CITY OF SALEM

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM MUNICIPAL SEPARATE STORM SEWER SYSTEM PERMIT RENEWAL APPLICATION

Permit Number: 101513

File Number: 108919

December 29, 2015

CITY OF Salem AT YOUR SERVICE

Assisted by:

Brown AND Caldwell

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CITY OF SALEM

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT RENEWAL APPLICATION PACKAGE

December 29, 2015

The undersigned hereby submits this permit renewal application package in accordance with NPDES Permit Number 101513. 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.

Peter Fernandez, P.E. Public Works Director

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Section 1 Introduction

1.1 Permit Background

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 an NPDES municipal separate storm sewer (MS4) permit. The City of Salem (City) was one of the six jurisdictions required to obtain an NPDES MS4 permit.

The City submitted Part 1 of its original NPDES MS4 permit application in April 1994, with the Oregon Department of Transportation as a co-permittee. Part 1 of the original permit application required review of the stormwater system including mapping, outfall inventories, stormwater monitoring, etc. The City submitted Part 2 of its application in July 1996. Part 2 of the application required the development of a Stormwater Management Plan (SWMP), which includes a number of best management practices (BMPs) to address specific sources of pollutants. The permit did not specify the number of type of BMPs to be implemented; rather the permit stated that BMPs should be implemented to reduce pollutant discharge to the “maximum extent practicable” (MEP). The City was issued its first NPDES MS4 permit in December 1997.

The original (1997) permit required a renewal at the end of the five-year permit period. The City was issued its second permit in March 2004, which expired February 28, 2009. On September 2, 2008, the City submitted its permit renewal application to DEQ for the third permit term, which included a revised SWMP.

The City of Salem received its third (current) NPDES MS4 permit on December 30, 2010. This permit expires on December 29, 2015. During each permit period, the SWMP was updated and improved through adaptive management and continues to be a central element of the permit.

This document represents the City of Salem’s NPDES MS4 permit renewal application and is being submitted to DEQ in accordance with Schedule F, Section A.4 (per DEQ letter dated April 13, 2015).

1.2 Description of Permit Area

The City of Salem is Oregon’s capital city and is located along the Willamette River, approximately 47 miles south of Portland, Oregon. The City is bisected by the Willamette River, and located in both Marion and Polk counties.

The City has a population of approximately 157,770 residents (as of 2013) and occupies a total of 47 square miles. There are significant areas of residential, commercial, industrial, and institutional land use within the City, as well as over 1,800 acres of park land. Due to its proximity in the Middle Willamette River subbasin, it is drained by a number of perennial streams that ultimately discharge into the Willamette River. These tributaries include Mill Creek, Battle Creek, Pringle Creek, and Clark Creek. A significant amount of Salem’s NPDES MS4 service area, defined as area within the city limits for which the City manages stormwater runoff, is subject to Total Maximum Daily Load (TMDL) waste load allocations (WLAs) established for urban stormwater under the Willamette Basin TMDL (2006) and the Molalla-Pudding Subbasin TMDL (2008).

1.3 Organization of Document

Table 1-1 summarizes the requirements of the permit renewal application and provides the corresponding submittal component's location within this permit renewal application.

Table 1-1. Permit Renewal Submittal Components

Submittal Component	Permit Requirement	Related 2015 Application Section
Introduction	-	Section 1.0
Proposed SWMP Modifications Narrative summary of proposed SWMP revisions and measurable goals, including rationale for revisions.	B.6.a	Section 3.0 Appendix B
MEP Evaluation Information and analysis related to: • How the City's existing program addressed requirements of the 2010 permit . • How the City's proposed program will meet maximum extent practicable (MEP) criteria.	B.6.b	Section 2.0
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 4.1
Total Annual Pollutant Loading Updated estimate of total stormwater pollutant loads for applicable TMDL pollutants and other identified pollutants.	B.6.c	Section 4.2
Wasteload Allocations (WLAs) and Benchmarks • List of WLAs met • New benchmarks	D.3.c, d B.6.h	Section 5.0 and Appendix C
Fiscal Evaluation Current permit term expenditures summary and projected program allocations for next permit cycle.	B.6.f	Section 6.0
Monitoring • Proposed monitoring program objectives matrix • Proposed monitoring plan	B.6.d D.3.c.vii	Section 7.0 Appendix D
Required Maps	B.6.g	Appendix A

Section 2
Maximum Extent Practicable Evaluation

<u>Permit Requirements</u>

Schedule B.6: MS4 Permit Renewal Application Package

…The application package must include an evaluation of the adequacy of the proposed SWMP 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 permittee's stormwater management program addressed the requirements of this permit. The permittee must 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 permittees 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's 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 2010 Permit Requirements
- Section 2.2: How the Proposed Stormwater Management Program Meets the MEP Requirement

2.1 How the Existing Stormwater Management Program Addressed 2010 Permit Requirements

The City's overall stormwater management program comprises 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 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 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, 2011. The adaptive management process outlined the approach for conducting annual adaptive management of the SWMP.

During the annual assessment, SWMP modifications in the form of adjustments to best management practices (BMPs) may be made to achieve continued and/or enhanced reduction of pollutants in stormwater discharges. Each annual report submitted to DEQ includes a section to summarize implementation of the adaptive management process and the resulting proposed SWMP changes.

The City's current, effective SWMP is dated April 1, 2011, but is referred to as the 2010 SWMP (in conjunction with issuance of the permit). Prior to submitting the annual reports, an evaluation form is provided to the City staff responsible for implementation of individual BMPs. Staff confirms whether there are modifications or changes to activities that may accelerate progress toward attainment of measurable goals or other improvements to increase BMP effectiveness or efficiencies.

Since Year 1 of the current permit issuance, the City has continually modified how its BMPs are carried out in order to find the most efficient approaches and maximize pollutant load reduction. While several refinements to BMP implementation were made during the permit term, the refinements were not at a level of detail to require formal SWMP adjustments. Refinements made during the permit term included the following:

- Increased street sweeping frequencies to those listed in proposed SWMP (OM-1)
- Initiated tracking of debris removed from individual catch basins to aid in the prioritization of cleaning locations and frequencies
- Initiated monthly inspections of Shops Complex to improve implementation of the City Shops Complex Stormwater Pollution Control Plan
- Improved outreach via direct email communication to the City's industrial users

2.1.2 Overall Program Requirements

Per Schedule A.2 of the permit (Reduce Pollutants to the Maximum Extent Practicable):

> *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 2010 permit requirements, as shown in Table 2-1. In addition, the City supplied information in each annual report related to meeting SWMP measurable goals. Therefore, the City's existing, overall program has met the MEP requirement.

Table 2-1. 2010 Permit Requirements			
Requirement	Permit section	Due date	Status *(shaded areas = permit requirement has been met)*
Illicit Discharge Detection and Elimination:			
• Document an enforcement response plan for responding to illicit discharges	A.4.a.ii	11/1/2011	• Enforcement Response Plan submitted to DEQ by 11/1/2011 with procedures implemented per authority and provisions provided by multiple chapters within Salem Revised Code.
• Document pollutant parameter action levels and report them to DEQ in an enforcement response plan	A.4.a.iii	7/1/2012	• Pollutant parameter action levels are documented in the City's Dry Weather Outfall and Illicit Discharge Screening Plan.
• Annual dry weather field screening activities must include identified priority locations, which are identified on a map	A.4.a.iv and xi	7/1/2012	• Dry weather field screening locations are mapped and referenced in the City's Dry Weather Outfall and Illicit Discharge Screening Plan.
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	1/1/2013	Strategy completed and implementation initiated. Critical elements include plan review, 1200-Z permit coordination with DEQ, industrial facility inspections in conjunction with the pretreatment program, and education and outreach.
Education and Outreach:			
Conduct or participate in an effectiveness evaluation to measure the success of public education activities	A.4.d.vi	11/1/2014	Participated in a regional public education effectiveness evaluation submitted to DEQ on 11/1/2014.
Public Involvement and Participation:			
Provide opportunities for public comments on the monitoring plan, annual reports, SWMP revisions, and the TMDL pollutant load reduction benchmark development	A.4.e	5/1/2011 (monitoring plan)	The monitoring plan was provided for public review and comment and submitted to DEQ by 5/1/2011. Annual reports, proposed SWMP revisions, and pollutant load reduction benchmarks have also been provided to the public for review and comment.
Post-Construction Site Runoff:			
• Implement a post-construction site runoff program that meets designated permit conditions	A.4.f	1/1/2014	• The City's Public Works Design Standards, detailed in the Salem Administrative Rules, Chapter 109, Division 004 were adopted by 1/1/2014.
• Identify, minimize, or eliminate barriers in ordinances, code, and development standards that inhibit low-impact development/green infrastructure	A.4.f.ii	1/1/2014	• The City's Public Works Design Standards fully consider low-impact development (LID) opportunities. Barriers to LID identified and eliminated per City Council adoption of Ordinance Bill No. 34-13.
• Develop or reference an enforceable post-construction stormwater management manual or equivalent document	A.4.f.iii	1/1/2014	• See above bullets.

Table 2-1. 2010 Permit Requirements			
Requirement	Permit section	Due date	Status *(shaded areas = permit requirement has been met)*
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	1/1/2013	Strategies for municipal pollution prevention compiled and submitted to DEQ by 1/1/2013. The City's Operations Pollution Prevention Plan includes additional strategies identified for the City's Shops Complex.
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	1/1/2013	Stormwater Facility Inventory, Inspection, and Maintenance Program submitted to DEQ by 1/1/2013 and processes are referenced in proposed BMP OM-6, OM-7, OM-8, PC-1, and PC-2, and are being implemented on an ongoing basis.
Hydromodification Assessment:			
Conduct assessment and submit report	A.5	11/1/2014	Submitted to DEQ 11/1/2014.
Retrofit Strategy:			
• Identify one stormwater quality improvement project	A.6.c	11/1/2013	• The retrofit project was identified as the Eola Ridge Park Bacteria Retrofit Project, and a letter identifying the project was submitted to DEQ 11/1/2013.
• Initiate, construct, or implement the project	A.6.c	Permit expiration	• Design was initiated in October 2013. Construction was initiated in October 2015. Construction was completed in November 2015.
• Develop a retrofit strategy and submit plan to DEQ	A.6.b	11/1/2014	• The retrofit strategy was submitted to DEQ 11/1/2014.
Monitoring and Reporting Requirements:			
Submit draft plan to DEQ for review	B.2	5/1/2011	• Surface Water and Stormwater Monitoring Plan submitted to DEQ by 5/1/2011.
Implement approved plan	B.2	7/1/2011	• Implementation of Surface Water and Stormwater Monitoring Plan initiated 7/1/2011.
Annual Reporting:			
Submit annual reports each year from the time period 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.

Table 2-1. 2010 Permit Requirements			
Requirement	Permit section	Due date	Status *(shaded areas = permit requirement has been met)*
Permit Renewal: Submit permit renewal application package	B.6	6/30/2015 (180 days before permit expiration)	Will be submitted by 12/29/2015 in accordance with National Pollutant Discharge Elimination System (NPDES) MS4 permit, Schedule F, Section A.4. and per DEQ approval letter dated 4/13/2015.
303(d) Listed Pollutants: Submit evaluation report in fourth annual report	B.5.k D.2	11/1/2014 (4th annual report)	Submitted with fiscal year (FY) 2013–14 annual report.
TMDLs:			
• Submit Wasteload Allocation Attainment Assessment	B.5.k D.3.b	11/1/2014 (4th annual report)	• Submitted with FY 2013–14 annual report.
• Submit TMDL Pollutant Load Reduction Evaluation	B.5.k D.3.c	11/1/2014 (4th annual report)	• Submitted with FY 2013–14 annual report.
• Submit TMDL benchmarks	D.3.d	7/30/2015 (180 days before permit expiration)	• Provided in Section 5 of this permit renewal application (see above bullet).
Adaptive Management: Submit adaptive management approach	D.4	11/1/2011	Submitted to DEQ 11/1/2011.
SWMP Measurable Goals: Revise to include new permit requirements	D.6	4/1/2011	Revised and submitted to DEQ 4/1/2011.

2.2 How the Proposed Stormwater Management Program Meets the MEP Requirement

The City's adaptive management process also 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 ongoing compliance with the MEP standard and provides the 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 of this permit renewal application.

2.2.1 MEP Background

MS4 permittees initially developed and established SWMPs that met the MEP requirement as part of their 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 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 that ensure 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 meets 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 1993 permit application:** All Phase I National Pollutant Discharge Elimination System (NPDES) MS4 permit applicants were encouraged by the United States Environmental Protection Agency (EPA) to design programs tailored for local problems, priorities, resources, and objectives. Part 1[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[2] of the application required development of a SWMP.

  The City employed a coordinated, comprehensive, and structured approach to developing its original NPDES SWMP. An interagency group of City personnel and the Oregon Department of Transportation (ODOT) (a co-permittee at the time) participated in a series of technical workshops. The overall process included regional water quality objective identification, objective definition, candidate BMP identification, BMP prioritization based on defined selection factors, BMP evaluation and selection, and documentation. The BMPs were evaluated with respect to meeting regulatory requirements, addressing pollutants of concern, life-cycle costs, ease of implementation, and reliability/sustainability. A SWMP was developed for the City to include 25 selected BMPs.

  Issuance of the first NPDES MS4 permit by DEQ, which included implementation of the SWMP, was regarded as acceptance of a program that met the MEP standard.

[1] Part 1 of the City of Salem NPDES Permit Application, April 1994.

[2] Part 2 of the City of Salem NPDES Permit Application, April 1996.

- **Overall SWMP review conducted for the Second Year Annual Report due in 2005:** DEQ issued the City its second-term MS4 permit in March 2004. The 2004 permit required a SWMP evaluation to be conducted and submitted to DEQ in conjunction with the City's (2005) Second Year Annual Report. For this evaluation, the effective (2002) SWMP was evaluated. The evaluation consisted of the review of performance indicators in the 2002 SWMP, a qualitative assessment of BMP effectiveness, and an assessment of improving stormwater controls and activities to ensure that permit objectives continued to be met. The specific evaluation methods included staff and consultant interviews, a peer community workshop, a City staff workshop, and public outreach. Based on the evaluation, completed tasks were removed from the SWMP, wording was refined, performance indicators were refined to be more quantitative, and new BMPs related to design standards and stormwater facility maintenance and geographic information system (GIS) tracking were incorporated.

  A revised SWMP was prepared and submitted to DEQ in 2005 as part of the Second Year Annual Report.
- **Overall SWMP review conducted for the 2008 permit renewal application:** As part of the adaptive management process, the City prepared a revised SWMP for the permit renewal application in 2008 for the third-term MS4 permit. The revised SWMP was intended to synthesize the implementation and findings from the permit cycle, and reflect an evaluation of the adequacy in reducing pollutants to the MEP, based on three evaluation criteria as required by DEQ: program effectiveness, local applicability, and program resources. The City reviewed the 2005 SWMP in conjunction with federal regulations and guidelines under the technical documents, *MS4 Program Evaluation Guidance* (EPA, January 2007) and *Protocol for Conducting Environmental Compliance Audits under the Stormwater Program* (EPA).

  Given the limited time between development of the 2005 SWMP and revised (2008) SWMP, no significant gaps in the program were identified, but some changes related to adaptive management were incorporated including the addition of measurable goals, revisions to tasks, and renaming of BMPs.
- **Continual adaptive management reported in annual reports (1993 to present):** The effectiveness of the City's SWMP programs, activities, and BMPs has been revisited annually to ensure that the City's SWMP continues to meet the MEP standards. As a part of this process, the City annually reviews and, if necessary, modifies how its BMPs are carried out to ensure the most efficient approaches to reducing pollutant loading. The annual report aids in this effort by allowing the City to track the status of implementation of components of the SWMP, and to highlight areas where deficiencies and potential changes are warranted.

2.2.2 MEP 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 permittees 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 over the years.

As part of this 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 the program was 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.
  - The program includes BMPs that target applicable 303(d) parameters, help to achieve TMDL pollutant load reduction benchmarks, and make progress toward TMDL wasteload allocations.
  - The program targets pollutant discharges from existing development, redevelopment, and new development activities.
- **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.
  - The program encourages and solicits feedback and involvement from stakeholders to ensure consistency with community-wide goals and objectives.
- **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.
  - The program considers public acceptance of program costs and benefits.

2.2.3 Program Assessment and Results for the Permit Renewal

Using the MEP factors and criteria described in Section 2.2.2, the City conducted a review of their stormwater program in order to identify proposed changes to their SWMP. Detail related to the program assessment and results is provided below.

2.2.3.1 Program Assessment

As described in the City's adaptive management approach, the permit cycle adaptive management process includes a review of annual assessments, permit term trends, a review of evaluations/reports produced during the permit term, and receipt of public input and comments. A description of each is provided below.

2.2.3.1.1 Review of Annual Adaptive Management Results during Current Permit Term

A summary of the results from the annual adaptive management process is provided in Section 2.1.1. As described, 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.

2.2.3.1.2 Review of Monitoring Information (Trends Results)

In 2014, a summary of water quality trends was submitted to DEQ based on the results of environmental monitoring conducted under the permit. The City discharges to the Middle Willamette River directly and via tributaries. Major tributaries include Mill Creek, Battle Creek, Clark Creek, Pringle Creek, and the West Fork Little Pudding River.

Water quality trends were calculated on the City's 21 instream sites that are monitored monthly. Monitoring has been conducted since 2001. Per Oregon Association of Clean Water Agencies guidance, the Mann-Kendall test was used for analysis on data sets containing a minimum of 30 data points recorded over a 5-year period. A total of 351 data sets (separated by site, parameter, and precipitation [no rain or rain event] were evaluated).

Of the data sets associated with rainfall/precipitation events, 57 data sets showed significant or somewhat significant trends. General results by water body are as follows:

- Battle Creek: Biochemical oxygen demand (BOD), turbidity, and nitrate data showed a trend toward improved water quality. The upstream Battle Creek site showed a trend toward decreasing dissolved oxygen (DO) concentrations (a sign of degraded water quality).
- Clark Creek: Nitrate data showed a trend toward improved water quality. The upstream Clark Creek site showed a trend toward increased bacteria concentrations (a sign of degraded water quality).
- Middle Willamette tributaries: Specific water bodies include Claggett Creek, Croisan Creek, Gibson Creek, Glenn Creek, and Shelton Ditch. Tributaries generally showed no trend; select parameters showed a trend toward improved water quality (nitrate, DO, turbidity). None of the specified water bodies showed trends indicating degrading water quality.
- Mill Creek: Bacteria data showed a slight trend toward improved water quality. No trends indicated degrading water quality.
- Pringle Creek: Nitrate data showed a slight trend toward improved water quality. No trends indicated degrading water quality.
- West Fork Little Pudding: DO data showed a slight trend toward improved water quality. No trends indicated degrading water quality.

Monitoring data evaluated for the water quality trends consist of grab samples, which capture a specific moment in time and can reflect the influence of a variety of factors. Results are viewed as a piece of information and not a conclusive statement as to the overall condition of sampled streams.

Based on the results from this trends analysis, improving trends were observed for select parameters and select locations but are not collectively interpreted to show overall improvement. Deteriorating trends were also observed for select parameters and select locations, but were mostly observed during dry weather conditions and thus less associated with stormwater runoff conditions. Given that development has occurred during the period reflected in the analyses, seeing improving trends or even no detectable trends is a positive result. These trends analyses did not result in any adjustments to the City's SWMP.

2.2.3.1.3 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 November 2014 included the following:

- *Public Education Effectiveness Evaluation*
- *Hydromodification Assessment*
- *Retrofit Strategy*
- *Evaluation of 303(d) Listed Pollutants*
- *Pollutant Load Reduction Evaluation* (PLRE)
- *Wasteload Allocation Attainment Assessment* (WLAAA)

As a result of the preparation of these permit-required deliverables, the main change made to the City's overall stormwater program was related to the development of the retrofit strategy. The objectives of the retrofit strategy include the identification and implementation of structural BMPs to further reduce 303(d) and total maximum daily load (TMDL) pollutant discharge and hydromodification impacts associated with the City's hydromodification assessment.

The Eola Ridge Bacteria Retrofit Project was the first stormwater treatment retrofit project that the City incorporated into its capital improvement program. Although the City's capital improvement program for Fiscal Years (FY) 2015-16 through FY 2019-20 does not include a project designed solely to address stormwater quality at this time, City staff will continue to evaluate and prioritize stormwater treatment retrofits annually, for inclusion into the capital improvement program. The City's retrofit strategy also reflects incorporation of structural BMPs into existing flood control and stormwater operation and maintenance projects and opportunistic retrofits on City-owned property and school district property.

Such structural BMPs were included in the City's update to pollutant load reduction benchmarks (as part of this permit renewal application package) to show how they will contribute toward making continued progress in reducing pollutant loads on the path to meeting wasteload allocations. It should be noted that in some cases, as identified in the WLAAA, meeting wasteload allocations will not be feasible.

With respect to the City's hydromodification assessment, a number of stream reaches were observed to suffer from the effects of hydromodification including erosion, incision and widening, and degraded habitat conditions. Retrofits that achieve stormwater flow reduction and attenuate peak runoff volumes in affected stream reaches were prioritized as part of the retrofit strategy.

In the case of future development or redevelopment on City property, stormwater runoff controls will now be guided by the newly adopted Public Works Design Standards, detailed in the Salem Administrative Rules, Chapter 109, Division 004, which contains low-impact development practices and encourages infiltration BMPs where practicable to reduce flow volumes. No additional strategies or tools are anticipated in the foreseeable future to address hydromodification impacts from new development or redevelopment.

2.2.3.1.4 End of Permit Term SWMP Review Process

For this permit renewal application, the City again implemented a detailed inter-department process to review the 2010 SWMP in conjunction with results of the annual adaptive management and findings from evaluations and reports completed over the permit term.

A total of 34 staff members from Public Works and Information Technology (staff that are routinely involved in the annual adaptive management review and reporting process) participated in a series of twelve separate meetings that were scheduled to review implementation processes and current program and staff organization. BMPs documented in the SWMP were reviewed and updated to eliminate tasks that had a specified end date and are now completed. Through the annual review process, it was determined that the SWMP contained a number of tasks that were repetitive in nature; thus, consolidation of tasks and BMPs were made to improve readability. Additionally, revisions to measurable goals and tracking measures were made to improve clarity and/or reflect efficiencies in implementation.

As part of this end of permit term SWMP review process, City staff discussed reformatting the SWMP in order to better align the current permit requirements with applicable BMPs, and renaming BMPs to reflect better the activities being conducted. Reformatting of the SWMP was initiated as part of this process.

2.2.3.1.5 Public Comment

After a two-week public comment period (from November 18, 2015 to December 2, 2015), no comments were received on the proposed SWMP revisions.

2.2.3.2 Program Assessment

As a result of the permit renewal program assessment, some modifications to the City's SWMP are proposed. 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 B of this permit renewal application.

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 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.

This section of the permit renewal application provides the proposed changes to the City of Salem's (City's) 2010 Stormwater Management Plan (SWMP), in conjunction with results of the maximum extent practicable (MEP) evaluation documented in Section 2.0.

Table 3-1 summarizes the proposed changes to the City's 2010 SWMP identified for this 2015 NPDES MS4 permit renewal effort. Changes have been organized into the following four categories to aid in the review:

O	**(Organizational change)**	SWMP organizational change.
R	**(Removed activity)**	Task/activity had a discrete timeline and has been completed. Task/activity is proposed for removal from the SWMP.
I	**(Implementation change)**	Implementation change affecting task description, measurable goals, or tracking measures. Change is due to improved efficiencies and adjustments to internal processes and procedures.
C	**(Consolidation)**	Consolidation and reorganization of tasks to address overlapping activities, staff responsibilities, realignment with permit requirements, and/or ambiguity in language.

The City's BMPs are identified in Table 3-1 by BMP ID and task number. For example, for BMP RC1 (Planning), Task 1, is abbreviated as RC1-1. Each BMP task contains individual measurable goals and tracking measures.

Due to the number of BMP tasks requiring consolidation and the fact that the BMP IDs are not descriptive to the individual tasks being completed under the BMP, the City has also proposed a reorganization of the SWMP and renaming of BMPs. Table 3-2 provides a linkage between the 2010 SWMP BMP ID and associated tasks and the proposed 2015 SWMP BMPs. Most BMP tasks are remaining the same, but are being reorganized under the following categories for consistency with the current permit organization:

PL Planning

EO Education and Outreach

PC Post-Construction Stormwater Management

OM Operations and Maintenance

IL Illicit Discharge Detection and Elimination

IC Industrial and Commercial Facilities

EC Erosion and Sediment Control

The proposed (2015) SWMP is included in its entirety in the permit renewal submittal as Appendix B.

