) are inspected monthly. Facilities are inspected for accumulated sediment and debris; indication of illegal dumping in the facility; and any broken or non-functioning structures in need of repair and/or replacement. Maintenance typically includes mowing and string trimming, shrub and tree care, leaf removal and trash pick-up, sediment removal, and repair to inlet and outlet structures. Repair and/or maintenance is scheduled as needed, based on inspections. - Private detention/water quality ponds for residential areas (publicly maintained) are maintained by the City per the maintenance procedures described above. - Private detention/water quality ponds for commercial/industrial areas (privately maintained). The City does not inspect these facilities as part of its routine public facility maintenance program, however it does report obvious maintenance needs to the property owner. - Public pollution control manholes are inspected once every two years and cleaned as required. - Public detention tanks are inspected during initial construction and periodically thereafter. These facilities typically do not require annual maintenance due to upstream pollution control facilities, but will be maintained if needed based on inspection results. - Public Stormwater Filters (StormFilters) are inspected annually and cleaned in accordance with manufacture's recommendations.	- Inspect and maintain public structural control facilities in accordance with the documented frequencies and procedures. - Update the public structural control facility inventory as needed. - Update the stormwater system map in accordance with new public facility installations and when discrepancies are found.	- Track the number of public structural facilities inspected and maintained. - Track the volume of sediment removed during cleaning activities. - Track changes to the public structural control facility inventory as needed.

BMP 8-4

Private Structural Control Facility Cleaning and Maintenance

BMP Implementation	Measurable Goals	Tracking Measures
BMP Owner: Oregon City Public Works Department Permit Year: Ongoing BMP Description: The City has established an inspection and maintenance program for private stormwater quality facilities. The program includes inspection schedules, maintenance criteria, and a tracking mechanism. The City maintains a map and inventory of known private structural water quality facilities. Currently, the City requires a maintenance agreement for all newly constructed private stormwater water quality and detention facilities. The maintenance agreement outlines required inspection and maintenance activities for each facility.	• Require new private water quality facilities to submit maintenance agreements to the City. • Maintain the inventory of existing private structural water quality facilities and collect maintenance agreements for newly constructed facilities. • Implement inspection and maintenance strategy for private water quality facilities.	• Track number of maintenance agreements submitted to the City each year. • Track progress related to the inventory and mapping of existing private structural control facilities. • Track the status of updating the inventory and map of private water quality facilities. • Track the number of private facility maintenance records returned to the City on an annual basis.

Appendix B: TMDL Pollutant Load Reduction Evaluation and Benchmarks



TMDL Pollutant Load Reduction Evaluation and Benchmarks

Prepared for

The City of Oregon City, Oregon

October 2015

Amended to include benchmarks: November 2016



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List of Abbreviations

ac	acre(s)
ACWA	(Oregon) Association of Clean Water Agencies
ASCE	American Society of Civil Engineers
BMP	best management practice(s)
C	commercial
CFU	colony forming unit(s)
City	City of Oregon City
COM	commercial
DEQ	(Oregon) Department of Environmental Quality
EMC	event mean concentration
EPA	U.S. Environmental Protection Agency
FUH	future urban holding
GIS	geographic information system
HR	high-density residential
IND	industrial
LA	load allocation
LCL	lower confidence limit
LR	low-density residential
MFR	multifamily residential
mL	milliliter(s)
MR	medium-density residential
MS4	municipal separate storm sewer system
MUC	mixed-use corridor
MUD	mixed-use downtown
MUE	mixed-use employment
NPDES	National Pollutant Discharge Elimination System
ODOT	Oregon Department of Transportation
PLRE	pollutant load reduction evaluation
SFR	single-family residential
TMDL	total maximum daily load
UCL	upper confidence limit
WLA	waste load allocation

Definitions

Load allocation

The amount of pollutant allocated to existing nonpoint sources and natural background in a total maximum daily load (TMDL). (EPA, 2014, <http://toxics.usgs.gov/definitions/tmdl.html>)

Pollutant load reduction benchmark

A future pollutant load reduction estimate for a parameter or surrogate, where applicable, for which a waste load allocation (WLA) is established. The benchmark is used to establish anticipated future progress toward achieving the WLA over an implementation period (typically 5 years).

Pollutant load reduction evaluation

An evaluation of current pollutant load generation, when compared to previous loads, for a parameter or surrogate, where applicable, for which a WLA is established. The pollutant load reduction evaluation (PLRE) is used to measure progress toward achieving a WLA or previously established benchmark.

Waste load allocation

The amount of pollutant load allocated to a specified point source (e.g., a permitted sewage treatment plant, industrial facility, or stormwater discharge) in a TMDL. (EPA, 2014, <http://toxics.usgs.gov/definitions/tmdl.html>)

Section 1

Introduction

This report presents the 2015 total maximum daily load (TMDL) pollutant load reduction evaluation (PLRE) and the 2016 TMDL pollutant load reduction benchmarks for the City of Oregon City (City). The City is subject to TMDLs in three waterbodies: Clackamas River, Middle Willamette tributaries, and Middle Willamette direct.

As required by the City's National Pollutant Discharge Elimination System (NPDES) Phase I Municipal Separate Storm Sewer System (MS4) permit, the PLRE includes:

- An evaluation of the estimated pollutant loading based on current land use from all MS4 permitted areas of the city
- An evaluation of the pollutant load reduction based on the City's current use of structural water quality controls or best management practices (BMPs)
- A comparison of the current pollutant load reduction to benchmarks established as part of the City's permit renewal application in 2008

The PLRE results presented in Section 4 show that the structural BMPs in Oregon City are estimated to be meeting the previously established pollutant load reduction benchmarks for *E. coli* in the three defined TMDL watersheds. However, significant additional pollutant reduction will be needed to achieve waste load allocations (WLAs). This additional reduction could come from additional structural BMPs, or non-structural BMPs such as source controls and programmatic activities.

As part of the City's NPDES MS4 permit renewal application, the City is required to establish new pollutant load reduction benchmarks for TMDL parameters where WLAs are not currently being achieved. The benchmark development includes:

- Identification of additional or modified BMPs anticipated over the next permit term
- An evaluation of the estimated pollutant loading and pollutant load reduction based on the City's current and anticipated future use of BMPs

Updated benchmarks for the three watersheds are presented in Section 5 and Appendix C.

This report also includes an analysis of long-term trends in receiving water quality based on in-stream monitoring data.

1.1 Permit Requirements

The City is a co-permittee on Clackamas County NPDES MS4 permit 101348, issued on March 16, 2012. The requirements to evaluate pollutant load reductions are detailed in Schedule D.3 as follows:

- Applicability: The requirements of this section apply to the co-permittee's MS4 discharges to receiving waters with established TMDLs or to receiving waters with new or modified TMDLs approved by EPA within three years of the issuance date of this permit. Established TMDLs are noted on page 1 of this permit. Pollutant discharges for those parameters listed in the TMDL with applicable WLAs must be reduced to the maximum extent practicable through implementation of BMPs and an adaptive management process.*

The following two subsections provide more detail regarding the TMDL pollutant load evaluation requirements from the permit: the PLRE and benchmarks.

1.1.1 PLRE Requirements

Per Schedule D.3.c of the Clackamas County NPDES MS4 permit, the City must complete a PLRE by November 1, 2015. The PLRE must include the following:

- i. *The rationale and methodology used to evaluate progress towards reducing TMDL pollutant loads.*
- ii. *An estimate of current pollutant loadings without considering BMP implementation, and an estimate of current pollutant loadings considering BMP implementation for each TMDL parameter with an established WLA.*
- iii. *A comparison of the estimated pollutant loading with and without BMP implementation to the applicable TMDL WLA.*
- iv. *A comparison of the estimated pollutant load reduction to the estimated TMDL pollutant load reduction benchmark established for the permit term, if applicable.*
- v. *A description of the estimated effectiveness of structural BMPs.*
- vi. *A description of the estimated effectiveness of non-structural BMPs, if applicable, and the rationale for the selected approach.*
- vii. *A water quality trends analysis, as sufficient data are available, and the relationship to stormwater discharges for receiving water bodies within the co-permittees jurisdictional area with an approved TMDL.*
- viii. *A narrative summarizing progress towards applicable TMDL WLAs and existing TMDL benchmarks, if applicable.*
- ix. *If the permittee estimates that TMDL WLAs are achieved with existing BMP implementation, the co-permittee must provide a statement supporting this conclusion.*

1.1.2 Benchmark Requirements

Per Schedule D.3.d of the Clackamas County NPDES MS4 permit, the City must develop pollutant load reduction benchmarks for the next permit term for each applicable TMDL parameter where existing BMP implementation is not shown to be achieving WLAs. Benchmarks must be submitted with the permit renewal application, which is due February 28, 2017. Per subsection D.3.d.ii, the benchmark submittal must include the following:

1. *An explanation of the relationship between the TMDL WLAs and the TMDL benchmark for each applicable TMDL parameter;*
2. *A description of how SWMP implementation contributes to the overall reduction of the TMDL pollutants during the next permit term;*
3. *Identification of additional or modified BMPs that will result in further reductions in the discharge of the applicable TMDL pollutants, including the rationale for proposing the BMPs; and*
4. *An estimate of current pollutant loadings that reflect the implementation of the current BMPs and the BMPs proposed to be implemented during the next permit term.*

1.2 TMDL Applicability

TMDLs are developed to project the maximum pollutant load capacity that can be directed to a particular water body without exceeding water quality standards. TMDLs may be developed for pollutants with direct links to stormwater runoff (e.g., metals, nutrients) or for pollutants not typically associated with urban stormwater runoff in the Willamette Valley (temperature).

Oregon City is located in the Middle Willamette River watershed, adjacent to both the Willamette and Clackamas rivers. The relevant TMDL is the Willamette Basin TMDL, approved on September 29, 2006, by the U.S. Environmental Protection Agency (EPA).

1.2.1 TMDL Pollutant Summary

The Willamette Basin TMDL addresses elevated in-stream temperatures, bacteria (*E. coli*), and mercury for the Willamette River and tributaries. Additional pollutant parameters are included in the Willamette Basin TMDL for select tributaries.

In Oregon City, the Willamette Basin TMDL includes water-body-specific allocations for urban stormwater sources of bacteria in the Clackamas River (as part of the Lower Willamette River subbasin), unspecified tributary discharges to the Middle Willamette River, and direct discharges to the Middle Willamette River. Bacteria are considered to be a pollutant with direct ties to stormwater runoff; thus, bacteria are regulated under the NPDES MS4 permits as a point source pollutant. Therefore, the City is required to conduct a PLRE and, as necessary, develop new benchmarks for bacteria.

Temperature can be considered both a point and nonpoint source pollutant, but the Oregon Department of Environmental Quality (DEQ) does not typically consider it to be a pollutant parameter associated with urban stormwater runoff. Temperature is regulated by DEQ and addressed by individual NPDES Wastewater Discharge permits and TMDL Implementation Plans, but not under the NPDES MS4 permit.

Mercury is identified as a pollutant with direct ties to stormwater runoff, but currently DEQ has not completed its analysis and establishment of source-specific WLAs for mercury. No pollutant load analyses or pollutant load reduction benchmarks were calculated for mercury in 2008. Therefore, no pollutant load reduction estimates for mercury are required for this evaluation.

1.2.2 TMDL WLAs

In the Willamette Basin TMDL, the WLA for bacteria¹ (*E. coli*) is calculated as a percent load reduction for each general land use type within the watershed. The MS4 contribution is assumed to equate to the urban land use. The water quality criterion for bacteria, which is the monthly logarithmic mean concentration of 126 *E. coli* per 100 milliliters (mL), was used to establish the required bacteria WLAs.

In 2008, the City conducted a PLRE and established pollutant load reduction benchmarks. Both the PLRE and pollutant load reduction benchmarks were submitted with the permit renewal applications in September 2008. The WLAs shown in Table 1-1 and the benchmarks established in 2008 are the two metrics used to evaluate whether the City's current pollutant load reductions are meeting regulatory obligations.

¹ There is some discrepancy in the way MS4 sources are addressed in various TMDL documents. The Willamette Basin TMDL uses the term "load allocation" to define pollutant load discharges from urban land uses, including the City's NPDES MS4 Permit area. For the purposes of this evaluation, the load allocation referenced in the Willamette Basin TMDL is assumed to be a WLA because it is applied to the City's NPDES MS4 permit area.

Table 1-1. Willamette River WLAs		
TMDL waterbody	Parameter	WLA
Clackamas River	Bacteria (<i>E. coli</i>)	78% (annual reduction)
Middle Willamette (via tributaries)	Bacteria (<i>E. coli</i>)	88% (summer seasonal reduction) 75% (fall, winter, spring seasonal reduction)
Middle Willamette (direct)	Bacteria (<i>E. coli</i>)	75% (annual reduction)

Section 2

PLRE and Benchmark Process and Methodology

In accordance with Schedule D.3.c of the City's NPDES MS4 permit, jurisdictions are required to conduct a PLRE for all applicable TMDL parameters. The PLRE must reflect current (2015) development conditions. The PLRE must include estimates of current pollutant loading both without and with BMP implementation. Results of the PLRE must be compared to previously established pollutant load reduction benchmarks and applicable WLAs. The PLRE can be used to estimate the effectiveness of stormwater management facilities and show how BMPs are making progress toward achieving pollutant load reductions.

For TMDL parameters where the PLRE indicates that a WLA is not being met, development of a new pollutant load reduction benchmark is required. A benchmark is an estimate of pollutant load reduction for an applicable TMDL pollutant at the end of the next 5-year NPDES MS4 permit term. Benchmarks account for current BMP implementation and additional BMP implementation anticipated during the course of the next permit term.

The PLRE was conducted and benchmarks were developed for each TMDL watershed and pollutant parameter listed in Table 1-1. The overall process and methodology for conducting the PLRE and establishing new benchmarks is described below. Modeling assumptions and input data are described in Section 3.

2.1 PLRE and Benchmark Process

Figure 2-1 depicts the process for conducting the PLRE, and the relationship to the pollutant load reduction benchmarks. Steps 1 through 6 are associated with the PLRE, and include review of TMDL assumptions, data compilation, pollutant load calculations, and comparison of pollutant loads with WLAs and benchmarks previously established for the current permit period. Step 7 includes development of new pollutant load reduction benchmarks for the upcoming permit period.

This overall process is based on the process collectively developed through the Oregon Association of Clean Water Agencies (ACWA) in 2005 to conduct pollutant loads modeling for TMDL compliance.

As shown on Figure 2-1, three general categories of BMPs are considered in the process:

1. Structural BMP systems for which pollutant removal can be reported quantitatively based on the results of scientific research (i.e., effluent concentrations). These BMPs include traditional ponds, swales, infiltration facilities, proprietary treatment systems, and wetlands.
2. Structural and/or source control BMP applications or practices where pollutant removal effectiveness information is limited or unavailable. These BMPs include downspout disconnection programs, street sweeping, and catch basin cleaning. These BMPs may be reflected in the modeling effort by simulating their specific coverage area with adjusted impervious areas, runoff coefficients, or land use event mean concentrations (EMCs).
3. Non-structural/source control BMP applications where pollutant removals are not likely to be reported in objective, quantitative terms. These BMPs include programmatic BMPs such as public education, illicit discharge detection programs, and spill prevention.

This process results in a conservative estimate of pollutant removal because it considers only those BMPs with quantitative pollutant removal effectiveness information (Category 1) and selected structural/source control BMPs under Category 2. Implementation of non-structural or non-quantifiable BMPs (Category 3) has the potential to reduce pollutant loads further than is reflected in this evaluation.

2.2 Model Methodology

The PLRE and benchmark analysis was conducted using a spreadsheet loads model that is based on the EPA simple method for pollutant load calculations. The model was developed in 2008 for multiple Oregon Phase I NPDES MS4 jurisdictions, including the City, to calculate pollutant loads and to develop pollutant load reduction benchmarks. The same spreadsheet loads model was used for this effort with the following modifications:

- A new land use category (public facilities) was added to separately categorize schools, hospitals, and other public areas.
- Updated impervious percentages were calculated for each land use category.
- New BMP categories were added to account for the following BMP facility types not modeled in 2008: porous pavement, lined planters/filtration rain gardens, and eco roofs.
- BMP effluent concentration data were refined based on a collective effort among ACWA jurisdictions to update BMP effectiveness information with new literature information.

The model has been configured with average pollutant concentration information for various land uses per 2008, and BMP categories per 2014 updates.

Rainfall, land use, and BMP coverage information was entered into the spreadsheet loads model. Using established land use EMCs, annual, seasonal, and design storm-specific (when applicable) pollutant loads were calculated as counts for *E. coli*. Pollutant loads were calculated for each TMDL watershed for bacteria as shown in Table 1-1.

Pollutant load and pollutant load reduction calculations were based on land use pollutant load concentrations and BMP effluent concentrations established through a joint effort between Oregon Phase I NPDES permittees. The statewide coordination process was facilitated through the Oregon ACWA Stormwater Committee. Tables of pollutant concentrations by land use, referred to in this report as “event mean concentrations” (EMCs), were originally developed in 2005 for Phase I jurisdictions and updated in 2008. The land use EMC data were developed using published, statistically verified national data, and data obtained by local jurisdictions. In each revision, the data were *bootstrapped*, a statistical method to estimate upper and lower confidence intervals.

The BMP effluent concentration data were originally developed in 2005, and updated in 2008 and 2014 to reflect additional BMP categories and updated BMP monitoring results. BMP effluent concentrations were used to calculate pollutant removal for bacteria due to the implementation of structural BMPs in each TMDL watershed (shown in Table 1-1).

Most structural BMPs are not capable of treating all runoff that may enter a facility in any given year. Generally, BMPs are designed to treat a proportion of the total annual rainfall/runoff that occurs. The City’s stormwater design standards call for treatment for 80 percent of the average annual runoff volume. Thus, structural BMPs included in the model were assumed to capture and treat 80 percent of the average annual rainfall, and bypass 20 percent of the average annual runoff.

Quantitative data are not currently available to assess the effectiveness of source control or non-structural BMPs for the City. Therefore, effectiveness of source control and non-structural BMPs were not included in the model, but are qualitatively incorporated in the pollutant load evaluation based on best professional judgment and summarized in Section 4.4.

Model simulations were conducted for each PLRE scenario (current no-BMP and current with-BMP). Pollutant loads and pollutant load removals for bacteria were calculated for the upper confidence limit (UCL), mean (or geometric mean for bacteria), and lower confidence limit (LCL), to yield a range in the resulting loads. The UCL and LCL represent the 95 percent confidence limits for the data used in establishing the land use EMCs.

For the development of new/updated bacteria benchmarks, an additional simulation (future with-BMP) was conducted. The future with-BMP scenario assumes all 2015 BMPs are still in place and functioning, and it includes the addition of new BMPs anticipated to be constructed by the end of the next 5-year permit term (i.e., by 2022). Pollutant loads and pollutant load reductions for bacteria were calculated using the current no-BMP and the future with-BMP scenarios consistent with the PLRE methodology.

2.3 Model Output and Comparison to WLAs

Based on the modeling results, the current no-BMP pollutant load range (LCL to UCL) was first documented for bacteria for each watershed. This current no-BMP load was the starting point for PLRE calculations, WLA comparisons, and benchmark development.

The estimated pollutant load reduction was calculated as the difference between the current no-BMP and current with-BMP pollutant loads. Because loads are presented as a range, the pollutant load reduction was also identified as a range, using the results from the LCL and UCL calculations.

2.3.1 Comparing Pollutant Loads to WLAs and Previous Benchmarks

For Oregon City, the WLAs for bacteria are defined as annual and seasonal percent reductions. The WLA (as a load) was calculated as the percent load reduction from the current no-BMP, mean pollutant load.

For graphic representation, the current no-BMP loads and current with-BMP loads are shown as a range. The WLA is shown as a single value, based on the mean value calculations. The resulting graphs and discussion related to modeling results are included in Section 4.

As part of the PLRE effort, pollutant load reduction estimates must be compared to previously established benchmarks (Schedule D.3.c.iv). The City previously developed TMDL benchmarks as part of the Phase I NPDES MS4 permit renewal submittal in September 2008. The 2008 benchmarks are presented in Section 4 as a pollutant load reduction range and are directly comparable with the PLRE results.

2.3.2 Calculating New Benchmarks

New benchmarks were calculated as the difference between the current no-BMP and future with-BMP pollutant loads. As with the PLRE, the benchmarks are identified as a range, using the results from the LCL and UCL calculations. Results and discussion related to development of TMDL benchmarks are included in Section 5.

Pollutant loads are tabulated in Appendix C for all modeled scenarios.

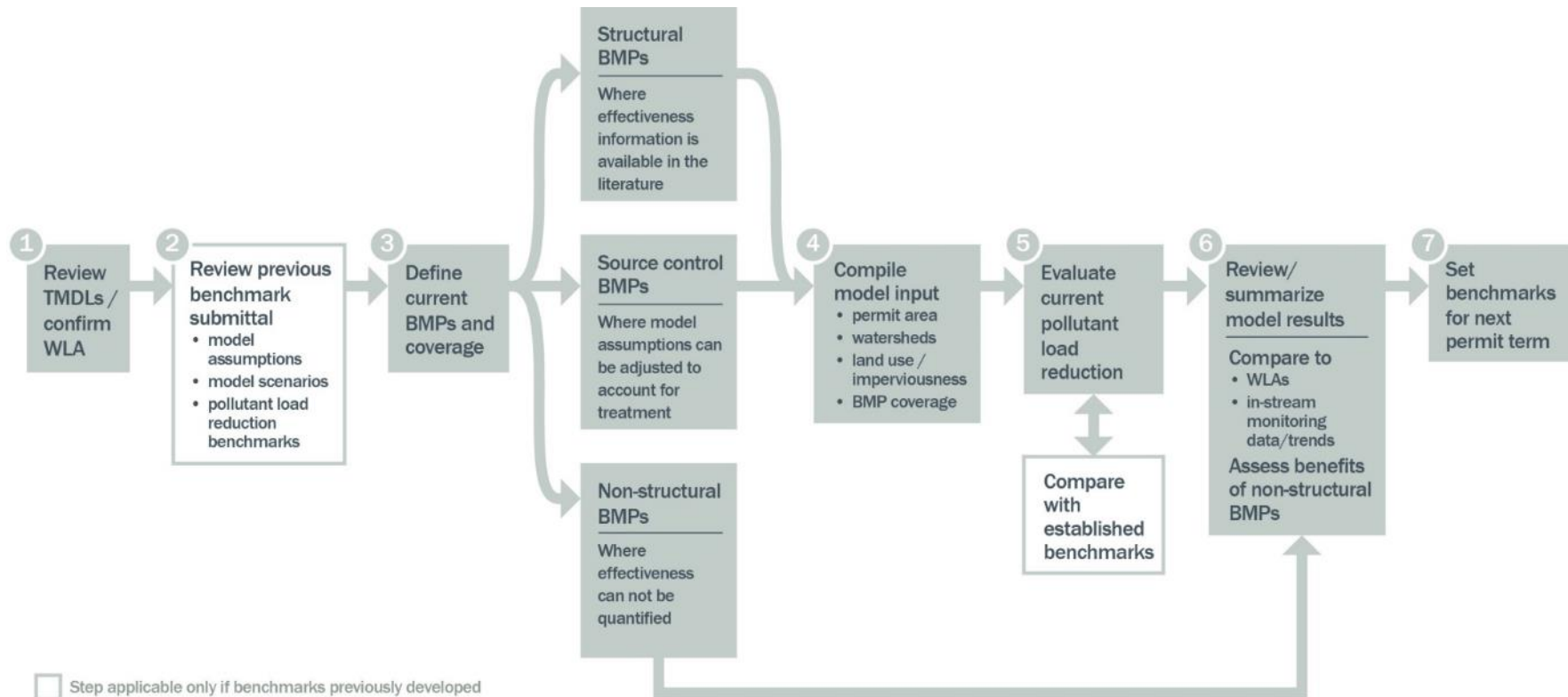


Figure 2-1. Pollutant load reduction evaluation and relationship to benchmark development efforts (2015)

Section 3

Modeling Assumptions and Input Data

This section describes the assumptions and input data associated with developing the spreadsheet loads model for this PLRE and benchmark analysis. Model input data were developed by City staff, using updated geographic information system (GIS) data sets maintained by the City.

Modeled area and land use coverage show only minor changes from the 2008 model. BMP coverage is significantly increased due to the construction of new stormwater management facilities associated with both private and public projects. Improved mapping data has also adjusted the BMP coverage assumptions compared to the 2008 analysis.

The subsections below include information regarding modeled areas, land use and impervious area assumptions, BMP coverage, runoff concentrations, and BMP effluent data. As applicable, 2008 modeling assumptions are provided for comparison to show how modeled conditions have changed in the watershed. Maps showing model input data, including current and anticipated BMP coverage are included as Figures 3-1 and 3-2.

3.1 Model Area

The City's NPDES MS4 permit covers "all existing and new discharges of stormwater from the MS4 within the service boundaries of incorporated cities" (DEQ, 2012). As such, the modeled area for this PLRE and benchmark analysis has been defined to include all areas within city limits as of August 2015.

As described in Section 1, individual WLAs are defined for three TMDL watersheds; therefore, each TMDL watershed was modeled separately and pollutant load generation was compared to the respective WLA. The City's watershed basin GIS layer was used to define the subbasins across the city that have been assigned to the larger TMDL watersheds as shown in Table 3-1.

Table 3-1. Oregon City TMDL Watershed Summary		
TMDL watersheds	Subbasins	
Clackamas River	Clackamas Basin Forsythe Basin Kelly Field Basin	
Middle Willamette tributaries	Park Place Basin Livesay Basin John Adams Basin Abernethy Basin Singer Basin Newel Basin Thimble Basin Tumwater Basin Clinton Basin	Coffee Basin Central Point Basin Mud Basin Caufield Basin Amanda Court Basin Alan Court Basin South End Basin Beaver Basin
Middle Willamette direct	Willamette North Basin Willamette South Basin Clackamas-Willamette Basin	

Areas within the city that are the responsibility of the Oregon Department of Transportation (ODOT) were omitted from the modeled area as ODOT has a separate NPDES MS4 permit for discharges from these areas. For Oregon City, this included the Interstate 205 corridor, the Oregon Highway 99E corridor, and the Oregon Highway 213 corridor. In addition, the open-water areas of the Willamette River, Clackamas River, and Clackamas Cove were excluded from the modeled areas. These exclusions are consistent with modeling assumptions from the 2008 analysis.

Table 3-2 compares the 2015 total modeled area by TMDL watershed to the 2008 total modeled area for each TMDL watershed. Changes in the modeled areas between 2008 and 2015 are due to City annexations, improved mapping, and a greater understanding of drainage basin boundaries. It should be noted that the City's defined MS4 permit area and total modeled area reflects an area that discharges directly to the MS4 system, and areas that may discharge directly to receiving waters without first entering the MS4.

Table 3-2. Modeled Areas		
TMDL watersheds	2015 PLRE, total modeled area (ac) ^a	2008 PLRE, total modeled area (ac) ^a
Clackamas River	352.4	289.6
Middle Willamette tributaries	5487.2	5549.8 ^b
Middle Willamette direct	123.8	

a. The total modeled area reflects the NPDES MS4 permit area boundary minus ODOT right-of-way and water bodies.

b. The 2008 model reported only the combined watershed areas discharging both directly and through tributaries to the Willamette River.

3.2 Land Use and Impervious Areas

The City created an updated land use coverage GIS layer to align 2015 land use conditions with the land use categories available in the pollutant loads model. The land use coverage also incorporated vacant land data from Metro, which is based on 2013 aerial photos. The land use categories from the *Oregon City Comprehensive Plan* (June 2004) were grouped into the land use modeling categories as shown in Table 3-3.

The City recalculated the impervious cover percentage for each modeled land use category based on the new land use coverage. Each parcel in the city was assigned an impervious area percentage based on either Metro impervious area coverages or Clackamas County Assessor's data. Roads were assumed to have a 90 percent impervious coverage. The average impervious coverage for all parcels in each modeled land use category was then calculated and input into the pollutant loads model (see Table 3-3). These modeled impervious coverage percentages were slightly higher than the percentages used in 2008. This adjustment was likely due to the addition of the public facilities category that includes large school parcels with low impervious coverage that were previously incorporated into the other model land use categories.

Table 3-3. Modeled Land Use Categories		
Comprehensive Plan land use category	Modeled land use category	2015 modeled impervious percentage
Low-density residential (LR)	Single-family residential	45
Medium-density residential (MR)	Single-family residential	
High-density residential (HR)	Multifamily	57
Commercial (C)	Commercial	74

Table 3-3. Modeled Land Use Categories

Comprehensive Plan land use category	Modeled land use category	2015 modeled impervious percentage
Mixed-use corridor (MUC)	Commercial	63
Mixed-use downtown (MUD)	Commercial	
Industrial (I)	Industrial	
Mixed-use employment (MUE)	Industrial	
Quasi-public	Public facility	34
Parks	Parks and open space	19
Future urban holding (FUH)	Agriculture ^a	48
All vacant	Vacant ^b	21

a. The impervious percentage for agriculture is higher than expected because the only areas designated as agriculture are portions of small farms along Beavercreek Road in the southeast corner of Oregon City. The areas included in Oregon City limits are typically driveways and houses, which include the bulk of the impervious area for those properties.

b. Vacant lands include areas of all land use categories that are not currently developed or are not developed to the density indicated in the comprehensive plan. Vacant land includes unused commercial and industrial land along the Oregon Highway 205 corridor.

The impervious percentages in the model were used to estimate runoff coefficients for each land use category by applying the following EPA equation:

$$\text{Runoff coefficient} = 0.05 + 0.009 (\text{percent impervious})$$

The rainfall was multiplied by the runoff coefficient to obtain an estimated runoff volume. The appropriate pollutant concentration was then applied to that runoff volume to obtain a load estimate based on the land use category as described in Section 3.4.

The breakdown of land use categories for each TMDL watershed is outlined in Table 3-4 and shown in Figure 3-1, *TMDL Watersheds and 2015 Land Use*.

Table 3-4. Summary of 2015 Model Input Parameters (Land Use)

TMDL water body	Total modeled area (ac)	Land use breakdown (ac)							
		Agriculture	Commercial	Industrial	Single-family residential	Multi-family residential	Vacant	Parks and open space	Public facility
Clackamas River	352.4	0.0	73.2	30.2	52.9	1.8	110.7	8.8	74.8
Middle Willamette tributaries	5,487.2	9.2	401.5	244.0	3,039.5	203.1	897.1	223.5	469.3
Middle Willamette direct	123.8	0.0	59.7	5.5	23.6	0.0	3.3	30.8	0.9

3.3 BMP Coverage

A more robust GIS BMP inventory was available for this modeling effort. The City maintains an inventory of public and private stormwater treatment facility installations, which is continually being enhanced as new facilities are constructed or identified. The 2015 modeling effort included refining the drainage areas associated with each facility. Where BMP drainage areas overlap, the area was as-

signed to the structural BMP that appears to be the farthest downstream, and provides the better overall treatment (i.e., lower BMP effluent concentrations). This method does not give credit for additional load removal likely achieved with BMPs that perform in series.

Table 3-5 summarizes the structural BMP categories included in the modeling effort. The modeled BMP categories are based on the category types with available BMP effluent concentrations, as described in Section 3.4. In some cases, the City GIS classification of BMPs differed from the modeled categories. Table 3-5 shows how City BMP categories were associated with model categories and Table 3-6 and Figure 3-2 show the breakdown of 2015 BMP coverage in each modeled TMDL watershed used to develop the PLRE.

Anticipated future BMP coverage used to develop benchmarks is also shown in Figure 3-1 and discussed in further detail in Section 5.

Table 3-5. Structural BMP Categories Used in Oregon City's Pollutant Loads Model

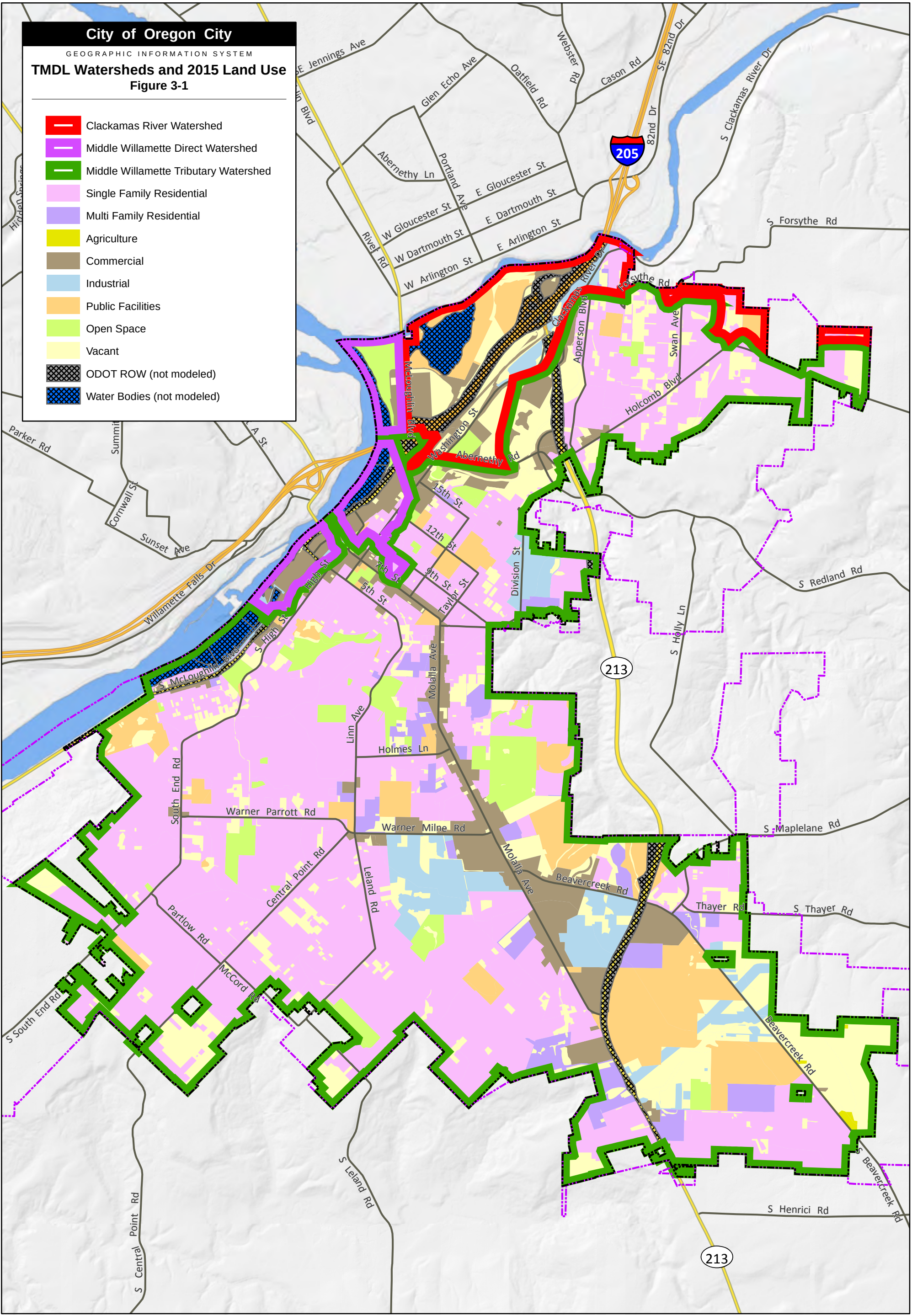
City BMP category	2015 modeled BMP category
Infiltration rain gardens	Infiltration rain garden
Wet ponds	Wet, retention pond
Dry ponds	Dry, detention pond
Flow through swales Filter strips	Lined planter/rain garden with underdrain
Vaults	Media filter
Pollution control manholes	Sedimentation manholes

Table 3-6. Summary of Model Input Parameters (2015 BMP Coverage)

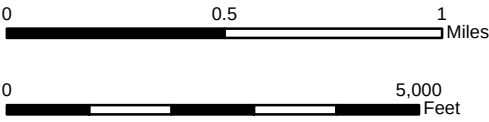
TMDL water body	BMP coverage area (% model area)	BMP coverage (ac)					
		Media filter	Dry, detention ponds	Wet, retention pond	Sedimentation manhole	Infiltration rain garden	Lined planter/rain garden with underdrain
Clackamas River	16	0.0	30.6	18.0	0.7	0.0	7.8
Middle Willamette tributaries	43	6.6	886.1	897.8	218.3	2.8	321.1
Middle Willamette direct	4	0.0	1.4	0.0	3.6	0.3	0.0

Non-structural BMPs were not included in the model simulations. Non-structural BMPs include street sweeping, illicit discharge investigations, public education, and other operational and/or programmatic actions. The model also did not account for private implementation of industrial source controls such as oil/water separators or spill control valves.

It is assumed that additional structural BMP facilities exist in Oregon City that are not known to City staff. While such facilities (likely associated with private property) may be providing additional pollutant load reduction, they are not currently part of the City's documented BMP inventory and therefore were not accounted for in the model.

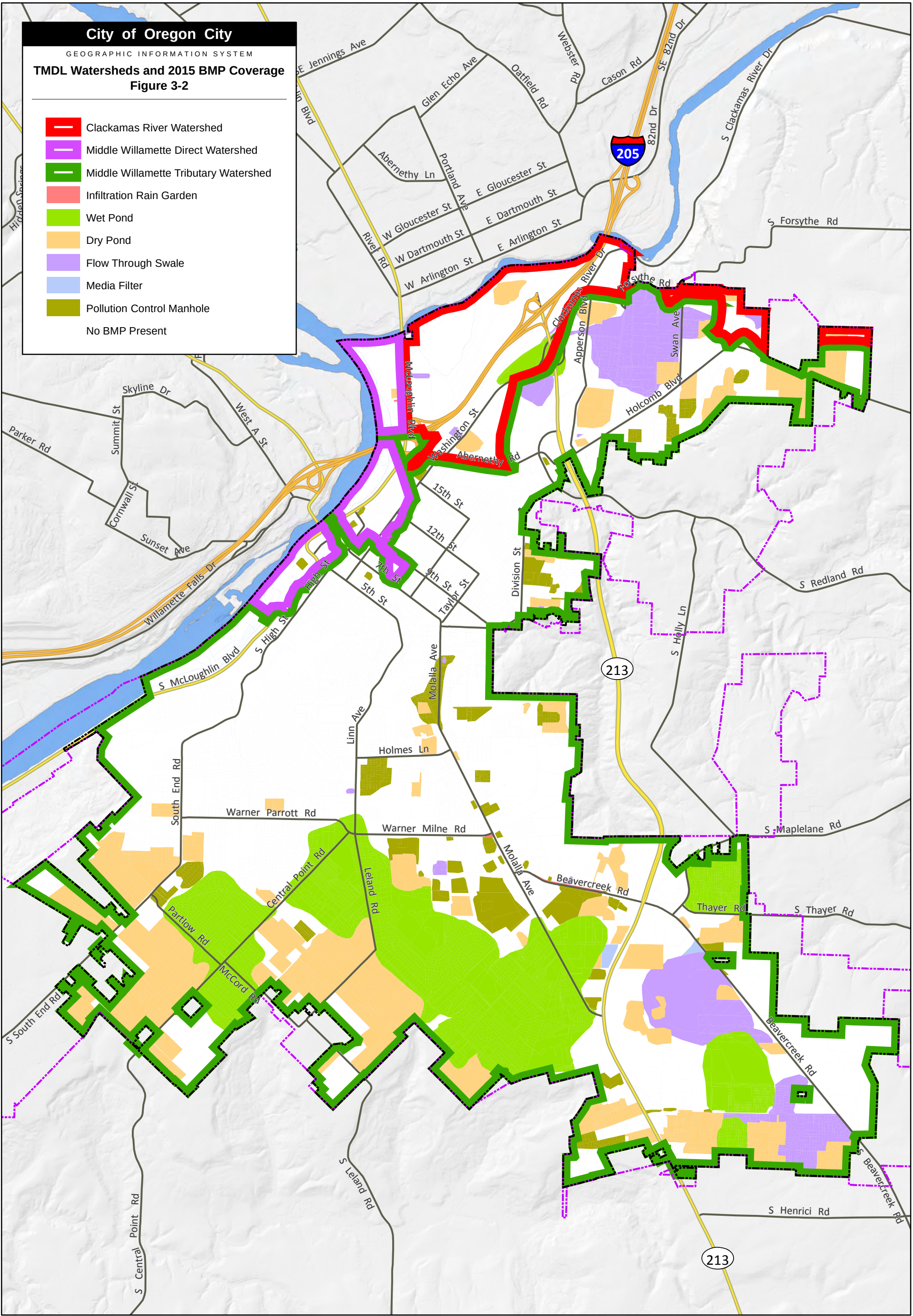


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City of Oregon City

GEOGRAPHIC INFORMATION SYSTEM

TMDL Watersheds and 2015 BMP Coverage

Figure 3-2

Clackamas River Watershed

Middle Willamette Direct Watershed

Middle Willamette Tributary Watershed

Infiltration Rain Garden

Wet Pond

Dry Pond

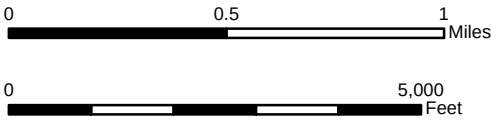
Flow Through Swale

Media Filter

Pollution Control Manhole

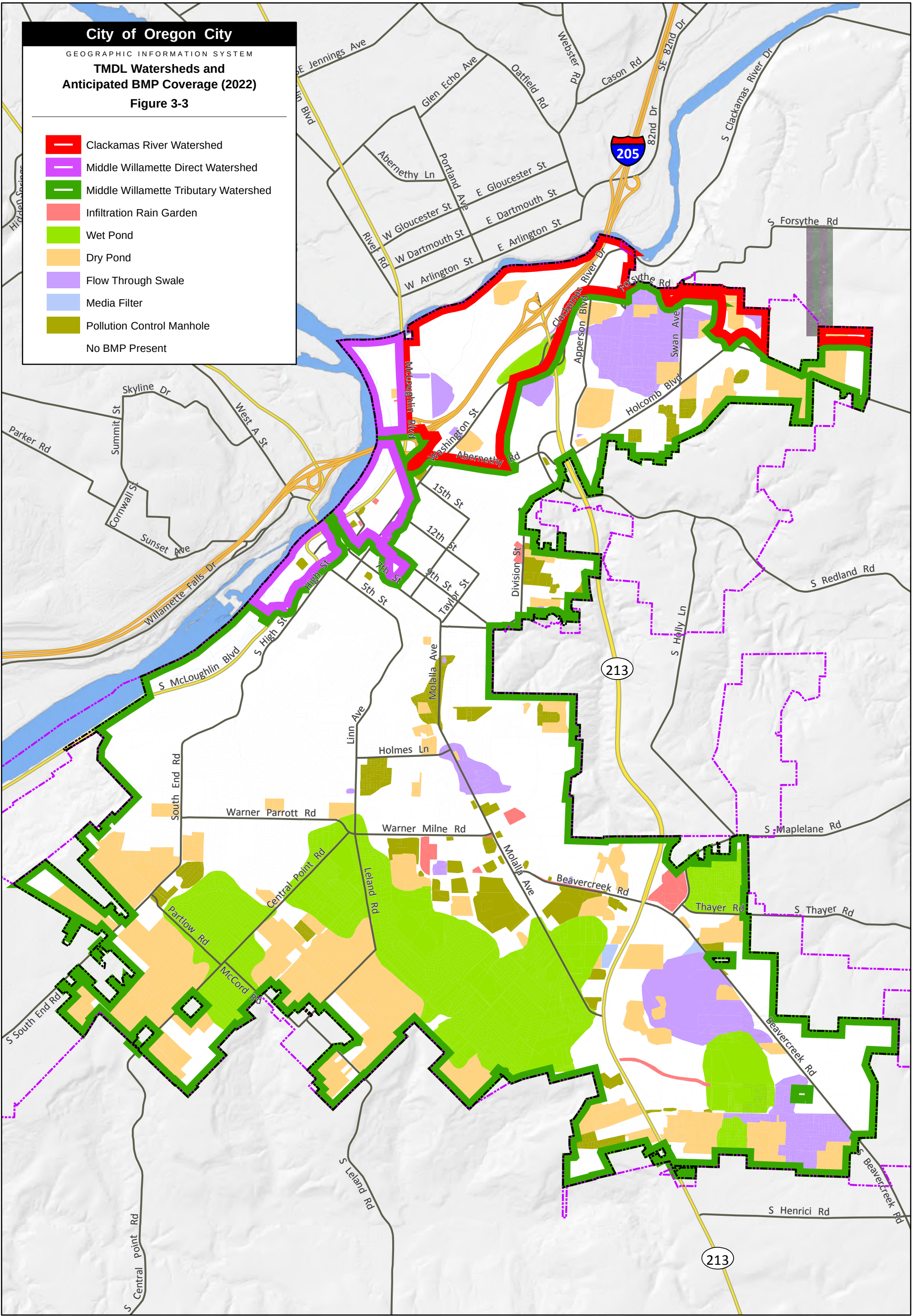
No BMP Present

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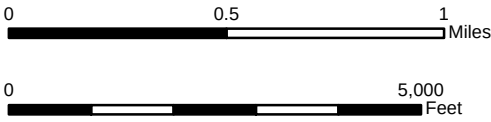


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3.4 Runoff Concentrations and BMP Effluent Data

In 2014, Phase I jurisdictions worked together to review and refine land use EMC data, BMP categories, and BMP effluent concentrations. Land use concentration data, including the upper and lower confidence intervals, are provided in Table 3-7. These values are consistent with the City's 2008 data assumptions. Analysis of *E. coli* is conducted via use of a geometric mean land use EMC.

Table 3-7. Land Use-Based Pollutant Load Concentration Values Used in the PLRE and Benchmark Analysis

Parameter	Land use	Count ^d	Bootstrapped mean		
			95% lower confidence limit	Mean	95% upper confidence limit
<i>E. coli</i> , CFU/100 mL (geomean)	Commercial ^a	52	573	1,247	2,409
	Industrial	58	154	438	1,004
	Open space ^b	9	57	87	124
	Residential ^c	65	970	1,656	2,651

Note: Data range (+/- 95%) provided by the City of Portland. Based on modified ACWA data set (2008).

a. Land use EMCs for Commercial are used to simulate pollutant loads from impervious areas of commercial, agriculture, and public facility land use.

b. Land use EMCs for open space are used to simulate pollutant loads in runoff from vacant land use.

c. Land use EMCs for residential are used to simulate pollutant loads in runoff from single-family residential and multifamily residential land use.

d. Reflects the sample size for the source land use concentration data.

The land use EMCs listed in Table 3-7 do not include all of the City's modeled land use categories. Therefore, some land use categories were modeled using concentration data from a land use category that has a comparable pollutant load. This occurred for the agriculture, public facility, vacant, and multifamily land use categories as described in the table footnotes.

BMP categories and BMP effluent concentrations were updated based on additional information contained in the American Society of Civil Engineers (ASCE) BMP database, and locally obtained data. New BMP categories included the addition of lined planters/filtration rain gardens, eco roofs, and porous pavement as options in the pollutant load model. The mean BMP effluent concentration values are provided in Table 3-8.

Table 3-8. BMP Effluent Concentration Values Used in the PLRE and Benchmark Analysis

Parameter	Units	Centrifugal separator hydrodynamic devices	Filters (leaf/sand/other)	Ponds: dry vegetated detention ponds	Ponds: wet retention basin	Swales: vegetated filter strips	Water quality wetlands	Sedimentation manhole	Green roofs	Porous pavement/UIC	Soakage trenches/infiltration rain gardens	Lined planters/filtration rain gardens
		Mean ^a										
<i>E. coli</i>	CFU/100 mL	5,587	<u>91</u>	1,922	499	1,922	499	5,587	20	N/A	N/A	91
Flow reduction	Decimal %	0.00	0.00	0.23	0.05	0.29	0.00	0.00	<u>0.50</u>	1.00	1.00	0.30

a. Most values are consistent with the 2008 ACWA data set.

Shaded values are updated values per the 2014 ACWA Stormwater Committee reanalysis of BMP effectiveness.

Underlined values reflect an increase from 2008 values.

Values in black background are new values per the 2014 ACWA Stormwater Committee reanalysis of BMP effectiveness.

Effluent concentrations shown as N/A are provided for BMP facilities that achieve 100% flow reduction, as no effluent is generated with which to analyze.

3.5 Annual and Seasonal Rainfall

The Willamette Basin TMDL includes varying WLAs for bacteria. For the Clackamas River and for direct discharge areas to the Middle Willamette, the bacteria WLAs are identified as single percent reductions and, for purposes of this evaluation, are evaluated on an annual basis with an annual rainfall of 47.06 inches. For tributary areas discharging to the Middle Willamette, bacteria WLAs are identified as seasonal percent reductions. The summer seasonal rainfall volume, reflecting rainfall between May 1 and October 31, is 6.82 inches. The fall-winter-spring seasonal rainfall volume, reflecting rainfall between November 1 and April 30, is 40.24 inches. The modeled rainfall volumes are consistent with assumptions from the 2008 PLRE and benchmark development.

3.6 Model Input Files

City staff generated GIS shapefiles and performed the calculations to develop the pollutant loads model input data. The land use and BMP coverage data as received from the City is provided for each watershed and included in Appendix A.

Section 4

Pollutant Load Reduction Evaluation Results

PLRE results for each TMDL watershed, including comparison of model results to the benchmarks established in 2008, are described below. Model results include a numeric estimate of the current (2015) pollutant load reduction range (Schedule D.3.c.ii), a comparison of the current pollutant loading to the WLA (Schedule D.3.c.iii), and a narrative summarizing progress toward existing WLAs (Schedules D.3.c.viii and D.3.c.ix).

PLRE results include estimates of the incremental improvements associated with the implementation of structural BMPs. The model results are not reflective of full implementation of the City's stormwater program, which includes additional non-structural BMP activities. Therefore, model results are assumed to underestimate the pollutant removal achieved through the City's stormwater program.

4.1 Clackamas River

Figure 4-1 shows that Oregon City is not currently estimated to be meeting the WLA for bacteria in the Clackamas River watershed area. The PLRE shows a mean pollutant load reduction of 5 percent compared with the WLA of 78 percent. The PLRE shows a mean load decrease of approximately 2.96×10^{11} counts when comparing conditions with and without BMPs.

In Oregon City, the Clackamas River watershed area is primarily commercial and industrial land use along the Oregon Highway 205 corridor. Many areas are vacant and identified for future redevelopment. Structural BMP implementation has increased since the 2008 model because of the identification and mapping of additional facilities. The structural BMPs implemented in this TMDL watershed (swales, wet ponds, and dry ponds) have varying effectiveness for bacteria removal. In general, wet ponds show better removal than dry ponds or swales. The watershed does not include any infiltration-based structural BMPs, which could achieve greater bacteria removal through volume reduction.

Significant additional load reduction would be needed beyond the current structural BMP implementation to achieve the WLA. Although source control and non-structural BMPs are implemented in this watershed (and not directly considered in the pollutant load reduction estimate), it is unlikely that the additional pollutant removal achieved would result in meeting the WLA. The WLA is considered to be an ultimate discharge goal. As described in Section 4.4, the City's structural BMPs in this watershed are estimated to be achieving the interim pollutant load removal benchmarks established in 2008.

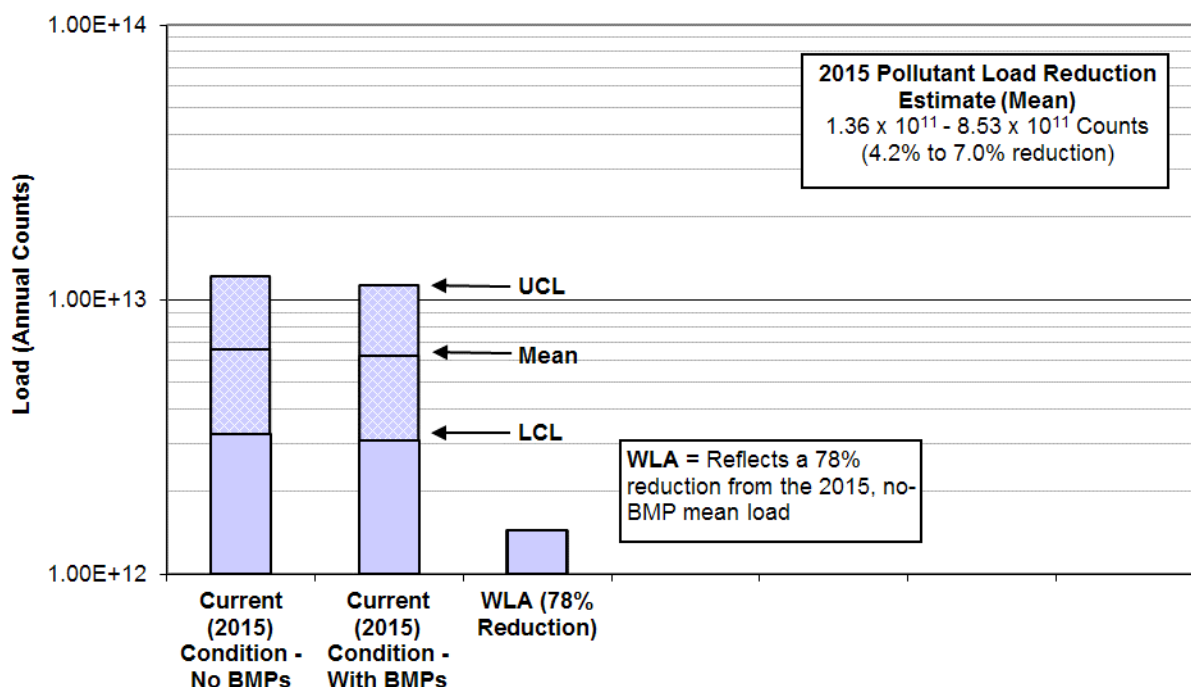


Figure 4-1. Oregon City: *E. coli* PLRE results for Clackamas River TMDL watershed

4.2 Middle Willamette Tributaries

Figures 4-2 and 4-3 show that Oregon City is not currently estimated to be meeting the WLA for bacteria in the Middle Willamette tributaries area. The current PLRE shows a mean pollutant load reduction of 18 percent for the summer season, compared with the WLA of 88 percent, and a mean pollutant load reduction of 18 percent for the fall, winter, and spring seasons compared with the WLA of 75 percent.