Table 3-1. 2015 Summary of Proposed SWMP Changes

O = Organizational change *R= Removed activity* *I = Implementation change* *C = Consolidation of BMP tasks*

Change category	BMP ID	Summary of changes to 2010 BMPs	Rationale/reason
O	MON1. Monitoring	Removed BMP MON1-1, MON1-2, and MON1-3 from the SWMP.	The City conducts monitoring in conjunction with Schedule B permit requirements. The City also maintains a monitoring plan and program independent from the SWMP, and changes to monitoring activities can be conducted in accordance with public processes separate from the SWMP.
R	RC1. Planning	RC1-2 and RC1-7 – Removed measurable goals and tracking measures associated with development of a hydromodification assessment and retrofit assessment.	Completed.
	RC1. Planning	RC1-3 – Removed measurable goals related to field ground truthing and updated mapping.	Completed.
	RC3. Update of Stormwater Management Design Standards	RC3-2 and RC3-3 – Removed these BMP tasks following development of the 2014 Public Works Stormwater Management Design Standards (referenced under RC3-1).	Completed.
	RC5. Public Education and Participation	RC5-1 – Removed measureable goal related to the public education effectiveness evaluation.	Completed.
	RC5. Public Education and Participation RC6. Stormwater Management Program Financing RC9. Legal/ Ordinances	RC5-4, RC6-2, RC 9-1, and RC9-3 – Removed these BMP tasks following the development of the stormwater utility.	Completed.
I	RC1. Planning	RC1-1 – Added measureable goal to begin implementation of the Battle Creek basin plan.	Associated with RC1-1 and RC1-2 consolidation.
	RC1. Planning	RC1-4 – Updated description, measurable goals and tracking measures to reflect use of team meetings and removed reference to the distribution of manuals.	Updated to reflect current implementation efforts, use of smaller group coordination, and digital communications.
	RC1. Planning	RC1-6 – Updated measurable goal to reflect continued participation with the SKAPAC organization instead of updating the antiquated Agreement.	Participating agencies are not interested in updating the Agreement, but ongoing implementation is acceptable to all parties.

Table 3-1. 2015 Summary of Proposed SWMP Changes			
O = Organizational change	*R= Removed activity*	*I = Implementation change*	*C = Consolidation of BMP tasks*
Change category	BMP ID	Summary of changes to 2010 BMPs	Rationale/reason
I (continued)	RC1. Planning	RC1-8 – Removed measurable goal reference to attend groundwater workshops and conferences as funding allows.	Not related to the NPDES MS4 permit.
	RC2. Capital Improvements	RC2-1 – Added tracking measure to report on funding source and retrofit project implementation status.	City would like record of funding sources for stormwater CIPs.
	RC2. Capital Improvements	RC2-2 and RC2-3 – Removed measurable goal and tracking measures associated with tracking permit status and easement acquisition for stormwater CIPS.	Permits and easements are requirements for any project, and tracking overall project implementation is part of RC2-1.
	RC3. Update of Stormwater Management Design Standards	RC3-1 – Updated task description and measurable goals to reflect the fact that new design standards have been developed (2014 Public Works Stormwater Management Design Standards).	Standards were developed in 2014. The new measureable goals are focused on implementation of the new standards.
	RC4. Operations and Maintenance	RC4-1 – Updated description and measurable goals to reflect an increased frequency of street sweeping.	Increased frequency in accordance with current practices.
	RC4. Operations and Maintenance	RC4-2 – Removed tracking measure related to documentation of review of recycling opportunities.	No new recycling opportunities have been identified to date.
	RC4. Operations and Maintenance	RC4-3 – Updated description and removed measurable goals associated with defining maintenance schedules using DPEN and Hansen IMS.	DPEN is no longer in use. Hanson is used to track assets, but maintenance is more efficiently tracked using GIS.
	RC4. Operations and Maintenance	RC4-6 – Updated measurable goals and tracking measures to reflect numeric goals for catch basin and pipe cleaning instead of percentages.	Reporting numbers and lengths of maintenance activities is consistent with the City's maintenance tracking software.
	RC4. Operations and Maintenance	RC4-12 – Added tracking measure to track the number of private stormwater facilities mapped and inspected.	Development of a maintenance strategy was conducted during 2010-2015 permit term. Facility tracking is included as a component of the strategy.
	ILL1. Spill Prevention and Response Program	ILL1-4 – Updated measurable goal to reflect annual review of the Operations Pollution Prevention Plan.	The Operations Pollution Prevention Plan was updated during 2010-2015 permit term, and the updated measurable goal reflects ongoing implementation.

Table 3-1. 2015 Summary of Proposed SWMP Changes

O = Organizational change *R= Removed activity* *I = Implementation change* *C = Consolidation of BMP tasks*

Change category	BMP ID	Summary of changes to 2010 BMPs	Rationale/reason
I (continued)	ILL2. Illicit Discharge Elimination Program	ILL2-4 – Added measurable goal to utilize GIS tracking of dry weather outfall inspection data.	Updated measurable goal reflects the ongoing implementation strategy for dry weather field screening.
	IND1. Industrial Stormwater Discharge Program	IND1-2 – Updated description to include review of commercial facilities for source control, in addition to industrial facilities.	Update for consistency with current City practice.
	IND1. Industrial Stormwater Discharge Program	IND1-4 – Updated measurable goal and tracking measures to reflect use of email correspondence with business owners instead of paper technical bulletins.	Update for consistency with current City practice.
	CON1. Construction Site Control Program	CON1-3 – Added tracking measures to track erosion control inspections conducted and number of 1200-CA inspections conducted.	This change was made to reflect City erosion control program updates that were made following the EPA audit.
C	Varies	BMPs and associated tasks that were identified for consolidation are listed below. Changes included adjustment to task descriptions and measurable goals and tracking measures as appropriate. Consolidation efforts included the following BMPs and tasks: • RC1-1 and RC1-2 • RC1-7, RC2-1, RC2-2, and RC2-3 • RC3-1, RC3-3, and CON1-4 • RC4-3 and RC4-4 • RC4-6, RC4-10, and RC4-11 • RC4-8 and RC4-9 • RC1-5, RC5-1, RC5-2, RC 5-3, and ILL3-3 • RC6-3 and RC8-1 • ILL1-1 and ILL1-2	BMP task descriptions are duplicative and consolidation would allow for more streamlined implementation, tracking, and reporting.

Table 3-2. BMP Crosswalk between Salem 2010 SWMP and proposed 2015 SWMP		
2010 BMP ID	2010 BMP tasks	Proposed 2015 BMP
RC1. Planning	RC1-1	PL-1. Stormwater Planning
	RC1-2	PL-1. Stormwater Planning
	RC1-3	OM-6. Asset Management and System Mapping
	RC1-4	EO-1. Staff Training and Coordination
	RC1-5	EO-3. Public Education and Outreach
	RC1-6	EO-2. Intergovernmental Coordination
	RC1-7	PL-2. Implement Stormwater CIP and Retrofit Projects
	RC1-8	EO-1. Staff Training and Coordination and EO-2. Intergovernmental Coordination
RC2. Capital Improvements	RC2-1	PL-2. Implement Stormwater CIP and Retrofit Projects
	RC2-2	PL-2. Implement Stormwater CIP and Retrofit Projects
	RC2-3	PL-2. Implement Stormwater CIP and Retrofit Projects
RC3. Update of Stormwater Management Design Standards	RC3-1	PC-1. Implement Stormwater Management Design Standards
	RC3-2	Deleted (see Table 3-1)
	RC3-3	Deleted (see Table 3-1)
	RC3-4	PC-2. Conduct Development Review Activities
RC4. Operations and Maintenance	RC4-1	OM-1. Street Sweeping and Debris Control
	RC4-2	OM-1. Street Sweeping and Debris Control
	RC4-3	EO-1. Staff Training and Coordination
	RC4-4	EO-1. Staff Training and Coordination and
	RC4-5	OM-2. Integrated Pest Management Procedures
	RC4-6	OM-3. Conveyance System Cleaning and Maintenance
	RC4-7	OM-5. Stream Cleaning Program
	RC4-8	OM-7. Public Stormwater Facility Inspection and Maintenance
	RC4-9	OM-7. Public Stormwater Facility Inspection and Maintenance
	RC4-10	OM-3. Conveyance System Cleaning and Maintenance
	RC4-11	OM-3. Conveyance System Cleaning and Maintenance
	RC4-12	OM-8. Private Stormwater Facility Maintenance Program
RC5. Public Education and Participation	RC5-1	EO-3. Public Education and Outreach
	RC5-2	EO-3. Public Education and Outreach
	RC5-3	EO-3. Public Education and Outreach
	RC5-4	Deleted (see Table 3-1)
RC6. Stormwater Management Program Financing	RC6-1	PL-3. Stormwater Funding
	RC6-2	Deleted (see Table 3-1)
	RC6-3	PL-3. Stormwater Funding

Table 3-2. BMP Crosswalk between Salem 2010 SWMP and proposed 2015 SWMP		
2010 BMP ID	2010 BMP tasks	Proposed 2015 BMP
RC7. Maintain and Update GIS System	RC7-1	OM-6. Asset Management and System wide Mapping
	RC7-2	OM-6. Asset Management and System wide Mapping
RC8. City Stormwater Grant Program	RC8-1	PL-3. Stormwater Funding
RC9. Legal/Ordinances	RC9-1	Deleted (see Table 3-1)
	RC9-2	PC-1. Implement Public Works Design Standards
	RC9-3	Deleted (see Table 3-1)
ILL1. Spill Prevention and Response Program	ILL1-1	IL-1. Spill Prevention and Response
	ILL1-2	IL-1. Spill Prevention and Response
	ILL1-3	IL-1. Spill Prevention and Response
	ILL1-4	OM-4. Pollution Prevention for Operations
ILL2. Illicit Discharge Elimination Program	ILL2-1	IL-2. Illicit Discharge Detection and Elimination
	ILL2-2	IL-2. Illicit Discharge Detection and Elimination
	ILL2-3	IL-2. Illicit Discharge Detection and Elimination
	ILL2-4	IL-3. Dry Weather Field Screening
	ILL2-5	IL-4. Contaminated Site Mapping
ILL3. Illegal Dumping Control Program	ILL3-1	OM-1. Street Sweeping and Debris Control
	ILL3-2	IL-2. Illicit Discharge Detection and Elimination
	ILL3-3	EO-3. Public Education and Outreach
	ILL3-4	EO-3. Public Education and Outreach
	ILL3-5	OM-1. Street Sweeping and Debris Control
IND1. Industrial Stormwater Discharge Program	IND1-1	IC-1. Industrial and Commercial Facility Review IC-2. Industrial and Commercial Site Inspections
	IND1-2	IC-1. Industrial and Commercial Facility Review IC-2. Industrial and Commercial Site Inspections
	IND1-3	IC-1. Industrial and Commercial Facility Review
	IND1-4	IC-1. Industrial and Commercial Facility Review
CON1. Construction Site Control Program	CON1-1	EC-1. Implement Erosion Control Requirements
	CON1-2	EO-4. Training for Construction Site Operators
	CON1-3	EC-1. Implement Erosion Control Requirements EC-2. Conduct Erosion Control Plan Review and Inspections
	CON1-4	PC-1. Implement Stormwater Management Design Standards
	CON1-5	EC-1. Implement Erosion Control Requirements EC-2. Conduct Erosion Control Plan Review and Inspections
MON1. Monitoring	MON1-1	Deleted (see Table 3-1)
	MON1-2	Deleted (see Table 3-1)
	MON1-3	Deleted (see Table 3-1)

Section 4
Service Area Expansions and Total Annual Pollutant Load Estimate

<u>Permit Requirements</u>

Schedule B.6: MS4 Permit Renewal Application Package

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

c. An updated estimate of total annual pollutant loads for applicable TMDL pollutants or applicable surrogate parameters, and the following pollutant parameters: BOD_5, 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.

This section of the permit renewal application provides both the description of anticipated service area expansions and the updated estimate of total annual stormwater pollutant loads. In accordance with the methodology and assumptions detailed in the City of Salem's (City's) 2008 permit renewal application, the updated estimate of total annual stormwater pollutant loads needs to account for projected annexations through the end of the permit term. Therefore, these two evaluations have been provided together in this section.

To address these requirements, this section 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 to estimate projected expansions of the City's NPDES MS4 service area.

4.1.1 Definition of Salem'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 its 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 right-of-way (ROW) associated with state highways and freeways. Therefore, the City's service area excludes ODOT ROW.

As of March 2015, Salem's NPDES MS4 service area is calculated to be 29,412 acres.

4.1.2 Identification of Projected Service Area Expansions

In Salem, three types of annexations may occur and result in expansion of the city limits and, in turn, expansion of the NPDES MS4 service area:

- **Applicant-initiated**: Annexation is initiated by the public in order to connect into City services. Applications are due 18 months prior to vote by the public. A cost is associated with the application and receipt of annexation, which often results in a multi tax-lot annexation territory to be processed under one application in order to cost-share.
- **City-initiated**: Annexation is initiated by the City in accordance with state law that requires annexation of enclaves. Since 2008, a limited number of enclave properties still require annexation.
- **Health and hazard**: Annexation is required primarily because of failing utilities (i.e., septic systems, water systems).

The applicant-initiated and City-initiated categories require voter approval and City Council approval, whereas the health and hazard category requires only City Council approval.

In April 2014 the Salem City Council approved new policy guidelines for processing annexations. New policy guidelines that are applicable to the identification of projected service area expansions for this effort include the following:

- Inclusion of adjacent ROW in the annexation territory
- Inclusion of adjacent properties and potential enclave properties in the annexation territory, only with full agreement by all parties
- Inclusion of the entire lot or parcel of record in the annexation territory

In order to identify areas projected to be annexed into Salem's city limits over the next permit term, staff in the Community Development Department reviewed current applicant-initiated annexations and known City-initiated annexations. Current planning includes annexations scheduled through 2018; properties forecasted for annexation have thus been identified up through that date. Therefore, future annexation areas can only be estimated through 2018.

A total of ten parcels have been identified for future annexation, totaling approximately 26.7 acres. These future annexation areas include City-initiated and applicant-initiated annexations that have already been approved by the voters and City Council as well as in-progress health and hazard annexations. The annexation areas are generally single lots, dispersed along the current outer city limits. A majority (over 20 acres) of the proposed annexations are zoned single-family residential, with the remainder of the area zoned multifamily residential and two parcels zoned industrial. Five of the ten annexations are city-initiated annexations that have been approved by voters and City Council but are not yet effective. These annexations are enclave annexations that, per the City's process, are zoned for and in residential use at the time of voter and City Council approval, and as such the effective date of annexation is delayed three years from approval.

Locations of anticipated service area expansions are shown on the MS4 maps, included in Appendix A of this permit renewal submittal.

4.2 Updated Estimate of Total Annual Pollutant Loads

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

The City of Salem submitted its original estimate of total annual pollutant loads in Part 2 of its 1996 NPDES MS4 permit application. Pollutant loads reflected the Salem MS4 permit area at that time (approximately 28,235 acres) and included ODOT ROW, which is a deviation from the current definition of the City's NPDES MS4 service area. Pollutant loads also reflected full-buildout land use conditions. Pollutant loads were calculated by drainage basin using land use-based event mean concentrations (EMCs) per City-specific monitoring data collected from January to May 1995. The U.S. Environmental Protection Agency's (EPA's) P-8 computer model, version 1.1 was used to conduct the analysis.

The City provided an updated estimate of total annual pollutant loads with its NPDES MS4 permit renewal application in 2008, which varied in modeling methods and assumptions from those used in 1996. Specifically, the City's NPDES MS4 service area was redefined to exclude ODOT ROW and include projected annexations through 2014 (the end of the permit term). The total modeled Salem MS4 permit area in 2008 was 29,848 acres. A spreadsheet loads model, using the EPA simple method equation, was developed and used for the analysis.

Modeling methods and assumptions used for this (2015) 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 projected annexations through the end of the permit term (2021). The total modeled MS4 permit area is 29,439 acres, which is less than the permit area assumed in 2008. Definition of the City's NPDES MS4 service area is outlined in Section 2.

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 of Salem, the Willamette TMDL (Middle Willamette subbasin) includes waste load allocations (WLAs) for bacteria *(E. coli).* The Molalla-Pudding TMDL includes WLAs for metals (iron and manganese), pesticides (total suspended solids [TSS] as a surrogate), and bacteria *(E. coli).* As described in the City's 2014 pollutant load reduction evaluation (PLRE), the TMDLs for iron and manganese are no longer valid, as the human-health criteria for these parameters changed in 2011. Therefore, bacteria *(E. coli)* and TSS are the TMDL parameters included in this evaluation.

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 EMCs, which were developed in 2008 as part of a coordinated effort between the Oregon Association of Clean Water Agencies (ACWA) and Oregon Phase I jurisdictions. The land use EMCs reflect monitoring data collected from all Oregon Phase I jurisdictions, and thus differ from the Salem-specific values used in the original permit application. Land use EMCs are calculated as a range reflecting the upper and lower 95 percent confidence limit and reflect general (commercial, residential, industrial, open space) land use categories. Table 4-1 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 2014 PLRE and calculate the 2015 TMDL benchmarks (see Section 5 and Appendix C of this permit renewal application).

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

Parameter	Land use	Count	Bootstrapped mean		
			95% lower confidence level (LCL)	Mean	95% upper confidence level (UCL)
Total suspended solids (TSS), mg/L	Commercial[c]	72	64	82	103
	Industrial	48	117	184	284
	Open space[a]	10	16	31	50
	Residential[b]	65	44	66	99
E. coli, CFU/100 mL (geomean)	Commercial[c]	52	573	1,247	2,409
	Industrial	58	154	438	1,004
	Open space[a]	9	57	87	124
	Residential[b]	65	970	1,656	2,651
BOD_5, , mg/L	Commercial[c]	22	8.5	11.9	16.6
	Industrial	23	26.1	39.6	56.1
	Open space[a]	3	2.4	3.3	4.2
	Residential[b]	28	5.9	8.1	10.8
COD, mg/L	Commercial[c]	26	51.8	65.1	81.5
	Industrial	25	76.8	102.6	134.1
	Open space[a]	9	11.1	19.6	27.6
	Residential[b]	36	37.4	50.9	66.0
Nitrate, mg/L	Commercial[c]	46	0.27	0.38	0.53
	Industrial	22	0.18	0.24	0.31
	Open space[a]	263	1.36	1.51	1.66
	Residential[b]	32	0.60	0.91	1.33
Total phosphorus, mg/L	Commercial[c]	26	0.28	0.38	0.50
	Industrial	25	0.40	0.51	0.64
	Open space[a]	8	0.095	0.12	0.15
	Residential[b]	36	0.23	0.34	0.48
Dissolved phosphorus, mg/L	Commercial[c]	46	0.09	0.11	0.14
	Industrial	21	0.10	0.17	0.27
	Open space[a]	261	0.04	0.04	0.04
	Residential[b]	30	0.08	0.11	0.15
Cadmium, total, µg/L	Commercial[c]	53	0.75	1.11	1.56
	Industrial	23	2.27	3.47	5.00
	Open space[a]	131	0.10	0.11	0.13
	Residential[b]	45	0.41	0.53	0.66

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

Parameter	Land use	Count	Bootstrapped mean		
			95% lower confidence level (LCL)	Mean	95% upper confidence level (UCL)
Copper, total, µg/L	Commercial[c]	26	20.8	28.6	38.2
	Industrial	26	33.8	45.5	58
	Open space[a]	10	2.0	2.5	3.0
	Residential[b]	33	10.5	13.4	17.1
Lead, total, µg/L	Commercial[c]	25	37.8	54.0	72.7
	Industrial	22	32.7	48.3	67.0
	Open space[a]	9	0.6	0.8	1.1
	Residential[b]	28	11.0	17.7	27.6
Zinc, total, µg/L	Commercial[c]	28	130	170	217
	Industrial	24	283	674	1353
	Open space[a]	9	6.3	7.8	9.5
	Residential[b]	39	77	104	134

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

a. Land use EMCs for open space are used to simulate parks and open-space land use.

b. Land use EMCs for residential are used to simulate single-family residential and multifamily residential.

c. Land use EMCs for commercial are used to simulate commercial and public facilities land use.

Full-buildout conditions (i.e., no vacant lands) were simulated in the spreadsheet loads model, consistent with the 2008 assumptions. As the City of Salem does not maintain an actual land use coverage map, the modeled land use categories are based instead on City zoning coverage. Zoning categories were reviewed and consolidated into those categories for which land use concentration information (per Table 4-1) exists. The City maintained consistent land use categories as the 2008 assumptions with the following exceptions. These exceptions are also reflected in the 2014 PLRE and 2015 TMDL benchmarks.

- A new land use category (public facilities) was developed to represent schools, hospitals, and large public properties with lower impervious area coverage than typical commercial development.
- Transportation is no longer a modeled land use category as it was in 2008. Transportation corridors have been assigned coverage based on the adjacent zoning. This change is due to the fact that transportation land use EMC data (used in 2008) is more reflective of arterial roads and highways and not local and collector streets, which compose a majority of the transportation area covered under the City's NPDES MS4 permit. This approach is considered to be more reflective of the current loading conditions anticipated.

Calculation of pollutant loads using the EPA simple method requires runoff coefficients reflective of each land use category. In 2014 for the PLRE, the City updated its land use-based impervious percentages to better reflect current development conditions. These updated impervious percentages by land use were used for this pollutant load calculation effort.

Table 4-2 summarizes the modeled land use areas and associated runoff coefficients used for this estimation of total annual pollutant loads.

Table 4-2. Modeled Area by Land Use and Impervious Percentage		
City zoning classification	Model area (ac)	Modeled impervious percentage (%)
Agriculture (AGR)	157.1	1
Single-family Residential (SFR)	14,401.8	40
Multifamily Residential (MFR)	2,100.3	55
Commercial (COM)	2,822.6	74
Industrial (IND)	4,131.6	63
Parks and Open Space (POS)	1,880.3	14
Public Facilities (PF)	3,945.3	27
Total permit area (includes annexations through the permit term)	29,439	

The annual pollutant load estimates are based on an average annual rainfall volume of 39.36 inches, consistent with the rainfall volume assumed in the 2008 NPDES MS4 permit renewal.

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 below in Table 4-3 for the applicable parameters. This updated estimate is presented in terms of a pollutant load range, due to 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.

Table 4-3. Updated Annual Estimate of Pollutant Loads for the City of Salem			
Pollutant load parameter	LCL (lb or counts)	Mean (lb or counts)	UCL (lb or counts)
Total suspended solids (TSS)	6,565,215	9,682,236	14,184,732
E. coli (counts)	3.30×10^{14}	6.12×10^{14}	1.05×10^{15}
BOD_5	1,092,025	1,582,253	2,195,447
COD	5,043,658	6,698,734	8,639,025
Nitrate	48,167	70,155	99,597
Total phosphorus	28,622	39,725	53,460
Dissolved phosphorus	8,984	12,626	17,705
Cadmium, total	89	130	180
Copper, total	1,824	2,428	3,140
Lead, total	2,261	3,374	4,796
Zinc, total	13,494	24,052	40,856

4.3 Qualitative Evaluation

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

Outcome from this evaluation is intended to support DEQ's determination as to whether the permit renewal will involve a substantial modification or intensification of the permitted activity, as referenced in the 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 of Salem expects to have only minor expansion of its service area during the next permit term (estimates from 2016 to 2021) and concludes that the expansion will not result in substantial increases in permitted area, runoff intensity, or pollutant loads. Support for this conclusion is detailed in the subsections below, as interpreted from Section 4.1 and 4.2.

4.3.1 Service Area Expansion

The City of Salem anticipates approximately 26.7 acres of service area expansion over the next 5-year permit term. This service area expansion represents less than 0.1 percent of the City's NPDES MS4 permit area anticipated in the year 2021, which is not a substantial increase in service area.

A majority of the proposed service area expansion will be zoned as residential or multifamily residential when annexed into the City. Two parcels are zoned industrial. In Salem, the service area expansions or annexations are often applicant-initiated in order to connect to City utility services or city-initiated enclaves; therefore, areas are often already developed by the time they are annexed. As outlined in Table 3-2, the anticipated, developed impervious percentage ranges from 40 to 60 percent, depending on land use. Vacant lands in and around the city typically are less than 10 percent impervious (PLRE, 2014). Therefore, with annexation, the imperviousness (or intensity per the NPDES MS4 permit language) of each site may increase slightly if the annexation property is classified as vacant, but the magnitude would vary widely, depending on the current site usage and development (prior to annexation).

At the present time, there is only one potential adjustment to the City's urban growth boundary (UGB) that could occur during the next permit term. The City of Salem's Community Development Department has identified a potential 27 acre UGB expansion necessary to accommodate a future bridge over the Willamette River. However, it is likely that the area will not be made part of the City's service area, and it is unlikely to be developed during the next permit term. As such it has not been included in this evaluation.

Widespread or large tract annexation of agricultural property is not commonplace and not anticipated over the next permit term.

4.3.2 Pollutant Load Impacts

With expansion of the service area, the pollutant load permitted under the City of Salem's NPDES MS4 permit would increase. However, the incremental increase in pollutant load generation would be mitigated by various programmatic and structural stormwater best management practices (BMPs) implemented by the City. As some pollutant load was likely already being generated by the property, 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 1997, the City has adaptively managed its stormwater program as detailed in both the City's Stormwater Management Plan (SWMP) (effective version dated 2010) and in the City's process outlined in the maximum extent practicable (MEP) 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.

In 2014, the City adopted stormwater design standards for water quality, which require installation of structural stormwater controls to mitigate pollutant discharges from new or redeveloping areas. In 2014, the City also prepared its stormwater retrofit strategy to outline how water quality treatment will be incorporated into existing development and with implementation of the City's capital improvement plan. Collectively, implementation of these policies will result in the ongoing, future installation of structural stormwater controls throughout existing development areas, redevelopment areas, and new development areas, including annexations. Typical structural stormwater controls include planter boxes, rain gardens, and swales, which are types of low-impact development (LID) practices that, in addition to direct treatment of stormwater runoff, also infiltrate stormwater runoff and limit pollutant load discharges through volume reduction.

As part of the City's 2014 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 in the city is generally the same or improving, even in consideration of service area expansions that have historically occurred and associated development and redevelopment activities. Most of the sites evaluated had either no trends observed or trends toward decreasing pollutant concentrations, indicating improved water quality.

Given the extensive efforts in implementing an effective stormwater program including source control 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 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**.

This section of the permit renewal application summarizes the City of Salem's (City's) total maximum daily load (TMDL) pollutant load reduction benchmarks in accordance with Schedule D.3.d of the City's NPDES MS4 permit.

Per Schedule D.3.d.ii (1-4), the TMDL benchmarks must reflect the City's commitment to achieving additional pollutant load reduction and progress towards achieving the TMDL wasteload allocation (WLA) during the next permit term. The TMDL 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.*

Detailed explanation of the four items above, including additional information related to pollutant modeling methods, assumptions, and results is provided in the City's Pollutant Load Reduction Evaluation and TMDL Benchmark Report (November 2014 and amended December 2015), which is included in Appendix C of this permit renewal application.

This section summarizes the relationship between the TMDL WLAs and benchmarks, lists the additional best management practices (BMPs) that will result in further reduction of TMDL pollutants, and summarizes the City's TMDL benchmarks. This section is organized as follows:

- Section 5.1: Relationship between TMDL WLAs and Benchmarks
- Section 5.2: BMP Identification
- Section 5.3: TMDL Benchmarks and Discussion

5.1 Relationship between TMDL WLAs and Benchmarks

The City must develop new TMDL pollutant load reduction benchmarks for each TMDL parameter where existing BMP implementation is not estimated to be achieving the WLA. By definition, TMDL benchmarks are estimates of pollutant load reduction in the future. They reflect current BMP implementation and projected BMP implementation over the next permit term.

The Willamette Basin TMDL (2006) and the Molalla-Pudding River TMDL (2008) reference the City of Salem as a designated management agency (DMA) due to urban stormwater discharge; the City's MS4 discharges either directly or via tributaries to the Middle Willamette River (under the Willamette Basin TMDL) or the Little Pudding River (under the Molalla-Pudding TMDL). Bacteria (*E coli*) is the applicable TMDL parameter. As a DMA for urban stormwater, the City is subject to WLAs for bacteria.

The City conducted a pollutant load reduction evaluation for bacteria in 2014. Based on results of the pollutant load reduction evaluation, the City is not estimated to be meeting TMDL WLAs for bacteria in any of the seven, modeled TMDL watersheds. Thus, the City is required to establish TMDL pollutant load reduction benchmarks for bacteria for the next permit term.

5.2 BMP Identification

To identify additional BMPs that will result in further TMDL pollutant reduction and to establish TMDL benchmarks, the City's public works and engineering staff collaborated to identify likely future public stormwater facility installations in conjunction with public works projects, stormwater capital improvement projects, and stormwater retrofits through 2021. The strategy and proposed implementation schedule for these projects is outlined in the City's 2014 Stormwater Retrofit Plan and the City's 5-year Capital Improvement Plan (CIP).

A total of 15 future capital projects, resulting in treatment of over 100 acres of previously untreated area were identified. Table 5-1 lists the proposed stormwater facility installations by TMDL watershed, facility type, and drainage area.

Table 5-1. 2015 TMDL Benchmark Status and Future Stormwater Facility Installations			
Waterbody	Season	2015 TMDL benchmark development	
		Future structural BMP installation	Total drainage area treated (ac)
Clark Creek	Summer	None.See discussion below.	N/A
	Fall, winter, spring		
Mill + Battle Creek	Summer	Wet pond	6.5
	Fall, winter, spring		
Pringle Creek Tributary	Summer	• Treatment train (filtration planter, swale, filter)[a] • Swale • Swale • Swale • Swale • Swale • Treatment train (planter, pollution control manhole)	30.3
	Fall, winter, spring		
Pringle Creek Direct	Summer	• Treatment train (filtration planter, swale, filter)[a]	1.8
	Fall, winter, spring		
Middle Willamette River Tributary	Summer	• Treatment train (swale, filter) • Lined, filtration planter • Swale • Wetland retrofit[b]	13.2
	Fall, winter, spring		
Middle Willamette River Direct	Annual	• Wetland retrofit[b] • Pollution control manhole • Lined, filtration planter	14.3
Little Pudding Tributaries	Annual	• Treatment train (filtration planter, filter) • Treatment train (swale, hydromodynamic separator, pollution control manhole	37.0

a. This CIP drainage area falls within the Pringle Creek direct and Pringle Creek tributary TMDL watersheds. Therefore, this project is shown as pertaining to both watersheds.

b. This CIP drainage area falls within the Middle Willamette direct and Middle Willamette tributary TMDL watersheds. Therefore, this project is shown as pertaining to both watersheds.

It should be noted that the TMDL benchmarks are based solely on proposed public structural BMP installations. This conservative assumption is due in part to the variable schedule of the private development activities (and private structural BMP installation schedules) and the unknown content and issuance date for the City’s reissued NPDES MS4 permit.

5.3 TMDL Benchmark Results and Discussion

The same spreadsheet loads model used for the pollutant load reduction evaluation and TMDL benchmarks 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. Table 5-2 provides TMDL benchmarks both as a load reduction and as a percentage load reduction. The load reductions are presented as a range to reflect the wide variability in stormwater data. Calculation of the TMDL benchmarks as a percentage load reduction allows for direct comparison between the WLAs established for bacteria.

Table 5-2. TMDL Benchmarks (2016–2021)

Waterbody	Season	WLA (%)[a]	TMDL benchmarks (% load reduction)[b], range	TMDL benchmarks (counts)[b], range
Clark Creek	Summer	94	None. See discussion below.	None. See discussion below.
	Fall, winter, spring	89	None. See discussion below.	None. See discussion below.
Mill + Battle Creek	Summer	89	0.6 to 1.0	2.59×10^{10} to 1.39×10^{11}
	Fall, winter, spring	81	0.6 to 1.0	3.86×10^{11} to 2.10×10^{12}
Pringle Creek Tributary	Summer	92	1.2 to 1.5	3.18×10^{10} to 1.23×10^{11}
	Fall, winter, spring	84	1.2 to 1.4	4.75×10^{11} to 1.80×10^{12}
Pringle Creek Direct	Summer	90	1.6 to 2.3	2.94×10^{9} to 1.79×10^{10}
	Fall, winter, spring	79	1.6 to 2.3	4.39×10^{10} to 2.67×10^{11}
Middle Willamette River Tributary	Summer	88	0.4 to 0.6	2.07×10^{10} to 8.45×10^{10}
	Fall, winter, spring	75	0.4 to 0.6	3.08×10^{11} to 1.30×10^{12}
Middle Willamette River Direct	Annual	75	1.1 to 1.4	4.59×10^{11} to 1.81×10^{12}
Little Pudding Tributaries	Annual	86	4.2 to 10.9	1.07×10^{12} to 8.49×10^{12}

a. *Bacteria WLA are expressed as a percent load reduction.*

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

The TMDL benchmarks presented in Table 5-2 are conservative estimates of the pollutant load reduction anticipated during the upcoming MS4 permit term with the use of public structural BMPs alone. However, the city's overall stormwater program is comprised of non-structural BMPs, programmatic activities and the ongoing implementation of structural BMPs. Therefore, the TMDL benchmarks do not reflect the full range of pollutant load reduction anticipated through implementation of the stormwater program. Additional load reduction is expected through the following:

- Non-structural and source control BMPs (e.g., erosion control, illicit discharge detection and elimination, street sweeping, public education, pet waste management activities, operation and maintenance) per the City's Stormwater Management Plan (SWMP).
- Targeted source identification and elimination efforts for bacteria in the Clark Creek TMDL watershed.
- Additional public and private structural BMPs, installed as retrofits and designed in conjunction with the 2014 City of Salem Stormwater Design Standards.

It should be noted that the City also prepared a WLA attainment assessment for DEQ in November 2014, which indicated that achievement of the WLA would require construction and maintenance costs that far exceed the City's definition of maximum extent practicable (MEP). As such, progress toward the WLA, and not achievement of the WLA, is Salem's goal for the TMDL benchmarks.

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 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.

This section of the permit renewal application provides the fiscal evaluation including a summary of stormwater-related expenses incurred from fiscal year (FY) 2010-11 through FY 2015-16 and projections of utility rate revenue through FY 2020-21. This section is organized as follows:

- Section 6.1: Funding Summary for Current Permit Cycle
- Section 6.2: Projected Program Allocations for Next Permit Cycle

6.1 Funding Summary for Current Permit Cycle

Program costs associated with stormwater management are included in the annual operational budget for multiple divisions and sections in the Public Works Department, and have been under the umbrella of the Utility Fund (previously Water and Sewer Fund) since FY 1990-91. The Utility Fund (Fund 310) is an enterprise fund, which means its expenses are fully funded from rates and fees associated with water, wastewater, and stormwater services. No General Fund monies are received except for minor amounts as payments for direct services provided.

Wastewater rates, which are comprised of a flow component (based on winter average water consumption) and a fixed user charge had been the primary source of funding for stormwater services for over 20 years. Recognizing the need for a more equitable and dedicated funding source for stormwater programs, staff incorporated a specific BMP (RC6 – Stormwater Management Program Financing) into the 2010 SWMP with the expressed goal of having a stormwater utility in place by the end of the current permit cycle (December 2015).

In 2009, Public Works began researching options for the development of a stormwater utility that would be funded by a separate stormwater service charge. On December 6, 2010, Salem City Council adopted an ordinance that created a stormwater utility with a separate stormwater fee. The stormwater fee consists of both a base fee and a fee that is calculated based on the impervious surface area associated with each ratepayer's property. In comparison to the wastewater rates, the new stormwater funding mechanism is better aligned with the impacts of impervious surfaces. Initial implementation of the stormwater utility began on January 1, 2013, and will be phased in over a period of four years. The complete separation of stormwater and wastewater rates will occur in January 2016.

Table 6-1 provides a summary of stormwater program expenditures through the current permit cycle. Adopted stormwater-related budgets have been compiled for City Sections directly involved with stormwater management activities. These annual Section budgets include stormwater-related costs associated with personal services as well as materials and services. Indirect costs, construction costs for stormwater capital improvement projects (CIP), and debt from previous CIPs are reflected in the total annual budgeted amounts.

Table 6-1. Adopted Stormwater-Related Budgets

Operating Costs	FY 2010-11	FY 2011-12	FY 2012-13	FY 2013-14	FY 2014-15	FY 2015-16
Stormwater Operations & Maintenance	1,675,250	1,840,780	1,908,170	2,061,450	2,164,930	2,602,320
Stormwater Quality	1,374,030	1,480,740	1,567,700	1,698,400	2,010,870	1,904,310
Cleaning	368,042	504,590	513,058	389,649	386,432	381,540
T.V. Inspection	173,651	188,273	184,985	185,912	233,992	325,211
Water and Environmental Resources	278,146	322,292	165,018	105,086	0[1]	0[1]
Environmental Services	227,374	246,138	243,673	250,029	296,213	297,129
Planning & Development	336,938	483,964	515,860	723,198	990,278	880,797
Laboratory	35,035	36,023	33,877	32,092	28,970	40,908
Operations Administration	121,227	124,480	125,136	129,070	207,124	328,539
Utility Billing	259,851	287,969	303,960	319,263	361,884	622,690
Dispatch	56,619	50,923	66,311	69,999	72,963	92,660
Debt for Capital	763,247	766,642	770,957	767,005	738,138	740,090
Department Administration and Indirect Costs (Nondivisional)	1,187,383	1,300,082	1,705,904	1,780,409	2,035,822	1,632,222
Nondivisional (Street Sweeping, Watershed Grants, HazMat/Emergency Management)	1,079,550	1,102,230	1,207,070	1,427,740	1,377,770	1,399,130
Budgeted Capital Improvements	2,767,380	4,549,390	6,621,520	6,792,390	5,981,470	4,803,080
TOTAL	10,703,723	13,284,516	15,933,199	16,731,692	16,886,855	16,050,626

[1]. Water and Environmental Resources Section was eliminated at the end of FY 2013-14.

6.2 Projected Program Allocations for Next Permit Cycle

Anticipated rate revenue from the Utility Fund over the next five years (next permit cycle) is provided in Figure 6-1. New utility rates are adopted by City Council every two years. In October 2014, City Council adopted Resolution No. 2014-58, approving a revenue slope and associated rates of 3% each January 2015 and January 2016. These increases, as well as an assumed 3% annual increase thereafter, are reflected in the figure below. Adequate funding for the stormwater program is expected through the next MS4 permit cycle.

Salem uses a Cost of Service model to set rates for each of the three utilities. Rates are based on anticipated demand for each service (volume of water to be treated and delivered, volume of wastewater to be treated and returned to the river, volume of stormwater to be conveyed) as well as assumptions about the number of customers, cost of services to be delivered, including maintenance and capital requirements. Reserves are established for bonded debt, operations, and rate stabilization. These reserves help to provide financial stability for a revenue stream that can vary based on weather and customer demand.

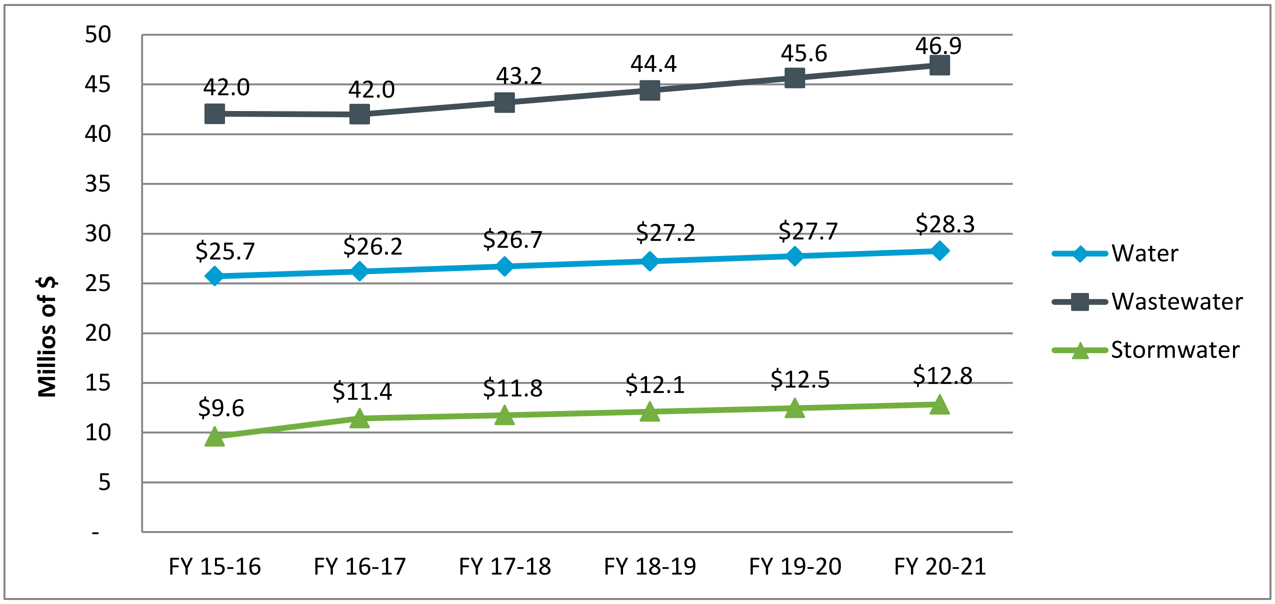

Figure 6-1. Anticipated Utility Fund Rate Revenue

Through 2015, the stormwater program continues to be funded in part by wastewater rates. In January 2016, rates for stormwater and wastewater will be fully separated. Future rate cycles may support different rate increases for water, wastewater, and stormwater in the future based on system requirements.

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 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 application provides a summary of proposed changes to the City's stormwater monitoring program and an updated monitoring program objectives matrix. The proposed City of Salem Surface Water and Stormwater Monitoring Plan (Plan) is provided as Appendix D in this permit renewal application.

In conjunction with the Maximum Extent Practicable (MEP) Evaluation process described in Section 2, the City's current (2011) Plan was reviewed in accordance with results of monitoring conducted over the last permit term and other evaluations and reports completed over the permit term. The City is proposing minor changes to the Plan, as listed below:

- Minor language and date changes throughout. Document reorganization to better reflect routine monitoring versus storm-event based monitoring.
- Addition of a weather forecasting and storm sampling response section under the section related to storm-event based monitoring.
- Reduction in the number of instream storm-event based monitoring locations from 25 to 15.
- Addition of three continuous instream monitoring stations.
- Adjusted the monitoring location of residential land use stormwater monitoring location.
- Adjusted the macroinvertebrate sites from three locations on Clark and Pringle Creeks to four locations on Battle and Waln Creeks.
- Removal of pesticide monitoring and mercury monitoring, as current permit commitments have been met.
- Adjusted the monthly sampling parameters for more consistency between monitoring locations. Changes include removal of alkalinity, total solids, and total dissolved solids, and the addition of total suspended solids (TSS), metals, and hardness for all sites.

Table 7-1 is the City's environmental monitoring objectives matrix, updated to reflect these proposed changes to the Plan. Table 7-2 is the City's program monitoring objective matrix, reflecting program components referenced in the Plan.

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Table 7-1. Environmental Monitoring Objectives

Stormwater Environmental Monitoring Program Element	Program Description	DEQ MS4 Monitoring Objectives					
		1 Evaluate the source of the 2010 303(d) listed pollutants applicable to the permit area	2 Evaluate the effectiveness of 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	6 Assess progress towards meeting TMDL pollutant load reduction benchmarks
Instream Storm	Three locations, grab and composite samples are taken instream during storm events for a total of 15 events.	Applicable 303(d) parameters will be monitored at in-stream storm event monitoring sites.	Data will be used to support the evaluation of the effectiveness of current structural and non structural BMPs within each catchment.	Data will contribute to the assessment and characterization of MS4 runoff discharges.	Data will contribute to the evaluation of long term trends in receiving waters. Monitoring element was established in 2011.	Data will contribute to the assessment of chemical effects of MS4 runoff on receiving waters.	*E.coli* and TSS data will assist in understanding progress toward TMDL wasteload allocations and benchmarks.
Stormwater	Three locations, grab and composite samples are taken in pipe during storm events for a total of 15 events.	Land use based monitoring may contribute to the source evaluation of 303(d) pollutants.	Data will be used to support the evaluation of the effectiveness of current structural and non structural BMPs within each catchment.	Data will contribute to characterization of MS4 runoff based on land use, geographical, and seasonality.	Data will assist in the interpretation of status and trends in receiving waters.	Data will contribute to the understanding of the chemical effects of MS4 discharges that enter receiving waters.	*E.coli* and TSS data will assist in understanding progress toward TMDL wasteload allocations and benchmarks.
Continuous Instream	Data collected every 15 minutes at 13 locations, 11 collect water quality and stage data, 2 are stage only.	303(d) pollutants are measured indirectly through indicator parameters.	Data will be used to support the evaluation of the effectiveness of current structural and non structural BMPs within each catchment.	Data will support seasonal, land use, and geographical characterization.	Data will contribute to the evaluation of status and trends in receiving waters. Monitoring element established in 2006.	Data may contribute to the assessment of chemical and physical effects of MS4 runoff on receiving waters.	May provide data in the long-term that helps assess/understand if progress is being made in meeting TMDL pollutant load reduction benchmarks.
Monthly Instream	24 locations, consists of grab samples taken once a month.	Applicable 303(d) parameters monitored. Upstream/downstream configuration assists with source identification.	Data will contribute to the identification of specific watersheds for focused structural and non-structural BMP efforts.	Data will support seasonal, land use, and geographical characterization when collected during storm events.	Data will contribute to the evaluation of status and trends in receiving waters. Established monitoring element, initiated in 2001.	Data may contribute to the assessment of chemical effects of MS4 runoff on receiving waters when collected during storm events.	*E. coli* (all sites) and TSS (West Fork Little Pudding) data will be used in trends analysis to gain an understanding of progress towards meeting the TMDL wasteload allocations and benchmarks.
Macro-invertebrate	Four locations, each location is sampled twice during the permit term.	This monitoring element is not designed to meet this objective.	Data collected may help support characterization of stream health and overall effectiveness of applied BMPs.	Data collected may help support characterization of stream health and overall effects of stormwater runoff.	Data will be used to assess trends in biological diversity and abundance.	Data will contribute in assessing the biological effect of MS4 runoff on receiving waters.	This monitoring element is not designed to meet this objective.

Table 7-2. Program Monitoring Objectives

Program Monitoring Elements	DEQ MS4 Monitoring Objectives					
	1 Evaluate the source of the 2010 303(d) listed pollutants applicable to the 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	6 Assess progress towards meeting TMDL pollutant load reduction benchmarks
Dry Weather Outfall Screening	May contribute to source identification of 303(d) pollutants.	Information gathered will contribute to the evaluation of SWMP BMPs. e.g., Illicit Discharge Elimination Program.	*This monitoring element is not designed to meet this objective.*	*This monitoring element is not designed to meet this objective.*	*This monitoring element is not designed to meet this objective.*	*This monitoring element is not designed to meet this objective.*
Literature Review	Literature review during permit term may contribute to the understanding of the source of 303(d) pollutants and most applicable BMPs.	Literature review will include BMP performance, removal efficiency, and life cycle cost may contribute to the evaluation and prioritization of BMPs.	*No literature review will be done to address this objective.*	*No literature review will be done to address this objective.*	Literature review during permit term may contribute to the understanding of the effects of MS4 runoff on receiving waters.	*No literature review will be done to address this objective.*
Data Evaluation/Trends	Helps contribute to 303(d) source evaluations	Helps contribute to annual report and end of permit term evaluations, including pollutant load reduction evaluations and benchmarks.	Helps contribute to annual report and end of permit term evaluations, including pollutant load reduction evaluations and benchmarks.	Helps contribute to annual report and end of permit term evaluations.	Helps contribute to annual report and end of permit term evaluations.	Used in the end of permit term TMDL pollutant load reduction evaluations and benchmark analysis.