The PLRE shows a mean load decrease of approximately 3.53×10^{12} counts for summer, and 2.08×10^{13} for fall, winter, and spring when comparing conditions with and without BMPs.

The Middle Willamette tributaries area covers the majority of Oregon City's management area, including over 3,000 acres of residential development. The City has had stormwater quality design standards in place since 1999. As a result, much of the newer development in the southern portion of the city has been constructed with stormwater quality management facilities. Current structural BMP coverage in the Middle Willamette tributaries area is 43 percent. Structural BMP implementation has increased since the 2008 model due to the identification and mapping of additional facilities.

The structural BMPs implemented in this TMDL watershed (swales, wet ponds, and dry ponds) have varying effectiveness for bacteria removal. In general, wet ponds show better removal than dry ponds or swales. The watershed has only a small area covered by infiltration-based structural BMPs; therefore, greater removal of bacteria could be achieved through additional infiltration facilities and volume reduction. The City's new stormwater design standards prioritize the use of infiltration-based structural controls when site conditions allow.

Although over 40 percent of this TMDL drainage area is covered by structural BMPs, significant additional load reduction would be needed to achieve the WLA. Additional load reductions could be achieved through non-structural BMPs (which are not quantified in this PLRE), or through the construction of additional structural BMPs as a result of redevelopment, or retrofit activities. As described in Section 4.4, the City's structural BMPs in this watershed are estimated to be achieving the interim pollutant load removal benchmarks established in 2008.

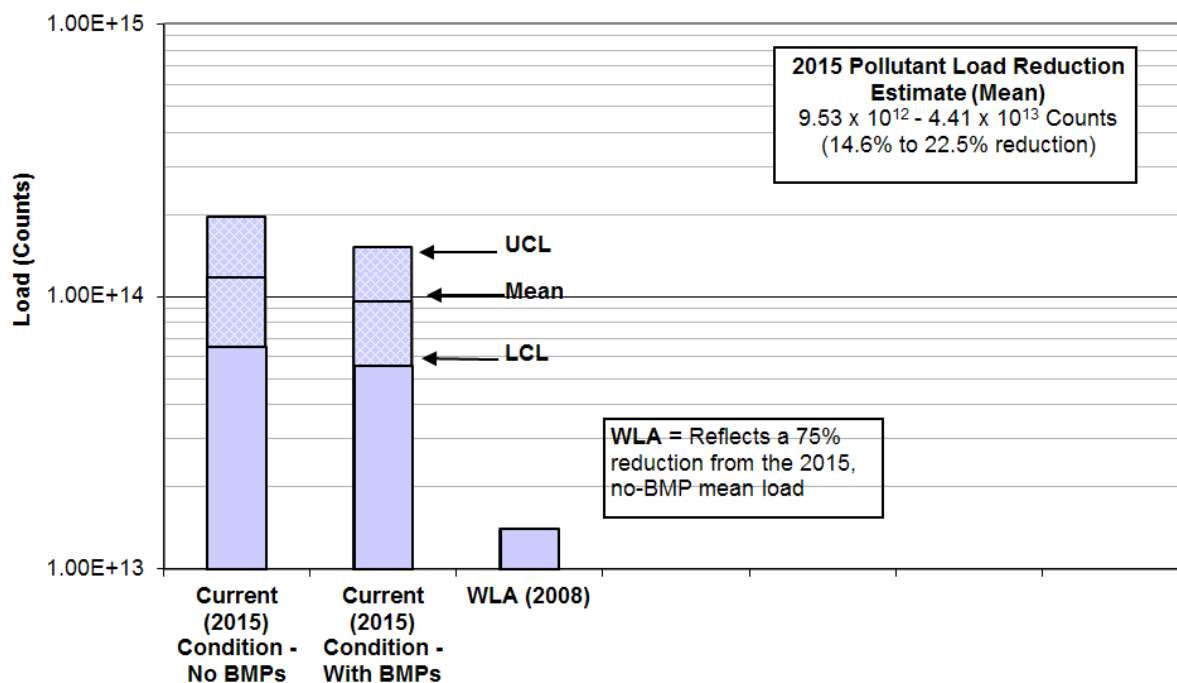


Figure 4-2. Oregon City: *E. coli* PLRE results for Middle Willamette tributaries TMDL watershed (fall, winter, spring seasons)

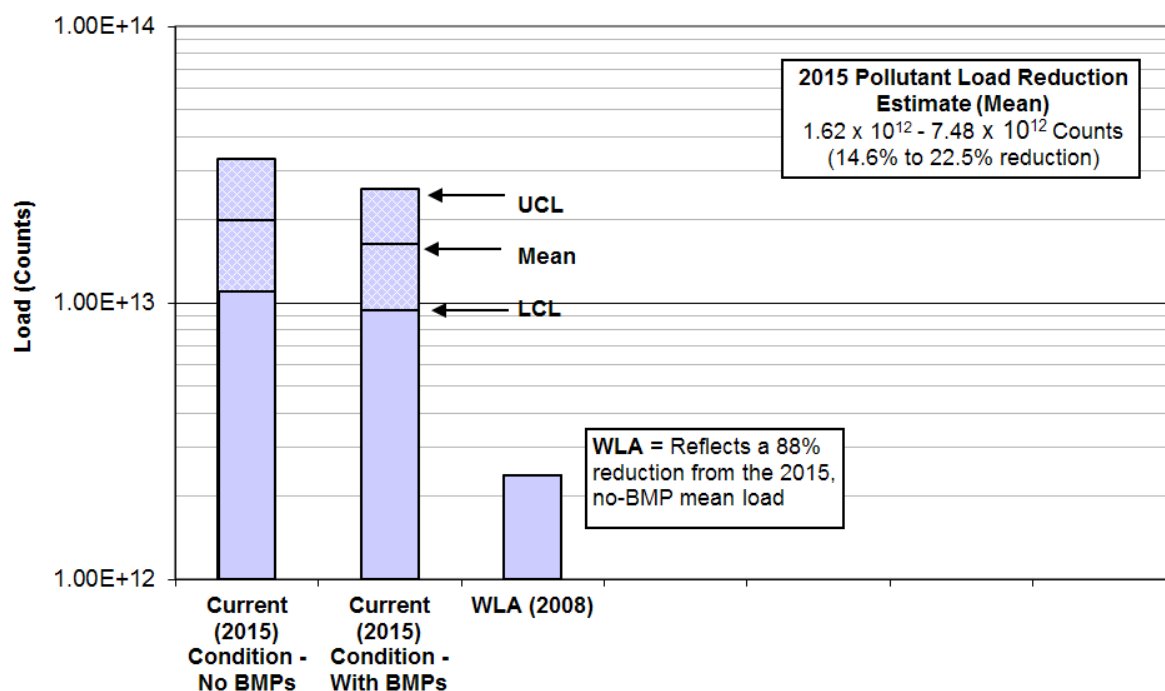


Figure 4-3. Oregon City: *E. coli* PLRE results for Middle Willamette tributaries TMDL watershed (summer season)

4.3 Middle Willamette Direct

Figure 4-4 shows that Oregon City is not currently estimated to be meeting the WLA for bacteria in the Middle Willamette direct watershed. The PLRE shows a mean pollutant load reduction of 1 percent compared with the WLA of 75 percent. The PLRE shows a mean load decrease of approximately 1.90×10^{10} counts when comparing conditions with and without BMPs.

In Oregon City, the Middle Willamette direct watershed area is primarily commercial and residential land uses in the historic downtown and surrounding neighborhoods. The drainage area is largely built out and most development has occurred without the installation of stormwater quality management facilities. The 2008 model did not account for any structural BMPs and no new BMPs were anticipated when developing the benchmarks. However, redevelopment and retrofit activities resulted in current structural BMP coverage of 4 percent.

Significant additional load reduction would be needed beyond the current structural BMP implementation to achieve the WLA. Although non-structural BMPs are implemented in this watershed (and not directly considered in the pollutant load reduction estimate), it is unlikely that the additional pollutant removal achieved would result in meeting the WLA. The WLA is considered to be an ultimate discharge goal. As described in Section 4.4, the City's structural BMPs in this watershed are estimated to be achieving the interim pollutant load removal benchmarks established in 2008.

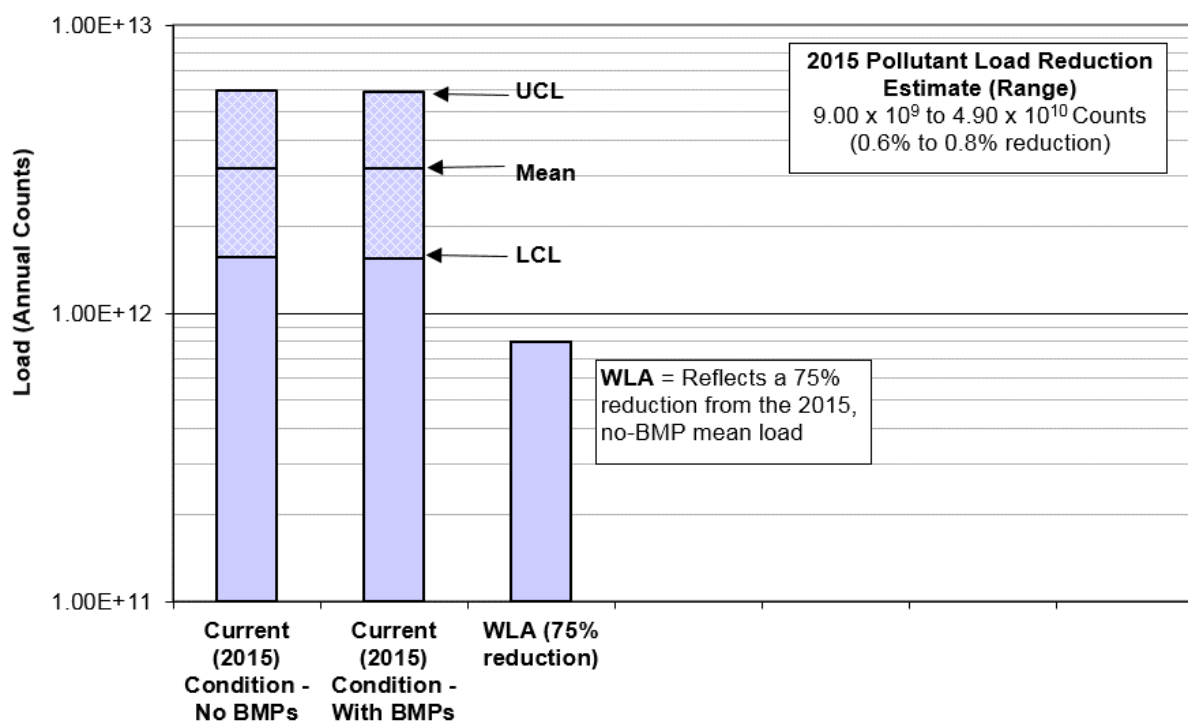


Figure 4-4. Oregon City: *E. coli* PLRE results for Middle Willamette direct TMDL watershed

4.4 Benchmark Comparison

As part of the PLRE effort, pollutant load reduction estimates must be compared to previously established pollutant load reduction benchmarks as applicable (Schedule D.3.c.iv). The City submitted a PLRE and TMDL pollutant load reduction benchmarks as part of the Phase I NPDES MS4 permit renewal submittal in September 2008. The established pollutant load reduction benchmarks were based on projected development conditions and associated BMP implementation 5 years in the future.

Table 4-1 shows the difference in modeled areas and BMP coverage areas between the 2008 benchmark development and the 2015 PLRE. Changes are largely a result of new BMP construction, as well as improved mapping data and a greater understanding of drainage basin boundaries.

Table 4-1. Benchmark Assumptions Comparison				
TMDL watershed	Assumption	2008 benchmark effort		2015 PLRE effort
		2008 (actual)	2013 (projected)	
Clackamas River	Model area (ac)	289.6	289.6	352.4
	BMP coverage (%)	4.7	8.9	16
Middle Willamette tributaries	Model area (ac)	5549.8	5679.5	5487.2
	BMP coverage (%)	25.7	31.8	43
Middle Willamette direct ^a	Model area (ac)	-	-	123.8
	BMP coverage (%)	-	-	4

a. For the 2008 benchmark effort, the Middle Willamette direct TMDL watershed was combined with the Middle Willamette Tributaries TMDL watershed for reporting of land use and BMP coverage.

Numeric pollutant load reduction benchmarks for bacteria were established in 2008 for the Clackamas River and Middle Willamette tributaries TMDL watersheds. Numeric pollutant load reduction benchmarks were not established for bacteria for the Middle Willamette direct TMDL watershed, as BMPs were not anticipated for installation in that watershed. Table 4-2 presents the results of the benchmark comparison, showing that bacteria benchmarks were estimated to be met in all three TMDL watersheds.

Table 4-2. Oregon City Pollutant Load Reduction Benchmark Comparison

TMDL watershed	Parameter (units)	2015 pollutant load reduction estimate ^a			2008 benchmarks based on projected 2013 conditions	Met benchmarks
		UCL	Mean	LCL		
Clackamas River	Bacteria (counts)	8.53×10^{11}	2.96×10^{11}	1.36×10^{11}	4.53×10^{10} to 2.86×10^{11}	Met
Middle Willamette tributaries	Bacteria (counts) Summer	7.48×10^{12}	3.53×10^{12}	1.62×10^{12}	7.57×10^{11} to 3.97×10^{12}	Met
	Bacteria (counts) Fall/Winter/Spring	4.41×10^{13}	2.08×10^{13}	9.53×10^{12}	4.47×10^{12} to 2.34×10^{13}	Met
Middle Willamette direct	Bacteria (counts)	4.90×10^{10}	1.90×10^{10}	9.00×10^9	n/a	n/a ^b

a. The UCL estimate is the difference between the no-BMP and with-BMP pollutant loads for the UCL; the mean estimate is the difference between the no-BMP and with-BMP pollutant loads for the mean; the LCL estimate is the difference between the no-BMP and with-BMP pollutant loads for the LCL.

b. No 2013 benchmarks for the Middle Willamette River direct TMDL watershed were specifically developed in 2008.

Because of the statistical variability of the underlying data, the current pollutant load reduction estimates and 2013 benchmarks are presented as ranges in loading. For purposes of this benchmark comparison effort, the mean 2015 pollutant load reduction estimate was compared to the 2013 pollutant load reduction benchmark range. Where the mean 2015 pollutant load reduction estimate falls within the benchmark range, the benchmarks are interpreted as likely to be met.

Benchmarks are pollutant load reduction estimates for anticipated future conditions, so they can be used as a tool and a goal for guiding adaptive management activities. Benchmarks are not considered to be numeric effluent limits.

4.5 Pollutant Load Reduction Evaluation Summary

The pollutant load reduction benchmarks comparison presented in Table 4-3 shows that bacteria benchmarks are estimated to be met in all three TMDL watersheds: Clackamas River, Middle Willamette tributaries, and Middle Willamette direct. Significant additional load reduction would be needed beyond the current structural BMP implementation to achieve the WLAs.

Due to the variable nature of stormwater runoff and the variety of undefined sources contributing to stormwater pollutant discharges, there are inherent difficulties in applying WLAs to MS4 discharges and quantitatively tracking pollutant loads to show progress toward WLAs.

In conducting a quantitative PLRE, the City chose a conservative approach to avoid overestimating the effectiveness of the programs. Over time, pollutant load reductions are expected to increase due to:

- Continued implementation of stormwater design standards for new development and re-development projects, resulting in construction of additional structural BMPs
- Stormwater retrofit efforts to install structural BMPs in untreated areas

- New technologies and scientific advances
- Increased implementation of emerging technologies that results in a reduction of costs (and therefore more frequent installation) of more effective treatment technologies

In addition, the pollutant load reduction estimates, as detailed in the PLRE, are conservative. Greater reductions are likely currently achieved because of implementation of non-structural BMPs.

The City conducts a variety of programmatic activities that are directly attributable to bacteria reduction. Such activities include erosion control, illicit discharge detection and elimination, street sweeping, catch basin cleaning, facility maintenance, operations and maintenance, pet waste programs, and public education. For example, the City's stormwater management program includes BMP 7-4 to control infiltration and cross-connections to the City's stormwater conveyance system. In the 2014–15 permit year, the City's program resulted in the discovery and correction of two sewer-stormwater cross-connections. These actions have a direct impact on reducing bacteria contributions to the MS4.

While numeric values for non-structural and source control BMP effectiveness were not specifically accounted for in the pollutant loads models, pollutant loads are presented as a range, and this range reflects the variable nature of stormwater runoff and may potentially account for non-structural and source control practices implemented upstream.

4.6 Water Quality Trends Analysis

In accordance with Schedule D.3.c.vii of the City's NPDES MS4 permit, the City prepared a water quality trends analysis as part of the PLRE. The City's overall monitoring program includes in-stream water quality monitoring, MS4 (stormwater) monitoring, biological monitoring, and physical condition monitoring. For the water quality trends analysis, in-stream monitoring data collected over the 5-year permit term were evaluated along with historical monitoring data to assess long-term trends in receiving water quality.

In-stream water quality trends were calculated for 6 sites in Oregon City as identified in the *Comprehensive Clackamas County NPDES MS4 Stormwater Monitoring Plan* (2014). The following pollutant parameters were included in the water quality trends analysis:

- Total suspended solids
- *E. coli*
- Total phosphorus
- Total and dissolved copper
- Total and dissolved zinc

Each parameter was analyzed at each sampling site. The analyses were performed for the “rain” and “no rain” conditions with the exception of samples collected from the Singer Creek site which were analyzed for the wet and dry season sampling dates due to the lack of rainfall data available for this site. These seasonal distinctions were used to help assess the potential influence of MS4 discharges on receiving water quality.

Temporal trends in water quality were evaluated using the Mann-Kendall test, a non-parametric method that is used for identifying monotonic (though not necessarily linear) trends. The Mann-Kendall test is particularly well-suited for analyzing environmental data because (1) it allows for missing values and unevenly spaced measurements, (2) there are no distributional assumptions, (3) outliers have minimal effect, and (4) some non-detects can be present in the data.

Table 4-3 summarizes results of the 2015 in-stream water quality trends evaluation for water bodies and parameters where observed trends are noted. Full documentation is included in Appendix B.

Table 4-3. Summary of Water Quality Trends Analysis				
Monitoring location	Improving trends (decreasing concentrations)		Deteriorating trends (increasing concentrations)	
	No rain	Rain	No rain	Rain
Park Place Creek behind 13530 Redland Road	Dissolved copper	Total suspended solids Total phosphorus Total copper Total zinc	None	None
Abernethy Creek at Holly Lane Bridge	None	Dissolved copper	None	Dissolved zinc
Abernethy Creek at 17th and Railroad Trestle	None	None	None	None
Coffee Creek at the outfall to the Willamette	None	Total suspended solids <i>E. coli</i> Total copper	None	Dissolved zinc
Singer Creek at the north end of Singer Creek Park	None	<i>E. coli</i>	None	Dissolved zinc
	Dry season	Wet season	Dry season	Wet season
Singer Creek at the Singer manhole	Total phosphorus Total copper Total zinc	Total phosphorus Total copper Total zinc	None	<i>E. coli</i> Dissolved zinc

Note: Reporting for trends where $p < 0.05$.

Results from the trends analysis indicate improving trends at 5 of the 6 in-stream sites for various parameters. No trends were observed at 1 in-stream site (Abernethy at 17th). No statistically significant trends were identified in either a positive or negative direction for over half of the data sets evaluated (54 out of 77 data sets). This trend analysis reflects a period of time when Oregon City grew in population by approximately 10,000, or approximately 25 percent. Given that level of population growth and the potential impacts associated with the resulting development, seeing no trend in water quality is a positive result.

The water quality trends analysis shows improving trends (decreasing concentrations) for many parameters and deteriorating trends for several parameters during rain conditions. Correlating data from instream and outfall water quality sampling with stormwater management activities is a challenging task because of the myriad other influences on water quality. The results of this trends analysis are not a definitive statement of the overall quality of sampled streams, but rather one piece of information to be considered within the larger watershed context. The City will continue to conduct instream water quality sampling in compliance with the NPDES MS4 permit.

Section 5

Benchmarks

Based on results of the pollutant load reduction evaluation (Section 4), the City of Oregon City is required to establish new pollutant load reduction benchmarks for bacteria in the Clackamas River, Middle Willamette direct, and Middle Willamette tributary TMDL watersheds.

The proposed benchmarks presented in this section are based on projected structural BMP implementation at the end of the next NPDES MS4 permit term (anticipated to be 2022). The benchmarks presented in Table 5-2 show anticipated bacteria load reductions between 1 and 23 percent, depending on the watershed and projected BMP coverage. Additional pollutant load reduction is expected to be achieved through non-structural measures.

5.1 Benchmark Development

Benchmarks are required for bacteria in the Clackamas River, Middle Willamette direct, and Middle Willamette tributary TMDL watersheds. In accordance with Schedule D.3.d.i of the City's NPDES MS4 permit, each benchmark must reflect the pollutant load reduction necessary to achieve the previously established benchmarks for the current permit term (2008 benchmark) and additional progress toward the TMDL WLA during the next permit term.

The benchmarks reflect current BMP implementation and projected BMP implementation over the upcoming permit term. As the City's current NPDES MS4 permit expires March 1, 2017, the next 5-year permit term is anticipated to be 2017 to 2022.

Benchmarks are developed by identifying stormwater BMPs that are likely to be installed before the end of the next permit term. City Engineering, Planning, and Public Works staff identified stormwater facility installations associated with upcoming public works projects. They also identified pending and constructed private stormwater facility installations associated with recent or in-progress development activities since the PLRE was completed in October 2015. In total, 24 new structural stormwater BMPs are anticipated, representing the City's projection for stormwater facility installations through 2022. These facility drainage areas are shown in Figure 3-1.

City staff efforts included identification of the location, type(s), and anticipated drainage area(s) for these projects. Table 5-1 summarizes the City's current status in meeting the 2008 benchmarks and the WLAs (as repeated from Table 4-2) and lists the anticipated stormwater facility installations by TMDL watershed, facility type, and drainage area.

Additional public and private facility installations beyond those shown in Figure 3-1 are likely but have not been projected. This conservative assumption is due to the variable schedules of private development activities and the unknown content and issuance date for the City's reissued NPDES MS4 permit.

Table 5-1. TMDL Benchmark Status and Projected Future Stormwater Facility Installations

TMDL watershed	Model time frame	Parameter	2015 pollutant load reduction estimate results		2016 TMDL benchmark development	
			Met TMDL WLA? (Y/N)	Met (2008) benchmark? (Y/N)	Projected BMP installations	Estimated Future BMP drainage area addition (ac) ^a
Clackamas River	Annual	Bacteria	N	Y	- Dry ponds - Flow through swales	19.25
Middle Willamette tributary	Summer Season	Bacteria	N	Y	- Underground filter systems - Dry ponds - Infiltration rain gardens - Flow through swales	118.47
	Fall, Winter, Spring Season	Bacteria	N	Y		
Middle Willamette direct	Annual	Bacteria	N	N/A ^b	Infiltration rain gardens	0.65

a. The future BMP drainage area includes 1) potential areas to be treated by new BMPs, and 2) area currently being treated by a structural BMP, but expected to receive treatment by a more effective BMP (through retrofit of existing systems or installation of downstream BMPs).

b. No benchmarks for the Middle Willamette River direct TMDL watershed were specifically developed in 2008.

5.2 TMDL Benchmark Results

The spreadsheet loads model used for the PLRE was used to simulate future BMP implementation in accordance with modeling methods and assumptions described in Section 3.

The benchmarks were calculated as the difference between the modeled loads associated with the current no-BMP scenario and the future with-BMP scenario. Due to the variability in stormwater quality data, pollutant loads themselves are typically calculated and presented as a range. Pollutant load estimates reflecting the current no-BMP, current with-BMP, and future with-BMP scenarios are provided in Appendix C.

Table 5-2 shows the WLAs and the new TMDL benchmarks for bacteria as both a load reduction and percentage load reduction.

Table 5-2. TMDL Benchmarks for Bacteria (2017–2022)

TMDL watershed	Time frame	Pollutant (units)	WLA (% reduction)	TMDL benchmarks (load reduction) ^a , range	TMDL benchmarks (% load reduction) ^a , range
Clackamas River	Annual	Bacteria (counts)	78%	1.47×10^{11} to 9.05×10^{11}	4.6 to 7.5
Middle Willamette tributary	Summer season	Bacteria (counts)	88%	1.69×10^{12} to 7.76×10^{12}	15.3 to 23.4
	Fall, Winter, Spring Season	Bacteria (counts)	75%	9.98×10^{12} to 4.58×10^{13}	15.3 to 23.4
Middle Willamette direct	Annual	Bacteria (counts)	75%	1.20×10^{10} to 6.30×10^{10}	0.8 to 1.0

a. The TMDL benchmarks are a load reduction, calculated as the difference between the current no-BMP scenario load and the future with-BMP scenario load. The benchmarks have also been calculated as a percent reduction for direct comparison with the WLA.

5.3 Discussion and Application of SWMP Implementation

The City's benchmarks reflect the projected installation of 24 new structural BMPs, covering approximately 138 acres of drainage area. Approximately 132 acres will be new treatment for drainage areas that are not currently treated. The remaining 6 acres reflects a drainage area that is currently treated by a structural BMP, but is expected to be managed by a more effective structural BMP in the future.

While the projected BMP coverage area and resulting bacteria load reductions are significant, the resulting pollutant load reductions fall short of achieving the WLAs. Large areas of the City have already developed without structural BMPs and structural stormwater BMPs are not 100 percent effective in removing bacteria. The City prepared a WLA attainment assessment for DEQ in February 2016, which indicated that achieving the WLAs would require construction of facilities and associated maintenance costs that far exceed the City's definition of maximum extent practicable. Progress toward the WLA, and not achievement of the WLA, is the City's goal in setting benchmarks. Such progress is reflected in Table 5-2 and Appendix C.