Appendices

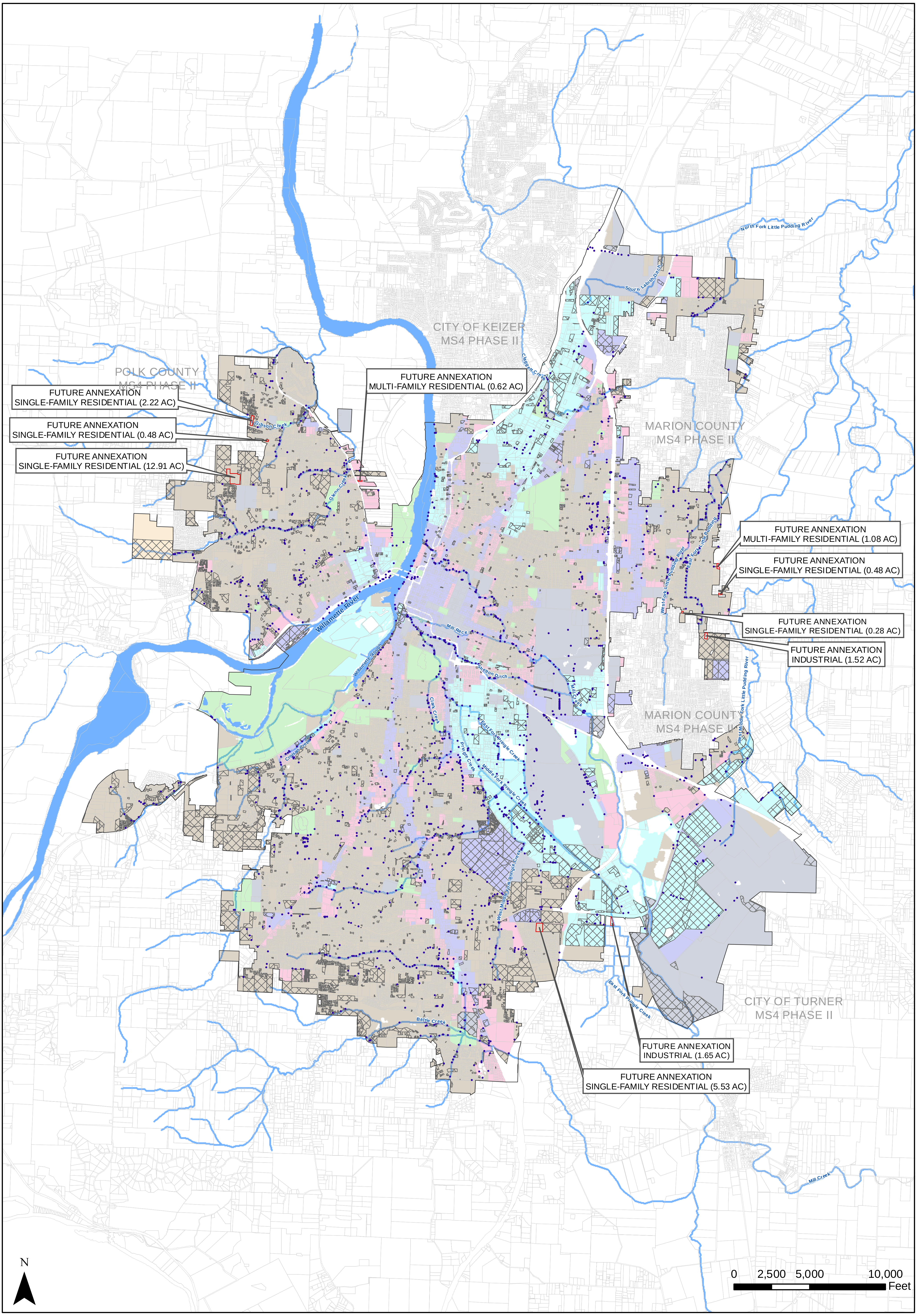
A MS4 Maps

B Proposed SWMP

C Pollutant Load Reduction Evaluation and TMDL Benchmark Report

D Proposed Monitoring Plan

Appendix A: MS4 Maps



CITY OF SALEM AT YOUR SERVICE

DECEMBER 2015

CITY OF SALEM MAPPING SUBMITTAL

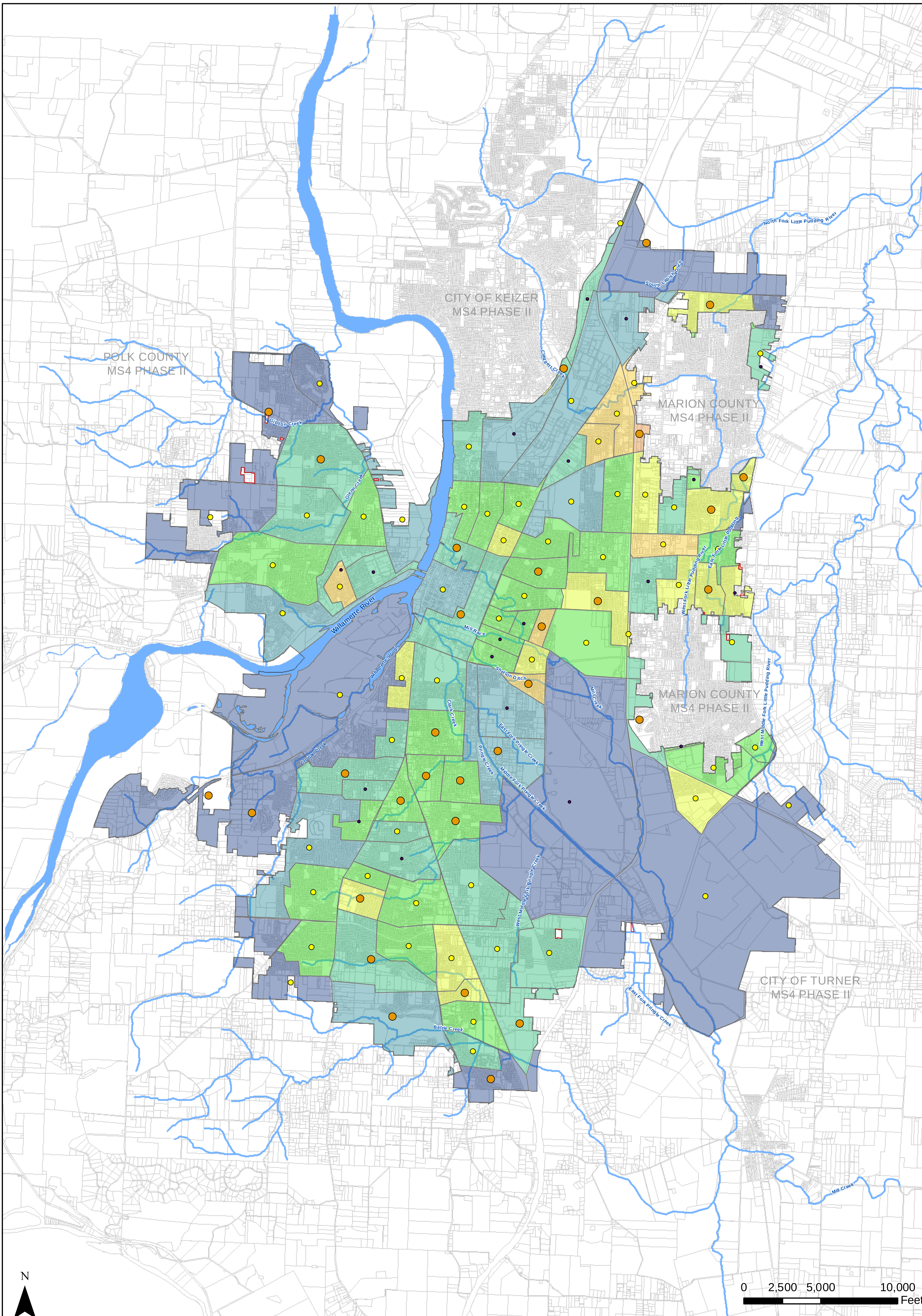
PERMIT RENEWAL APPLICATION
PERMIT #101513

MAP 1: SERVICE AREA AND LAND USE

ZONING (2015)

- ARICULTURE (AGR)
- COMMERCIAL (COM)
- INDUSTRIAL (IND)
- MULTI-FAMILY RESIDENTIAL (MFR)
- PARKS AND OPEN SPACE (POS)
- PUBLIC PROPERTY (PP)
- SINGLE-FAMILY RESIDENTIAL (SFR)

- MS4 OUTFALLS
- CREEKS
- SALEM CITY LIMITS
- FUTURE ANNEXATION
- VACANT (VAC)
- TAXLOTS



CITY OF SALEM MAPPING SUBMITTAL

PERMIT RENEWAL APPLICATION
PERMIT #101513

MAP 2: POPULATION DENSITY AND GROWTH PROJECTION

CITY OF Salem AT YOUR SERVICE

DECEMBER 2015

2015 POPULATION DENSITY PER SQUARE MILE

< 1000, 1,001 - 3000, 3001 -, 5001 -, 7001, 9001 -, 11001 -

ESTIMATED 10-YR POPULATION GROWTH

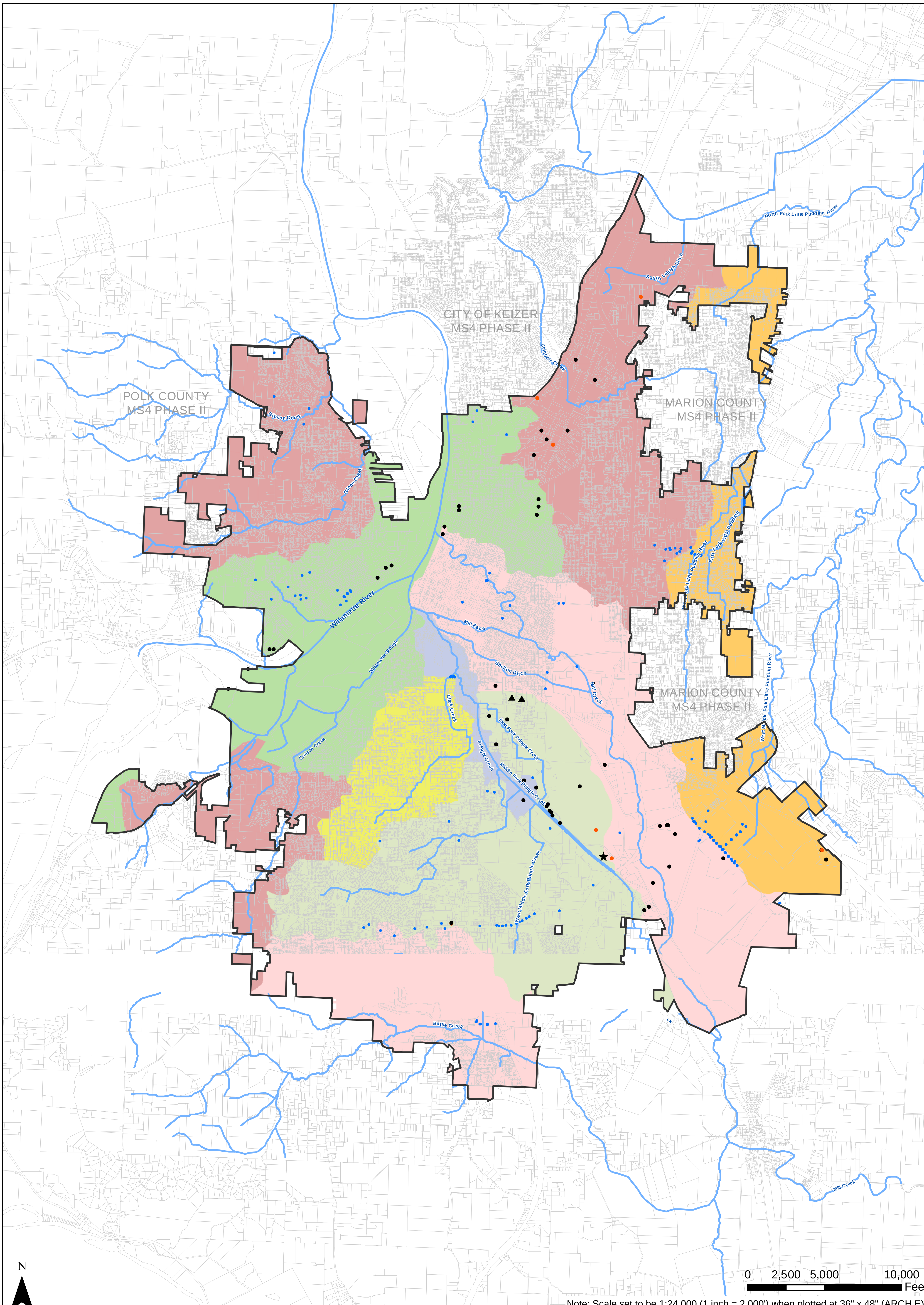
- < 0%
- 0-5%
- 5-25%

CREEKS

SALEM CITY LIMITS

FUTURE ANNEXATION

TAXLOTS



CITY OF SALEM MAPPING SUBMITTAL

PERMIT RENEWAL APPLICATION
PERMIT #101513

City of Salem AT YOUR SERVICE

JULY 2015

MAP 3: PUBLIC FACILITIES

CREEKS
SALEM CITY LIMITS
TAXLOTS
SOLID WASTE SITES (OPEN AND CLOSED)
NPDES PERMITTED FACILITIES (1200-Z AND 1200-A)
PUBLIC FACILITIES AND PROPERTIES WITH MS4
MAJOR STRUCTURAL CONTROLS
OPERATIONS - STREET SWEEPING STORAGE
OPERATIONS YARD

TMDL WATERSHEDS
CLARK CREEK
LITTLE PUDDING
PRINGLE CREEK TRIBUTARIES
PRINGLE CREEK DIRECT
MILL CREEK & BATTLE CREEK
MIDDLE WILLAMETTE DIRECT
MIDDLE WILLAMETTE TRIBUTARIES

Appendix B: Proposed SWMP

CITY OF Salem AT YOUR SERVICE

City of Salem Stormwater Management Plan (2015)

November 2015

Stormwater Management Plan (2015)

Overview

In accordance with the City of Salem's (City's) Municipal Separate Storm Sewer (MS4) National Pollutant Discharge Elimination System (NPDES) Permit, Permit number 101513 and effective upon issuance of the renewed permit, the City implements the following Stormwater Management Plan (SWMP).

This version of the SWMP is based on an internal review process in accordance with the City's Adaptive Management Approach (2011) and the 2015 NPDES MS4 Permit Renewal Application. This SWMP has been updated to better align and correspond with permit language reflected in the City's current, issued NPDES MS4 permit.

Organization

The SWMP is organized into the eight major stormwater program elements listed below. These eight elements correspond to those outlined in the current 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: Structural Stormwater Controls Operation and Maintenance Activities

The City's stormwater program activities are organized into BMPs with numbering and titles based on the elements listed above. The City's BMP categories and alignment with the program elements are listed below:

BMP numbering	BMP category	Corresponding program element
IL	Illicit Discharge Detection and Elimination	Element 1
IC	Industrial and Commercial Facilities	Element 2
EC	Erosion and Sediment Control	Element 3
EO	Education and Outreach	Element 4
PI	Public Involvement and Participation	Element 5
PC	Post-Construction Stormwater Management	Element 6
PL	Planning	Element 7
OM	Operations and Maintenance	Elements 7 and 8

Element 1. Illicit Discharge Detection and Elimination

The City's NPDES permit requirements for Element 1 are listed below. In some cases, language for the listed permit requirements has been condensed or consolidated. Applicable provisions are outlined under Schedule A.4.a of the City's MS4 NPDES permit. See Table 1 for a description of the City's BMPs that address the permit requirements listed under Element 1.

SWMP Element 1. Illicit Discharge Detection and Elimination				
	Applicable BMPs			
Schedule A.4.a Permit Requirement	IL-1. Spill Prevention and Response	IL-2. Illicit Discharge Detection and Elimination Program	IL-3. Dry Weather Field Screening	IL-4. Contaminated Site Mapping
i. Prohibit, through ordinance or other regulatory mechanism, illicit discharges into the permittee's MS4.		X		
ii. Describe enforcement response procedures by November 1, 2011.	**Activity was completed and submitted to DEQ by November 1, 2011.**			
iii. Develop or identify pollutant parameter action levels that will be used as part of the field screening and analysis….The pollutant parameter action levels and rationale for using the action levels must be documented in an enforcement response plan or similar document, and reported to the Department by July 1, 2012.	**Activity was completed and submitted to DEQ by July 1, 2012.**			
iv. Conduct dry-weather inspection activities during the term of the permit. By July 1, 2012, the dry-weather inspection activities must include identified priority locations documented by the permittee and field screening at these locations at a minimum of once per calendar year…. The dry-weather field screening activities must be documented and include: 1) General observation; 2) Field Screening; and 3) Laboratory Analysis.	**Activity was completed and submitted to DEQ by July 1, 2012.**		X	
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.			X	

SWMP Element 1. Illicit Discharge Detection and Elimination

Schedule A.4.a Permit Requirement	Applicable BMPs: IL-1. Spill Prevention and Response	Applicable BMPs: IL-2. Illicit Discharge Detection and Elimination Program	Applicable BMPs: IL-3. Dry Weather Field Screening	Applicable BMPs: IL-4. Contaminated Site Mapping
vi. Maintain a system for documenting illicit discharge complaints or referrals, and suspected illicit discharge investigation activities.	X	X		
vii. Once the source of an illicit discharge is determined, the permittee must take appropriate action to remove illicit discharges…within 5 working days. If elimination will take more than 15 days…the 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. In lieu of developing and implementing an individual action plan…the permittee may document and implement response procedure, a response plan, or similar document….		X		
viii. Describe and implement procedures to prevent, contain, respond to, and mitigate spills that may discharge into the MS4….	X			
ix. In the case of a known illicit discharge that originates within the permittee's MS4 regulated area and that discharges directly to a storm sewer system or property under the jurisdiction of another municipality, the permittee must notify the affected municipality as soon as practicable, and at least within one working day of becoming aware of the discharge.		X		
x. In the case of a known illicit discharge that is identified within the 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 permittee must notify the contributing municipality or municipality with jurisdiction as soon as practicable, and at least within one working day of identifying the illicit discharge.		X		
xi. Maintain maps identifying known permittee-owned MS4 outfalls discharging to waters of the State. The dry-weather screening priority locations must be specifically identified on maps by July 1, 2012….	**Activity was completed and submitted to DEQ by July 1, 2012.**			
			X	X
xii. Unless (the following non-stormwater discharges) are identified as a significant source of pollutants to waters of the State by the permittee or the Department, they are not considered illicit discharges and are authorized by this permit (see Schedule A.4.a.xi for list of discharges)…. If any of these non-stormwater discharges under the permittee's jurisdiction is a significant source of pollutants, the permittees must develop and require implementation of appropriate BMPs to reduce the discharge of pollutants associated with the source.		X		

Table 1. Illicit Discharge Detection and Elimination BMPs

BMP name	BMP implementation	Annual tracking measures
IL-1. Spill Prevention and Response (Previously ILL1-1, ILL1-2, ILL1-3)	**Responsible Parties**: Salem Fire Department and Public Works Department (Environmental Services) **Implementation Schedule**: Ongoing **BMP Description**: Salem Fire (SF) and Environmental Services (ES) provide immediate response to reports of spills, illicit discharges or any unusual substances noticed by the public or City crews. SF has the lead role for emergency response, structural fires, and all major vehicular accidents. ES staff provides assistance when requested by the on-scene incident commander. For small discharges, ES may provide first response for containment and cleanup, as necessary. ES leads source investigation efforts to bill responsible parties for clean-up costs if identified. SF and ES will continue to implement the existing spill prevention and emergency response program in order to coordinate timely responses to, and clean-up of emergency response sites and structural fires. New spill response activities will be proposed and implemented as appropriate, and coordination and cooperation among other relevant agencies and ODOT will be maintained and improved. SF's Standard Operation Guideline (SOG) #2.6.3 includes procedures designed to control the release of materials to the MS4 from fire-fighting training activities. Additional procedures have been documented in SOG #2.1.21 that are designed to protect the MS4 from general maintenance and cleaning activities at the fire stations. City staff will continue to conduct daily City vehicle and equipment inspections for leaks/repairs, will review current procedures on an ongoing basis, and implement improvements as necessary. **Measurable Goals**: • Continue to implement the spill prevention and emergency response program. Review and revise the program as needed. • Continue to implement the daily equipment inspection program.	• Report refinements to cleanup procedures for vehicular accidents and structural fires. • Track the number and category of spill events responded to and any associated enforcement actions. • Report revisions to the daily equipment inspection program.
IL-2. Illicit Discharge Detection and Elimination Program (Previously ILL2-1, ILL2-2, ILL2-3, ILL3-2)	**Responsible Parties**: Public Works Department (Environmental Services, Stormwater Services, Wastewater Collections) **Implementation Schedule**: Ongoing **BMP Description**: The illicit discharge detection and elimination program collectively consists of water quality monitoring (see also BMP IL-3), TV inspections of piped conveyance systems (see BMP OM-3), responding to and investigating complaints, collaboration with Wastewater Collection Services to eliminate cross connections, and using wastewater pretreatment inspections to address both stormwater and wastewater issues. The City will continue to provide the 24-hour Public Works Dispatch Reporting Center to receive and respond to calls regarding illegal dumping and other environmental complaints/problems. The hotline is advertised on the City website, utility bill inserts, business cards, and public brochures. Environmental Services (ES) responds to reports of unusual discharges or suspicious water quality conditions within the stormwater system and urban streams. Where able, ES will identify sources/causes and implement appropriate corrective actions. A database is used to document associated activities. ES staff will continue inspections of the City's permitted wastewater users, through the pretreatment program, verifying the proper handling and disposal of both wastewater and stormwater. ES and Stormwater Services staff will work with Wastewater Collections to identify and correct cross-connections between the sanitary sewer and stormwater systems.	• Record number and types of reported illegal dumping incidents. • Track mitigation actions in response to illicit discharges. • Track media outreach when a discharge warrants. • Track the number of pretreatment inspections conducted and associated findings pertinent to stormwater. • Document number of cross-connections identified and corrective actions taken.

Table 1. Illicit Discharge Detection and Elimination BMPs		
BMP name	**BMP implementation**	**Annual tracking measures**
IL-2 (continued)	**Measurable Goals**: • Continue to operate the 24-hour Public Works Dispatch Reporting Center. • Assign reports to appropriate City staff, and respond to reports of illicit discharges and suspicious water quality conditions. • Maintain database to document unusual/suspicious discharges, sources found, and corrective actions taken. • Inspect the City's permitted wastewater users for proper management of wastewater and stormwater. • Review stormwater and ambient stream monitoring data to identify possible cross-connection discharges into the stormwater system. • Maintain communications with Wastewater Collections and other City staff to identify any system cross-connection problems.	
IL-3. Dry Weather Field Screening (Previously ILL2-4)	**Responsible Party:** Public Works Department (Stormwater Services) **Implementation Schedule**: Annual **BMP Description**: Dry weather field screening and associated water quality monitoring results may alert the City to high levels of pollutants that might be related to upstream spills or illicit discharges. Any unusual findings are investigated and tracked to identify the cause. The City continually evaluates their processes for identifying and eliminating illicit discharges. Stormwater Services implements a storm sewer outfall dry weather inspection and monitoring program per the Dry Weather Outfall and Illicit Discharge Screening Plan. **Measurable Goals**: • Prioritize outfalls for storm sewer outfall inspection and monitoring and inspect a minimum of 35 outfalls annually. • Develop GIS geodatabase for storage and display of outfall inspection data. • Continue to review and refine the Dry Weather Outfall and Illicit Discharge Screening Plan.	• Document revisions made to the Dry Weather Outfall and Illicit Discharge Screening Plan. • Document priorities for monitoring and inspection. • Track the number of outfall inspections conducted, results of inspections, and associated follow-up activities.
IL-4. Contaminated Site Mapping (Previously ILL2-5)	**Responsible Parties**: Public Works Department (Environmental Services) and Information Technology (GIS Section) **Implementation Schedule**: Ongoing **BMP Description**: Environmental Services (ES) provides updates on known contaminated sites to the Information Technology (IT) workgroup to be included in the City’s GIS system. The workgroup maintains an inventory of contaminated sites in the GIS system. With input from other City departments ES will continue to identify areas where there has been a substantial spill or there is the potential for a spill or illicit discharge are documented. These areas are identified based on activities on site, history of problems, or specific industries. These contaminated areas are mapped in the GIS system for use across City departments. **Measurable Goals**: • Continue to identify and map contaminated sites in the GIS system.	• Track number of contaminated sites added to GIS system.

Element 2. Industrial and Commercial Facilities

The City's NPDES permit requirements for Element 2 are listed below. In some cases, language for the listed permit requirements has been condensed. Applicable provisions are outlined under Schedule A.4.b. of the City's MS4 NPDES permit. See Table 2 for a description of the City's BMPs that address the permit requirements listed under Element 2.

<table>
<tr><th colspan="3">SWMP Element 2. Industrial and Commercial Facilities</th></tr>
<tr><th rowspan="2">Schedule A.4.b Permit Requirement</th><th colspan="2">Applicable BMP</th></tr>
<tr><th>IC-1. Industrial and Commercial Facility Review</th><th>IC-2. Industrial and Commercial Site Inspections</th></tr>
<tr><td>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.</td><td>X</td><td></td></tr>
<tr><td>ii. 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.</td><td>X</td><td></td></tr>
<tr><td rowspan="2">iii. 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 January 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.</td><td colspan="2">Activity was completed and submitted to DEQ by January 1, 2013.</td></tr>
<tr><td>X</td><td>X</td></tr>
</table>

<table>
<tr><th colspan="3">Table 2. Industrial and Commercial Facility BMPs</th></tr>
<tr><th>BMP name</th><th>BMP implementation</th><th>Annual tracking measures</th></tr>
<tr><td>IC-1. Industrial and Commercial Facility Review
(Previously IND1-1, IND1-2, IND1-3, IND1-4)</td><td>Responsible Party: Public Works Department (Environmental Services)
Implementation Schedule: Ongoing
BMP Description: Environmental Services (ES) manages the Wastewater Industrial Pretreatment Program, under SRC Chapter 74, that involves permitting of industries to meet local discharge limits set by the EPA, DEQ, and the City. This program provides the framework for this BMP.
During plan review activities, ES reviews industrial and commercial facilities for the potential of requiring additional stormwater source controls based on the activities at the specific facility.
ES works with DEQ to coordinate the permitting and compliance processes for industrial users in the Salem area, including DEQ-issued 1200-Z permitted sources, underground storage tank (UST) removal, and site remediation permits issued by DEQ for sources/sites within the City. Coordination efforts include receiving information on proposed 1200-Z permits, commenting on proposed permits, and meeting periodically with DEQ on coordination efforts.
In addition, surveys are sent to applicable business classes (restaurants, metal finishers/platers, radiator shops, dry cleaners, printing shops, photo processors, etc.) as part of the industrial pretreatment program for wastewater. Customers are surveyed regarding major onsite activities to identify potential locations for public education, future sampling, and tracking down illicit discharges.
ES continues to communicate with the City's industrial users through a variety of materials and means. This activity is principally associated with the City's wastewater Pretreatment Program, but is used as a vehicle to address stormwater-related issues as well.
Measurable Goals:
Review industrial/commercial plans for additional stormwater source control needs.
Send surveys to new customers as accounts are opened. Enter survey results into database as surveys are returned.
Send targeted email communication to each permitted wastewater user at least once per year.</td><td>Maintain database of plans reviewed and final inspections conducted.
Track number of surveys sent.
Track number of surveys returned and entered into database.
Track targeted communication/education to specific industries.</td></tr>
<tr><td>IC-2. Industrial and Commercial Site Inspections
(Previously IND1-1, IND1-2)</td><td>Responsible Party: Public Works Department (Environmental Services)
Implementation Schedule: Ongoing
BMP Description: Environmental Services (ES) inspects stormwater systems while conducting inspections of City-permitted industrial wastewater users (Pretreatment Program). Inspections conducted confirm whether appropriate source controls were built and are being maintained in accordance with approved design plans.
Measurable Goals:
Inspect stormwater systems while conducting inspections of City-permitted wastewater users. Inspections shall confirm that construction and source control installations were completed in accordance with approved plans.
Continue to coordinate with DEQ on industrial permits within the City.
Maintain database of plans reviewed and final inspections conducted.</td><td>Track follow-up actions related to stormwater that are the result of industrial and commercial site inspections.
Track coordination efforts with DEQ.</td></tr>
</table>

Element 3. Construction Site Runoff Control

The City's NPDES permit requirements for Element 3 are listed below. In some cases, language for the listed permit requirements has been condensed. Applicable provisions are outlined under Schedule A.4.c of the City's MS4 NPDES permit. See Table 3 for a description of the City's BMPs that address the permit requirements listed below.

SWMP Element 3. Construction Site Runoff Control		
Schedule A.4.c Permit Requirement	Applicable BMPs	
	EC-1. Implement Erosion Control Requirements	EC-2. Conduct Erosion Control Inspections
i. Include ordinances or other enforceable regulatory mechanism that require 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 January 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 ft^2 or greater.	**Activity completed by January 1, 2014.** X	
ii. Require construction site operators to develop site plans, and to implement and to maintain effective erosion prevention and sediment control BMPs.	X	
iii. 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.	X	
iv. 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.	X	
v. Permittee 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.		X
vi. Describe in an enforcement response plan or similar document the enforcement response procedures the 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.	X	X

Table 3. Construction Site Runoff Control BMPs

BMP name	BMP implementation	Annual tracking measures
EC-1. Implement Erosion Control Requirements (Previously CON1-1, CON1-3, CON1-5)	**Responsible Party:** Public Works Department (Engineering) **Implementation Schedule:** Ongoing **BMP Description:** Salem Revised Code (SRC) Chapter 75 provides the City with the legal authority to enforce erosion prevention and sediment control on construction sites. The City implements several programs, policies, and educational activities in order to enforce this portion of the City code. Public Works Engineering implements the Erosion Prevention and Sediment Control program for developments that meet or exceed the threshold indicated in SRC Chapter 75, which includes the submission of erosion prevention and sediment control plans with structural and nonstructural BMPs. The program is reviewed annually and improvements (including Code amendments) are implemented as appropriate. Staff continues to coordinate with the City's 1200-CA Permit for City construction projects subject to its program. **Measurable Goals:** • Implement SRC Chapter 75. • Continue to review and update site plan review, inspection, and enforcement procedures annually. • Implement appropriate improvements and/or Code amendments. • Perform plan reviews for erosion control requirements. • Ensure requirements for 1200-CA compliance are incorporated into City construction plans, specifications, and contract documents. • Make erosion prevention and sediment control key agenda items at all preconstruction conferences. • Include inspection of all site erosion prevention and sediment control measures as part of City projects.	• Track revisions to the program based on annual review. • Track number of erosion control plans reviewed for compliance with SRC 75. • Track renewal of 1200-CA permit.
EC-2. Conduct Erosion Control Inspections (Previously CON1-3, CON1-5)	**Responsible Party:** Public Works Department (Engineering) **Implementation Schedule:** Ongoing **BMP Description:** Public Works Engineering will continue implementation of site plan review, inspection, and enforcement procedures for the construction site runoff control program. **Measurable Goal:** • Conduct construction site inspections in accordance with enforcement response procedures.	• Track the number of erosion control inspections performed and permits issued. • Track number of 1200-CA inspections.

Element 4. Education and Outreach

The City's NPDES permit requirements for Element 4 are listed below. In some cases, language for the listed permit requirements has been condensed. Applicable provisions are outlined under Schedule A.4.d of the City's MS4 NPDES permit. See Table 4 for a description of the City's BMPs that address the permit requirements listed under Element 4.

SWMP Element 4. Education and Outreach				
Schedule A.4.d Permit Requirement	Applicable BMPs			
	EO-1. Staff Training and Coordination	EO-2. Intergovernmental Coordination	EO-3. Public Education and Outreach	EO-4. Training for Construction Site Operators
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.			**X**	
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.			**X**	
iii. Provide public education on the proper use and disposal of pesticides, herbicides, fertilizers and other household chemicals.			**X**	
iv. Provide public education on the proper operation and maintenance of privately-owned or operated stormwater quality management facilities.	**See BMP OM-8.**			
v. Provide notice to construction site operators concerning where education and training to meet erosion and sediment control requirements can be obtained.				**X**

SWMP Element 4. Education and Outreach				
Schedule A.4.d Permit Requirement	Applicable BMPs			
	EO-1. Staff Training and Coordination	EO-2. Intergovernmental Coordination	EO-3. Public Education and Outreach	EO-4. Training for Construction Site Operators
vi. 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 by November 1, 2014	**Activity was completed and submitted to DEQ by November 1, 2014.**			
vii. Include training for municipal 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 fire fighting-related training activities, and stormwater system maintenance.	**X**	**X**		
viii. Promote, publicize, and facilitate public reporting of illicit discharges through the use of newspapers, newsletters, utility bills, door hangars, radio public service announcements, videos, televised council meetings, brochures, signs, posters, or other effective methods.	**See BMP IL-2.**			

Table 4. Education and Outreach BMPs

BMP name	BMP implementation	Annual tracking measures
EO-1. Staff Training and Coordination (Previously RC 1-4, RC1-8, RC 4-3, RC 4-4)	**Responsible Party:** Public Works Department (Stormwater Services) **Implementation Schedule:** Ongoing **BMP Description:** The City has numerous programs, activities, and personnel associated with stormwater. Coordination currently occurs informally across departments, divisions, and sections as needed to share information and resources. City staff will meet throughout each year as part of smaller project teams and workgroups to discuss coordination efforts relating to stormwater. Topics of the coordination meetings may include outreach activities, program reviews and documentation of maintenance protocols, annual reporting, monitoring, sharing of data, adaptive management, review/update of documents and procedures, training needs, use of the Hansen IMS database, the involvement of inspection, maintenance, and operations staff in plan review and program development, checklists, and erosion control. A major objective of the Operations and Maintenance (O&M) workgroup is to conduct safety and tailgate meetings in order to review and improve the O&M practices and training needs with regards to safety and protection of water quality. As necessary, formal staff meetings will continue to be held as appropriate to provide general information regarding MS4 permit requirements/updates/anticipated staffing needs. However, a majority of staff coordination occurs in smaller/diverse workgroups. Training needs are identified in conjunction with coordination meetings. Current employee training is provided as follows: • Factsheets are provided to new employees to inform them about the City's efforts for pollution prevention. • Annual trainings at a minimum are provided to applicable City of Salem employees involved in MS4-related activities regarding the permit, including its intentions and their responsibilities in relation to the MS4. Feedback for improving processes will be encouraged and brought to the coordination meeting(s). • Additional conference and workshop opportunities are identified and attendance is scheduled as funding allows. Staff will insert stormwater pollution prevention articles into internal newsletters to address pollution prevention on a City-wide level. **Measurable Goals:** • Conduct coordination meetings for stormwater on a regular basis. • Conduct annual training of employees involved in MS4-related positions, more often if necessary. • Conduct O&M safety meetings twice per month. • Conduct weekly tailgate meetings with O&M workgroup. • Review and update O&M practices and activity schedules every 3 years. • Attend a minimum of one stormwater-related workshop or conference annually.	• Track major items/ topics of coordination meetings. • Document review and changes made to the O&M training program based on coordination discussions. • Record O&M training activities completed. • Track external training and conference attendance. • Document suggestions for MS4 training changes.

Table 4. Education and Outreach BMPs

BMP name	BMP implementation	Annual tracking measures
EO-2. Intergovern-mental Coordination (Previously RC1-6, RC1-8)	**Responsible Party:** Public Works Department (Stormwater Services) **Implementation Schedule:** Ongoing **BMP Description:** The City coordinates with other governmental agencies and organizations in order to address stormwater quality. The City works with Marion and Polk Counties and the City of Keizer (Salem/Keizer Area Planning Advisory Committee or SKAPAC) to coordinate stormwater management programs and activities within the greater Salem-Keizer UGB. Continued coordination may include the establishment of intergovernmental agreements (IGAs) as appropriate. The City also continues to be an active member of the Oregon Association of Clean Water Agencies (ACWA) and uses this medium to obtain copies of materials that have been produced by others. Staff will stay current on latest available educational and technical guidance materials. **Measurable Goals:** • Make information obtained through these coordination efforts available to other City staff. • Continue participation with SKAPAC based on current group coordination level. • Develop a list of contacts and identify issues of coordination. • Attend ACWA committee meetings and workshops as scheduled.	• Report on significant coordination activities or programs. • Document frequency and type of support activities for Marion County. • Report on updates to SKAPAC Agreement and other IGAs. • Document any MOAs/IGAs. • Document ACWA meetings and workshops attended.
EO-3. Public Education and Outreach (Previously RC1-5, RC5-1, RC5-2, RC5-3, ILL3-3, ILL3-4)	**Responsible Party:** Public Works Department (Stormwater Services) **Implementation Schedule:** Ongoing **BMP Description:** The City has developed and continues to implement a public outreach and education strategy (i.e., the Public Outreach Program Matrix) with goals, objectives, identified target audiences, partners, identified target contaminants, messaging and evaluation of outreach effectiveness procedures. Activities are coordinated amongst various groups within the Public Works Department and other City departments assigned responsibility for public outreach and citizen contacts on stormwater matters. Ongoing outreach efforts include the following: Pet Waste Program: Utilization of various outreach tools, including radio advertisements, mutt mitt locations, television commercials, event participation, and school programs to encourage pet waste pick up and disposal. Storm Drain Markers: Marker installation on storm drains and catch basins to alert the public not to dump any substance into the storm drainage system. Dumping: Development and distribution of educational materials related to the environmental effects and proper disposal/ recycling techniques for household chemicals. School Presentations and Educational Outreach: Presentations, field trips, and tours are provided to students, addressing a variety of water resources topics. Stream health is the focus of the Adopt-a-Stream Program. The City also actively seeks opportunities to increase the use of community partnerships to carry out outreach goals. Continued coordination efforts are conducted with other agencies such as NGOs, private environmental groups, and watershed councils. The City continues to support Marion County with their efforts to provide convenient alternatives for legal disposal of household hazardous wastes and other recyclable materials.	• Document public outreach and involvement activities for the two (2) education campaigns. • Document changes made to outreach efforts based on the results of the effectiveness evaluation and/or the adaptive management process. • Document quarterly outreach meetings and outcomes. • Document partnerships and outcomes of partnership activities.

Table 4. Education and Outreach BMPs

BMP name	BMP implementation	Annual tracking measures
EO-3 (continued)	**Measurable Goals:** • Create or implement two (2) public education campaigns from the Public Outreach Program Matrix over the permit term. • Support outreach and educational activities for other divisions. • Continue to participate in quarterly meetings of various groups assigned responsibility for public outreach and citizen contacts on stormwater matters. • Continue to support the Adopt a Stream program. • Develop one new partnership per year to carry out outreach goals. • Continue to support Marion County in providing alternatives for household hazardous waste disposal.	
EO-4. Training for Construction Site Operators (Previously CON 1-2)	**Responsible Parties:** Public Works Department (Engineering, Stormwater Services) **Implementation Schedule:** Ongoing **BMP Description:** The City's Public Works Department leads efforts to train City staff and private contractors about stormwater pollution at construction sites, with an emphasis on prevention and control BMPs. Notices are provided to construction site operators concerning where education and training to meet erosion and sediment control requirements can be obtained. **Measurable Goals:** • Provide annual erosion control training for City staff and private contractors.	• Track education and training programs conducted and number of staff/public trained.

Element 5. Public Involvement and Participation

The City's NPDES permit requirement for Element 5 is listed below. The City continues to provide opportunities for public involvement in accordance with permit requirements for specific deliverables. As such, a dedicated BMP for this effort is not included in the SWMP.

SWMP Element 5. Public Involvement and Participation	
Schedule A.4.e Permit Requirement	Applicable BMPs
i. Permittees must implement a public participation approach that provides opportunities for the public to effectively participate in the development, implementation, and modification of the permittee's stormwater management program. The process must include provisions for receiving and considering public comments on the monitoring plan due to the Department on May 1, 2011, annual reports, SWMP revisions, and the TMDL pollutant load reduction benchmark development.	**Not applicable**

Element 6. Post-Construction Site Runoff

The City's NPDES permit requirements for Element 6 are listed below. In some cases, language for the listed permit requirements has been condensed. Applicable provisions are outlined under Schedule A.4.f of the City's MS4 NPDES permit. See Table 6 for a description of the BMPs that address the permit requirements listed under Element 6.

SWMP Element 6. Post-Construction Site Runoff		
Schedule A.4.f Permit Requirement	Applicable BMPs	
	PC-1. Implement Public Works Design Standards	PC-2. Conduct Development Review Activities
i. By January 1, 2014, the post-construction stormwater pollutant and runoff control program applicable to new single-family residential development and single-family residential redevelopment projects that create or replace 1,300 ft^2 of impervious surface, and new parcel-based development and parcel-based redevelopment projects that create or replace 10,000 ft^2 of impervious surface must meet the following conditions: 1) Incorporate site-specific management practices that target natural surface or predevelopment hydrologic functions as much as practicable; 2) Minimize site specific post-development stormwater runoff volume, duration, and rates of discharges to the municipal separate storm sewer system (MS4); 3) Prioritize and implement Low-Impact Development (LID), Green Infrastructure (GI) or equivalent design and construction approaches; and, 4) Capture and treat 80% of the annual average runoff volume, based on a documented local or regional rainfall frequency and intensity.	**Activity was completed by January 1, 2014**	
	X	
ii. The 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., LID, GI). Such modifications to ordinance, code and development standards are only required to the extent they are permitted under federal and state laws. The permittee must review ordinance, code and development standards for modification, minimization or elimination, and appropriately modify ordinance, code or development standard barriers by January 1, 2014. If an ordinance, code or development standard barrier is identified at any time subsequent to January 1, 2014, the applicable ordinance, code or development standard must be modified within 3 years.	**Activity was completed by January 1, 2014.**	
	X	

SWMP Element 6. Post-Construction Site Runoff		
	Applicable BMPs	
Schedule A.4.f Permit Requirement	PC-1. Implement Public Works Design Standards	PC-2. Conduct Development Review Activities
iii. To reduce pollutants and mitigate the volume, duration, time of concentration and rate of stormwater runoff, the permittee must develop or reference an enforceable post-construction stormwater quality management manual or equivalent document by January 1, 2014, that, at a minimum, includes the following: 1) A minimum threshold for triggering the requirement for post-construction stormwater management control and the rationale for the threshold; 2) A defined design storm or an acceptable continuous simulation method to address the capture and treatment of 80% of the annual average runoff volume; 3) Applicable LID, GI or similar stormwater runoff reduction approaches, including the practical use of these approaches; 4) Conditions where the implementation of LID, GI or equivalent approaches may be impracticable; 5) BMPs; and 6) Pollutant removal efficiency performance goals that maximize the reduction in discharge of pollutants.	**Activity was completed by January 1, 2014.** X	X
iv. The permittee must review, approve, and verify proper implementation of post-construction site plans for new development and redevelopment projects applicable to this section.		X
v. 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... a stormwater quality structural facility mitigation bank, or a payment-in-lieu program.	X	
vi. A description of the inspection and enforcement response procedures the permittee will follow when addressing project compliance issues with the enforceable post-construction stormwater management performance standards.	X	

Table 6. Post-Construction Site Runoff BMPs

BMP name	BMP implementation	Annual tracking measures
PC-1. Implement Public Works Design Standards (Previously RC 3-1, RC 9-2)	**Responsible Parties**: Public Works Department (Utilities Planning, Engineering, Development Services) **Implementation Schedule**: Ongoing BMP Description: The City continues to require the use of structural BMPs for stormwater quality improvement and flood peak reduction through implementation of the Public Works Design Standards (Design Standards) and maintenance practices identified in Chapter 109 of the City's Administrative Rules. The Design Standards require use of low impact development (LID) practices to the Maximum Extent Feasible for new and redevelopment activities that meet defined project thresholds. The Standards also reflect erosion prevention and sediment control guidelines (see BMP EC-1). The City will continue to enforce the City's Administrative Rules and Salem Revised Code (SRC) and will review and revise these as necessary to reflect the updated Design Standards that principally focus on requirements associated with onsite water quality facilities for new development or redevelopment. **Measurable Goals**: • Implement the Public Works Design Standards for water quality. • Continue to review additional options for providing incentives to LID. • Update Public Works Design Standards as new information becomes available. • Revise SRC (as needed).	• Document revisions made to Public Works Design Standards. • Document the development of any new incentives for implementation of LID techniques. • Track any MS4 stormwater-pertinent revisions made to the SRC
PC-2. Conduct Development Review Activities (Previously RC 3-4)	**Responsible Parties:** Public Works Department (Utilities Planning, Engineering, Development Services, Stormwater Services) **Implementation Schedule:** Ongoing **BMP Description:** The City continues to review all residential, commercial, and industrial plans submitted for compliance with the City's Public Works Design Standards (Design Standards). Public Works staff conduct inspections of completed stormwater facilities prior to the City's acceptance of those projects and project closeout to ensure work was done in accordance with approved plans. Staff continues to maintain a database of plans reviewed and final inspections conducted. **Measurable Goals:** • Review all residential, commercial, and industrial plans submitted for City-issued permits for compliance with the Public Works Design Standards and associated SRC provisions. • Maintain database of plans reviewed and final inspections conducted. • Conduct inspections once construction is completed to ensure work was done in accordance with approved plans.	• Track the number of plans reviewed for compliance with the Public Works Design Standards.

Element 7. Pollution Prevention for Municipal Operations

The City's NPDES permit requirements for Element 7 are listed below. In some cases, language for the listed permit requirements has been condensed. Applicable provisions are outlined under Schedule A.4.g of the City's MS4 NPDES permit. See Table 7 for a description of the City's BMPs that address the permit requirements listed under Element 7.

SWMP Element 7. Pollution Prevention for Municipal Operations								
Schedule A.4.g Permit Requirement	Applicable BMPs							
	OM-1. Street Sweeping and Debris Control	OM-2. Integrated Pest Management Procedures	OM-3. Conveyance System Cleaning and Maintenance	OM-4. Pollution Prevention for Operations	OM-5. Stream Cleaning Program	PL-1. Stormwater Planning	PL-2. Implement Stormwater CIP and Retrofit Projects	PL-3. Stormwater Funding
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;	X				X			
ii. Implement a management program to control and minimize the use and application of pesticides, herbicides and fertilizers on permittee-owned properties;		X						
iii. By January 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, or other permit designed to reduce the discharge of pollutants;	**Activity was completed and submitted to DEQ by January 1, 2013.**							
				X				
iv. Limit infiltration of seepage from the municipal sanitary sewer system to the MS4;	**See BMP IL-2**							
v. Implement a strategy to control the release of materials related to fire-fighting training activities;	**See BMP IL-1**							
vi. Assess 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;						X	X	

Table 7. Pollution Prevention for Municipal Operations BMPs

BMP name	BMP implementation	Annual tracking measures
OM-1. Street Sweeping and Debris Control (Previously RC4-1, RC4-2, ILL3-1, ILL3-5)	**Responsible Parties:** Public Works Department (Signs and Sweeping, Streets Maintenance) **Implementation Schedule:** Ongoing **BMP Description:** The City conducts sweeping in conjunction with the existing street sweeping schedule (see measurable goals for schedule) and maintains a daily log of routes swept and an annual record of the amount of material collected. The information that is collected assists staff in making recommendations for modified methods, schedules, and for annual reporting and overall program evaluation. Both sanding and de-icing chemicals are used to treat roadways for ice and snow. The City continues to perform deicing operations in a way that minimizes stormwater pollution. Annual inspections and training are conducted to ensure proper operation of the deicing chemical storage facility, and the City uses an expanded covered storage area for deicing material storage. Sand material is swept up and disposed of as soon as possible following the return to safe driving conditions. Salem continues to sponsor the Adopt-a-Street Program. The program is an effective way to get residents involved in keeping the community's streets and right-of-way clean, and consequently preventing trash and debris from entering the storm drainage system. Additionally, Salem continues to support the annual Fall Leaf Haul. **Measurable Goals:** • Review street sweeping program annually for effectiveness and any necessary revisions to sweeping schedules. • Continue sweeping City streets on a four zone schedule, sweeping the heaviest zone 13 times per year and the lightest zone 6 times per year. • Continue sweeping City-owned parking lots as needed. • Continue current deicing operations to prevent stormwater pollution. • Continue to research potential cost-effective recycling opportunities for deicing sand materials. • Continue to support the Adopt–a-Street Program. • Continue to support the Fall Leaf Haul effort.	• Track and report changes made to sweeping schedules, if any. • Record the quantity of material collected during sweeping operations. • Record the number of curb-miles of streets swept. • Document dates of annual inspections and training related to deicing. • Document deicing quantities applied annually. • Record the miles of adopted streets, number of participating groups, and volume of litter collected through the Adopt-a-Street Program. • Record the amount of leaves collected and level of participation in the Fall Leaf Haul.
OM-2. Integrated Pest Management Procedures (Previously RC 4-5)	**Responsible Parties:** Public Works Department (Stormwater Services, Parks Operations) **Implementation Schedule:** Ongoing **BMP Description:** The City will continue to implement the program for careful monitoring and management of pesticides, herbicides, and fertilizers. Over the permit term, staff will review and refine the City's Integrated Pest Management (IPM) Plan, ensuring proper handling and storage of pesticides, herbicides, and fertilizers. **Measurable Goals:** • Continue to review and refine (as needed) the IPM Program during the MS4 permit cycle. • Conduct routine inspections of storage facilities for proper storage of materials and chemicals.	• Document revisions made to IPM Program. • Document inspections of chemical storage facilities.

Table 7. Pollution Prevention for Municipal Operations BMPs

BMP name	BMP implementation	Annual tracking measures
OM-3. Conveyance System Cleaning and Maintenance (Previously RC 4-6, RC 4-10, RC 4-11)	**Responsible Party(ies):** Public Works Department (Stormwater Services, Wastewater Collections) **Implementation Schedule:** Ongoing **BMP Description:** Maintenance activities associated with the stormwater conveyance system and components include regular TV inspection, cleaning of storm drains and catch basins, and ditch maintenance. Maintenance is performed to minimize impacts to the environment. Wastewater Collections conducts routine cleaning and TV inspection of the public storm conveyance system (see frequency under measurable goals), looking for potential illicit discharges and any seepage from sanitary sewers (see also BMP IL-2). Efforts are focused on significant industrial/commercial areas where potential illicit discharges may be of concern. Ditch maintenance is performed by Stormwater Services to assure adequate conveyance, and includes three primary activities: 1. Roadside Ditch Cleaning: consists of removal of sediment in the bottom of roadside ditches only as needed for proper conveyance, with limited vegetation disturbance and the use of straw wattles to reduce sedimentation and erosion within the ditch. 2. Roadside Ditch Mowing: maintains vegetation for improved conveyance. 3. Drainage Ditch Mowing: typically conducted by inmate crews using handheld equipment. Vegetation cutting facilitates conveyance and reduces the risk of potential fires in summer months. **Measurable Goals:** • Concentrate storm sewer cleaning and TV inspection on areas with historical problems and high potential for debris. • Inspect 120,000 LF of stormwater conveyance pipe to determine maintenance and repair needs. • Clean a minimum of 300,000 LF of stormwater conveyance pipe annually. • Inspect and clean 3,800 catch basins annually. • Periodically analyze the material removed from the catch basins. • Regularly inspect and maintain 100% of City ditches using appropriate water quality BMPs.	• Track number of cross-connections found. • Track length of conveyance system cleaned and inspected. • Track the number of catch basins cleaned and inspected. • Report on any analysis of material removed from catch basins. • Track length of ditch maintenance performed (cleaning and mowing). • Track amount of sediment and debris removed from ditches and catch basins.
OM-4. Pollution Prevention for Operations (Previously ILL1-4)	**Responsible Party(ies):** Public Works Department (Stormwater Services, Operations) **Implementation Schedule:** Ongoing **BMP Description:** In conjunction with BMP EO-1 (Staff Training and Coordination), Public Works is responsible for implementing and updating the Operations Pollution Prevention Plan to incorporate new/expanded/relocated Operations-oriented facilities. The Operations Pollution Prevention Plan provides strategies to reduce the impact of stormwater runoff from the City's Shops Complex. **Measurable Goals:** • Review the Operations Pollution Prevention Plan annually. • Continue to implement the updated Operations Prevention Plan.	• Track updates/revisions to the Operations Pollution Prevention Plan.