The proposed benchmarks are conservative estimates of the pollutant load reduction anticipated during the next permit term with the use of structural BMPs alone. The load reduction estimates do not account for:

- Non-structural BMPs, as described in Section 4.5
- Future stormwater program enhancements to target TMDL parameters as pollutants of concern, to be identified in future SWMP updates.
- Additional structural BMPs installed in conjunction with future development and redevelopment projects that have not yet submitted land use applications to the City.
- New water quality capital projects, identified through the development of the City's new Stormwater Master Plan, which is anticipated to be completed in 2017.

Each of these efforts is expected to further reduce the bacteria pollutant loads in runoff from the City's watersheds to below the levels indicated in these benchmark projections.

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Section 6

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Section 7

Limitations

This document was prepared solely for Oregon City in accordance with professional standards at the time the services were performed and in accordance with contracts between the City and Brown and Caldwell dated January 15, 2014 and July 6, 2016. This document is governed by the specific scope of work authorized by the City; it is not intended to be relied upon by any other party except for regulatory authorities contemplated by the scope of work. We have relied on information or instructions provided by the City and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

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Appendix A: PLRE Model Input Data

Information Needed for TMDL Pollutant Load Reduction Evaluation and TMDL Benchmarks

Watershed Name:

Clackamas River

Total watershed area within OCs permit area 2015 ⁽¹⁾:

ODOT ROW Area ⁽²⁾

Waterbody Surface Area ⁽²⁾

Total Model Area 2015 ⁽³⁾:

Modeled Land Use Areas (acres) and imperviousness (%):

Area

479.7

75.7

51.6

Areas that are both in ODOT ROW and Waterbodies are only included in the Waterbodies numt

352.4

	Area (ac)	Impervious (%) ⁽⁴⁾
Agriculture (AGR):	0.0	48%
Commercial (COM):	73.2	74%
Industrial (IND):	30.2	63%
Residential (RES):	52.9	45%
Multi Family Residential (MFR):	1.8	57%
Vacant (VAC):	110.7	21%
Parks and Open Space (POS):	8.8	19%
Public Property (Schools/ Hospitals) (PP):	74.8	34%
TOTAL	352.4	

Acres generated for individual watershed. Calculations exclude Waterbodies and ODOT ROW

Impervious % calculations only generated for entire area, not individual watersheds. Calculations exclude Waterbodies, but include ODOT

Modeled Current Structural BMP Drainage areas (acres):

Acres generated for individual watershed. Calculations exclude Waterbodies and ODOT ROW

OC BMP Type

Vault
Dry Pond
Wet Pond

Pollution Control Manhole

Infiltration Rain Garden
Flow Through Swale

		Current Condition Land Use Breakdown ⁽⁵⁾						
		AGR	COM	IND	RES	MFR	VAC	POS
Media Filters (sand filters, StormFilters):								
Dry, detention ponds:			0.457		14.509		1.855	5.756
Wet, retention ponds:			1.315	11.986			4.688	
Biofiltration Swale/ Vegetated Filter Strips:								
Wetlands:								
Sedimentation Manholes:			0.663				0.04	
Hydrodynamic Device (CDS, Stormceptor):								
Ecoroof:								
Infiltration Raingarden/ Porous Pavement:								
Lined Planter/ Filtration Raingarden with Underdrain:			2.706	0.303	0.736		1.178	2.874
Drywell								
SUBTOTAL (BMP Coverage by Land Use)		0.0	5.1	12.3	15.2	0.0	7.8	5.8

Sum (for report)

0.0
30.6
18.0
0.0
0.0
0.7
0.0
0.0
0.0
7.8
0.0
57.1

Modeled Future Structural BMP Drainage areas (acres): TO BE COMPLETED WITH BENCHMARK EVALUATION

		Future Condition Land Use Breakdown ⁽⁵⁾						
		AGR	COM	IND	RES	MFR	VAC	POS
Media Filters (sand filters, StormFilters):								
Dry, detention ponds:								
Wet, retention ponds:								
Biofiltration Swale/ Vegetated Filter Strips:								
Wetlands:								
Sedimentation Manholes:								
Hydrodynamic Device (CDS, Stormceptor):								
Ecoroof:								
Infiltration Raingarden/ Porous Pavement:								
Lined Planter/ Filtration Raingarden with Underdrain:								
Drywell								
SUBTOTAL (BMP Coverage by Land Use)		0.0	0.0	0.0	0.0	0.0	0.0	0.0

Notes:

- 1) This area reflects the total watershed area within the City including annexations proposed through 2015.
- 2) This information is not essential for the modeling exercise but will be documented in the narrative for transparency.
- 3) This number reflects the watershed area minus ODOT ROW, and surface water feature area
- 4) Calculated percent impervious by modeled land use category. Same for all watersheds. Based on original calculation methodology, as discussed in 8/27/15 meeting.
- 5) Provide a breakdown of land use within the drainage area for each category of structural BMP. This will allow us to take appropriate credit for the placement of BMPs.

Information Needed for TMDL Pollutant Load Reduction Evaluation and TMDL Benchmarks

Watershed Name:

M Willamette (direct)

Total watershed area within OCs permit area 2015 ⁽¹⁾:

ODOT ROW Area ⁽²⁾

Waterbody Surface Area ⁽²⁾

Total Model Area 2015 ⁽³⁾:

Modeled Land Use Areas (acres) and imperviousness (%):

Area
203.3
18.3
61.2
123.8

Areas that are both in ODOT ROW and Waterbodies are only included in the Waterbodies numt

	Area (ac)	Impervious (%) ⁽⁴⁾
Agriculture (AGR):	0.0	48%
Commercial (COM):	59.7	74%
Industrial (IND):	5.5	63%
Residential (RES):	23.6	45%
Multi Family Residential (MFR)	0.0	57%
Vacant (VAC):	3.3	21%
Parks and Open Space (POS):	30.8	19%
Public Property (Schools/ Hospitals) (PP):	0.9	34%
TOTAL	123.8	

Acres generated for individual watershed. Calculations exclude Waterbodies and ODOT ROW

Impervious % calculations only generated for entire area, not individual watersheds. Calculations exclude Waterbodies, but include ODOT

Modeled Current Structural BMP Drainage areas (acres):

Acres generated for individual watershed. Calculations exclude Waterbodies and ODOT ROW

OC BMP Type

Vault
Dry Pond
Wet Pond

Pollution Control Manhole

Infiltration Rain Garden
Flow Through Swale

		Current Condition Land Use Breakdown ⁽⁵⁾							
		AGR	COM	IND	RES	MFR	VAC	POS	PP
Vault	Media Filters (sand filters, StormFilters):								
	Dry, detention ponds:		1.366						
	Wet, retention ponds:								
Dry Pond	Biofiltration Swale/ Vegetated Filter Strips:								
	Wetlands:								
	Sedimentation Manholes:		3.559						
Wet Pond	Hydrodynamic Device (CDS, Stormceptor)								
	Ecoroof:								
	Infiltration Raingarden/ Porous Pavement:		0.297						
Pollution Control Manhole	Lined Planter/ Filtration Raingarden with Underdrain								
	Drywell								
	SUBTOTAL (BMP Coverage by Land Use)	0.0	5.2	0.0	0.0	0.0	0.0	0.0	0.0

Sum (for report)

0.0
1.4
0.0
0.0
0.0
3.6
0.0
0.0
0.3
0.0
0.0
5.2

Modeled Future Structural BMP Drainage areas (acres): TO BE COMPLETED WITH BENCHMARK EVALUATION

		Future Condition Land Use Breakdown ⁽³⁾ -							
		AGR	COM	IND	RES	MFR	VAC	POS	PP
	Media Filters (sand filters, StormFilters):								
	Dry, detention ponds:								
	Wet, retention ponds:								
	Biofiltration Swale/ Vegetated Filter Strips:								
	Wetlands:								
	Sedimentation Manholes:								
	Hydrodynamic Device (CDS, Stormceptor)								
	Ecoroof:								
	Infiltration Raingarden/ Porous Pavement:								
	Lined Planter/ Filtration Raingarden with Underdrain								
	Drywell								
	SUBTOTAL (BMP Coverage by Land Use)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Notes:

- 1) This area reflects the total watershed area within the City including annexations proposed through 2015.
- 2) This information is not essential for the modeling exercise but will be documented in the narrative for transparency.
- 3) This number reflects the watershed area minus ODOT ROW, and surface water feature area
- 4) Calculated percent impervious by modeled land use category. Same for all watersheds. Based on original calculation methodology, as discussed in 8/27/15 meeting.
- 5) Provide a breakdown of land use within the drainage area for each category of structural BMP. This will allow us to take appropriate credit for the placement of BMPs.

Information Needed for TMDL Pollutant Load Reduction Evaluation and TMDL Benchmarks

Watershed Name:

M Willamette (tributary)

Total watershed area within OCs permit area 2015 ⁽¹⁾:

ODOT ROW Area ⁽²⁾

Waterbody Surface Area ⁽²⁾

Total Model Area 2015 ⁽³⁾:

Modeled Land Use Areas (acres) and imperviousness (%):

Area
5630.8
91.5
52.1
5,487.2

Areas that are both in ODOT ROW and Waterbodies are only included in the Waterbodies numt

	Area (ac)	Impervious (%) ⁽⁴⁾
Agriculture (AGR):	9.2	48%
Commercial (COM):	401.5	74%
Industrial (IND):	244.0	63%
Residential (RES)	3039.5	45%
Multi Family Residential (MFR)	203.1	57%
Vacant (VAC):	897.1	21%
Parks and Open Space (POS):	223.5	19%
Public Property (Schools/ Hospitals) (PP):	469.3	34%
TOTAL	5487.2	

Acres generated for individual watershed. Calculations exclude Waterbodies and ODOT ROW

Impervious % calculations only generated for entire area, not individual watersheds. Calculations exclude Waterbodies, but include ODOT

Modeled Current Structural BMP Drainage areas (acres):

Acres generated for individual watershed. Calculations exclude Waterbodies and ODOT ROW

OC BMP Type

Vault
Dry Pond
Wet Pond

Pollution Control Manhole

Infiltration Rain Garden
Flow Through Swale

		Current Condition Land Use Breakdown ⁽⁵⁾						
		AGR	COM	IND	RES	MFR	VAC	POS
Media Filters (sand filters, StormFilters):	Dry, detention ponds:	0.312	5.186	34.594	698.664	52.896	55.157	5.141
	Wet, retention ponds:		31.32	46.812	617.992	45.928	74.671	17.932
	Biofiltration Swale/ Vegetated Filter Strips:							
Wetlands:	Sedimentation Manholes:		48.325	46.144	103.842	9.819	8.164	1.04
	Hydrodynamic Device (CDS, Stormceptor)							
	Ecoroof:							
Infiltration Rain Garden	Infiltration Raingarden/ Porous Pavement:		2.393	0.223	0.232			
	Lined Planter/ Filtration Raingarden with Underdrain	0.492	14.331	18.032	141.918	0.965	56.114	5.755
	Drywell							
SUBTOTAL (BMP Coverage by Land Use)		0.8	101.6	150.1	1562.6	109.6	194.2	29.9

Sum (for report)

6.6
886.1
897.8
0.0
0.0
218.3
0.0
0.0
2.8
321.3
0.0
2332.9

Modeled Future Structural BMP Drainage areas (acres): TO BE COMPLETED WITH BENCHMARK EVALUATION

		Future Condition Land Use Breakdown ⁽⁵⁾						
		AGR	COM	IND	RES	MFR	VAC	POS
Media Filters (sand filters, StormFilters):	Dry, detention ponds:							
	Wet, retention ponds:							
	Biofiltration Swale/ Vegetated Filter Strips:							
Wetlands:	Sedimentation Manholes:							
	Hydrodynamic Device (CDS, Stormceptor)							
	Ecoroof:							
Infiltration Rain Garden	Infiltration Raingarden/ Porous Pavement:							
	Lined Planter/ Filtration Raingarden with Underdrain							
	Drywell							
SUBTOTAL (BMP Coverage by Land Use)		0.0	0.0	0.0	0.0	0.0	0.0	0.0

Notes:

- 1) This area reflects the total watershed area within the City including annexations proposed through 2015.
- 2) This information is not essential for the modeling exercise but will be documented in the narrative for transparency.
- 3) This number reflects the watershed area minus ODOT ROW, and surface water feature area
- 4) Calculated percent impervious by modeled land use category. Same for all watersheds. Based on original calculation methodology, as discussed in 8/27/15 meeting.
- 5) Provide a breakdown of land use within the drainage area for each category of structural BMP. This will allow us to take appropriate credit for the placement of BMPs.

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Appendix B: Water Quality Trends Analysis



Technical Memorandum

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Prepared for: City of Oregon City

Project Title: MS4 NPDES Permit Assistance

Project No.: 145358.018

Technical Memorandum

Subject: Instream Water Quality Trends Analyses

Date: October 27, 2015

To: Martin Montalvo and Gail Johnson

From: Valerie Fuchs, Angela Wieland, and Krista Reininga, Brown and Caldwell

Limitations:

This document was prepared solely for Oregon City (City) in accordance with professional standards at the time the services were performed and in accordance with the contract between the City and Brown and Caldwell dated August, 2015. This document is governed by the specific scope of work authorized by the City; it is not intended to be relied upon by any other party except for regulatory authorities contemplated by the scope of work. We have relied on information or instructions provided by the City and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

Summary

The purpose of this technical memorandum (TM) is to summarize the review and analysis of instream water quality monitoring data for the City of Oregon City (City). This data review and trends analysis was completed to comply with one of the City's National Pollutant Discharge Elimination System (NPDES) municipal separate storm sewer system (MS4) permit requirements.

The City is a Phase 1 co-permittee on the Clackamas County NPDES MS4 permit along with several other local governments and service districts in Clackamas County, Oregon. As part of the NPDES MS4 permit requirements, the City must evaluate the overall effectiveness of its stormwater management program by conducting a pollutant load reduction evaluation (Schedule D.3 of the permit). This evaluation includes a requirement to conduct an instream water quality trends analysis including a summary of the relationship of identified trends to stormwater discharges.

The City has been collecting instream water quality monitoring data since 2002 from six creek sites. Brown and Caldwell (BC) was retained to review these instream environmental monitoring data and develop the trends analysis that is provided in this TM. This TM includes a summary of the review and processing of the data, a summary of the Mann-Kendall statistical analysis, and a summary of the results.

Data Review and Pre-Processing

BC reviewed the instream data collected within the City's watersheds in order to summarize and pre-process the data sets. Pre-processing of data was conducted to determine which data sets were sufficient to perform a statistically valid water quality trends analysis. Each record in the data to be analyzed represents a measurement recorded for one parameter at one site, and each data set represents all of the data collected for one parameter at one site during either a wet or dry day. The original criteria for determining which data sets would be used for the trends analysis were that only data sets with at least 5 years of data and 30 or more data points would be used, and that data sets for wet days and dry days would be analyzed separately (or wet season and dry season where daily rainfall records were not available). These criteria were recommended in a draft guidance document developed in 2007 by the Oregon Association of Clean Water Agencies (ACWA) Phase I stormwater committee. However, not all of the City's data sets included 30 or more observations; some of the data sets had 10 or more observations. Based on the review of the City's data, BC completed the analysis based on the following refined/updated ACWA criteria:

- Data were analyzed separately for wet days and dry days (with one exception described below) given that information regarding the occurrence of rainfall in association with data collection was readily available.
- The threshold for the trends analysis was reduced to data sets with 10 or more observations in order to allow for a trends analysis to be performed for copper and zinc and to be able to separate the data into wet-day and dry-day data sets when that resulted in fewer than 30 observations.
- Data sets were analyzed only when 50 percent or more of the data were reported as above the detection limit to provide more rigorous and statistically valid trends analyses.

The NPDES MS4 permit does not specify the parameters required for the trends analysis. The ACWA Committee draft guidance recommends that trends analyses be performed for total suspended solids (TSS), total phosphorus (TP) or other relevant nutrient, copper (total recoverable and soluble), zinc (total recoverable and soluble), and *E. coli* if adequate data are available to perform a rigorous Mann-Kendall trends analysis. BC performed the Mann-Kendall trends analysis for these seven parameters.

Most of the City data sets had daily rainfall records, but the Singer site did not have daily rainfall observations available for the complete monitoring period. The trends analysis for the Singer site was performed for wet season and dry season.



Based on the criteria described above for conducting the trends analyses, pre-processing of the data included a review of the following for each monitoring site and parameter:

- Total number of data points (where a single data point is one measurement recorded for one parameter at one site)
- Number of data points associated with wet-day conditions (record marked “Y” for rainfall greater than or equal to 0.1 inch during the sampling event) or dry-day conditions (record marked “N” for no rainfall)
- For the Singer site, the number of data points associated with wet season conditions (October 1 – April 30) or dry season conditions (May 1 – September 31). These dates are consistent with permit-defined wet and dry seasons.
- Number of non-detects
- Summary of monitoring frequency
- Summary of the monitoring sites and parameters with adequate data for a trends analysis

For this analysis, BC assumed that the quality assurance/quality control (QA/QC) review of stormwater data was already completed by the City.

None of the City’s sites had data sets with 30 or more observations. In order to perform a trends analysis for these data sets, as mentioned above, BC elected to reduce the threshold for the trends analysis to data sets with 10 or more observations.

Table 1 shows a check mark (✓) for each data set that met the project criteria for conducting a Mann-Kendall trends analysis. All of the City’s data sets met the criteria for the trends analysis.

Table 1. Summary of Monitoring Sites and Data Review Statistics							
Park Place Creek (13530 Redland Rd.)							
Statistic/parameter	TSS	<i>E. coli</i>	TP	Copper	Copper (diss.)	Zinc	Zinc (diss.)
Monitoring date range	2007–15	2007–15	2007–15	2007–15	2007–15	2007–15	2007–15
Number of observations	30	30	30	30	30	30	30
Wet-day detects	16	16	13	16	16	16	16
Wet-day non-detects	0	0	3	0	0	0	0
Wet-day data set 10+ records and 50% or more detects	✓	✓	✓	✓	✓	✓	✓
Dry-day detects	14	14	5	14	14	14	14
Dry-day non-detects	0	0	9	0	0	0	0
Dry-day data set 10+ records and 50% or more detects	✓	✓	✓	✓	✓	✓	✓
Abernethy Creek (Holly Ln.)							
Statistic/parameter	TSS	<i>E. coli</i>	TP	Copper	Copper (diss.)	Zinc	Zinc (diss.)
Monitoring date range	2007–15	2007–15	2007–15	2007–15	2007–15	2007–15	2007–15
Number of observations	30	30	30	30	30	30	30
Wet-day detects	16	16	13	16	16	16	15
Wet-day non-detects	0	0	3	0	0	0	1
Wet-day data set 10+ records and 50% or more detects	✓	✓	✓	✓	✓	✓	✓
Dry-day detects	14	14	7	14	14	14	12
Dry-day non-detects	0	0	7	0	0	0	2
Dry-day data set 10+ records and 50% or more detects	✓	✓	✓	✓	✓	✓	✓

Table 1. Summary of Monitoring Sites and Data Review Statistics

Abernethy Creek (316 17th St.)							
Statistic/parameter	TSS	<i>E. coli</i>	TP	Copper	Copper (diss.)	Zinc	Zinc (diss.)
Monitoring date range	2007–15	2007–15	2007–15	2007–15	2007–15	2007–15	2007–15
Number of observations	30	30	30	30	30	30	30
Wet-day detects	23	22	23	12	12	12	12
Wet-day non-detects	0	0	0	0	0	0	0
Wet-day data set 10+ records and 50% or more detects	✓	✓	✓	✓	✓	✓	✓
Dry-day detects	14	14	6	14	14	14	13
Dry-day non-detects	0	0	8	0	0	0	1
Dry-day data set 10+ records and 50% or more detects	✓	✓	✓	✓	✓	✓	✓
Singer Creek (Singer MH)							
Statistic/parameter	TSS	<i>E. coli</i>	TP	Copper	Copper (diss.)	Zinc	Zinc (diss.)
Monitoring date range	2002–15	2002–15	2002–15	1994–15	2007–15	1994–15	2007–15
Number of observations	50	50	50	50	30	50	30
Wet-day detects	27	30	20	20	20	24	20
Wet-day non-detects	3	0	10	10	0	6	0
Wet-day data set 10+ records and 50% or more detects	✓	✓	✓	✓	✓	✓	✓
Dry-day detects	20	20	11	10	10	19	10
Dry-day non-detects	0	0	9	10	0	1	0
Dry-day data set 10+ records and 50% or more detects	✓	✓	✓	✓	✓	✓	✓
Singer Creek (N End Singer Creek Park)							
Statistic/parameter	TSS	<i>E. coli</i>	TP	Copper	Copper (diss.)	Zinc	Zinc (diss.)
Monitoring date range	2007–15	2007–15	2007–15	2007–15	2007–15	2007–15	2007–15
Number of observations	161	205	212	109	41	107	41
Wet-day detects	58	65	66	41	37	45	37
Wet-day non-detects	0	2	1	5	0	0	0
Wet-day data set 10+ records and 50% or more detects	✓	✓	✓	✓	✓	✓	✓
Dry-day detects	116	137	145	68	39	80	39
Dry-day non-detects	1	6	5	21	0	9	0
Dry-day data set 10+ records and 50% or more detects	✓	✓	✓	✓	✓	✓	✓
Coffee Creek (415 S McLoughlin)							
Statistic/parameter	TSS	<i>E. coli</i>	TP	Copper	Copper (diss.)	Zinc	Zinc (diss.)
Monitoring date range	2007–15	2007–15	2007–15	2007–15	2007–15	2007–15	2007–15
Number of observations	29	28	29	29	29	29	29
Wet-day detects	16	16	7	16	16	16	16
Wet-day non-detects	0	0	9	0	0	0	0
Wet-day data set 10+ records and 50% or more detects	✓	✓	✓	✓	✓	✓	✓
Dry-day detects	14	14	1	14	14	14	13
Dry-day non-detects	0	0	13	0	0	0	1
Dry-day data set 10+ records and 50% or more detects	✓	✓	✓	✓	✓	✓	✓

Mann-Kendall Trends Analysis

Temporal trends in water quality were evaluated using the Mann-Kendall test, a non-parametric method that is used for identifying monotonic (though not necessarily linear) trends. The Mann-Kendall test is particularly well-suited for analyzing environmental data because (1) it allows for missing values and unevenly spaced measurements, (2) there are no distributional assumptions, (3) outliers have minimal effect, and (4) some non-detects can be present in the data. The Mann-Kendall test is described in a number of references including Gibbons (1994), Gilbert (1987), Hollander and Wolfe (1973), and U.S. EPA (2006).

The null and alternative hypotheses for this analysis are:

H_0 : slope = 0 (null)

H_a : slope $\neq$ 0 (alternative)

The null hypothesis (H_0) of “no trend” was rejected if the absolute value of the test statistic (p-value) exceeded the critical p-value. The critical p-value depends on the number of observations and the desired significance level of the results. Significance levels of both 5 and 10 percent were selected for this analysis (i.e., there is at most a 5 or 10 percent chance that the trend observed is not actually a trend but due to variability of the data). P-values less than 5 percent were assumed to demonstrate a statistically significant trend. P-values between 5 and 10 percent were assumed to demonstrate a marginally significant trend. P-values corresponded to a two-sided analysis where there is interest in both upward and downward trends.

A rejection of the null hypothesis, H_0 , indicates a high likelihood of a temporal trend in the data. If H_0 is not rejected, it cannot be concluded that there is a temporal trend in the data. The Mann-Kendall trend test compares each observation in a time series with all previous observations, tallying a point when the observation is larger than a previous observation, and subtracting a point when the observation is smaller than a previous observation. The total tally is the Kendall Score, and its sign determines the direction of the trend.

A negative value indicates a downward trend with time and a positive value indicates an upward trend. When the null hypothesis is rejected, the conclusion is that the Kendall score (and the temporal trend) is not significantly different from zero.

Mann-Kendall tests for trends were conducted using the package “Kendall” in the programming language R. R is an open-source language and integrated suite of software applications for statistical computing, for which statistical packages are developed and scientifically peer-reviewed (available through the Comprehensive R Archive Network from the R Core Team [2013]). The Kendall package is the program developed to run the Mann-Kendall trends analysis (McLeod, 2011). Results of the Mann-Kendall trends analysis in R are produced in a table of values including two-sided p-value and Kendall Score. BC processed all data sets for each monitoring site using R, resulting in a table of Mann-Kendall trends analysis values for each of the parameters for the site.

To provide quality assurance on the automated processing of the site data, the Mann-Kendall test was also conducted in ProUCL for selected data sets. ProUCL is a statistical software package developed by the U.S. Environmental Protection Agency (EPA) for analysis of environmental data (U.S. EPA, 2013). Because of the inability to automate the processing of data sets in ProUCL, ProUCL was used solely to spot-check selected results from the R package. The Kendall Score and p-value from the ProUCL Mann-Kendall trend analysis were compared with the Kendall Score and p-value from R. In all spot-checked cases, the results of the two software packages were in agreement, providing confidence in the results from all data sets processed through R.

Statistical Test Results

As described above, trends analyses were conducted on all wet-day and dry-day data sets (or wet season and dry season) that had at least 50 percent detected values and at least 10 observations. As a result of the data review and pre-processing of instream water quality monitoring data, a total of 77 trends analyses were

completed, including 37 trends analyses for dry weather and 40 trends analyses for wet weather. Rainfall data was unavailable for the complete set of observations for the Singer MH site; trends for that site were based on wet season (October 1 – April 30) and dry season (May 1 – September 30).

A legend for the results is shown in Table 2, and results of the trends analyses are summarized in Table 3. Based on the selected data criteria for performing the trends analysis, trends were evaluated for both the 5 and 10 significance levels (i.e., alpha of 0.05 and 0.10).

Table 2. Legend for Summary of Trends	
No rain	< 0.1 inch of rainfall in the 24 hours prior to sampling
Rain	>= 0.1 inch of rainfall in the 24 hours prior to sampling
↑	Significant upward trend (p <= 0.05)
↓	Significant downward trend (p <= 0.05)
⇧	Somewhat significant upward trend (0.05 < p <= 0.1)
⇩	Somewhat significant downward trend (0.05 < p <= 0.1)
	Improvement in water quality indicator parameter
	Deterioration in water quality indicator parameter
	Not enough data for analysis
NA	Not enough uncensored values for analysis (<10)
	No trend was detected

Table 3. Summary of Trends															
TMDL watershed	M Willamette (Abernethy)														
Water body	Park Place Creek					Abernethy Creek					Abernethy Creek				
Site/Station ID	13530 Redland Rd					Holly Ln					316 17th				
2015 instream monitoring site	Behind 13530 Redland Rd					At Holly Lane Bridge					17th Street at railroad trestle				
WQ parameter	Date range	No rain		Rain		Date range	No rain		Rain		Date range	No rain		Rain	
		N	Trend	N	Trend		N	Trend	N	Trend		N	Trend	N	Trend
TSS	2007-2015	22		28	↓	2007-2015	14		16		2007-2015	14		16	
<i>E. coli</i>	2007-2015	22		28		2007-2015	14		16		2007-2015	14		16	
TP	2007-2015	22	↓	28	↓	2007-2015	14		16		2007-2015	14		16	
Total copper	2007-2015	22		28	↓	2007-2015	14		16		2007-2015	14		16	
Copper (diss.)	2007-2015	12	↓	18		2007-2015	14		16	↓	2007-2015	14		16	
Total zinc	2007-2015	22		28	↓	2007-2015	14		16		2007-2015	14		16	
Zinc (diss.)	2007-2015	12		18		2007-2015	14		16	↑	2007-2015	14		16	↑
TMDL watershed	M Willamette										M Willamette (Coffee Creek)				
Water body	Singer Creek										Coffee Creek				
Site/Station ID	Singer MH					NE End Singer Creek Pk					415 S McLoughlin				
2015 instream monitoring site	Singer MH					N End Singer Creek Park					Outfall at Willamette				
WQ parameter	Date range	Dry Season		Wet Season		Date range	No rain		Rain		Date range	No rain		Rain	
		N	Trend	N	Trend		N	Trend	N	Trend		N	Trend	N	Trend
TSS	2002-2015	20	↓	30		2007-2015	14		16		2007-2015	14		15	↓
<i>E. coli</i>	2002-2015	20		30	↑	2007-2015	14		16	↓	2007-2015	14		15	↓
TP	2002-2015	20	↓	30	↓	2007-2015	14		16		2007-2015	14		15	↓
Total copper	2007-2015	20	↓	30	↓	2007-2015	14		16		2007-2015	14		15	↓
Copper (diss.)	2007-2015	10		20		2007-2015	14		16		2007-2015	14		15	
Total zinc	2007-2015	20	↓	30	↓	2007-2015	14		16		2007-2015	14		15	
Zinc (diss.)	2007-2015	10		20	↑	2007-2015	14		16	↑	2007-2015	14		15	↑

Summary/Conclusions

A summary of results based on Table 3 is as follows:

- Given a significance level of 10 percent, more declining water quality trends (i.e., increasing pollutant concentrations) were observed during wet weather (six declining trends) than during dry weather (no declining trends).
- Given a significance level of 10 percent, more improving water quality trends (i.e., decreasing pollutant concentrations) occurred during wet weather (13 improving trends) than during dry weather (six improving trends).
- The majority of all of the trends analyses (52 out of 77, or 68 percent) showed no trend given a significance level of 10 percent.
- The majority (i.e., 83 percent) of the six declining water quality trends occurred for dissolved zinc (five declining trends).
- One declining water quality trend occurred for bacteria.
- Twenty-six percent of the improving water quality trends occurred for phosphorus (5 out of 19 trends), and 21 percent occurred for total copper (4 out of 19).
- Three improving water quality trends occurred for TSS, three for total zinc, two for bacteria, and two for dissolved copper.
- Singer MH had the most data sets showing improving water quality trends (seven improving trends), followed by Park Place Creek (six improving trends) and Coffee Creek (four improving trends). It should be noted that the data from the Singer MH site were also sorted by wet season and dry season as opposed to rain and no rain.
- Singer MH had the most data sets showing declining water quality trends (two declining trends).

These trends results should be evaluated in the context of where samples are collected and what watershed influences may be affecting water quality at each sampling site, while also considering the data available for the trends analysis such as the length of the measurement period and the number of data points in the data sets evaluated. In addition, these trends reflect a period when Oregon City grew in population by approximately 10,000 or approximately 25 percent. Given that growth, and the potential impacts associated with the resulting development, seeing no trend in water quality is a positive result.

It should be noted that water quality data from grab samples represent conditions during a specific snapshot in time and the results can be influenced by many factors. Although there is evidence that stormwater management activities can have a measurable impact on reducing pollutants in stormwater, correlating data from instream and outfall water quality sampling with stormwater management activities is a challenging task because of the myriad of other influences on water quality. The results of the trends analyses presented here are not a definitive statement of the overall quality of the sampled streams, but rather one piece of information to be considered within the larger watershed context. Both the number of data points in a data set and the scatter of the data affect the results of the Mann-Kendall trends analysis. Data sets with more data may be more likely to exhibit a trend (if the data are not widely scattered) than data sets with fewer data points (McBride et al., 1993). In addition, a statistically significant result is not necessarily practically significant.

Other factors such as the magnitude and range of reported values compared to various water quality criteria can also be more practically significant, as well as longer-term indicators of watershed health such as benthic macroinvertebrate survey results. The results of the trends analysis are one piece of an overall evaluation of water quality.

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Appendix C: Pollutant Load Summary

Appendix C. City of Oregon City Bacteria Load Summary, for use with the PLRE and TMDL Benchmarks																				
Waterbody	Season	WLA (% reduction or concentration)	Pollutant Loading Estimate (counts)									Pollutant Load Reduction Estimate (counts) ^b								
			Current, no BMPs			Current, with BMPs			Future, with BMPs ^a			Current Conditions			Future Conditions ^c			Future Conditions (% reduction) ^c		
			Upper confidence limit (UCL)	Mean	Lower confidence limit (LCL)	Upper confidence limit (UCL)	Mean	Lower confidence limit (LCL)	Upper confidence limit (UCL)	Mean	Lower confidence limit (LCL)	Upper confidence limit (UCL)	Mean	Lower confidence limit (LCL)	Upper confidence limit (UCL)	Mean	Lower confidence limit (LCL)	Upper confidence limit (UCL)	Mean	Lower confidence limit (LCL)
Clackamas River	annual	78%	1.22 x 10 ¹³	6.57 x 10 ¹²	3.22 x 10 ¹²	1.13 x 10 ¹³	6.27 x 10 ¹²	3.09 x 10 ¹²	1.12 x 10 ¹³	6.25 x 10 ¹²	3.08 x 10 ¹²	8.53 x 10 ¹¹	2.96 x 10 ¹¹	1.36 x 10 ¹¹	9.05 x 10 ¹¹	3.15 x 10 ¹¹	1.47 x 10 ¹¹	7.5%	4.8%	4.6%
Middle Willamette Tributary	Summer season	88%	3.32 x 10 ¹³	1.98 x 10 ¹³	1.11 x 10 ¹³	2.57 x 10 ¹³	1.63 x 10 ¹³	9.44 x 10 ¹²	2.54 x 10 ¹³	1.61 x 10 ¹³	9.37 x 10 ¹²	7.48 x 10 ¹²	3.53 x 10 ¹²	1.62 x 10 ¹²	7.76 x 10 ¹²	3.68 x 10 ¹²	1.69 x 10 ¹²	23.4%	18.6%	15.3%
	Fall, winter, spring season	75%	1.96 x 10 ¹⁴	1.17 x 10 ¹⁴	6.53 x 10 ¹³	1.52 x 10 ¹⁴	9.62 x 10 ¹³	5.57 x 10 ¹³	1.50 x 10 ¹⁴	9.53 x 10 ¹³	5.53 x 10 ¹³	4.41 x 10 ¹³	2.08 x 10 ¹³	9.53 x 10 ¹²	4.58 x 10 ¹³	2.17 x 10 ¹³	9.98 x 10 ¹²	23.4%	18.5%	15.3%
Middle Willamette Direct	annual	75%	5.95 x 10 ¹²	3.21 x 10 ¹²	1.57 x 10 ¹²	5.90 x 10 ¹²	3.19 x 10 ¹²	1.56 x 10 ¹²	5.88 x 10 ¹²	3.18 x 10 ¹²	1.56 x 10 ¹²	4.90 x 10 ¹⁰	1.90 x 10 ¹⁰	9.00 x 10 ⁹	6.30 x 10 ¹⁰	2.60 x 10 ¹⁰	1.20 x 10 ¹⁰	1.0%	0.8%	0.8%

- a. The future (2022) with-BMP load estimate is required per Schedule D.3.d.ii.4 of the NPDES MS4 permit. This load estimate provides the basis for development of benchmarks.
- b. The pollutant load reduction estimate is calculated as the difference between the no-BMP and the with-BMP loads. The pollutant load reduction estimate is presented as a range, consistent with the pollutant loading estimate.
- c. The future condition pollutant load reduction estimates are the TMDL Benchmarks. Benchmarks have been calculated as a load reduction (for comparison to future PLRE evaluations) and also as a percentage load reduction (to compare to the WLAs).

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Appendix C: Updated Monitoring Plan

Comprehensive Clackamas
County NPDES MS4
Stormwater Monitoring Plan

January 2017

Implementation start: July 1, 2017

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Comprehensive Clackamas County NPDES MS4 Stormwater Monitoring Plan

Prepared for

Clackamas County
City of Gladstone, Oregon
City of Milwaukie, Oregon
City of Oregon City, Oregon
City of West Linn, Oregon
City of Wilsonville, Oregon
City of Happy Valley, Oregon
City of Rivergrove, Oregon
Clackamas County Service District #1
Surface Water Management Agency of Clackamas County
Oak Lodge Water Services District

January 2017

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List of Abbreviations

°C	degree(s) Celsius
µg/L	microgram(s) per liter
2004 permit	2004 NPDES MS4 permit
2012 permit	2012 NPDES MS4 permit
ACWA	(Oregon) Association of Clean Water Agencies
BMP	best management practice
BOD	biochemical oxygen demand
CaCO ₃	calcium carbonate
CCSD #1	Clackamas County Service District #1
CFR	Code of Federal Regulations
cm	centimeter(s)
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorophenyltrichloroethane
DEQ	(Oregon) Department of Environmental Quality
DO	dissolved oxygen
EPA	U.S. Environmental Protection Agency
JFA	Joint Funding Agreement
mg/L	milligram(s) per liter
mL	milliliter(s)
MPN	most probable number
MS4	Municipal Separate Storm Sewer System
NPDES	National Pollutant Discharge Elimination System
OLWSD	Oak Lodge Water Services District
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
Plan	Comprehensive Clackamas County NPDES MS4 Stormwater Monitoring Plan
QA/QC	quality assurance/quality control
RSAT	Rapid Assessment Technique
SM	Standard Methods
SOP	standard operating procedure
SWMACC	Surface Water Management Agency of Clackamas County
SWMP	stormwater management plan
TCE	trichloroethylene
TMDL	total maximum daily load
UIC	underground injection control
USGS	U.S. Geological Survey
WES	(Clackamas County) Water Environment Services

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Section 1 Introduction

As part of the National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit requirements, Clackamas County co-permittees are required to develop and implement a stormwater monitoring program. Stormwater monitoring requirements and objectives are outlined in Schedule B of the Clackamas County NPDES MS4 permit (101348), issued March 16, 2012 (2012 permit), and provide the basis for monitoring activities described in this 2017 Comprehensive Clackamas County NPDES MS4 Stormwater Monitoring Plan (Plan).

NPDES stormwater monitoring programs require two components. The first component is **program monitoring**, which involves the tracking and assessment of programmatic activities, as described in the individual permittees' stormwater management plans (SWMPs). The second component is **environmental monitoring**, which includes the actual collection and analysis of samples. The purpose of this 2017 Plan is to address the environmental monitoring component of the requirements.

Clackamas co-permittees initiated implementation of environmental monitoring programs in July 2012 to address requirements of the 2012 permit. Specific monitoring obligations (e.g., data collection requirements, coordinated pesticide monitoring study, mercury monitoring) under the 2012 permit have been completed. This 2017 Plan documents updates to monitoring activities based on outcomes from completed monitoring and includes the following elements referenced in Schedule B.2 of the 2012 permit:

- Identification of how the monitoring objectives are addressed
- Discussion of how the monitoring program is related to adaptive management and a long-term monitoring program strategy
- Documentation and recordkeeping procedures
- Documentation of monitoring sites, parameters, and sample collection frequency and methods
- Identification of the analytical methods
- Protocols for quality assurance and quality control (QA/QC)
- Discussion of data management, review, validation, and verification

Following this introductory Section 1, this 2017 Plan is organized into the following sections:

- Section 2. Objectives- Summarizes objectives of the 2017 Plan, specifically related to the six objectives listed in Schedule B of the 2012 permit
- Section 3. Development and Implementation of the Plan- Provides background information related to the development of the 2017 Plan
- Section 4. Data Gathering Strategies- Outlines various data gathering and data collection strategies and describes how collected data will be used in the adaptive management of the individual stormwater programs and in the development of a long-term monitoring program strategy
- Section 5. Monitoring Activities- Describes environmental monitoring activities including monitoring frequency and locations
- Section 6. Sampling Parameters, Analytical Methods, and Quality Assurance and Control- Provides a summary of sampling parameters, sampling procedures, and analytical methods including applicable QA/QC
- Section 7. Monitoring Data Management and Plan Modifications- Summarizes data analyses, interpretation, and management activities

Section 2 Objectives

Schedule B.1 of the 2012 permit lists six specific monitoring objectives to be addressed with the stormwater monitoring program. The six objectives are listed below:

1. *Evaluate the source(s) of the 2004/2006 303(d) listed pollutants applicable to the co-permittees' permit area;*
2. *Evaluate the effectiveness of Best Management Practices (BMPs) in order to help determine BMP implementation priorities;*
3. *Characterize stormwater based on land use type, seasonality, geography or other catchment characteristics;*
4. *Evaluate status and long-term trends in receiving waters associated with MS4 stormwater discharges;*
5. *Assess the chemical, biological, and physical effects of MS4 stormwater discharges on receiving waters; and,*
6. *Assess progress towards meeting total maximum daily load (TMDL) pollutant load reduction benchmarks.*

Each of the environmental monitoring activities listed in Section 5 below will be conducted in an attempt to answer specific questions to support the monitoring objectives listed above. These questions are listed for each monitoring activity. Descriptions of the monitoring activities also include a narrative describing how the monitoring objectives will be addressed.

Section 3 Development and Implementation of the Plan

Because of the wide range of variability in stormwater data, collecting and analyzing sufficient data to address environmental monitoring requirements and objectives requires significant resources in order to obtain statistically valid and robust data sets. The Oregon Department of Environmental Quality (DEQ) has acknowledged this issue and provided the following clause in the 2012 permit (Schedule B.4) to allow for a coordinated monitoring approach:

Environmental monitoring conducted to meet a permit condition in Table B-1 may be coordinated among co-permittees or conducted on behalf of a co-permittee by a third party. Each co-permittee is responsible for environmental monitoring in accordance with Schedule B requirements. The co-permittee may utilize data collected by another permittee, a third party, or in another co-permittee's jurisdiction to meet a permit condition in Table B-1 provided the co-permittee establishes an agreement prior to conducting coordinated environmental monitoring.

The original Plan was developed in 2006 by nine Clackamas County co-permittees and was implemented beginning in July 2007. In 2016, coverage was expanded to include two additional co-permittees, Oak Lodge Water Services District (OLWSD), formerly Oak Lodge Sanitary District, and the City of Wilsonville. This 2017 Plan reflects this expansion of coverage.

Development of a coordinated monitoring program stemmed from the need to address the monitoring objectives listed in the 2004 NPDES MS4 permit (2004 permit). Previously, jurisdictions were collecting samples based solely on locations and frequencies outlined in the permit without additional consideration of the new monitoring objectives. Given the limited individual monitoring efforts, smaller jurisdictions with less significant environmental monitoring requirements did not

have the resources to address the new monitoring objectives without substantial additional effort beyond the “maximum extent practicable” requirement.

The 2006 Plan was developed by reviewing and compiling each participating co-permittee’s existing monitoring efforts (through annual reports). Information compiled included monitoring locations, sample collection methods, sample collection frequencies, water bodies, TMDL/303(d) list status, and contributing land uses. Jurisdictions participated in a series of workshops to evaluate existing activities combined as a whole. Monitoring activities were then refined to (1) address the identified implementation gaps, (2) minimize duplication of monitoring efforts, and (3) ensure that data collected contained information that was sufficiently comprehensive to address the permit-required monitoring objectives. Key changes and features of the 2006 Plan included the following:

- Additional tracking and targeting of storm events during instream sample collection activities to better evaluate the impacts of stormwater runoff on receiving water quality
- Geographic distribution of instream monitoring locations to avoid “clustering of sites”
- Selection of instream monitoring locations based on “high-priority” tributaries, which were identified as those on the 303(d) list (water quality impaired), and/or those with significant development potential upstream
- Selection of stormwater monitoring locations to ensure representation of varying land use categories
- Changing instream and stormwater sample collection methods from grab sampling to use of a timed-composite sampling method in order to better represent changing runoff conditions throughout a storm event

Since 2006, the Plan has periodically been updated to reflect adjustments in monitoring locations, consistency with revisions to Table B-1 (per the 2012 permit), and inclusion of additional detail related to quality assurance procedures.

As mentioned above, for this 2017 Plan, two additional co-permittees (OLWSD and the City of Wilsonville) joined the coordinated monitoring program. Additionally, in June 2017, the co-permittees’ monitoring obligations under the 2012 permit will be met, prompting this update to the Plan.

This 2017 Plan, to be implemented beginning in July 2017, reflects completion of some select, one-time monitoring obligations under the 2012 permit and refinement of monitoring locations, parameters, and activities based on information collected over the last permit term. Key modifications include the following:

- Inclusion of OLWSD and City of Wilsonville instream, stormwater, and biologic monitoring activities
- Removal of mercury and pesticide monitoring activities, as those obligations have been met
- Removal of biochemical oxygen demand (BOD) and total volatile solids (for co-permittees outside of the Tualatin basin) from the analyte list, because of the limited usefulness of the collected data to date
- Adjustment of analytical methods and reporting limits based on consistency with Code of Federal Regulations (CFR) Title 40 and current laboratory capabilities
- Adjustment of monitoring locations to ensure geographic distribution of data and to continue to inform trends analyses
- Inclusion of routine instream sampling, in addition to targeted dry weather/wet weather instream sampling activities

- Removal of Clackamas County Service District #1's (CCSD #1's) geomorphic monitoring activities from the Plan, as physical conditions are evaluated during biologic (macroinvertebrate) monitoring activities
- Minor editorial updates to improve clarity and consistency with current practices

This 2017 Plan serves as an established agreement to conduct a coordinated monitoring effort. The current participating co-permittees include the cities of Gladstone, Milwaukie, Oregon City, Wilsonville, and West Linn; OLWSD; CCSD #1; and the Surface Water Management Agency of Clackamas County (SWMACC). Monitoring conducted by CCSD #1 and SWMACC is conducted on behalf of Clackamas County and the cities of Happy Valley and Rivergrove, and they are included as participants in this 2017 Plan as well.

Section 4 Data Gathering Strategies

As described in Section 3, development of the original (2006) Plan and subsequent iterations to the Plan have applied adaptive management principles in order to refine individual monitoring activities into a coordinated program and address monitoring objectives. This 2017 Plan reflects the results of these adaptive management efforts.

Three primary strategies are outlined in this 2017 Plan to obtain and review data and information necessary to address the six monitoring objectives of the 2012 permit. These strategies include the following:

1. *Collect water quality data and macroinvertebrate data to address the specified monitoring objectives:* Monitoring locations, frequencies, and parameters were reviewed by the co-permittees as providing beneficial information for the city/jurisdiction in order to address the current monitoring objectives. For some jurisdictions, this exercise resulted in a change (increase or decrease) in data points documented in Table B-1 of the 2012 permit. Selection of the monitoring locations, frequencies, and parameters reflects data that co-permittees have historically collected so that adequate data will be available to assess trends in the future.
2. Conduct literature reviews to track relevant technical information related to stormwater quality that is collected by others, yet representative of co-permittee activities: The scientific community, public agencies, and private organizations interested in stormwater management continue to conduct research related to stormwater characterization and treatment. This costly research is often beyond the means of any one co-permittee to conduct an equivalent type of study. Organizations such as the Oregon Association of Clean Water Agencies (ACWA), Bay Area Stormwater Management Association, Water Environment Research Foundation, state transportation departments, vendors of proprietary stormwater treatment systems, colleges and universities, and others continually conduct this type of research and examine complex stormwater-related issues. By participating in these groups and following current research, 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 plan to rely on information garnered by these organizations to address some of the more complex and costly objectives of the permit, especially with respect to understanding the effectiveness of BMPs.
3. Review and evaluate the monitoring results and other information (literature and stormwater management program tracking measures) collected by the co-permittees to support future decisions related to adaptive management and refinement of both the SWMP and environmental monitoring plan: The compilation of monitoring data during the annual reporting period and the permit renewal period will allow co-permittees to ensure that data are being collected as required and that the data are providing useful information to support adaptive management

goals. In conjunction with the monitoring objectives and adaptive management approach submitted to DEQ by the co-permittees in November 2012, the monitoring data can potentially provide rationale for co-permittees in making decisions related to the allocation of resources among stormwater management activities. Monitoring activities are then revised to better address needs. The intent of the stormwater monitoring program is to provide data to support conclusions related to implementation of the co-permittee's SWMPs (e.g., what are the trends) and NPDES MS4 permit requirements and to ensure that the data continue to provide value as questions are answered or new questions arise.

Section 5 Monitoring Activities

This section describes the coordinated environmental monitoring efforts for the participating Clackamas County co-permittees. This section is organized according to the following monitoring activities:

- Instream monitoring efforts (routine and targeted)
- Stormwater system monitoring efforts
- Biological monitoring efforts
- BMP effectiveness monitoring

The questions to be answered and objectives addressed by each monitoring activity are listed at the beginning of each subsection.

5.1 Instream Monitoring

Instream monitoring throughout the Clackamas MS4 permit area addresses objectives 2, 4 and 5 from Schedule B.1.a of the 2012 permit:

- 2. Evaluate the effectiveness of Best Management Practices (BMPs) in order to help determine BMP implementation priorities;*
- 4. Evaluate status and long-term trends in receiving waters associated with MS4 stormwater discharges; and*
- 5. Assess the chemical, biological, and physical effects of MS4 stormwater discharges on receiving waters.*

Instream monitoring activities will attempt to address the following questions:

- What is the ambient water quality status of the water body?
- What are the trends in water quality observed for the water body?
- How is stormwater runoff impacting receiving water quality?
- How does instream water quality change from an upstream location to a downstream location within an urbanized area?

The following sections describe the instream monitoring locations (Section 5.1.1), sample collection methods (Section 5.1.2), and additional instream sample collection efforts (Section 5.1.3).

5.1.1 Description of Instream Monitoring Locations

Instream monitoring efforts conducted by the participating Clackamas County co-permittees as part of this 2017 Plan include a total of 25 sampling locations representing 20 water bodies.

Instream monitoring site selection was conducted to prioritize locations with water quality impairment, meaning they have a TMDL in place or are 303(d)-listed for a specific parameter. Within the

Clackamas County area, the TMDL water bodies and effective and pending 303(d)-listed water bodies are listed in Table 1.

Table 1. Summary of Clackamas County TMDL and 303(d) Listed Streams															
Monitored water body	Bacteria	Temperature	Dissolved oxygen (DO)	Ammonia	Phosphorus	pH/chlorophyll a	Mercury	PCBs	TCE	PAHs	DDE/DDT	Pesticides (dieldrin, aldrin, endosulfan)	Arsenic	Thallium	Zinc
TMDLs															
Willamette River (and tributaries) (2006)	✓	✓					✓								
Johnson Creek (2006)	✓	✓					✓				✓	✓			
Tualatin River (1998/2001)	✓	✓	✓		✓	✓	✓								
2010 (effective) 303(d) list															
Johnson Creek								✓		✓					
Willamette River (Lower or Middle)						✓		✓		✓	✓	✓		✓	✓
Tualatin River/Fanno Creek			✓									✓		✓	✓
2012 (proposed) 303(d) list (additional parameters)															
Johnson Creek											✓	✓			
Abernethy Creek			✓												
Kellogg Creek			✓												
Fanno Creek			✓						✓				✓	✓	✓
Willamette River (lower or middle)			✓				✓							✓	✓
Tualatin River				✓			✓							✓	✓

DDE = dichlorodiphenyldichloroethylene

DDT = dichlorophenyltrichloroethane

PAH = polycyclic aromatic hydrocarbon

PCB = polychlorinated biphenyl

TCE = trichloroethylene

Instream monitoring site selection was also based on the length of record of historical data. Locations are primarily consistent with those included in the 2006 Plan and subsequent updates, to ensure a long enough period of record to inform future trends analyses. Finally, site selection was made to ensure geographic coverage of the participating co-permittees' MS4 permit areas.

Paired instream monitoring locations were selected when possible. Paired monitoring locations include one upstream location that represents more baseflow and/or rural conditions, generally located close to the co-permittee's MS4 permit area boundary, and one downstream location that

represents urban MS4 stormwater runoff and baseflow conditions generated inside of the co-permittee's MS4 permit boundary. Paired monitoring was selected to help identify the effects of urban development on receiving water quality.

Figure 1 identifies the instream monitoring locations and includes the specific water body, responsible jurisdiction, and type of sampling method employed (see Section 5.1.2). Table 2 summarizes the total number of locations and the total number of data points (product of monitoring location and frequency) collected by participating co-permittees each year.

Table 2. Summary of the Clackamas County Co-permittee Instream Monitoring Efforts		
Jurisdiction	Total number of monitoring locations	Data points/year
CCSD #1	8	72
SWMACC	1	9
Milwaukie	1	4
Oregon City	6	24
West Linn	3	15
Gladstone	1	3
OLWSD	3	12
Wilsonville	2	8
Total	25	147

5.1.2 Sample Collection Methods

Instream sample collection methods vary by jurisdiction and include either storm-targeted sample collection efforts or routine sample collection efforts. A description of both methods is provided below.

5.1.2.1 Targeted Sample Collection

The 2006 Plan's instream monitoring efforts were focused on collecting ambient water quality data during both dry weather and wet weather conditions. As instream water quality tends to vary during storm events, sample collection that is targeted during storm events and during dry weather conditions allows jurisdictions that conduct monitoring less frequently to assess water quality impacts associated with MS4 discharges. For this 2017 Plan, select jurisdictions (Milwaukie, West Linn, and OLWSD) opted to continue targeting storm events to meet their instream sampling requirements.

Grab samples will be collected instream during dry weather conditions. During storm events, multiple time-spaced grab samples will be collected throughout the storm event to provide a single time-composited sample. A composite sample collected during a storm event allows for capture of a larger portion of the storm hydrograph and better represents fluctuating pollutant concentrations. Rationale related to the use of a time-composite sampling approach was previously submitted to DEQ in 2012.

Instream sampling procedures applicable to this 2017 Plan are as follows:

1. Instream water quality samples will be collected during both dry and wet weather conditions, to support future trends analyses and evaluate differences in receiving water quality due to weather conditions and MS4 stormwater runoff. A select (varies by jurisdiction) number of samples will be collected during storm events (see Table 3).
2. Samples collected during a storm event will be collected as time-composited grab samples, which will require grab samples to be collected at a defined frequency and combined prior to analysis.
3. A minimum of 14 days shall be maintained between consecutive instream sampling events.