Table 7. Pollution Prevention for Municipal Operations BMPs

BMP name	BMP implementation	Annual tracking measures
OM-5. Stream Cleaning Program (Previously RC4-7)	**Responsible Party:** Public Works Department (Stormwater Services) **Implementation Schedule:** Ongoing **BMP Description:** The City of Salem continues to support the annual Stream Cleaning Program. More than one half of the total stream miles in the city are inspected annually by walking each stream segment. Using summer interns, the City inspects the riparian areas and streams, picks up litter and garbage, inspects for illicit discharges (see IL-2), addresses potential conveyance concerns, and evaluates areas for stream restoration. **Measurable Goals:** • Walk 50% of the waterways within the city each year for stream cleanup and enhancement. • Complete one stream restoration project each year.	• Track length of waterways walked each year. • Document stream restoration projects completed each year. • Document the amount of litter and garbage removed each year.
PL-1. Stormwater Planning (Previously RC 1-1, RC 1-2)	**Responsible Parties:** Public Works Department (Utilities Planning, Stormwater Services, Engineering) **Implementation Schedule:** Ongoing **BMP Description:** Stormwater needs and improvements are principally identified through the master planning process. Salem conducts city-wide stormwater Master Planning through development of individual Basin Plans that address both water quality and water quantity. The City is in the process of finalizing the Battle Creek Basin Plan to be used as a model for the City's other urban watersheds. As part of the master planning efforts, the City continues to evaluate new detention and water quality opportunities and identify capital improvement needs and potential "early action" activities/ projects to ensure that the each plan has a strong implementation component. **Measurable Goals:** • Continue to complete Basin Plans within the MS4 permit cycle. • Begin implementing selected action items identified in the Battle Creek Basin Plan within 2 years of final adoption of the plan.	• Report on schedule for completing future Basin Plans. • Report on Basin Plan implementation activities.
PL-2. Implement Stormwater CIP and Retrofit Projects (Previously RC 1-7, RC 2-1, RC 2-2, RC 2-3)	**Responsible Parties:** Public Works Department (Engineering, Utilities Planning, Stormwater Services) **Implementation Schedule:** Ongoing **BMP Description:** The individual Basin Plans (PL-1) identify integrated water quality capital improvement projects including on-site facilities, stream restoration projects, and other specific smaller scale improvements. In addition, the Retrofit Plan (2014) identified water quality projects in conjunction with scheduled capital improvement projects in the current Capital Improvement Program (CIP). The City will continue to implement stormwater projects (including stormwater conveyance, quantity, quality, and stream/habitat improvement) based on priorities established under the current CIP, the Retrofit Plan, and Basin Plans consistent with available funding. During implementation, the City will continue to acquire resource permitting and physical access/easements for public and private stormwater facilities. **Measurable Goals:** • Review, prioritize, and budget for identified capital improvement projects and other stormwater retrofits annually. • Implement capital improvement projects and retrofits based on prioritization and available funding.	• Track number and description of capital improvement projects related to stormwater completed. • Report on funding sources and completion of retrofit project efforts annually.

<table>
<tr><th colspan="3">Table 7. Pollution Prevention for Municipal Operations BMPs</th></tr>
<tr><th>BMP name</th><th>BMP implementation</th><th>Annual tracking measures</th></tr>
<tr><td>PL-3. Stormwater Funding
(Previously RC 6-1, RC 6-3, RC 8-1)</td><td>Responsible Parties: Public Works Department (Utilities Planning, Stormwater Services)
Implementation Schedule: Ongoing
BMP Description: In order to implement the activities presented in this Stormwater Management Plan (SWMP), including operations and maintenance, planning, public education, capital improvement projects and other stormwater programs, the City must ensure that there is adequate funding. Funding is currently provided through a stormwater utility, revenue bonds, grants, and a Stormwater System Development Charge (SDC).
In conjunction with stormwater master planning efforts (PL-1), the City will continue to review and update the SDC methodology to address both stormwater quantity and quality, in tandem with the recently adopted stormwater utility rate.
City staff will continue to identify and pursue external grant opportunities for stormwater quality projects, including potential retrofit and LID project opportunities.
The City will also continue to implement the Watershed Protection and Preservation matching grant (Watershed Grant) program that is available to local residents and non-profit organizations. The grant supports riparian restoration efforts, education, and/or stormwater-related improvements within the city, such as stormwater quantity reduction and/or stormwater quality/treatment.
Measurable Goals:
• Update the Stormwater SDC methodology by the end of the MS4 permit cycle.
• Pursue external grant opportunities as staff resources allow.
• Continue to fund $50,000 annual grant program, which requires recipients to provide some level of fund matching.
• Promote the grant program in conjunction with BMP EO-3 outreach activities.</td><td>• Report on updates to the Stormwater SDC methodology.
• Track number of external grants applied for each year.
• Track number of grants received each year.
• Maintain annual list of approved Watershed Grants (funds awarded and project descriptions).</td></tr>
</table>

Element 8. Structural Stormwater Controls Operation and Maintenance Activities

The City's NPDES permit requirements for Element 8 are listed below. In some cases, language for the listed permit requirements has been condensed. Applicable provisions are outlined under Schedule A.4.h of the City's MS4 NPDES permit. See Table 8 for a description of the City's BMPs that address the permit requirements listed under Element 8.

SWMP Element 8. Structural Stormwater Controls Operation and Maintenance Activities			
	Applicable BMPs		
Schedule A.4.h Permit Requirement	OM-6. Asset Management and Systemwide Mapping	OM-7. Public Stormwater Facility Inspection and Maintenance	OM-8. Private Stormwater Facility Maintenance Program
i. By January 1, 2013, the 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: 1) Legal authority to inspect and require effective operation and maintenance; 2) A strategy to inventory and map public and private stormwater management facilities as provided under Schedule A.4.h.ii; and, 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.	**Activity was completed and submitted to DEQ by January 1, 2013**		
	X	X	X
ii. As part of the Stormwater Structural Facilities and Controls Inspection and Maintenance program, the permittee must develop and implement a strategy that guides the long-term maintenance and management of all permittee-owned and identified privately-owned stormwater structural facilities. At a minimum, the strategy must describe the following: a. Permittee-owned or operated stormwater management facilities inventory and mapping process, inspection and maintenance schedule, inspection, operation and maintenance criteria and priorities, description of inspector type and staff position or title, and, inspection and maintenance tracking mechanisms; and b. Privately-owned or operated stormwater management facilities procedures for and types of stormwater facilities that will be inventoried and mapped, inspection criteria, rationale, priorities, inspection frequency and procedures, required training or qualifications to inspect private stormwater facilities, reporting requirements, and, inspection and maintenance tracking mechanism.	X	X	X

Table 8. Structural Stormwater Controls Operation and Maintenance Activities BMPs

BMP name	BMP implementation	Annual tracking measures
OM-6. Asset Management and Systemwide Mapping (Previously RC1-3, RC 7-1, RC 7-2)	**Responsible Parties:** Information Technology Department (GIS Section), Public Works Department (Stormwater Services, Wastewater Collections) **Implementation Schedule:** Ongoing **BMP Description:** The City continually updates its Geographic Information System (GIS) database(s) so that the City's MS4 system, including open channels and piped systems are accurate, up to date, and can be relied upon for stormwater planning, preliminary project design, and program management. The GIS database contains information on the stormwater conveyance system, including piped systems, ditches, structural controls (public and private), and capital improvement projects. Operations and maintenance activities are currently stored in the Hansen IMS database. Ongoing updates reflect completion of any capital improvement projects, the addition of new stormwater facilities, and the refinement of data for the existing system. Staff also continues to update the official "waterways" geodatabase for use by all City staff in applying various regulations and standards. This includes updates to the delineation of wetlands, perennial streams, waterways, and floodplain/floodway designations. As studies are performed that warrant the revision of the designated waterways, including ground-truthing, that information will be incorporated into the update process. The GIS Section is in the process of integrating the information in GIS and Hansen IMS. The City plans to integrate the data from both the GIS and Hansen IMS databases so that information in the Hansen IMS database can be visualized using the GIS system. **Measurable Goals:** • Continue to perform routine maintenance and updates to the GIS database(s) annually. This includes new public and private BMP installations and drainage areas. • Create records of GIS maintenance activities. • Continue to review and refine the database of maps and waterways. • Complete and implement an action plan for how the GIS and IMS system will be integrated and updated.	• Record maintenance/updates made to the GIS database(s). • Track completion of additional ground-truthing activities and waterways map updates. • Track completion of action plan items and implementation status of the GIS and Hansen IMS database integration.
OM-7. Public Stormwater Facility Inspection and Maintenance (Previously RC 4-8, RC 4-9)	**Responsible Party:** Public Works Department (Stormwater Services) **Implementation Schedule:** Ongoing **BMP Description:** The City inventories all public stormwater facilities when constructed and maps them in accordance with BMP OM-6. Staff will continue to regularly inspect and maintain public structural stormwater control facilities. Inspection and maintenance procedures are outlined in the Stormwater Facility Inventory, Inspection & Maintenance Program. The City will continue to implement and refine the Stormwater Facility Inventory, Inspection & Maintenance Program for public stormwater control facilities in conjunction with coordination meetings and efforts outlined in BMP EO-1. **Measurable Goals:** • Regularly inspect all public detention and water quality facilities. • Continue to implement a long-term maintenance strategy for public stormwater control facilities.	• Track number of public facilities mapped, inspected and maintained. • Track amount of sediment and debris removed from all facilities.

Table 8. Structural Stormwater Controls Operation and Maintenance Activities BMPs		
BMP name	**BMP implementation**	**Annual tracking measures**
OM-8. Private Stormwater Facility Maintenance Program (Previously RC4-12)	**Responsible Party:** Public Works Department (Stormwater Services) **Implementation Schedule:** Ongoing **BMP Description:** As with public facilities, the City inventories all private stormwater facilities when constructed and maps them in accordance with BMP OM-6. Staff will continue to implement and refine the maintenance program for private stormwater control facilities. This program includes procedures for inspecting and ensuring maintenance of private facilities. The City provides informational packets that outline ownership and maintenance responsibilities for owners of private stormwater control facilities. **Measurable Goals:** • Continue to provide informational packets for ownership maintenance responsibilities for detention and water quality facilities. • Continue to implement maintenance activities and requirements identified in the Stormwater Facility Inventory, Inspection, & Maintenance Program.	• Track number of information packets distributed regarding private stormwater control facilities. • Track number of private facilities mapped and inspected.

Appendix C: Pollutant Load Reduction Evaluation and TMDL Benchmark Report

Pollutant Load Reduction Evaluation and TMDL Benchmarks

Prepared for

City of Salem, Oregon

November 1, 2014 (Pollutant Load Reduction Evaluation)

Amended December 29, 2015 (addition of TMDL Benchmarks)

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List of Abbreviations

AC	acre
ACWA	Oregon Association of Clean Water Agencies
BMP	best management practice
BOD	biological oxygen demand
CFU	colony forming unit
City	City of Salem
DEQ	Oregon Department of Environmental Quality
EMC	event mean concentration
GIS	geographic information system
I-5	Interstate 5
IEH	Institute of Environmental Health
LA	load allocation
LCL	lower confidence limit
LWI	local wetland inventory
MFR	multi-family residential
mL	milliliter
MS4	Municipal Separate Storm Sewer System
MST	microbial source tracking
MUR	mixed use residential
NPDES	National Pollutant Discharge Elimination System
ODOT	Oregon Department of Transportation
SFR	single family residential
SWMP	Stormwater Management Plan
TMDL	total maximum daily load
TSS	total suspended solids
UCL	upper confidence limit
UIC	underground injection control
USEPA	U.S. Environmental Protection Agency
VAC	vacant
WLA	waste load allocation
WTM	Watershed Treatment Model
WWTP	wastewater treatment plant

Section 1

Introduction

The City of Salem's (City's) National Pollutant Discharge Elimination System (NPDES) Phase I Municipal Separate Storm Sewer System (MS4) permit, issued December 30, 2010, requires an evaluation of total maximum daily load (TMDL) pollutant loads for the City's jurisdictional area. The evaluation must reflect the estimated pollutant load and estimated pollutant load reduction for all applicable TMDL parameters, representing current (2014) development conditions in the City. In addition, TMDL benchmarks are required for TMDL parameters where wasteload allocations (WLAs) are not currently being achieved.

1.1 Applicability

The requirements to evaluate pollutant load reduction are detailed in Schedule D (3) (a) of the City's NPDES MS4 permit as follows:

> *(a) 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 Willamette River TMDL was approved in 2006 and includes established allocations for bacteria from urban stormwater and MS4 sources. Stormwater runoff from a majority of the City enters the MS4 and various tributaries (e.g., Mill Creek, Pringle Creek) prior to discharge to the Willamette River (Middle Willamette Subbasin). Although urban stormwater runoff is regulated under the City's NPDES MS4 permit, the City's MS4 contribution has a defined load allocation (LA) as a percent load reduction instead of a waste load allocation (WLA). The City addresses its contribution of bacteria pollutant load(s) from the MS4 in accordance with the Willamette River TMDL and the assumption that the defined LA is reflective of the WLA.

The Molalla-Pudding River TMDL was approved in 2008 and includes established allocations for bacteria, pesticides, and metals from urban stormwater and MS4 sources. Stormwater runoff from a relatively small area of the City along the eastern City boundary enters the MS4 and various tributaries to the Little Pudding River, a tributary to the Pudding River. Like the Willamette River TMDL, the Molalla-Pudding River TMDL does not define WLAs for urban stormwater. The TMDL instead defines LAs as a percentage load reduction by dominant land use. The MS4 contribution is assigned the same LA as contributing urban land use. The City addresses its contribution of pollutant loads from the MS4 in accordance with the Molalla-Pudding TMDL and the assumption that the defined LAs for urban land use are reflective of the WLA.

1.2 Permit Requirements

In accordance with the City's NPDES MS4 permit, Schedule D.3.c, the City must complete a pollutant load reduction evaluation by November 1, 2014. Per Schedule D.3.c (i-ix), the pollutant load reduction evaluation 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 trend 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*.

Per items iv and viii, pollutant load reduction benchmarks were established by the City in 2008 for the Middle Willamette River and tributaries. The pollutant load reduction benchmarks reflected projected development conditions and associated pollutant load reduction in 2013. As part of this pollutant load reduction evaluation, pollutant load reduction estimates for current (2014) development conditions will be compared with the 2013 pollutant load reduction benchmarks. Due to the statistical variability of the underlying data, the pollutant load reduction estimates and benchmarks are presented as ranges in loading.

By definition, a pollutant load reduction benchmark is a pollutant load reduction estimate for each parameter or surrogate, where applicable, for which a WLA is established. The benchmark is used to measure the overall effectiveness of the stormwater management program and progress towards achieving the WLA over an implementation period (typically 5 years). Thus, benchmarks are pollutant load reduction estimates for the future. They are used as a tool and a goal for guiding adaptive management activities and are not considered a numeric effluent limit.

In accordance with the City's NPDES MS4 permit, Schedule D.3.d, the City must develop new TMDL pollutant load reduction benchmarks for each TMDL parameter where existing BMP implementation is not achieving the WLA. The TMDL benchmarks must reflect the City's commitment to achieving additional pollutant load reduction and progress towards achieving the TMDL WLA during the next permit term. Per Schedule D.3.d.ii (1-4), the TMDL benchmarks 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.*

1.3 Document Organization

This technical report was prepared to fulfill the City's requirements related to the development of a pollutant load reduction evaluation, as required per Schedule D.3.c of the City's NPDES MS4 permit. This technical report, as amended, also fulfills the City's requirements related to development of TMDL benchmarks, as required per Schedule D.3.d of the City's NPDES MS4 permit.

This report is organized according to the following sections:

Section 2. Review of the Willamette River TMDL, the Molalla-Pudding TMDL, and applicable LAs.

Section 3. Description of the City's general process for conducting the pollutant load reduction evaluation and for developing pollutant load reduction benchmarks.

Section 4. Pollutant load modeling methods and assumptions including changes in modeling assumptions from those used in 2008.

Section 5. Results of the pollutant load modeling and pollutant load reduction evaluation, including comparison of results to the WLA and comparison of results to the 2013 pollutant load reduction benchmarks where applicable. A summary of the water quality trends analysis is also provided.

Section 6. TMDL Pollutant Load Reduction Benchmarks.

Section 7. References.

Section 2

TMDL Applicability

Total Maximum Daily Loads (TMDLs) are developed to document the projected maximum pollutant load capacity of a waterbody that should be met so as not to exceed water quality standards. They may be developed for pollutants with direct links to stormwater runoff (e.g. metals, nutrients) and also for pollutants not typically associated with urban stormwater runoff (temperature).

To translate a TMDL into guidelines for NPDES permitted entities (municipalities, industries, WWTP), waste load allocations (WLAs) are developed. WLAs are developed as a means to regulate discharges from defined point sources of pollution that operate under an NPDES discharge permit (e.g., industries and WWTPs). LAs are developed to allocate pollutant discharges from non-point sources that do not generally operate under an NPDES discharge permit (e.g., agriculture and forestry).

With the implementation of National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permits, by definition, WLAs should be used to regulate discharges from urban stormwater runoff for areas covered by NPDES MS4 permits. However, depending on the language of the TMDL, MS4 sources may be undefined or excluded from the WLA calculation and/or mistakenly covered under the LAs. As such, interpretation of TMDL requirements specific for MS4 sources is difficult.

The Willamette River TMDL and Molalla-Pudding TMDL both use LAs to define pollutant load discharge from urban land uses including the City's NPDES MS4 permit area. However, because the pollutant load discharge is managed through implementation of the City's NPDES MS4 permit, for purposes of this report, it is assumed these LAs were meant to be WLAs. The term WLA is used in this report.

2.1 Willamette River TMDL

The Willamette River TMDL was approved by the U.S. Environmental Protection Agency (EPA) on September 29, 2006. Due to the effective date of the TMDL approval, a pollutant load reduction evaluation and TMDL pollutant load reduction benchmarks were developed and submitted for Salem as part of the City's Phase I NPDES MS4 permit renewal submittal in 2008.

2.1.1 TMDL Overview

The Willamette River TMDL addresses elevated in-stream temperature, bacteria (*E. coli*), and mercury for the Willamette River and tributaries.

Temperature can be considered both a point and non-point source pollutant, but it is not typically considered a pollutant parameter associated with urban stormwater runoff. Temperature is regulated by the Oregon Department of Environmental Quality (DEQ) and addressed by the City under its NPDES Wastewater Discharge permit and TMDL Implementation Plan, but not under the NPDES MS4 permit.

Mercury is identified as a pollutant with direct ties to stormwater runoff, but currently analysis and establishment of WLAs for mercury have not been completed by DEQ. Therefore, no pollutant load reduction estimates are required, as there is not an established WLA.

Bacteria is considered to be a pollutant with direct ties to stormwater runoff; thus, bacteria are regulated under the City's NPDES MS4 permit as a point source pollutant. Therefore, the City is required to conduct a pollutant load reduction evaluation for bacteria and develop TMDL benchmarks, as applicable.

2.1.2 Application for Salem

A majority (approximately 90 percent) of the City's NPDES MS4 permit area is located in the Middle Willamette River Subbasin. WLAs for bacteria are established for individual tributaries (e.g., Mill Creek, Clark Creek, Pringle Creek) and for discharge to the Middle Willamette River directly (see Willamette River TMDL, Chapters 2 and 7).

WLAs for bacteria (*E coli*) are calculated as a percent load reduction for each waterbody and applied to the contributing watershed area based on land use (e.g., urban, agricultural, etc.). The MS4 contribution is assumed to equate to the urban land use (when not otherwise specified). Depending on the waterbody, the WLAs are assigned as a seasonal (summer versus fall, winter, and spring) or as an annual reduction. The water quality criterion for bacteria (monthly log mean concentration of 126 *E. coli* per 100 milliliters) was used to establish the required WLAs.

The Willamette River TMDL was reviewed for this report to verify the appropriate bacteria WLAs for the City's MS4 contribution. The TMDL was previously reviewed in 2008 in conjunction with the City's permit renewal submittal and TMDL benchmarks. Identified bacteria WLAs are listed in Table 2-1.

Table 2-1. Middle Willamette Subbasin Bacteria WLAs (applicable to the City's MS4)

Waterbody	2008 WLA		2014 WLA	
	Summer	FWS	Summer	FWS
Clark	94%	89%	94%	89%
Mill + Battle	89%	81%	89%	81%
Pringle Creek Tribs	90%	79%	92%	84%
Pringle Creek			90%	79%
Middle Willamette Tribs	88%	75%	88%	75%
Middle Willamette Direct	75%		75%	

Note: Bacteria WLAs are expressed as a percentage reduction in bacteria load.

As shown in Table 2-1, some changes to the applicable WLAs were identified based on the 2014 Willamette River TMDL review. Specifically, Chapter 2 and Chapter 7 of the TMDL identify different WLAs for the Pringle Creek watershed, depending on whether discharge is to a tributary to Pringle Creek or to Pringle Creek itself. In 2008, only the Chapter 2 reference to the Pringle Creek WLA was used. This change in assumptions was reviewed with DEQ and resulted in changes to the pollutant load modeling for Pringle Creek for this 2014 pollutant load reduction evaluation (Technical Memorandum 1, May 16, 2014).

2.2 Molalla-Pudding TMDL

The Molalla-Pudding TMDL was approved by the EPA on December 31, 2008. The Molalla-Pudding TMDL was not in effect when the City's NPDES MS4 permit renewal application was submitted in 2008. Therefore, a pollutant load reduction evaluation and TMDL benchmarks have not previously been prepared for this TMDL.

2.2.1 TMDL Overview

The Molalla-Pudding TMDL addresses elevated in-stream temperature, bacteria (*E. coli*), nitrate, pesticides, and metals (iron, arsenic, and manganese) for the Molalla River, the Pudding River, and associated tributaries.

As with the Willamette River TMDL, temperature is not typically considered a pollutant parameter associated with urban stormwater runoff. Temperature is addressed by the City under its NPDES Wastewater Permit and TMDL Implementation Plan, but not the NPDES MS4 permit.

The TMDL for nitrate is specific to Zollner Creek, which is not identified as receiving water for the City under its NPDES MS4 permit and is therefore not addressed in this pollutant load reduction evaluation.

At the time of approval of the Molalla-Pudding TMDL, DEQ was proposing to delist arsenic and manganese based on evidence that they are present in surface waters at natural concentrations. WLAs and LAs are only provided for iron. In 2010, DEQ submitted a request to the EPA to withdraw the human health criteria for iron and manganese. This withdrawal was subsequently approved by the EPA in June 2011. As the heavy metal TMDL for iron was developed to address the human health beneficial use criteria, the TMDL and associated WLAs and LAs are no longer applicable. Therefore, the City is not addressing metals in this technical report (see Technical Memorandum 1, May 16, 2014).

The TMDL for pesticides includes DDT, chlordane, and dieldrin. Pesticide WLAs are expressed as a percent reduction of DDT and dieldrin (99 percent and 92 percent, respectively). Adherence to the WLAs is documented to be partially attained by meeting an instream total suspended solids (TSS) concentration of 15 mg/L (Pudding River and Zollner Creek) and 7 mg/L (Little Pudding River). Although no specific WLA is listed for MS4 sources, pesticides are addressed in this technical report based on use of TSS as a surrogate parameter (see additional discussion in Section 2.2.2).

Bacteria are considered to be a pollutant with direct ties to stormwater runoff; thus, bacteria are regulated under the City's NPDES MS4 permit as a point source pollutant and are addressed in this technical report.

2.2.2 Application for Salem

Approximately 10 percent of the City's NPDES MS4 permit area is located within the Little Pudding River Subbasin. The Little Pudding River is a tributary to the Pudding River. MS4 discharges from the City occur via tributaries to the Little Pudding River (i.e., North Fork Little Pudding, West Fork Little Pudding, West Middle Fork Little Pudding).

WLAs for pesticides were calculated as a percent reduction in DDT and dieldrin. Given limited monitoring data for such pesticides, and the fact that use of these pesticides is currently prohibited, the percent reductions were established based on attainment of a surrogate, instream TSS concentration. For the Little Pudding River, the instream TSS concentration target is 7 mg/L.

WLAs for bacteria (*E coli*) were calculated as a percent load reduction based on land use. The MS4 contribution is specifically referenced in the TMDL and is assigned a WLA consistent with urban land use area. The WLA is an annual load reduction based on meeting the single sample water quality criterion for bacteria (single sample concentration of 406 *E. coli* per 100 milliliters).

The Molalla-Pudding TMDL was reviewed for this report to verify the appropriate WLAs for the City's MS4 contribution. Results of the TMDL review and associated WLAs are described in Table 2-2.

Table 2-2. Molalla-Pudding WLAs (applicable to the City's MS4)

Waterbody	Parameter	2014 WLA or Target Pollutant Discharge Concentration
Little Pudding Tributaries	Bacteria (*E. Coli*)	86% (annual reduction)
	Pesticides (TSS surrogate)	7 mg/L TSS (instream concentration target)
	Metals	N/A – Water quality standards change in 2011

DEQ was contacted to verify interpretation of the pesticide TMDL. The TMDL acknowledges that meeting TSS instream concentration may not be adequate in addressing the pesticide WLAs and states that further research on potential hotspots is needed (Molalla-Pudding TMDL, page 4-52). Therefore it is unclear whether pesticides or TSS is the appropriate evaluation parameter. DEQ indicated that TSS is the appropriate parameter to evaluate with regard to the pollutant load reduction evaluation, and the appropriate "allocation" is 7 mg/L (Personal Communication, April 23, 2014).

In conducting the pollutant load evaluation for pesticides (TSS as a surrogate), use of an instream concentration target is difficult to apply as a WLA pertaining to a specific point source of discharge, as it does not account for dilution, baseflow, etc. For purposes of the pollutant load reduction evaluation, current (2014) TSS loads are calculated and compared to the equivalent TSS load associated with a concentration of 7 mg/L. The equivalent TSS load should be considered conservative and is not considered the applicable WLA, and as such, is not used to establish quantitative pollutant load reduction benchmarks.

Section 3

Overall Process for Developing Pollutant Load Reduction Estimates and Benchmarks

Conducting a pollutant load reduction evaluation and establishing pollutant load reduction benchmarks rely on the use of a pollutant loading model to calculate pollutant loads for select parameters and select scenarios, under select development conditions.