Table 3 outlines the storm-targeted instream monitoring locations, frequencies, and responsible jurisdiction. As shown in Table 3, a total of 31 individual samples are planned for collection via the storm-targeted instream sampling method per year, representing 7 water bodies. Approximately 17 of those samples are time-composited samples collected during storm events.

NOTE: The most resource-intensive element of water quality monitoring is sampling during storm events. Because of the difficulty in identifying suitable storms, the uncertainty associated with weather forecasts, and the need to mobilize in a timely manner to allow for characterizing the storm, storm-targeted sampling requires a significant time commitment. Staff conducting the sampling are typically assigned other responsibilities in addition to stormwater monitoring. To ensure that monitoring does not consume inordinate resources at the expense of activities that reduce pollution, the following limitations apply to the commitments made in this 2017 Plan related to storm event sample collection.

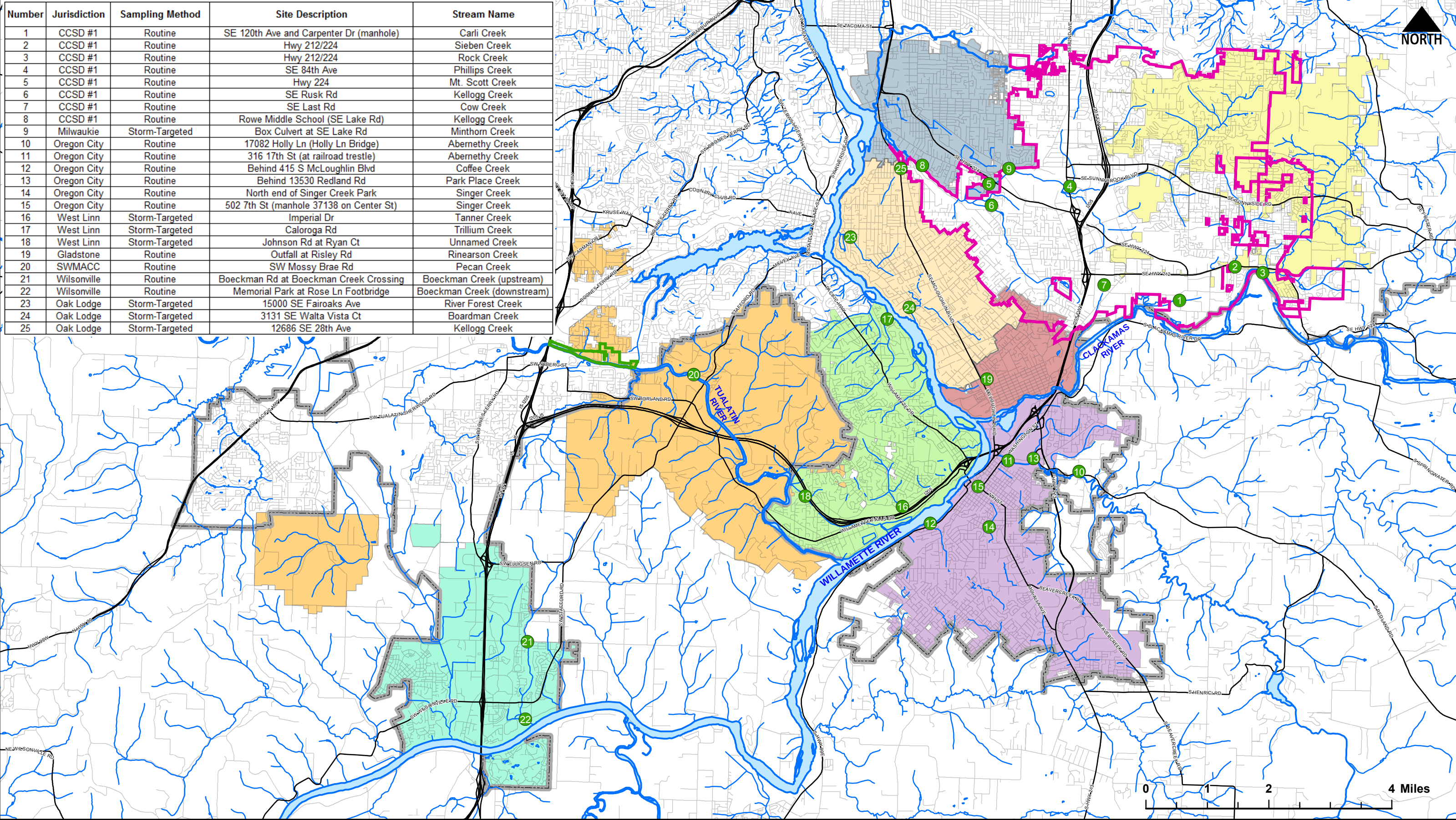
- Storms will not be sampled on major holidays including Thanksgiving Day, Christmas Eve, Christmas Day, New Year's Eve, New Year's Day, President's Day, Independence Day, Labor Day, Memorial Day, and Easter.
- Storm events shall be a minimum of 0.1 inch of rainfall and of a size for which, once a crew is mobilized, runoff is anticipated to occur for a minimum of 2 hours.
- For time-composite sample collection, the duration of time between the collection of individual grab samples will vary as necessary to meet the goal of obtaining at least three grab samples per storm event (these three grab samples will then be combined into one composited sample for analyses). In some cases, a storm may not last long enough to collect three individual grab samples. In these cases, the samples that are collected will be composited and analyzed; no minimum number of samples is specified.

Table 3. Targeted Instream Monitoring Site Summary

Monitored water body	Responsible party	Number of locations	Sampling frequency	Parameters monitored (field/lab) ^a	Storm events targeted
Minthorn Creek	Milwaukie	1	4/year	Field and lab	Y (2 of 4)
Summerlinn Creek	West Linn	1	5/year	Field and lab	Y (3 of 5)
Tanner Creek	West Linn	1	5/year	Field and lab	Y (3 of 5)
Trillium Creek	West Linn	1	5/year	Field and lab	Y (3 of 5)
River Forest Creek	OLWSD	1	4/year	Field and lab	Y (2 of 4)
Boardman Creek	OLWSD	1	4/year	Field and lab	Y (2 of 4)
Kellogg Creek	OLWSD	1	4/year	Field and lab	Y (2 of 4)

a. The term "field" indicates samples that are analyzed using meters in the field—typically for temperature, conductivity, DO, and pH.

Number	Jurisdiction	Sampling Method	Site Description	Stream Name
1	CCSD #1	Routine	SE 120th Ave and Carpenter Dr (manhole)	Carli Creek
2	CCSD #1	Routine	Hwy 212/224	Sieben Creek
3	CCSD #1	Routine	Hwy 212/224	Rock Creek
4	CCSD #1	Routine	SE 84th Ave	Phillips Creek
5	CCSD #1	Routine	Hwy 224	Mt. Scott Creek
6	CCSD #1	Routine	SE Rusk Rd	Kellogg Creek
7	CCSD #1	Routine	SE Last Rd	Cow Creek
8	CCSD #1	Routine	Rowe Middle School (SE Lake Rd)	Kellogg Creek
9	Milwaukie	Storm-Targeted	Box Culvert at SE Lake Rd	Minthorn Creek
10	Oregon City	Routine	17082 Holly Ln (Holly Ln Bridge)	Abernethy Creek
11	Oregon City	Routine	316 17th St (at railroad trestle)	Abernethy Creek
12	Oregon City	Routine	Behind 415 S McLoughlin Blvd	Coffee Creek
13	Oregon City	Routine	Behind 13530 Redland Rd	Park Place Creek
14	Oregon City	Routine	North end of Singer Creek Park	Singer Creek
15	Oregon City	Routine	502 7th St (manhole 37138 on Center St)	Singer Creek
16	West Linn	Storm-Targeted	Imperial Dr	Tanner Creek
17	West Linn	Storm-Targeted	Caloroga Rd	Trillium Creek
18	West Linn	Storm-Targeted	Johnson Rd at Ryan Ct	Unnamed Creek
19	Gladstone	Routine	Outfall at Risley Rd	Rinearson Creek
20	SWMACC	Routine	SW Mossy Brae Rd	Pecan Creek
21	Wilsonville	Routine	Boeckman Rd at Boeckman Creek Crossing	Boeckman Creek (upstream)
22	Wilsonville	Routine	Memorial Park at Rose Ln Footbridge	Boeckman Creek (downstream)
23	Oak Lodge	Storm-Targeted	15000 SE Fairoaks Ave	River Forest Creek
24	Oak Lodge	Storm-Targeted	3131 SE Walta Vista Ct	Boardman Creek
25	Oak Lodge	Storm-Targeted	12686 SE 28th Ave	Kellogg Creek



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FIGURE 1. INSTREAM MONITORING LOCATIONS

CCSD #1, SWMACC, Happy Valley, Rivergrove, Gladstone, Milwaukie, Oak Lodge, Oregon City, West Linn, and Wilsonville

● Instream Monitoring Locations

▭ Urban Growth Boundary

▭ Oak Lodge Sanitary District

▭ CCSD #1

▭ Rivergrove

▭ SWMACC

▭ Gladstone

▭ Happy Valley

▭ Milwaukie

▭ Oregon City

▭ West Linn

▭ Wilsonville

5.1.2.2 Routine Sample Collection Methods

Routine instream monitoring efforts are focused on collecting ambient water quality data year round during both dry weather and wet weather seasons in accordance with a predetermined schedule.

For this 2017 Plan update, select jurisdictions (Wilsonville, Oregon City, Gladstone, SWMACC, and CCSD #1) opted to conduct routine instream monitoring instead of specifically targeting dry weather events and storm events to meet their instream sampling requirements. Routine sampling provides a more unbiased and comprehensive picture of ambient water quality conditions. Routine sampling requires prescheduling of sampling activities, reflective of consistent timing and frequency over the monitoring year. When prescheduled, samples will presumably be collected during both dry weather and wet weather conditions to allow for assessment of water quality impacts associated with MS4 discharges.

As with the storm-targeted instream sampling method, grab samples will be collected instream during dry weather conditions. During storm events, multiple time-spaced grab samples will be collected throughout the storm event to provide a single time-composited sample.

Instream sampling procedures applicable to this 2017 Plan are as follows:

1. Prior to the start of the monitoring year, the co-permittee shall establish an instream sampling schedule, based on frequencies shown in Table 4. Deviation from the predetermined schedule during the monitoring year is to be avoided to the extent possible.
2. Instream water quality samples will be scheduled and collected during both the dry and wet weather seasons. A minimum of 50 percent of the samples will be collected during the wet weather season (October 1 to April 30).
3. If it is raining on a prescheduled sampling day, samples shall be collected as time-composited grab samples, which will require grab samples to be collected at a defined frequency and then combined prior to analysis. Detail related to the time-composite sample collection procedures is provided in Section 5.1.2.1.
4. A minimum of 14 days shall be maintained between consecutive instream sampling events.

Table 4, below, outlines the routine instream monitoring locations, frequencies, and responsible jurisdiction. As shown in Table 4, a total of 116 individual samples are planned for collection via the routine instream sampling method per year, representing 18 locations across 14 water bodies.

Table 4. Routine Instream Monitoring Site Summary

Monitored water body	Responsible party	Number of locations ^a	Sampling frequency	Parameters monitored (field/lab) ^b
Carli Creek	CCSD #1	1	9/year	Field and lab
Cow Creek	CCSD #1	1	9/year	Field and lab
Kellogg Creek	CCSD #1	2	9/year	Field and lab
Mt Scott Creek	CCSD #1	1	9/year	Field and lab
Phillips Creek	CCSD #1	1	9/year	Field and lab
Rock Creek	CCSD #1	1	9/year	Field and lab
Sieben Creek	CCSD #1	1	9/year	Field and lab
Abernethy Creek	Oregon City	2	4/year	Field and lab
Coffee Creek	Oregon City	1	4/year	Field and lab
Park Place Creek	Oregon City	1	4/year	Field and lab
Singer Creek	Oregon City	2	4/year	Field and lab
Pecan Creek	SWMACC	1	9/year	Field and lab
Rinearson Creek	Gladstone	1	3/year	Field and lab
Boeckman Creek	Wilsonville	2	4/year	Field and lab

a. Two locations on the same monitored water body reflects paired sampling sites.

b. The term "field" indicates samples that are analyzed using meters in the field—typically for temperature, conductivity, DO, and pH.

5.1.3 Additional Instream Monitoring Efforts

Since 1998, the City of Milwaukie and Clackamas County Water Environment Services (WES) have participated in a cooperative Johnson Creek watershed study with the U.S. Geological Survey (USGS) and other partners (Gresham, Portland, etc.). The project objectives included the following:

- Assess hydrologic hazards: Analysis of real-time flow and water surface elevations will allow for assessment of flooding conditions as a result of ongoing, significant changes in land use and groundwater discharges.
- Assess water quality: Analysis of stream temperature and turbidity data will provide insight into the effects of land use practices and pollutant sources.
- Assess the interaction between surface water and groundwater: The study provides data and analyses that relate directly to the inter-related nature of the surface and groundwater systems.

As part of this ongoing project, multiple technical reports and publications have been developed. Publications are available for public use and include topics such as: (1) pesticide contributions and transport, (2) overall system hydrology, and (3) suspended sediment loading and the relationship to turbidity levels.

In 2014, the City of Milwaukie and WES (on behalf of CCSD #1) agreed to extend participation in the study through September 2019. Joint Funding Agreements (JFAs) are prepared annually for each partner in order to provide funds to USGS (in part) to operate and monitor continuous flow gauges on Johnson Creek. This monitoring effort directly supports monitoring objective 4 and helps to assess ambient conditions in Johnson Creek. Because of the variable nature of the funding of this study and because future participation is unknown, this effort is referenced separately as an additional instream monitoring activity.

5.2 Stormwater System Monitoring Efforts

Stormwater monitoring throughout the Clackamas County MS4 permit area addresses objectives 1, 2, 3, 5, and 6 from Schedule B.1.a of the 2012 permit:

1. *Evaluate the source(s) of the 2004/2006 303(d) listed pollutants applicable to the co-permittees' permit area;*
2. *Evaluate the effectiveness of Best Management Practices (BMPs) in order to help determine BMP implementation priorities;*
3. *Characterize stormwater based on land use type, seasonality, geography or other catchment characteristics;*
5. *Assess the chemical, biological, and physical effects of MS4 stormwater discharges on receiving waters; and*
6. *Assess progress towards meeting TMDL pollutant load reduction benchmarks.*

Stormwater (outfall) monitoring activities will attempt to address the following questions:

- Are stormwater-related sources of 303(d) pollutants discharging to receiving waters?
- How do stormwater pollutant concentrations vary based on land use?
- How do stormwater pollutant concentrations vary based on BMP implementation upstream?
- Are pollutant loads from stormwater being reduced over time?

The following sections describe outfall monitoring locations (Section 5.2.1) and sample collection methods (Section 5.2.2).

5.2.1 Description of Stormwater Monitoring Locations

Stormwater monitoring efforts conducted by the participating Clackamas County co-permittees as part of this 2017 Plan represent a total of 11 sampling locations and five land use categories. As with the instream monitoring locations, stormwater outfall monitoring locations were originally selected as part of the 2006 Plan development and have been continually refined based on site accessibility and safety.

In 2006, stormwater monitoring locations were originally selected based on the distribution and consistency of the upstream land use type or category (i.e., residential, commercial, industrial, and mixed use). Classification of stormwater quality by land use allows for estimation and evaluation of the sources of specific pollutants. Additionally, the classification of stormwater quality based on land use can be used for pollutant load modeling efforts, and the identification and application of specific BMPs to address specific pollutant loading from a particular land use. Monitoring locations were also selected based on whether non-stormwater flow (e.g., baseflow from groundwater) was present. Samples collected during a storm event from locations with significant baseflow would not be entirely representative of MS4 discharges. Therefore, sites with baseflow were avoided.

Figure 2 identifies the selected stormwater monitoring locations and includes the associated receiving water, upstream contributing land use, and sampling frequency. Table 5, below, summarizes the total number of locations and total number of data points (product of monitoring location and frequency) collected by participating co-permittees each year.

Table 5. Summary of the Clackamas County Co-permittee Stormwater Monitoring Efforts

Upstream land use	Number of outfalls monitored	Total number of samples collected per year
Residential	4	12
Multifamily residential	1	3
Commercial	2	6
Mixed use	3	9
Industrial	1	3
Total	11	33

5.2.2 Sample Collection Methods

Stormwater monitoring efforts are focused on capturing storm-specific data from select outfall locations representing drainage from various land use categories. In conjunction with the monitoring objectives, collection of stormwater samples allows for the identification of pollutant sources, characterization of stormwater (based on land use), and indication of the effects that stormwater runoff may have on instream water quality when compared with instream water quality data.

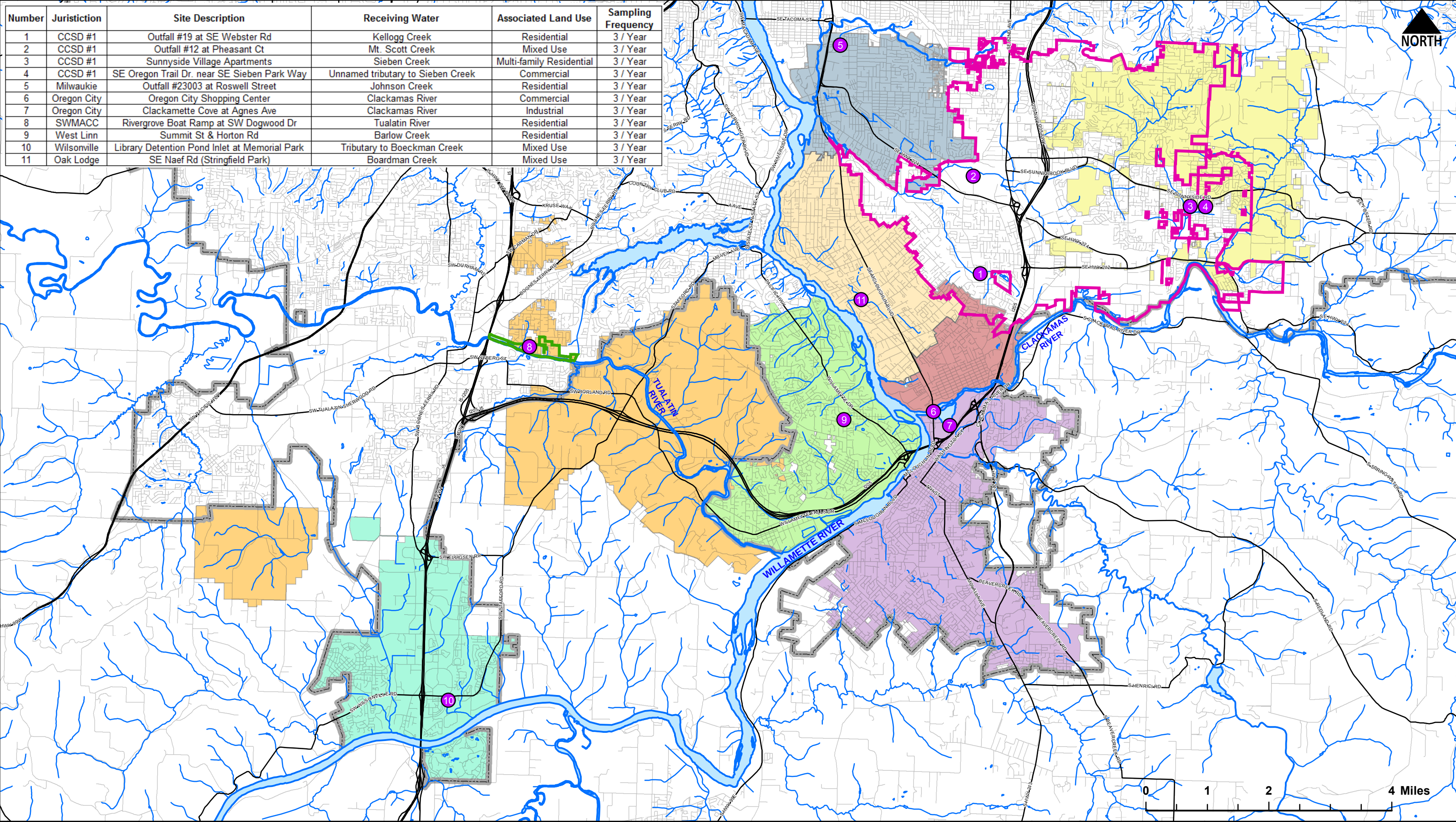
Samples will be collected as time-composite grab samples. Given the number of stormwater monitoring sites and the geographic coverage of sites, a time-composite sampling method is preferred for participants in the Comprehensive Clackamas County Monitoring Program as opposed to flow composite sampling. Composited samples (either time- or flow-composited samples) collected during storm events allow for capture of a larger portion of the storm hydrograph. As fluctuations of pollutant concentrations vary throughout a storm event, use of composite sampling techniques will better represent those variations during storm events.

Stormwater sampling procedures are as follows:

1. Qualifying stormwater monitoring events must be associated with a storm event resulting in greater than 0.1 inch of rainfall.
2. As possible, qualifying stormwater monitoring events shall occur after a minimum 24-hour antecedent dry period.
3. Stormwater samples will be collected during three storm events per year per location.
4. For each sampling event, a minimum of three time-spaced grab samples will be collected throughout the storm event. As possible, based on the number and location of stormwater monitoring sites, sample collection will be initiated toward the beginning of the storm event and individual grab samples will be collected throughout the storm event, but no more frequently than one sample per 30 minutes.
5. The time-spaced grab samples collected will be combined into a single time-composited sample in accordance with the field collection methods outlined in Appendix A.

The discussion in Section 5.1.2.1 regarding limitations on the commitments for storm event sampling for instream monitoring efforts is also applicable to stormwater monitoring efforts.

For each monitored storm event, the contributing storm event rainfall depth will be estimated based on local rainfall gauge records. In lieu of storm event rainfall depth estimates, the flow rate in the pipe may be estimated. Flow rate may be estimated using the average depth of flow measurement taken in the pipe (or outfall) during sample collection activities, the pipe (or outfall) slope and diameter, and Manning's equation.



Number	Jurisdiction	Site Description	Receiving Water	Associated Land Use	Sampling Frequency
1	CCSD #1	Outfall #19 at SE Webster Rd	Kellogg Creek	Residential	3 / Year
2	CCSD #1	Outfall #12 at Pheasant Ct	Mt. Scott Creek	Mixed Use	3 / Year
3	CCSD #1	Sunnyside Village Apartments	Sieben Creek	Multi-family Residential	3 / Year
4	CCSD #1	SE Oregon Trail Dr. near SE Sieben Park Way	Unnamed tributary to Sieben Creek	Commercial	3 / Year
5	Milwaukie	Outfall #23003 at Roswell Street	Johnson Creek	Residential	3 / Year
6	Oregon City	Oregon City Shopping Center	Clackamas River	Commercial	3 / Year
7	Oregon City	Clackamette Cove at Agnes Ave	Clackamas River	Industrial	3 / Year
8	SWMACC	Rivergrove Boat Ramp at SW Dogwood Dr	Tualatin River	Residential	3 / Year
9	West Linn	Summit St & Horton Rd	Barlow Creek	Residential	3 / Year
10	Wilsonville	Library Detention Pond Inlet at Memorial Park	Tributary to Boeckman Creek	Mixed Use	3 / Year
11	Oak Lodge	SE Naef Rd (Stringfield Park)	Boardman Creek	Mixed Use	3 / Year



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FIGURE 2. OUTFALL MONITORING LOCATIONS

CCSD #1, SWMACC, Happy Valley, Rivergrove, Gladstone, Milwaukie, Oak Lodge, Oregon City, West Linn, and Wilsonville

Outfall Monitoring Locations
 CCSD #1
 Gladstone
 Oregon City

Urban Growth Boundary
 Rivergrove
 Happy Valley
 West Linn

Oak Lodge Sanitary District
 SWMACC
 Milwaukie
 Wilsonville

Each stormwater monitoring location is listed in Table 6, along with a reference regarding the sampling frequency and parameters monitored.

Table 6. Stormwater System Monitoring Site Summary					
Upstream land use	Outfall description	Receiving water	Responsible party	Sampling frequency	Parameters monitored (field/lab)
Residential	Outfall 19: SE Webster Road	Kellogg Creek	CCSD #1	3/year	Field and lab
Residential	Rivergrove Boat Ramp at SW Dogwood Drive	Tualatin River	SWMACC	3/year	Field and lab
Residential	Outfall 23003 at Roswell Street	Johnson Creek	Milwaukie	3/year	Field and lab
Residential	Summit Street and Horton Road	Barlow Creek	West Linn	3/year	Field and lab
Multifamily residential	Sunnyside Village Apartments	Sieben Creek	CCSD #1	3/year	Field and lab
Mixed use (industrial, highway, commercial, residential)	Outfall 12: SE Pheasant Court	Mt. Scott Creek	CCSD #1	3/year	Field and lab
Mixed use (park, school, commercial, residential)	Inlet to Library Detention Pond at Memorial Park	Unnamed tributary to Boeckman Creek	Wilsonville	3/year	Field and lab
Mixed use (park, highway, commercial, residential)	SE Naef Road at Stringfield Park	Boardman Creek	OLWSD	3/year	Field and lab
Commercial	SE Oregon Trail Drive near SE Sieben Park Way	Unnamed tributary to Sieben Creek	CCSD #1	3/year	Field and lab
Commercial	Oregon City Shopping Center	Clackamas River	Oregon City	3/year	Field and lab
Industrial	Clackamette Cove at Agnes Avenue	Clackamas River	Oregon City	3/year	Field and lab

5.3 Biological Monitoring Efforts

Biological monitoring throughout the Clackamas County MS4 permit area addresses objective 5 from Schedule B.1.a of the 2012 permit:

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

Biological monitoring activities will attempt to address the following questions:

- What are the biologic conditions of receiving waters?
- Based on past macroinvertebrate sampling activities, are there noticeable trends of improvement or impairment in receiving waters?

The following sections describe the macroinvertebrate monitoring site locations (Section 5.3.1), sample collection methods (Section 5.3.2), and connection to physical condition monitoring (Section 5.3.3).

5.3.1 Description of Biological Monitoring Locations

Biological monitoring efforts conducted by the participating Clackamas County co-permittees as part of this 2017 Plan include a total of 21 sampling locations representing 17 water bodies.

Biological monitoring sites reflect locations where biologic and water quality sampling has historically been conducted. In some cases, the locations are consistent with previous pesticide monitoring activities and/or ongoing instream water quality monitoring. Conclusions and recommendations from previous biological monitoring efforts related to site conditions and site adjustments were considered for this 2017 Plan.

For CCSD #1 and SWMACC, biological monitoring locations reflect the Clackamas County Water Environmental Services (WES) clustered monitoring approach and locations of detailed, in-stream physical condition assessments, not directly included in this 2017 Plan. WES's clustered monitoring approach is internal to CCSD #1 and SWMACC and is intended to allow for a more comprehensive assessment of watershed conditions at specific sites.

The biological monitoring locations are described in Table 7 and shown graphically in Figure 3.

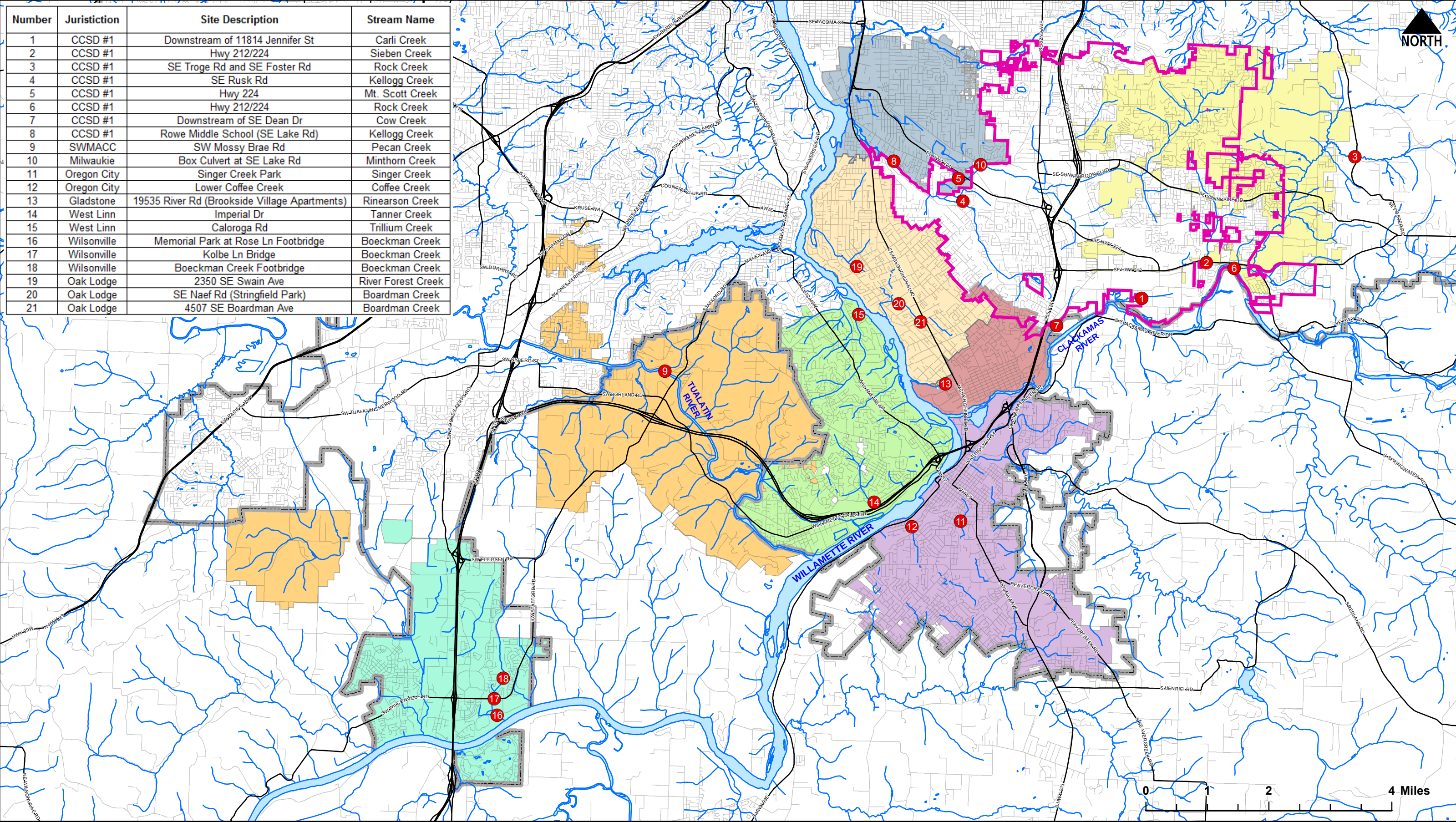
Table 7. Biologic Monitoring Site Summary

Jurisdiction	Target monitoring date	Site description	Receiving water	Past biologic monitoring efforts?	Existing instream water quality monitoring location?
CCSD #1	2018	Rowe Middle School (SE Lake Road)	Kellogg Creek	Y (2009, 2011, 2015)	Y
CCSD #1	2018	Downstream of 11814 Jennifer Street	Carli Creek	Y (2007, 2009, 2011, 2015)	Y ^a
CCSD #1	2018	Highway 212/224, near SE 135th	Sieben Creek	Y (2007, 2009, 2011, 2015)	Y
CCSD #1	2018	SE Troge Road and SE Foster Road	Rock Creek	Y (2007, 2009, 2011, 2015)	N
CCSD #1	2018	SE Rusk Road	Kellogg Creek	Y (2007, 2009, 2011, 2015)	Y
CCSD #1	2018	Highway 224	Mt. Scott Creek	Y (2007, 2009, 2011, 2015)	Y ^b
CCSD #1	2018	Highway 212/224, near SE 142nd Avenue, upstream of confluence with Trillium Creek	Rock Creek	Y (2007, 2009, 2011, 2015)	Y
CCSD #1	2018	Downstream of SE Dean Drive	Cow Creek	Y (2007, 2009, 2011, 2015)	N
SWMACC	2018	SW Mossy Brae Road	Pecan Creek	Y (2007, 2009, 2011, 2015)	Y
Gladstone	2018	River Road (Brookside Village Apartments)	Rinearson Creek	N ^c	N
Milwaukie	2018	SE Lake Road	Minthorn Creek	Y (2013)	Y
Oregon City	2018	Singer Creek Park	Singer Creek	Y (2013)	Y
Oregon City	2018	Lower Coffee Creek	Coffee Creek	Y (2013)	Y
West Linn	2018	Imperial Drive	Tanner Creek	Y (2013)	Y
West Linn	2018	Caloroga Road	Trillium Creek	Y (2013)	Y
Wilsonville	2018	Memorial Park at Rose Lane footbridge	Boeckman Creek	Y (2013)	Y
Wilsonville	2018	Kolbe Lane Bridge	Boeckman Creek	Y (2004, 2013)	N
Wilsonville	2018	Boeckman Creek footbridge	Boeckman Creek	Y (2004, 2013)	N
OLWSD	2018	2350 SE Swain Avenue	River Forest Creek	Y (2013)	N
OLWSD	2018	SE Naef Road at Stringfield Park	Boardman Creek	Y (2013)	N
OLWSD	2018	4507 SE Boardman Avenue	Boardman Creek	Y (2013)	N

a. The Carli Creek biologic monitoring location corresponds to the CCSD #1 instream monitoring location at SE 120th Avenue and Carpenter Drive. This biologic monitoring site description is consistent with the historical biologic monitoring reports.

b. The Mt. Scott Creek biologic monitoring location corresponds to the historical CCSD #1 instream and biologic monitoring location at North Clackamas Park. The past biologic monitoring efforts refer to the North Clackamas Park location. The instream and biologic monitoring site was relocated to Highway 224 for the 2013–14 monitoring year.

c. This site was relocated from the Risley Road instream monitoring location based on recommendations following Gladstone's 2013 biological monitoring effort.



Number	Jurisdiction	Site Description	Stream Name
1	CCSD #1	Downstream of 11814 Jennifer St	Carli Creek
2	CCSD #1	Hwy 212/224	Sieben Creek
3	CCSD #1	SE Troge Rd and SE Foster Rd	Rock Creek
4	CCSD #1	SE Rusk Rd	Kellogg Creek
5	CCSD #1	Hwy 224	Mt. Scott Creek
6	CCSD #1	Hwy 212/224	Rock Creek
7	CCSD #1	Downstream of SE Dean Dr	Cow Creek
8	CCSD #1	Rowe Middle School (SE Lake Rd)	Kellogg Creek
9	SWMACC	SW Mossy Brae Rd	Pecan Creek
10	Milwaukie	Box Culvert at SE Lake Rd	Minthorn Creek
11	Oregon City	Singer Creek Park	Singer Creek
12	Oregon City	Lower Coffee Creek	Coffee Creek
13	Gladstone	19535 River Rd (Brookside Village Apartments)	Rinearson Creek
14	West Linn	Imperial Dr	Tanner Creek
15	West Linn	Caloroga Rd	Trillium Creek
16	Wilsonville	Memorial Park at Rose Ln Footbridge	Boeckman Creek
17	Wilsonville	Kolbe Ln Bridge	Boeckman Creek
18	Wilsonville	Boeckman Creek Footbridge	Boeckman Creek
19	Oak Lodge	2350 SE Swain Ave	River Forest Creek
20	Oak Lodge	SE Naef Rd (Stringfield Park)	Boardman Creek
21	Oak Lodge	4507 SE Boardman Ave	Boardman Creek



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FIGURE 3. MACROINVERTEBRATE MONITORING LOCATIONS
 CCSD #1, SWMACC, Happy Valley, Rivergrove, Gladstone, Milwaukie, Oak Lodge, Oregon City, West Linn, and Wilsonville

● Macroinvertebrate Monitoring Sites

▭ Urban Growth Boundary

▭ Oak Lodge Sanitary District

▭ CCSD #1

▭ Rivergrove

▭ SWMACC

▭ Gladstone

▭ Happy Valley

▭ Milwaukie

▭ Oregon City

▭ West Linn

▭ Wilsonville

5.3.2 Sample Collection Methods

Biological monitoring efforts will be conducted by each participating co-permittee a minimum of once over the next 5 years (i.e., July 2017 through July 2022). Efforts include macroinvertebrate sampling and associated physical habitat, riparian assessment, and water chemistry sampling that accompanies the sample collection. Historically, the co-permittees have used a contractor to conduct the sampling and prepare the documentation in a separate report.

Sampling efforts are typically targeted for summer or early fall, low-flow conditions.

Sample collection processes and methods summarized below are consistent with methods previously employed. Detailed documentation of methods can be referenced in the *Clackamas County NPDES MS4 2013 Coordinated Macroinvertebrate Assessment* (February 2014), prepared by Cole Ecological, Inc. on behalf of the cities of Gladstone, Lake Oswego, Milwaukie, Oregon City, West Linn, and Wilsonville. At the time of sampling, sampling methods may be slightly adjusted to conform to new technologies. Such changes will be documented in a final assessment report at the conclusion of the monitoring event.

Macroinvertebrate community sampling will be conducted using the *Benthic Macroinvertebrate Sampling Protocol for Wadeable Rivers and Streams* (DEQ 2003). Samples are sorted and identified to the level of taxonomic resolution recommended for Level 3 macroinvertebrate assessments. Level 3 protocols include duplicate composite sampling for quality assurance. Both glide and riffle samples are assessed using a multi-metric analysis and using a predictive model.

Water temperature, dissolved oxygen (DO), and specific conductivity will be measured at each site. Standard operating procedures (SOPs) and calibration procedures will be provided to participating co-permittees by the contractor prior to field sampling efforts.

5.3.3 Connection to Physical Condition Monitoring

With urbanization and increased development along the stream corridor, the timing and magnitude of discharge to stream channels often results in changes to the geomorphic character of the channel. This physical change to the stream channel can be observed through changes to stream channel width and depth and changes to the riparian vegetation.

During macroinvertebrate community sampling activities, habitat surveys and riparian assessments are conducted to inform the presence or lack of macroinvertebrates. Habitat surveys and riparian assessments are a type of physical condition monitoring that also help to locate areas of erosion, incision, and migration, and other changes to the stream corridor.

The physical conditions of the stream corridor are assessed using the modified Rapid Assessment Technique (RSAT), which includes data collection from channel habitat units (a sample reach equal to 20 times the wetted width or 75 meters, whichever is greater), channel cross sections, and the adjacent riparian zone. Habitat surveys are conducted to measure or visually estimate the number, length, gradient, and depth of pools and riffles instream; the percent of eroding or downcutting banks; woody debris characteristics; and substrate characteristics. Riparian assessment efforts include identification of riparian plant community type and percent vegetative cover present in the riparian area.

5.4 BMP Monitoring Efforts

Monitoring to analyze the effectiveness of BMPs is conducted to address monitoring objective 2 from Schedule B.1.a of the 2012 permit:

2. *Evaluate the effectiveness of BMPs in order to help determine BMP implementation priorities; and,*
6. *Assess progress towards meeting TMDL pollutant load reduction benchmarks.*

BMP monitoring activities will attempt to address the following questions:

- What are the relative pollutant removal capabilities of BMPs being used/implemented in the jurisdiction?
- Has implementation of programmatic BMPs provided information to validate whether stormwater quality improvement is being made, based on defined schedules, and frequencies in the SWMP?

BMP is a broad term that can be used to describe structural water quality facilities and source control/programmatic activities (as reported in the co-permittees' SWMPs). Both are implemented to achieve a net water quality benefit. The monitoring of a structural BMP facility (e.g., detention and retention ponds, swales, constructed wetlands, proprietary systems) would represent an environmental monitoring effort, while monitoring (tracking) of source control/ programmatic activities (erosion and sediment control, stormwater conveyance system cleaning and maintenance, industrial and business inspection programs, and public education and outreach) would represent a program monitoring effort.

This 2017 Plan focuses on environmental monitoring efforts. However, program monitoring is referenced because it also addresses objective 2 from Schedule B.1.a of the 2012 permit. Additionally, the evaluation of stormwater monitoring data, when combined with programmatic monitoring information, may help to quantify the water quality benefit of BMPs.

BMP monitoring also helps indirectly to address monitoring objective 6: *Assess progress towards meeting applicable pollutant load reduction benchmarks*. BMP effectiveness data are used in pollutant load modeling and the development of pollutant load reduction estimates in order to meet requirements for TMDL compliance. Evaluating BMP effectiveness allows for refinement of these effectiveness values used in the model and allows for the pollutant load modeling to reflect current conditions more accurately.

The following sections describe BMP monitoring efforts pertaining to environmental monitoring (Section 5.4.1) and program monitoring (Section 5.4.2).

5.4.1 BMP Monitoring (Environmental)

Limited environmental monitoring is currently being conducted by Clackamas County co-permittees associated with the performance of structural or source control BMPs. Structural BMP monitoring can be a very time- and cost-intensive activity, while the results apply only to the specific characteristics of the sampled BMP. Sampling of stormwater for purposes of evaluating source control activities often provides inconclusive results because of the variability of stormwater runoff, pollutant sources, and implementation efforts.

As stormwater management and stormwater treatment are continually changing and evolving fields, extensive literature regarding the monitoring of various treatment technologies and practices (structural and source control BMPs) is being generated by researchers, public entities, and private companies to meet both regulatory and non-regulatory needs. Clackamas co-permittees collect effectiveness information and cost information for various BMPs in conjunction with implementation of their stormwater programs. When made available from local, regional, and national sources, Clackamas County co-permittees obtain information that aids their individual stormwater management efforts and influences future decision making regarding appropriate levels of treatment technology to require for new development and redevelopment. Review

and application of these findings provides a more cost-effective means of addressing monitoring objective 2.

A number of Clackamas County co-permittees are actively involved in ACWA, which provides an open forum for stormwater management discussions and provides additional educational opportunities for local officials regarding stormwater quality and treatment. Participation in ACWA will continue to support literature tracking efforts.

Finally, the City of Milwaukie will begin monitoring a large, structural BMP that serves as a regional water quality facility. Objectives of the monitoring include evaluation of the performance of the system (from a water quality perspective) and potential refinement of the BMP effluent concentrations used to evaluate pollutant load reduction of the facility in order to establish TMDL benchmarks. Table 8 summarizes the structural BMP to be evaluated, the proposed sampling frequency, and the parameters to be evaluated.

Table 8. Structural BMP Monitoring Site Summary				
Responsible party	Structural BMP description	Receiving water	Sampling frequency	Parameters monitored (field/lab)
Milwaukie	Roswell detention facility	Johnson Creek	1/year	Field and lab

5.4.2 BMP Monitoring (Programmatic)

Clackamas County co-permittees currently conduct a variety of program monitoring efforts, generally related to implementation of their SWMPs. Qualitative information is currently collected in the form of tracking measures. These tracking measures provide valuable information to assist in the assessment of BMPs. Examples of BMP categories that are assessed for effectiveness through the use of tracking measures include the following:

- Illicit discharge detection and elimination (e.g., have the number of illicit discharge incidents decreased?)
- Public education (e.g., based on survey information, is there increased public awareness related to the jurisdiction's stormwater program and overall stormwater management?)
- Maintenance of structural controls (e.g., based on inspection records, is maintenance being performed more regularly? Are facilities operating more consistently?)

Specific tracking measures for these BMP categories are described in each of the co-permittees' SWMPs and are reported on with annual reports.

Quantitative effectiveness data for the programmatic elements outlined in the SWMP are currently not collected, but efforts to look at the effectiveness of these source control activities may occur as discussed above under Section 5.4.1.

Section 6 Sampling Parameters, Analytical Methods, and Quality Assurance and Quality Control

This section includes a summary of sampling parameters and analytical methods (Section 6.1) and a summary of QA/QC procedures (Section 6.2).

6.1 Sampling Parameters and Analytical Methods

The purpose of both instream and stormwater outfall monitoring efforts is to assess the degree to which ambient water quality is impacted by stormwater runoff. Therefore, consistent pollutant parameters are monitored for both instream and outfall (stormwater) sampling locations.

Pollutant parameters for this 2017 Plan are based on Table B-1 of the 2012 permit and are listed below in Table 9. A suggested analytical method is also identified in Table 9; however, use of an alternative, U.S. Environmental Protection Agency (EPA)-approved method listed in the most recent publication of 40 CFR 136 is permissible. The suggested analytical methods documented in Table 9 include both EPA and Standard Methods and (SM) are consistent with provisions of 40 CFR 136.

Table 9. Pollutant Parameters and Analytical Methods

Type (field or lab)	Analyte	Sample type (grab or time-spaced composite)	Unit	Suggested analytical method	Target MDL	Notes
Field	Specific conductivity	Grab	µmhos/cm	SM 2510 B	1	Method assumes use of probe
Field	pH	Grab	Standard units	SM 4500-H B	0.1	Method assumes use of probe
Field	Temperature	Grab	°C	SM 2550-B	0.1	Method assumes use of probe
Field	DO	Grab	mg/L	EPA 360.1	0.1	Method assumes use of probe
Lab	Copper, total	Composite	µg/L	EPA 200.8	0.1	
Lab	Copper, dissolved	Composite	µg/L	EPA 200.8	0.1	
Lab	DO ^a	Grab	mg/L	SM 4500-C	0.02	Conducted to ver- ify field reading
Lab	<i>E. coli</i>	Grab	MPN/100 mL	SM 9223 B	1.0	
Lab	Total hardness	Composite	mg CaCO ₃ /L	SM 2340 C	5	
Lab	Lead, total	Composite	µg/L	EPA 200.8	0.01	
Lab	Lead, dissolved	Composite	µg/L	EPA 200.8	0.01	
Lab	Nitrogen: ammonia	Composite	mg/L	SM 4500 NH ₃ G	0.05	
Lab	Nitrogen: nitrate	Composite	mg/L	SM 4500-NO ₃ F	0.04	
Lab	Phosphorus, total	Composite	mg/L	SM 4500-P A, B, & E	0.04	
Lab	Phosphorus, ortho-phosphate	Composite	mg/L	SM 4500-P FEPA 300.0 365.3	0.02	
Lab	Solids: total suspended	Composite	mg/L	SM 2540 D	1.0	
Lab	Solids: total dissolved	Composite	mg/L	SM 2540 C	5.6	
Lab	Solids: total volatile ^b	Composite	mg/L	SM 2540 B	5.0	
Lab	Zinc, total	Composite	µg/L	EPA 200.8	1	
Lab	Zinc, dissolved	Composite	µg/L	EPA 200.8	1	

a. The Winkler Titration Method is employed to verify field DO readings in accordance with field sampling procedures outlined in Appendix A. Some jurisdictions may opt to analyze DO using only the Winkler Titration Method instead of collecting field samples.

b. Parameter is monitored by SWMACC and West Linn only.

°C = degrees Celsius; µg/L = micrograms per liter; CaCO₃ = calcium carbonate; cm = centimeters; mg/L = milligrams per liter; mL = milliliters; MPN = most probable number.

Water quality monitoring conducted as part of the macroinvertebrate sampling will conform to documented SOPs and may deviate from the approved methods listed in 40 CFR 136.

6.2 Quality Assurance and Quality Control Procedures

For purposes of this 2017 Plan, QA/QC procedures for field analysis are initiated directly by the jurisdiction. QA/QC procedures for laboratories are developed by the individual laboratories and available on request.

Field QA/QC procedures are outlined in Appendix A and included in the SOPs for field sample collection (SOP A-1), chain of custody (SOP A-2), and sample handling and transportation (SOP A-3). General sampling procedures for parameters analyzed in the field are provided in SOP A-4. ACWA developed detailed QA/QC procedures for stormwater data collection and sample handling and custody as part of the ACWA UIC [Underground Injection Control] Monitoring Study. Provisions from this ACWA study have been incorporated into the field QA/QC procedures in Appendix A as appropriate.

Co-permittees will use laboratories that have comprehensive QA programs and are DEQ-accredited. The WES water quality laboratory, which currently conducts laboratory analysis for samples collected by some Clackamas County co-permittees operating under this 2017 Plan, operates under the *WES Water Quality Assurance Manual* (May 17, 2007). This manual outlines pertinent test methods, validation, and reporting limits; equipment calibration and maintenance procedures; sample handling and storage procedures; sample acceptance and results reporting procedures; and data qualification and validation procedures. This manual is available by request from the WES Water Quality Laboratory.

Contracted monitoring activities related to biologic monitoring employ field procedures and protocols unique to the monitoring effort. A description of study methods and QA/QC guidelines will be documented in the final assessment report provided to each jurisdiction at the conclusion of the monitoring event.

Section 7 Monitoring Data Management and Plan Modifications

This section includes a summary of data management procedures (Section 7.1) and procedures for modifying this 2017 Plan (Section 7.2).

7.1 Data Management

Participants in this 2017 Plan individually (or through an inter-governmental agreement) collect samples and are responsible for the quality control of their samples prior to delivery at the laboratory. Field sample collection procedures are outlined in Appendix A. Sample validation and verification is conducted at the laboratory and, following analysis, the monitoring results are provided to the responsible jurisdiction to validate and verify that the findings are consistent with their expectations. Questionable monitoring results will be flagged for further review and possible follow-up in the field. If data quality indicators (i.e., field blanks, field duplicates) suggest that contamination or corruption of the sample occurred, data may be discarded and sampling would be conducted again, and the cause of the failure would be evaluated. If the cause is found to be equipment failure, calibration and/or maintenance techniques will be assessed and improved; if the cause is found to be with the sample collection process, field techniques will be assessed, revised, and retrained as appropriate.

Individual jurisdictions are responsible for the compilation of instream and stormwater monitoring data in database or spreadsheet format. Monitoring data are compiled by monitoring location and monitoring event, and data include times, concentrations, and indication of whether a sample represents a grab- or time-composited sample. Statistics (i.e., mean, maximum, minimum) may be calculated on the data by an individual jurisdiction for its own use. A summary of monitoring results is provided to DEQ with submittal of the individual jurisdiction's NPDES MS4 annual reports. Compiled monitoring data may be provided to DEQ in digital format upon request.

Technical reports documenting results of the biologic monitoring effort shall be maintained by individual jurisdictions and results shall be summarized or attached to the associated NPDES MS4 annual report.

A water quality trends analysis will be conducted during the fifth year of this 2017 Plan implementation, based on the instream monitoring data collected to date. The benefit of a coordinated monitoring program is that resources can be distributed more widely to produce data that will provide comprehensive information for Clackamas County as a whole. As a result, data analyses will be conducted specific to each jurisdiction and water body, but assessment and interpretation can be conducted for watersheds as a whole. As part of the water quality trends analysis effort, previously collected monitoring data specific to the water body will be reviewed.

7.2 Plan Modifications

Modifications to monitoring locations and frequency as outlined in this 2017 Plan are permissible as long as the number of monitoring data points collected on an annual basis (the product of monitoring location and frequency) is not reduced. Additionally, if on an annual basis a participating co-permittee is not able to collect the required samples because of climatic conditions, sampling conditions, equipment malfunction, monitoring location inaccessibility, etc., such inability is not directly reflective of a need to modify the monitoring plan.

Currently, as required in the extended 2012 permit, if a modification to this 2017 Plan is requested or required, such need will be documented to DEQ in the form of a 30-day notice of proposed monitoring plan modification. Written approval must be received from DEQ before such modification can take place. If DEQ does not respond within 30 days, the proposed modification is deemed to be approved without written approval.

Appendix A: Field QA/QC Procedures



Appendix A: Field Quality Assurance and Control Procedures for Sample Collection, Handling, and Custody

SOP A-1: Field Sample Collection Procedures.....	A-1
SOP A-2: Monitoring Field Data Sheets and Chain-of-Custody Records.....	A-5
SOP A-3: Transporting, Packaging, and Shipping of Samples from Field to Lab.....	A-7
SOP A-4: Sampling Procedures for Parameters Analyzed in the Field.....	A-8

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SOP A-1: Field Sample Collection Procedures

Field crews are responsible for collecting samples, recording information, and transferring collected samples.

Prior to sample collection, field crews shall verify that adequate sample collection bottles and sample storage equipment are obtained. Sample collection bottles shall be of adequate size and appropriate material, per requirements of the applicable analytical method. Most sample collection bottles are pre-preserved by the laboratory for the appropriate analytical test. If necessary to meet preservation requirements, additional preserving agents will be added to samples by the laboratory upon receipt of the samples.

Upon arrival at the site, field crews shall establish a safety zone for sample collection if necessary (this may include the placement of traffic cones, etc.). Site conditions and other sampling notes shall be recorded in a monitoring log and/or on the Monitoring Field Data Sheet.

Procedures for conducting grab sampling and composite sampling are as follows.

Grab Sampling Procedures

Grab sample collection methods shall be employed for all dry weather instream monitoring activities and for wet weather instream and stormwater (outfall) monitoring activities for select parameters.

Bottle preparation

Obtain clean half-pint, pint, quart, or half-gallon sample bottles from the laboratory conducting the water quality analyses. Each monitoring site would require a minimum number of sample bottles such that separate sample bottles are obtained based on the analytical test methods to be employed by the laboratory. Bottles shall be pre-labeled by field crews or staff to include the site number and monitoring parameter. In some cases, the laboratory may pre-label sample bottles.

1. Based on the number of sampling sites, obtain additional sample bottles for the collection of grab sample duplicates and field blanks. Bottles for duplicate sampling and field blanks shall be obtained from the laboratory conducting the water quality analyses as required. Based on the number of analytical test methods to be employed, the appropriate number of bottles should be obtained for the collection of duplicate samples and field blanks at a site. Bottles for duplicate and field blank samples shall also be pre-labeled with the designated duplicate site number and monitoring parameter.
2. Procedures related to the collection of grab sample duplicates and field blanks are outlined under SOP A-1, QA/QC Sampling Procedures.