The pollutant load reduction evaluation is an exercise to estimate TMDL pollutant load generation and TMDL pollutant removal based on current development conditions and best management practice (BMP) implementation. Pollutant loads are calculated using the pollutant loads model and compared to the applicable waste load allocation (WLA) from the TMDL. Pollutant load reductions (based on the use of BMPs) are calculated and compared to previously established TMDL benchmarks, as applicable. The pollutant load reduction evaluation can be used to estimate the effectiveness of stormwater management programs and show how programs are making progress towards achieving pollutant load reduction.

A pollutant load reduction 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. The pollutant load reduction benchmarks account for current BMP implementation and additional BMP implementation anticipated during the course of the permit term.

In 2008, the City conducted a pollutant load reduction evaluation and established pollutant load reduction benchmarks. Both the pollutant load reduction evaluation and pollutant load reduction benchmarks were submitted with the permit renewal application in accordance with requirements of the City's 2004 NPDES MS4 permit.

The City's current (2010) NPDES MS4 permit requires submission of the pollutant load reduction evaluation (including comparison to previously established benchmarks) prior to submission of future pollutant load reduction benchmarks. Because this calculation and evaluation process has been updated from 2008, a general process flow chart was developed to document the pollutant load reduction evaluation process versus the benchmark development effort (Figure 3-1).

Figure 3-1 identifies the overall process for conducting the pollutant load reduction evaluation and pollutant load reduction benchmarks. Steps 1-5 are associated with the pollutant load reduction evaluation and include review of TMDL assumptions, data compilation, pollutant load calculations, pollutant load evaluation, and comparison of pollutant loads with WLAs and benchmarks. Steps 6 and 7 are associated with development of pollutant load reduction benchmarks. This process is loosely based on the process collectively developed through the Oregon Association of Clean Water Agencies (ACWA) in 2005 (updated in 2008) to conduct pollutant loads modeling for TMDL compliance.

If benchmarks were previously established, Figure 3-1 identifies the points at which model assumptions and model results are to be reviewed and referenced. If benchmarks were not previously established, such activities are not required. For the City, a significant number of model assumptions changed between 2008 and 2014. Therefore, documentation of changes is necessary in order to accurately review and interpret model results.

As shown on the flow chart, there are three categories of best management practices (BMPs) that were considered in the process:

1. Structural BMP systems for which pollutant removal can be reported quantitatively and are 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 administered where pollutant removal potentially could be reported in objective, quantitative terms, but the research has not been conducted and information is not yet available. These BMPs are applied to a specific coverage area and can be simulated by changing model assumptions (impervious area, land use event mean concentrations, etc.) within that coverage area. These BMPs include downspout disconnection programs, street sweeping, and catch basin cleaning.
3. Non-structural/source control BMP applications where pollutant removals are not likely to be reported in objective, quantitative terms. These BMPs include public education, illicit discharge detection programs, and spill prevention.

The overall process reflected in Figure 3-1 is intended to be conservative, because it does not directly estimate pollutant load removal achieved by Category 2 or Category 3 BMPs. Instead, pollutant loads are generated after applying structural BMPs in Category 1 and select source control BMPs in Category 2 to provide a relative picture as to how close or how far off the stormwater program is with regard to meeting the WLAs and previous benchmarks. It is acknowledged that implementation of non-structural or non-quantifiable BMPs has the potential to reduce pollutant loads further; however, documentation of such BMPs is formalized in the development of qualitative (programmatic) pollutant load reduction benchmarks instead of solely quantitative (numeric) pollutant load reduction benchmarks.

This report (Section 5) reflects the City's pollutant load reduction evaluation (through Step 6 of Figure 3-1). This report (Section 6) also reflects the City's pollutant load reduction benchmark development (through Step 7 of Figure 3-1) for the next permit term.

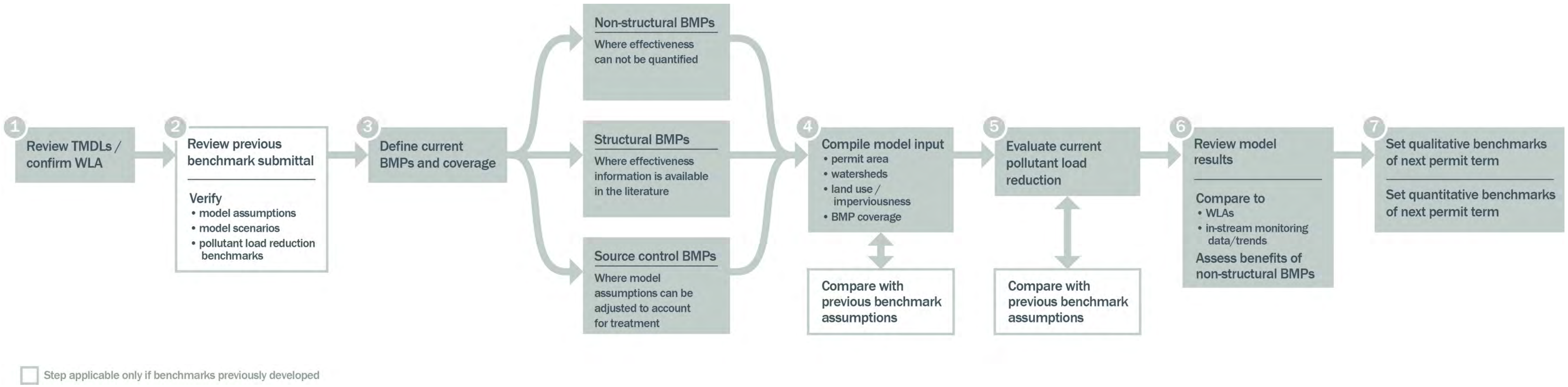


Figure 3-1. Pollutant Load Reduction Evaluation and Benchmark Development Process (2015)

Section 4

Modeling Methods and Assumptions

To conduct the pollutant load reduction evaluation and develop TMDL benchmarks, the City used a spreadsheet loads model that utilizes the U.S. Environmental Protection Agency (USEPA) simple method for pollutant load calculations. The model was used to calculate bacteria and TSS loads within the City's National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit boundary in conjunction with the Willamette River and Molalla-Pudding River TMDLs.

This section describes the modeling methods and assumptions associated with developing the spreadsheet loads model for 2014 conditions. The subsections below include information regarding model development, model areas, model scenarios, model input, and model assumptions related to land use and best management practice (BMP) effectiveness. As applicable, 2008 modeling assumptions are provided for comparison.

4.1 Model Description

A spreadsheet loads 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 2014 pollutant load reduction evaluation and TMDL benchmarks with the following modifications:

- A new land use category (public facilities) was added to separately categorize schools, hospitals and other public areas so that they could be distinguished from the standard commercial land uses, which have different impervious area coverage.
- Transportation is no longer a separately modeled land use category. The transportation land use event mean concentration (EMC) is more reflective of arterial streets and high traffic corridors which do not comprise a majority of the transportation land use coverage for the City. For this reason, transportation areas have been modeled as the adjacent land use coverage.
- Updated impervious percentages (by land use) were added based on 2011 aerial photography and direct impervious area calculations by modeled 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 raingardens, and ecoroofs.
- BMP effluent concentration data was refined based on a collective effort among ACWA jurisdictions to update BMP effectiveness information with new literature information.

Detail related to the model modifications is described later in this section.

Rainfall, land use, and BMP coverage information is entered into the model; the model has been configured with average pollutant concentration information for various land uses and BMP categories. Pollutant loads are automatically calculated. The model was used to estimate pollutant loads reflective of current (2014) development conditions and structural BMP implementation and pollutant loads reflective of current (2014) development conditions and future (through December 2021) structural BMP implementation. 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 are based on best professional judgment and summarized in Section 5 and Section 6, respectively.

4.2 Model Area

The City's NPDES MS4 permit covers "all existing and new discharges of stormwater from the municipal separate storm sewer system within the incorporated areas of the City of Salem." As a result, the City defines its NPDES MS4 permit area as its City limits. It should be noted that the City limits are located entirely within the urban growth boundary (UGB) for a majority of the City area. One exception is a single parcel which lies outside the UGB in the Willamette River tributary TMDL watershed (along Glenn Creek). This area was annexed into the City in 1982 and has development restrictions in place.

Areas within the City limits that are the responsibility of another permittee (e.g., state roadways, county roadways), or are covered under another permit for stormwater runoff (i.e., NPDES 1200-Z permit, NPDES 1200-A permit), were reviewed and omitted from the modeled area. For the City, this includes the Interstate 5 (I-5) corridor and Highway 22 corridors, which are the responsibility of the Oregon Department of Transportation (ODOT), and multiple individual NPDES stormwater permit areas. In addition, waterbodies and large wetland areas (per the Oregon Local Wetland Inventory (LWI)) were omitted from the modeled area. Such exclusions resulted in significant differences between the 2008 modeled area and the 2014 modeled area, as ODOT area was the only identified exclusion in 2008.

As described in Section 2, individual WLAs are defined for seven TMDL waterbodies; therefore, each TMDL watershed is modeled separately and pollutant load generation is compared to the WLAs. Geographic information system (GIS) was used to define and delineate the modeled area. It should be noted that the delineation of the Pringle Creek Tributary and Pringle Creek Direct TMDL watersheds is based on the City's naming and management of the stream channels and deviates from DEQ's naming of the stream channel. As implemented by the City, the Pringle Creek direct drainage area is isolated to the downstream portion of the channel.

Table 4-1 summarizes the total area, the exclusion area, and the model area by TMDL watershed. Table 4-1 also compares the total model area for 2014 versus 2008 model area assumptions.

Table 4-1. Model Areas

TMDL/subbasin	TMDL waterbodies	2014 pollutant load reduction evaluation a			2008 modeled area
		Total watershed area (ac)	Total exclusion area (ac)	Total modeled area (ac)	
Willamette/ Middle Willamette	Clark	1544.7	13.2	1531.5	1535.4
	Mill +Battle	7849.6	1229.3	6620.3	8168.0
	Pringle Creek Tributary	5270.9	769.6	4501.3	5032.3
	Pringle Creek Direct	514.0	45.2	468.8	
	Middle Willamette Tributaries	8189.9	576.4	7613.5	7675.5
	Middle Willamette Direct	5324.8	1029.4	4295.4	4906.7
Molalla-Pudding/ Little Pudding	Little Pudding Tributaries	2746.1	170.2	2575.9	N/A

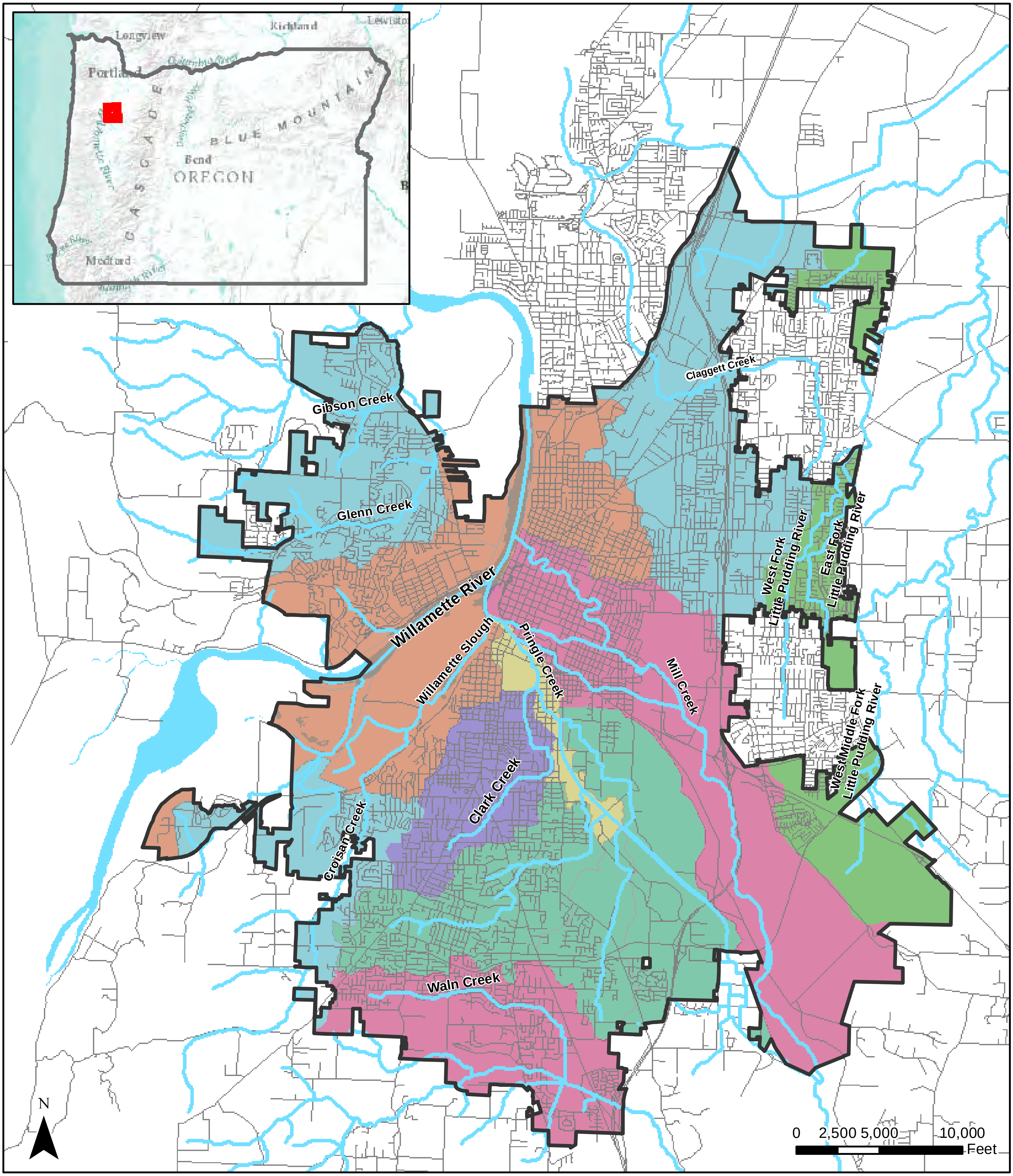
a. *Differences in 2014 Model Area versus the 2008 modeled area reflect removal of 1200-Z and 1200-A permit areas and the removal of waterbody surface area.*

The City developed new land use and structural BMP coverages in GIS specifically for the 2014 pollutant load reduction evaluation modeling effort. GIS files reflecting land use and structural BMP coverage from 2008 were unavailable and thus were regenerated.

The breakdown of current (2014) modeled area by land use and structural BMP coverage is outlined in Tables 4-2 and 4-3. An overview map showing all modeled TMDL watersheds for the City is provided as Figure 4 1. Figures reflecting the land use and BMP coverage (both existing and future) for each TMDL watershed are provided as Figures 4-2 to 4-8.

Table 4-2. Summary of Model Input Parameters (Land Use)										
TMDL/ subbasin	TMDL waterbody	Total modeled area (ac)	Land use breakdown (acres)							
			Agriculture	Commercial	Industrial	Single family residential	Multi family residential	Vacant	Parks and open space	Public property
Willamette/ Middle Willamette	Clark	1531.5	0.0	199.7	14.6	962.6	188.7	51.5	80.9	33.6
	Mill +Battle	6620.3	0.0	747.6	305.4	2177.1	640.6	1142.6	130.7	1476.3
	Pringle Creek Tributary	4501.3	0.0	209.1	639.2	2288.9	235.3	943.0	50.2	135.7
	Pringle Creek Direct	468.8	0.0	61.0	197.1	27.1	36.2	10.8	102.5	34.1
	Middle Willamette Tributaries	7613.5	78.0	566.2	659.3	3790.4	406.5	1217.6	386.0	509.5
	Middle Willamette Direct	4295.4	0.0	432.8	414.9	1752.3	422.6	282.8	891.2	98.8
Molalla-Pudding/ Little Pudding	Little Pudding Tributaries	2575.9	0.0	89.9	94.6	1112.6	172.4	436.1	17.1	653.2

Table 4-3. Summary of Model Input Parameters (2014 BMP Coverage)													
TMDL/subbasin	TMDL waterbody	BMP coverage area (% model area)	BMP coverage (acres)										
			Filters	Dry, detention ponds	Wet, retention ponds	Swale/ filter strip	Wet-lands	Sedimentation manholes	Hydro-dynamic devices	Eco-Roofs	Infiltration raingarden/ porous pavement	Filtration raingarden/ lined planter	UIC/ drywell
Willamette/Middle Willamette	Clark	0.4%	0.0	0.0	0.0	3.9	0.0	0.0	1.4	0.0	0.4	0.0	0.3
	Mill +Battle	4.2%	21.2	1.8	0.0	140.1	2.7	48.5	50.2	0.0	5.7	8.6	0.0
	Pringle Creek Tributary	5.0%	17.4	26.0	0.0	51.4	0.0	47.9	45.6	0.0	36.2	0.0	0.0
	Pringle Creek Direct	4.0%	6.8	0.0	2.1	2.6	0.0	0.5	2.6	0.0	3.2	1.0	0.0
	Middle Willamette Tributaries	4.6%	8.9	0.3	0.0	74.4	0.0	36.1	219.1	0.0	0.2	7.8	0.0
	Middle Willamette Direct	5.0%	25.4	25.3	3.7	22.6	0.0	49.0	77.6	0.0	2.3	6.8	0.3
Molalla-Pudding/ Little Pudding	Little Pudding Tributaries	19.3%	0.8	0.0	0.0	70.0	396.7	0.0	20.1	0.0	2.2	7.7	0.0



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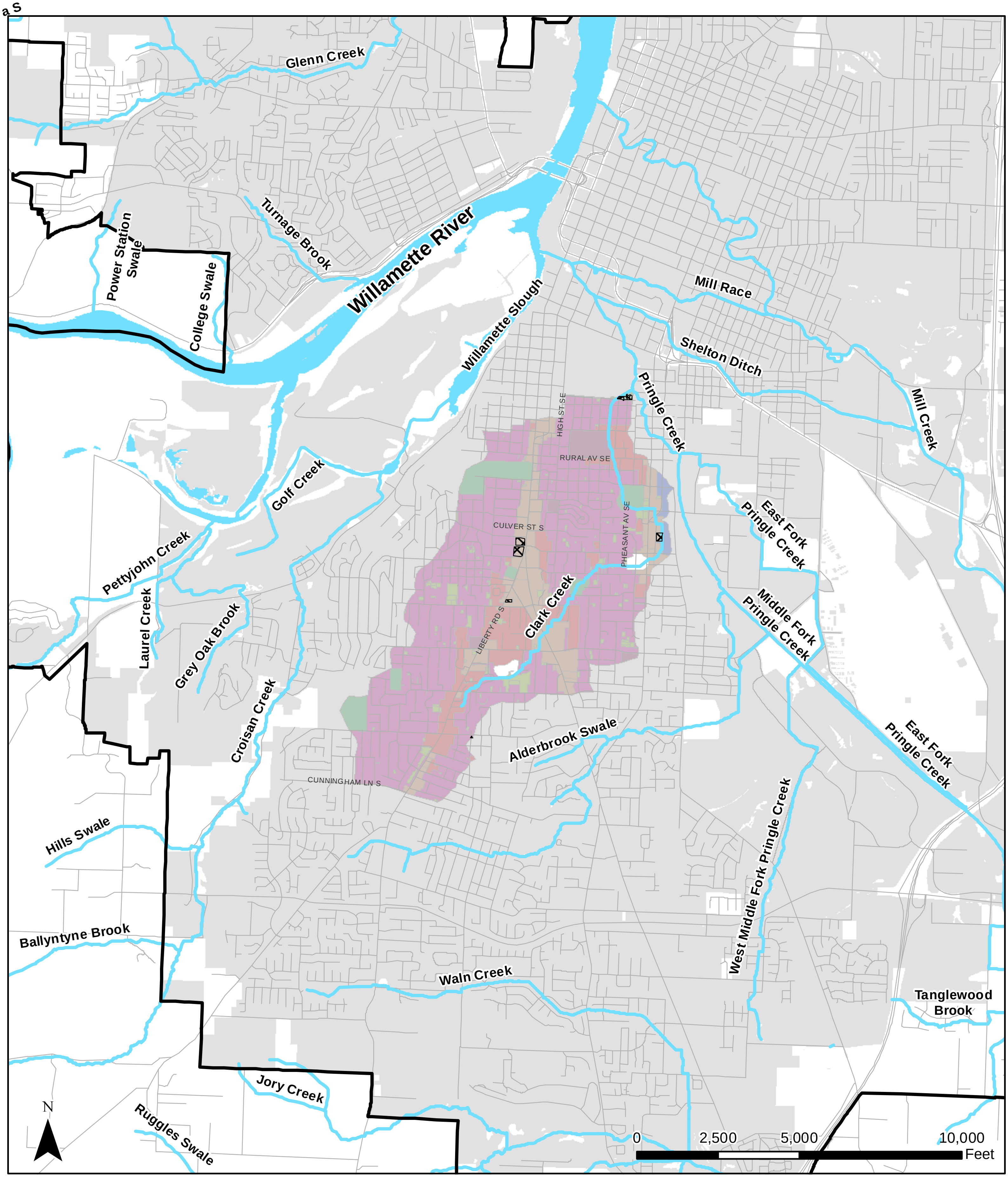
OCTOBER 2014

CITY OF SALEM

POLLUTANT LOAD REDUCTION EVALUATION

FIGURE 4-1. SALEM TMDL WATERSHEDS

- CLARK CREEK
- LITTLE PUDDING TRIBUTARY
- MIDDLE WILLAMETTE DIRECT
- MIDDLE WILLAMETTE TRIBUTARY
- MILL AND BATTLE CREEK
- PRINGLE CREEK DIRECT
- PRINGLE CREEK TRIBUTARY
- CITY LIMITS
- CREEKS
- STREETS



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SEPTEMBER 2015

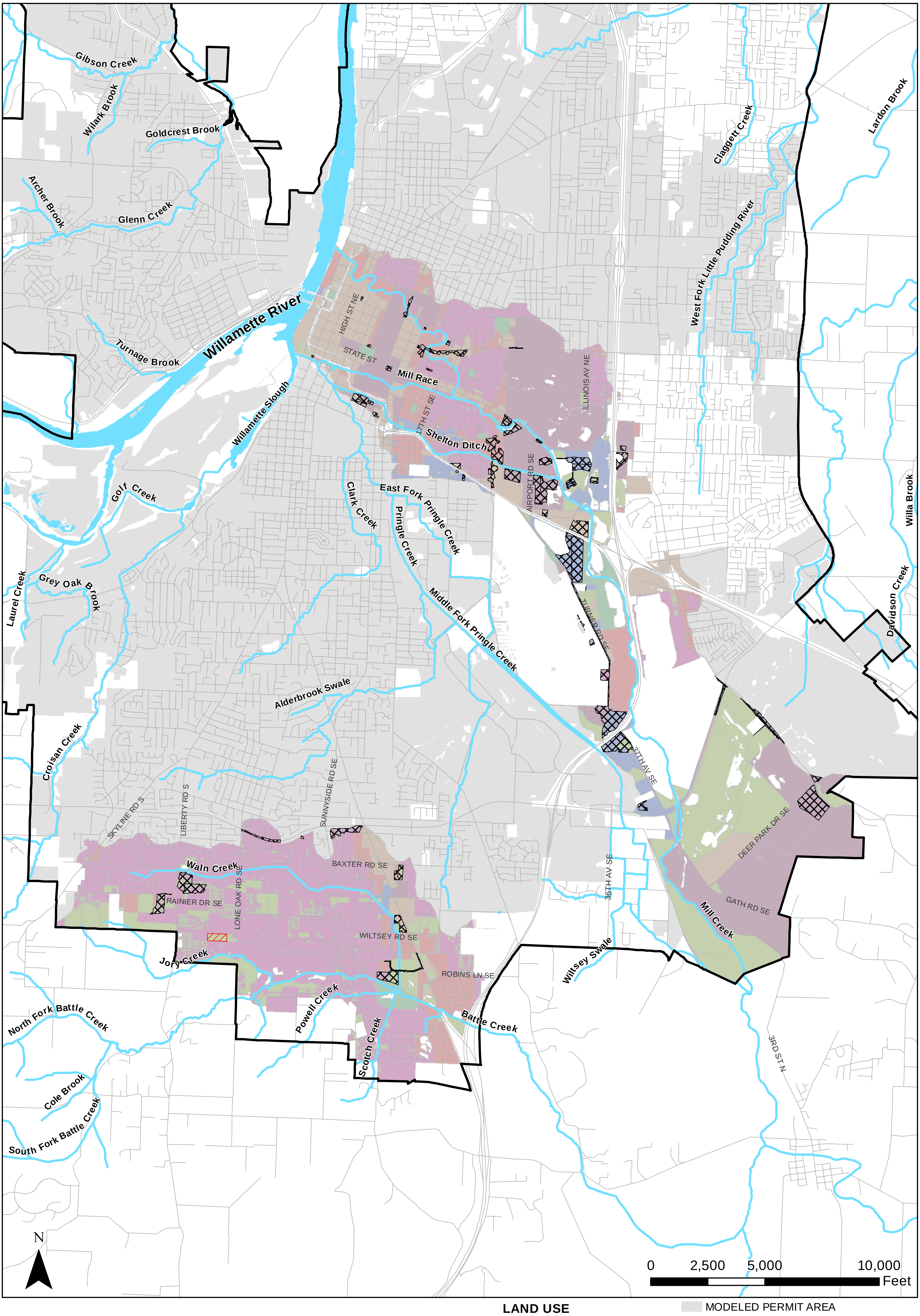
CITY OF SALEM

POLLUTANT LOAD REDUCTION EVALUATION

FIGURE 4-2. CLARK CREEK BASIN LAND USE AND BMP IMPLEMENTATION

LAND USE
- COMMERCIAL
- INDUSTRIAL
- MULTI-FAMILY RESIDENTIAL
- PARKS AND OPEN SPACE
- PUBLIC PROPERTY
- RESIDENTIAL
- VACANT