Grab sampling technique

Depending on the site characteristics, samples can be obtained by hand or with the aid of tools (i.e., a grab pole).

1. For sample collection from a (flowing) surface water body, the sample should be collected from the middle of the flow stream (if possible). Care must be taken to avoid collecting particulates that are suspended as a result of bumping the bottle on the

streambed. To sample with a hand-held bottle/container, stand downstream of the bottle while it is being filled.

2. If sampling at a surface water outfall, the sample should be collected, if possible, at the point where the flow leaves the pipe.
3. When no sample is collected because of lack of flow or any other circumstances beyond the sampler's control, the associated condition should be noted in the appropriate entry point on the Monitoring Field Data Sheet.
4. Once the bottle is filled to the proper level, replace the lid on the sample bottle and complete the Monitoring Field Data Sheet with appropriate information related to sample collection (i.e., time, sampling conditions, date, etc.).
5. As directed by the laboratory, filter or preserve samples as necessary in accordance with laboratory-issued standard operating procedures. As an example, the WES laboratory requires field filtration of ortho-phosphate at the time of sample collection.
6. Samples should be stored for transport to the laboratory in an "iced" cooler (i.e., using ice or an ice substitute that has been frozen).
7. If a grab sample duplicate is to be obtained at a particular sampling site, the duplicate samples will be obtained by completing the normal grab sampling procedures and documenting information on the Monitoring Field Data Sheet consistent with collection of an actual sample.
8. For samples that are collected for the analysis of bacteria, samples must be transported to the lab within 6 hours of sample collection.
9. Ensure that all elements of the Monitoring Field Data Sheet are complete prior to relinquishing the samples to the laboratory.

Composite Sampling Procedures

Composite sample collection methods shall be employed for wet weather instream and stormwater (outfall) monitoring activities for all laboratory parameters (with the exception of bacteria) as outlined in Table 9 of the Comprehensive Clackamas County NPDES MS4 Stormwater Monitoring Plan.

Bottle preparation

Obtain a minimum of one clean, half-gallon sample bottle from the laboratory or other clean sampling receptacle for collection of the individual samples and one carboy (i.e., large glass or plastic vessel) to combine the individual samples and mix the composited sample. The bottle(s) and the carboy shall be pre-labeled to include the site number.

Obtain additional, clean half-pint, pint, quart, or half-gallon sample bottles for transport of the composited sample to the laboratory. Each monitoring site would require a minimum number of sample bottles such that separate sample bottles are obtained based on the analytical test methods to be employed by the laboratory. Bottles shall be pre-labeled to include the site number and monitoring parameter.

1. Based on the number of sampling sites, obtain the same number of sample bottles as outlined above for the collection of a composite duplicate samples and field blank samples. Bottles for duplicate sampling and field blanks shall also be obtained from the laboratory conducting the water quality analyses as required.

2. Procedures related to the collection of composite duplicate samples and field blank samples are outlined under SOP A-1, QA/QC Sampling Procedures.

Composite sampling technique

Depending on site conditions, samples can be obtained by hand or with the aid of a tool (i.e., grab pole).

Grab sample collection methods, steps 1 through 4 as documented above, should be employed for each of the minimum three individual grab samples collected prior to pouring in the carboy. Composite samples are generally collected at timed intervals and/or on a sampling rotation. Following collection of the minimum three individual grab samples that will compose the composited sample, the following procedures should be followed:

1. Ensure equal portions from individual grab samples are poured into the pre-labeled carboy. This effort shall occur in a closed or covered environment.
2. Properly mix the composited sample and pour a sufficient quantity of water into each pre-labeled sample bottle that is to be relinquished to the lab for analysis.
3. Implement grab sample collection methods, steps 5 through 7.
4. Update the Monitoring Field Data Sheet to document completion of the composite sample collection efforts.

Please note if a composite sample duplicate is to be obtained at a particular sampling site, in order to test the accuracy of the sample collection procedures, the duplicate sample shall be obtained by completing the normal grab sampling procedures, compositing as indicated above, and transferring the composited sample into the pre-labeled sample collection bottles for the laboratory.

QA/QC Sampling Procedures

The use of field blanks and grab and composite sample duplicates will help to identify potential sources of error in the stormwater sampling process, specifically those associated with sample collection, transportation, and analytical procedures.

For grab and composite samples for all parameters, field blanks and grab or composite duplicates shall be collected at a minimum of 10 percent of the total number of monitoring locations for a single event and for samples collected by a single sampling crew. For example, if samples are to be collected at 10 sites or less for one monitoring event, then one field blank and one duplicate sample shall be obtained for that monitoring event. If individual grab samples are to be collected at 12 sites for one monitoring event, then two field blanks and two grab sample duplicates shall be obtained for that monitoring event. A minimum of one field blank and one duplicate shall be obtained for a single monitoring event.

Guidelines related to the collection of a field blank and duplicate sample are outlined below:

1. Procedures for collection of field blank samples should follow the appropriate grab or composite sampling procedures with the exception that the analyte bottle (in the case of grab sample collection) or half-gallon sample bottles (in the case of composite sample collection) are instead filled with deionized (DI) water as provided by the lab. The field blanks shall be transported to all sampling sites associated with a monitoring event in the storage containers with other sample bottles. This will assist with identifying any potential contamination that may occur with the sample collection and transportation of samples.
2. Procedures for collecting the duplicate sample should follow the appropriate grab or composite sample procedures. The duplicate sample bottles shall be pre-labeled with the designated duplicate site number and monitoring parameter. These duplicate samples will assist with identifying any potential contamination that may occur with sample collection or analytical procedures.

SOP A-2: Field Data Sheets and Chain-of-Custody Records

Monitoring Field Data Sheets are completed by field staff conducting the monitoring activities during sample collection activities. Monitoring Field Data Sheets are maintained with the samples during transport to the laboratory.

A chain-of-custody (COC) record is a legal document generated at the laboratory based on information contained in the Monitoring Field Data Sheet. The COC is prepared either prior to or during the delivery of the samples and identifies the person(s) responsible for the sample bottles during all elements of monitoring activity.

The Monitoring Field Data Sheet(s) shall be completed for each sampling location and event. The COC shall be maintained for each sampling event.

The procedures for filling out these forms are as follows.

Before and during Sample Collection

Before sample collection activities, field staff shall document the following general information on a Monitoring Field Data Sheet, unless otherwise documented on the COC:

- Source/location
- Site code or ID
- Person(s) sampling
- Type of sample (instream dry weather/season, instream wet weather/season, or stormwater outfall)
- Date of sample collection
- Time of sample collection
- Number of sample (if applicable): pertains to collection of multiple individual grab samples to compile as a time-composite sample
- Parameters desired for analysis

During sample collection, the Monitoring Field Data Sheet should remain with the sample bottles. During sampling, staff should add to the Monitoring Field Data Sheet for each individual grab sample to document the time and date that the sample was collected.

The Monitoring Field Data Sheets should remain with the samples for the duration of sampling.

After Sample Collection

If composite sampling methods are being used, the Monitoring Field Data Sheet should be updated to include the time and date at which the individual grab samples were composited. If a separate Monitoring Field Data Sheet is completed for the composite sample, any Monitoring Field Data Sheets associated with individual grab samples used to generate the composite sample should be maintained (e.g., stapled to the back) of the composite sample Monitoring Field Data Sheet.

At the Laboratory

The person responsible for completion of the Monitoring Field Data Sheets should be the one to relinquish this paperwork to laboratory personnel or other staff as necessary. At the time of transfer, information contained on the Monitoring Field Data Sheets shall be entered into the laboratory's tracking database (e.g., Clackamas County Water Environment Services Labworks program). In addition to information contained on the Monitoring Field Data Sheets, any special instructions and information related to the transfer of responsibility is also documented.

Using the laboratory's tracking system, the COC is recorded and internal tracking labels may be generated.

SOP A-3: Transporting, Packaging, and Shipping Samples from Field to Lab

Procedures for handling and transportation of samples to the applicable water quality laboratory are as follows:

1. Keep the Monitoring Field Data Sheet with the samples at all times.
2. Pack samples well within ice chest to prevent breakage or leakage.
3. As stated previously, samples should be packed in ice or an ice substitute with a goal to maintain a sample temperature of 4 degrees Celsius during transport. Acquire more ice or ice substitute as necessary.
4. Samples must be delivered to the water quality laboratory within 6 hours (standard for bacteria analysis) or in accordance with required holding times for other parameters.
5. Most samples will be collected in pre-preserved bottles. Some samples may require additional preservation agents to meet preservation requirements. If needed, additional preserving agents will be added to samples by the laboratory personnel upon receipt of the samples.

SOP A-4: Sampling Procedures for Parameters Analyzed in the Field

Sampling procedures for field parameters (i.e., dissolved oxygen [DO]/temperature, conductivity, and pH) are outlined below.

Field Dissolved Oxygen/Temperature Procedure

Meter preparation

1. Check the device for damage.
2. Check and replenish the field supply of deionized (DI) water.
3. Calibrate the device for DO (refer to current manufacturer's calibration instructions). Record calibration in a Calibration Log Book. As necessary, have experienced personnel calibrate the device prior to field sampling event.
4. Verify the device's temperature reading to a National Institute of Standards and Technology (NIST) thermometer. The temperature reading should be within ± 0.5 degree Celsius. Record the temperature verification in a Calibration Log Book.

Analysis timeline

1. All temperature and DO samples are obtained in the field.
2. Samples must be obtained in a fresh glass or plastic bottle or beaker.
3. Sample analysis is performed on site.

Technique

1. Immerse the device directly in the sample. The device is not to be moved around in the sample. Depending on the device used, measurement may occur in a pre-rinsed sample beaker or bottle or directly in the flow path.
2. Record the DO and temperature readings on the Monitoring Field Data Sheet.
3. Remove the device from the sample and rinse with DI water prior to storage or analysis of the next sample.

QA/QC

1. In order to verify DO concentrations obtained in the field, employ the Winkler Titration Method for one sample collected per event. A separate grab sample shall be collected and analyzed at the laboratory, and results shall be compared to the instrument analysis from the same location.
2. In accordance with the rationale outlined in SOP B-1, duplicate samples shall be collected.
3. Monitoring Field Data Sheets are completed during field sample collection and during grab sample collection (when conducting the Winkler test).

Field pH Procedure

Meter preparation

1. Set up the field pH meter(s).
2. Check the device for damage.
3. Check and replenish the buffer solution (4, 7, 10) and DI water.
4. Calibrate the device using at least two pH buffers (4 and 7) and document (refer to current manufacturer's calibration instructions). As necessary, be sure to remove the device's filling solution vent plug before making any pH measurements.

Analysis timeline

1. All pH samples are obtained in the field as grab samples.
2. Samples must be obtained in fresh glass or plastic bottles or beaker.
3. Sample analysis shall be performed on site within 15 minutes of grab time.

Technique

1. Remove device from the field storage solution. Do not remove from storage solution until water sample is ready for analysis.
2. Pre-rinse the sample bottle or beaker with sample water prior to obtaining the actual sample.
3. Collect a 200-milliliter (mL) sample (minimum).
4. Thoroughly rinse the device tip with DI water, pat dry with clean paper towel, and put the device into the sample.
5. Once the device is immersed in the sample, slowly rotate in a circular pattern until the reading stabilizes (30 seconds).
6. Record the pH (to nearest 0.1 unit).
7. Enter the pH data on the Monitoring Field Data Sheet.
8. Remove the device from the sample and rinse with DI water prior to storage or analysis of the next sample.

QA/QC

1. Monitoring Field Data Sheets are completed in the field as the samples are collected.
2. After the completion of each day's sampling, device calibration(s) must be verified and checked for accuracy. The verified pH readings shall be recorded in the pH Calibration Log Book. Devices should be cleaned with DI water and stored in the correct storage solution.
3. A low ionic strength pH probe and an automatic temperature compensation (ATC) probe should be used (e.g., pH probe Orion 815600 and ATC probe 917005).

Field Conductivity Procedure

Meter preparation

1. Set up the field conductivity meter.
2. Check the device for damage.
3. Calibrate the device according to current manufacturer's calibration instructions.
4. Check and replenish the field supply of DI water for rinsing the device following sampling.

Analysis timeline

1. All conductivity samples are obtained in the field as grab samples.
2. Samples must be obtained in fresh glass or plastic bottles or beaker.
3. Sample analysis is performed on site within 15 minutes of grab time.

Technique

1. Pre-rinse the sample bottle with sample water prior to obtaining the actual sample.
2. Collect 200 mL sample (minimum).
3. Ensure that the meter is reading in conductivity mode, if necessary.
4. Rinse device with DI water and pat dry with clean paper towel.
5. Immerse the device in the sample and do not allow the device to touch the bottom of the container or any solid object.
6. Enter the conductivity data on the Monitoring Field Data Sheet.
7. Remove the device from the sample and rinse with DI water prior to storage or the next analysis.

QA/QC

1. Monitoring Field Data Sheets are completed in the field as the samples are collected.
2. After the completion of each day's sampling, device calibration(s) must be verified, checked for accuracy, and recorded.
3. Devices should then be cleaned with DI water and stored appropriately.

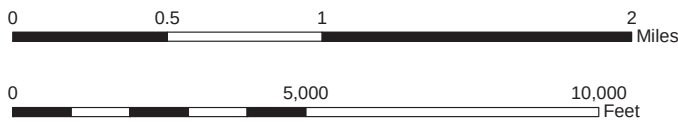
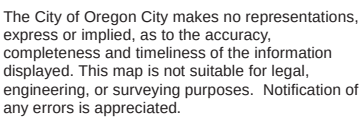
Appendix D: MS4 Maps

Service Area and Land Use

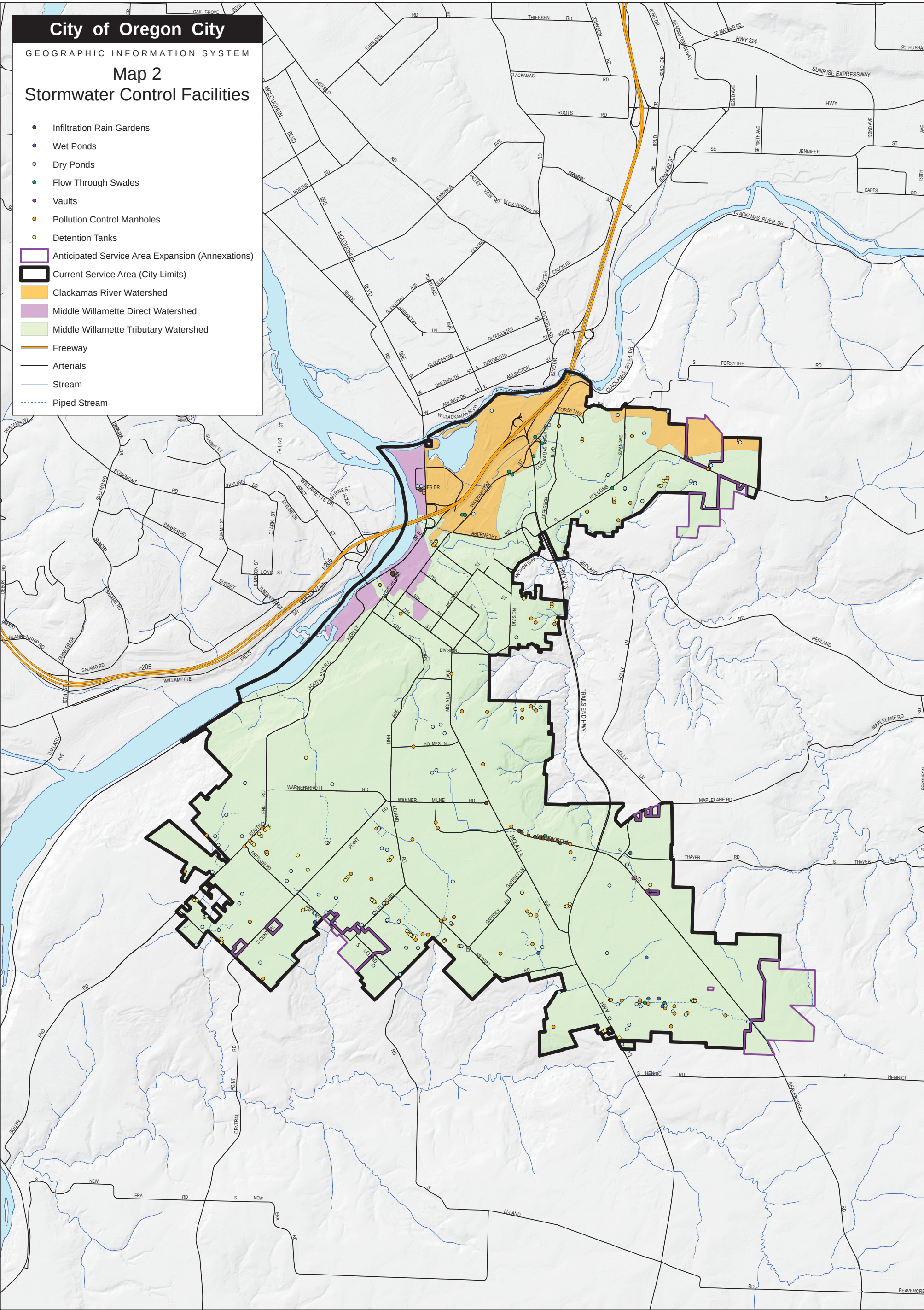
-  Outfalls to Waterways
-  NPDES Industrial Permit Locations
-  Anticipated Service Area Expansion (Annexations)
-  Current Service Area (City Limits)
-  Freeway
-  Arterials
-  Stream
-  Piped Stream
-  Vacant Lands (2013)

Generalized Land Use

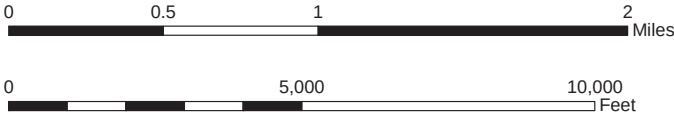
-  Industrial
-  Commercial
-  Single Family Residential
-  Multi Family Residential
-  Agriculture
-  Public Property
-  Parks and Open Space



Plot date: February 9, 2017
Plot name: Map 1 - Service Area and Land Use - 24x36P - 20170209.pdf
Map name: Map 1 - Service Area and Land Use - 24x36P.mxd



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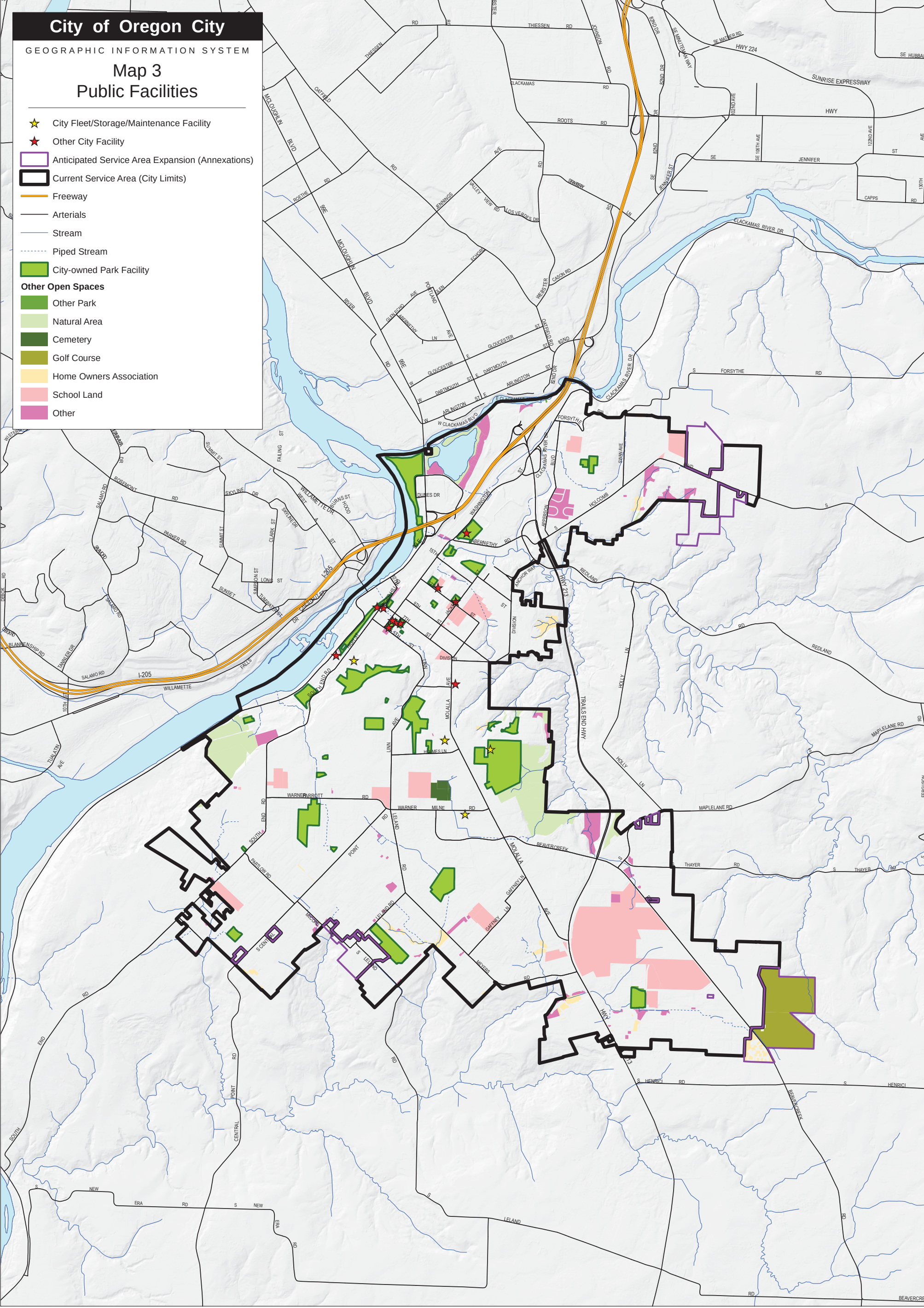


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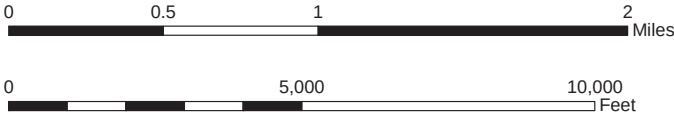


Plot date: January 26, 2017
Plot name: Map 2 - Stormwater Control Facilities - 24x36P - 20170126.pdf
Map name: Map 2 - Stormwater Control Facilities - 24x36P.mxd

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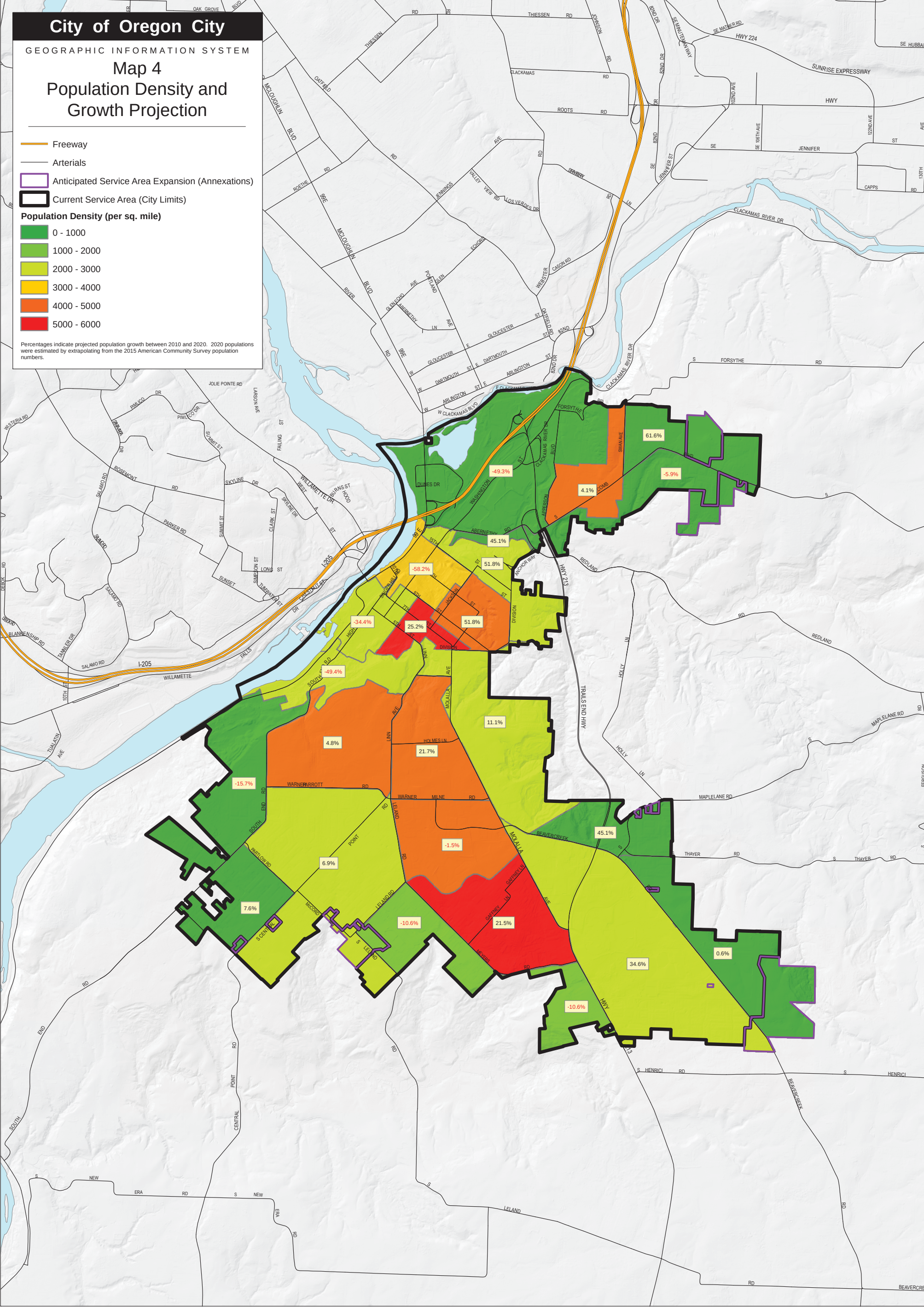


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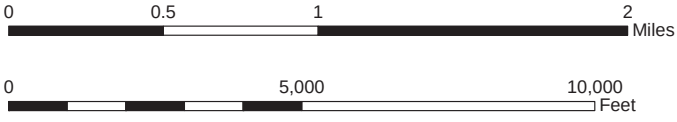


Plot date: February 9, 2017
Plot name: Map 3 - Public Facilities - 24x36P - 20170209.pdf
Map name: Map 3 - Public Facilities - 24x36P.mxd

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