- MODELED PERMIT AREA
- CURRENT (2015) BMP DRAINAGE AREA
- URBAN GROWTH BOUNDARY (UGB)
- CREEKS
- STREETS



LAND USE

- COMMERCIAL
- INDUSTRIAL
- MULTI-FAMILY RESIDENTIAL
- PARKS AND OPEN SPACE
- PUBLIC PROPERTY
- RESIDENTIAL
- VACANT
- MODELED PERMIT AREA
- FUTURE (2021) BMP DRAINAGE AREA
- CURRENT (2015) BMP DRAINAGE AREA
- URBAN GROWTH BOUNDARY (UGB)
- CREEKS
- STREETS

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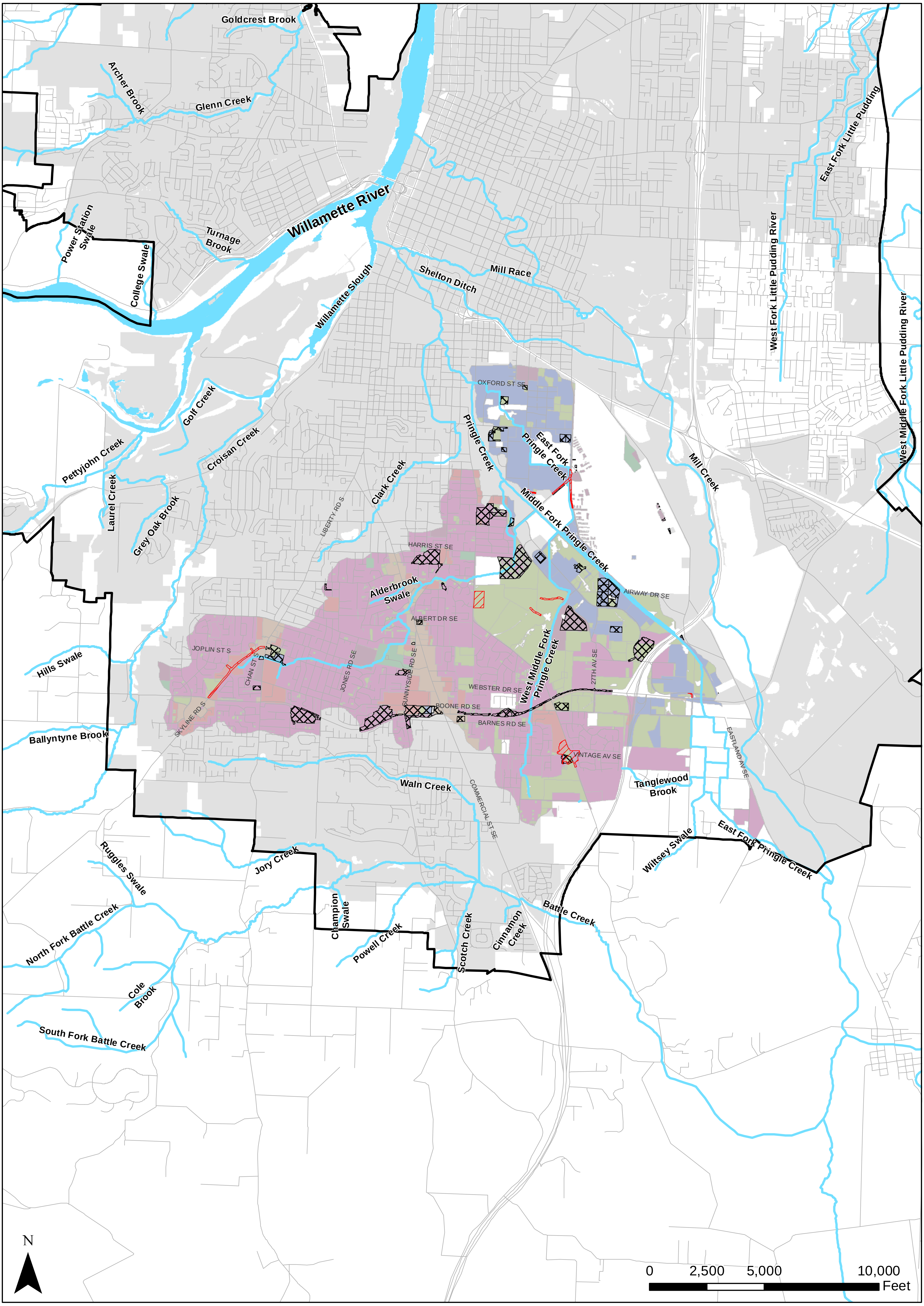
CITY OF SALEM

POLLUTANT LOAD REDUCTION EVALUATION

FIGURE 4-3. MILL + BATTLE CREEK LAND USE AND BMP IMPLEMENTATION



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SEPTEMBER 2015

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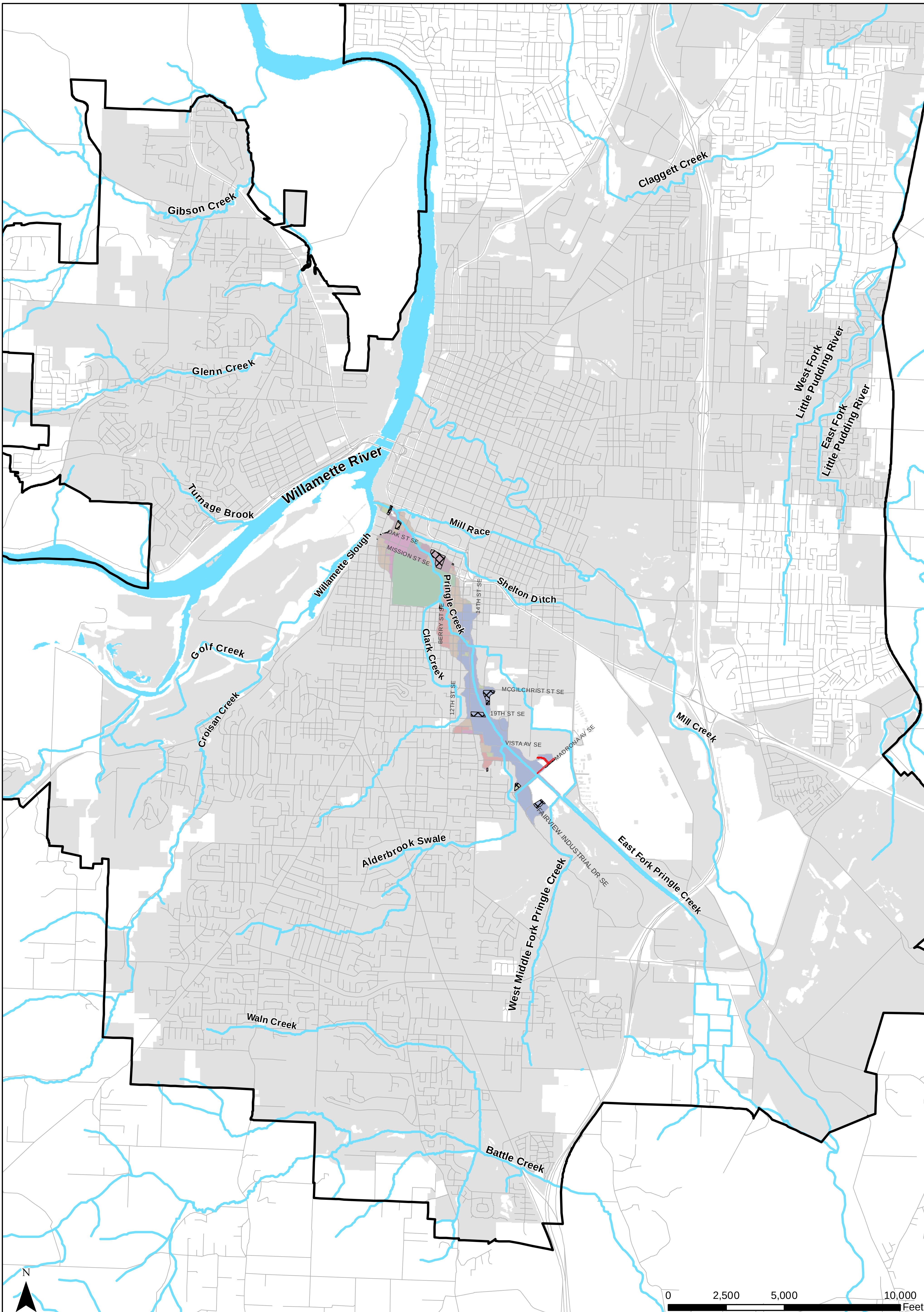
POLLUTANT LOAD REDUCTION EVALUATION

FIGURE 4-4. PRINGLE CREEK TRIBUTARIES LAND USE AND BMP IMPLEMENTATION

LAND USE

- COMMERCIAL
- INDUSTRIAL
- MULTI-FAMILY RESIDENTIAL
- PARKS AND OPEN SPACE
- PUBLIC PROPERTY
- RESIDENTIAL
- VACANT

- MODELED PERMIT AREA
- FUTURE (2021) BMP DRAINAGE AREA
- EXISTING (2015) BMP DRAINAGE AREA
- URBAN GROWTH BOUNDARY (UGB)
- CREEKS
- STREETS



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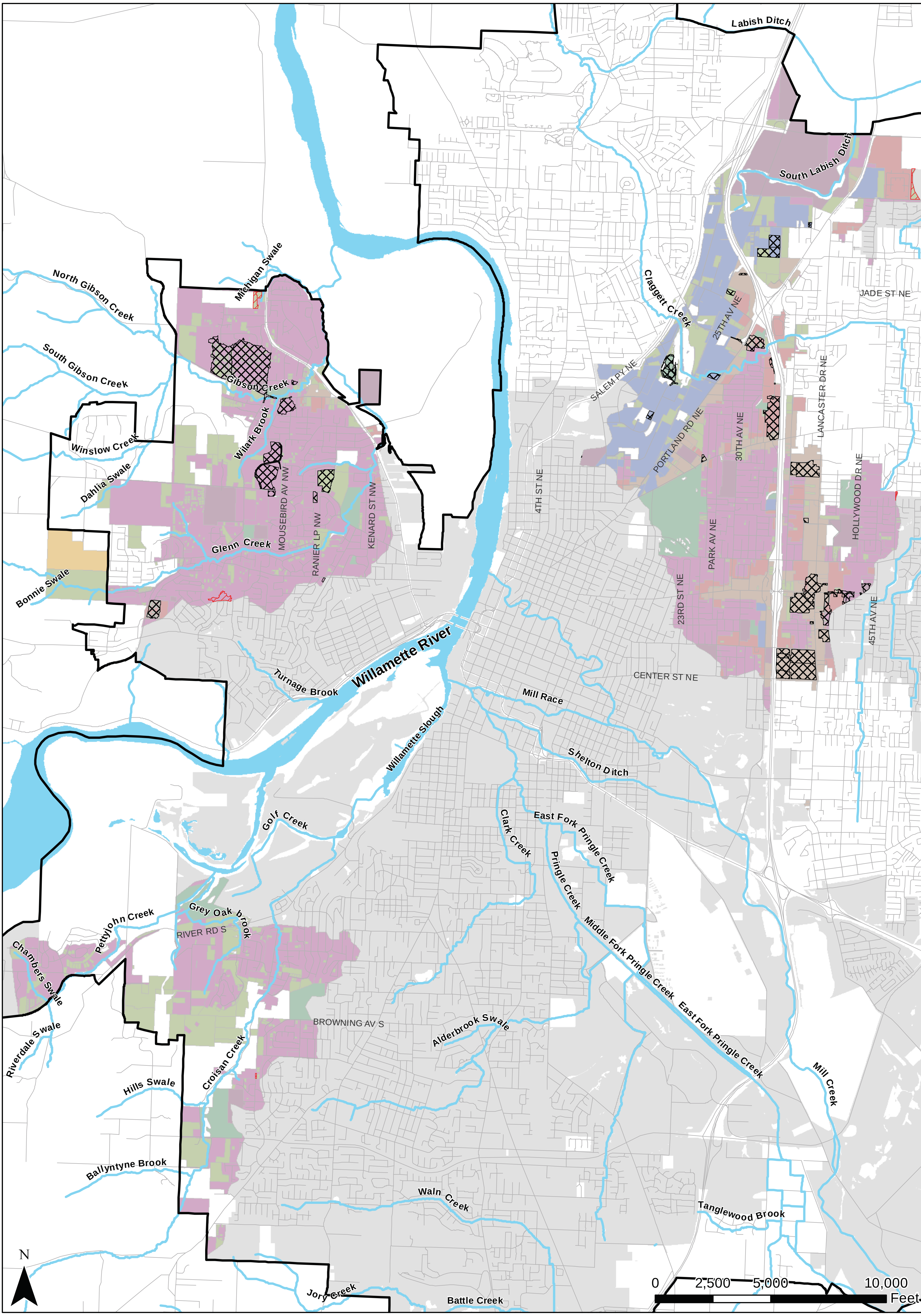
CITY OF SALEM

POLLUTANT LOAD REDUCTION EVALUATION

FIGURE 4-5. PRINGLE CREEK DIRECT LAND USE AND BMP IMPLEMENTATION

LAND USE
- COMMERCIAL
- INDUSTRIAL
- MULTI-FAMILY RESIDENTIAL
- PARKS AND OPEN SPACE
- PUBLIC PROPERTY
- RESIDENTIAL
- VACANT

- MODELED PERMIT AREA
- FUTURE (2021) BMP DRAINAGE AREA
- CURRENT (2015) BMP DRAINAGE AREA
- URBAN GROWTH BOUNDARY (UGB)
- CREEKS
- STREETS



LAND USE

- AGRICULTURE
- COMMERCIAL
- INDUSTRIAL
- MULTI-FAMILY RESIDENTIAL
- PARK AND OPEN SPACE
- PUBLIC PROPERTY
- RESIDENTIAL
- VACANT
- MODELED PERMIT AREA
- FUTURE (2021) BMP DRAINAGE AREA
- CURRENT (2015) BMP DRAINAGE AREA
- URBAN GROWTH BOUNDARY (UGB)
- CREEKS
- STREETS

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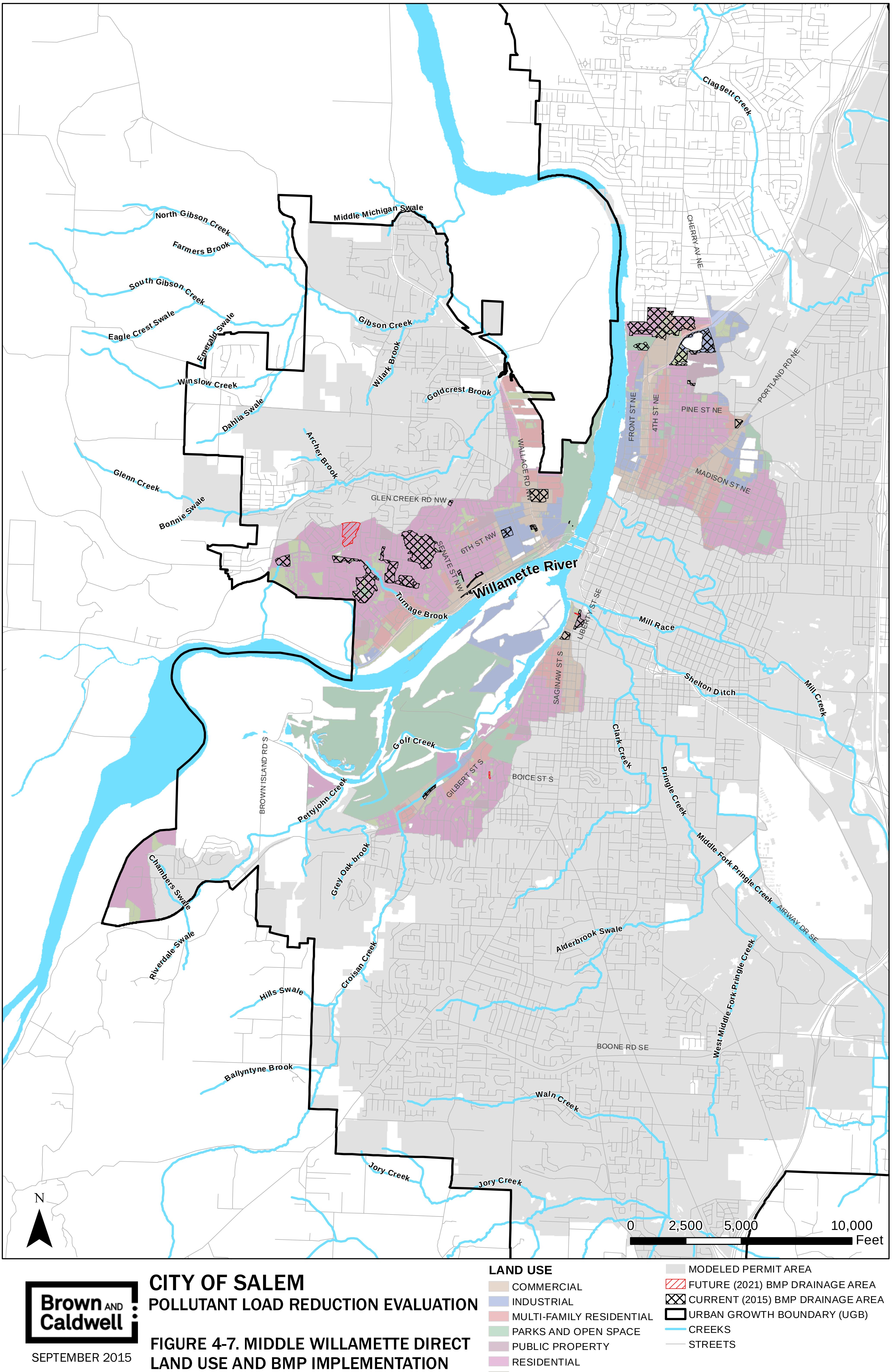
POLLUTANT LOAD REDUCTION EVALUATION

FIGURE 4-6. MIDDLE WILLAMETTE TRIBUTARIES LAND USE AND BMP IMPLEMENTATION



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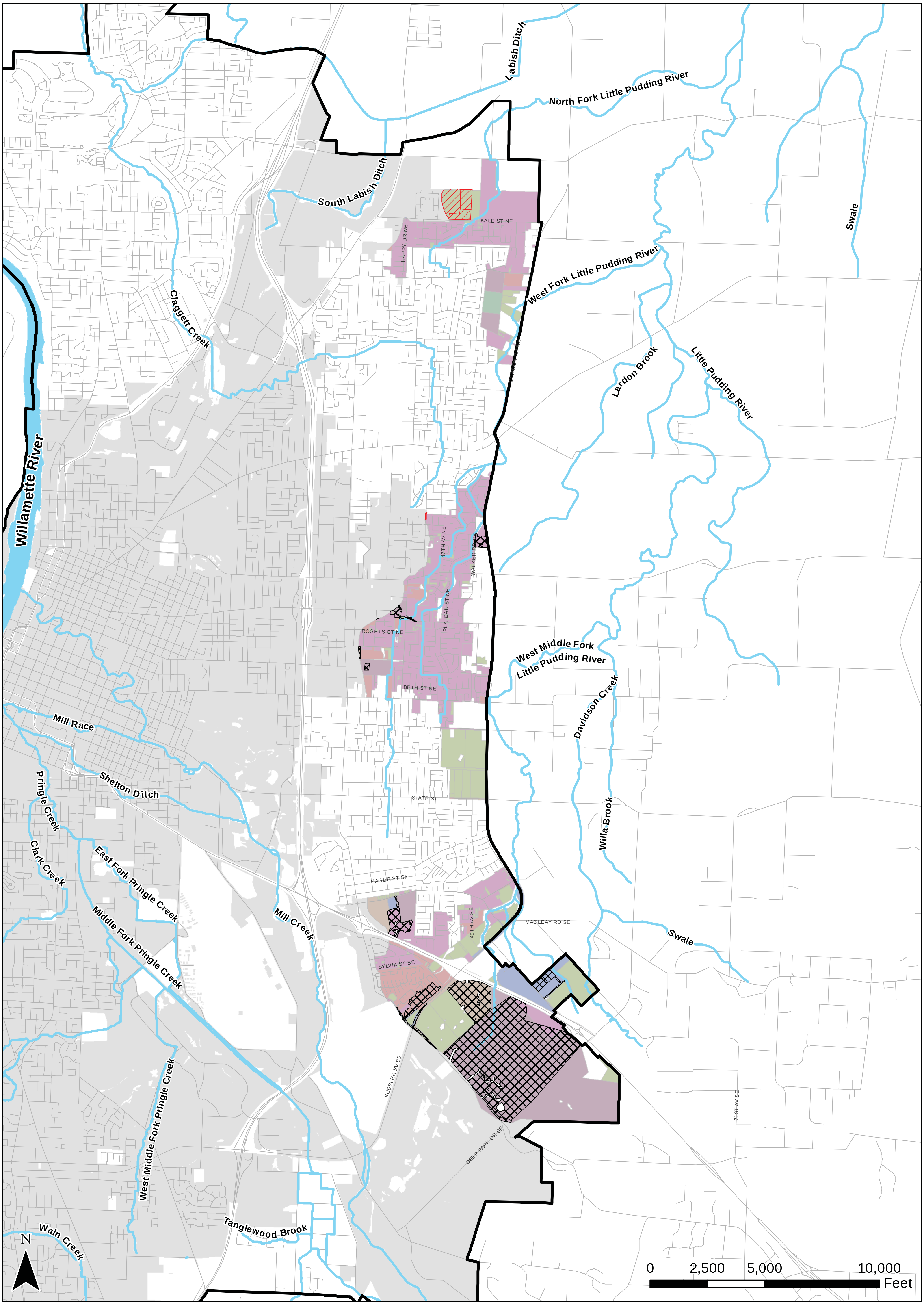
POLLUTANT LOAD REDUCTION EVALUATION

FIGURE 4-7. MIDDLE WILLAMETTE DIRECT LAND USE AND BMP IMPLEMENTATION



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POLLUTANT LOAD REDUCTION EVALUATION

FIGURE 4-8. LITTLE PUDDING TRIBUTARIES LAND USE AND BMP IMPLEMENTATION

LAND USE
- COMMERCIAL
- INDUSTRIAL
- MULTI-FAMILY RESIDENTIAL
- PARKS AND OPEN SPACE
- PUBLIC PROPERTY
- RESIDENTIAL
- VACANT

- MODELED PERMIT AREA
- FUTURE (2021) BMP DRAINAGE AREA
- CURRENT (2015) BMP DRAINAGE AREA
- URBAN GROWTH BOUNDARY (UGB)
- CREEKS
- STREETS

4.3 Model Assumptions and Input Data

To generate pollutant loads, a number of assumptions were made with regard to the acquisition, processing, and utilization of land use concentration data and BMP effluent concentration data. Assumptions were also made with respect to land use categories, BMP categories, and modeling methods. These assumptions are described below.

4.3.1 Land Use and BMP Effluent Data

Development of land use and BMP effluent data for use by Oregon Phase I NPDES MS4 permittees for pollutant load modeling began in 2004. In anticipation of future pollutant load reduction benchmark requirements in their NPDES MS4 permits, select Phase I jurisdictions coordinated efforts to maintain consistency with respect to interpretation and implementation of the benchmark requirement. The statewide coordination process was facilitated through the Oregon Association of Clean Water Agencies (ACWA) Stormwater Committee. One item that ACWA coordinated was the determination of appropriate, typical land use runoff concentrations and BMP effluent concentrations for use in pollutant loads modeling.

Tables of land use event mean concentration (EMC) and BMP effluent concentrations were originally developed in 2005 for Phase I jurisdictions required to develop pollutant load reduction benchmarks as part of their Interim Evaluation Report submittals (in 2006). The tables of original concentration data were developed using published, statistically-verified national data and data obtained by local jurisdictions.

For the 2008 pollutant load reduction benchmark submittals, the original land use EMC and BMP effluent concentrations developed in 2005 were revisited. The original land use concentration data were adjusted to include additional data reflective of the open space land use category and revisions to the statistical method of dealing with non-detects and outliers. As was done in 2005, the data were *bootstrapped*, a statistical method to estimate upper and lower confidence intervals. The original BMP effluent values were reviewed for inconsistencies and questionable values (e.g., data points where the dissolved concentration is greater than the total concentration, and data points where the BMP effluent concentration is greater than local land use EMCs).

For this (2014) pollutant load reduction evaluation and (2015) TMDL benchmark effort, Phase I jurisdictions again coordinated to refine BMP categories and BMP effluent data per updated information contained in the American Society of Civil Engineers (ASCE)-BMP database and locally obtained data. No changes were made to the 2008 land use EMC data. BMP updates focused on inclusion of refined flow reduction values for infiltration-related BMPs. New BMP categories and effluent concentration data reflecting lined planters/filtration raingardens, ecoroofs, and porous pavement were added.

Land use concentration data, including the upper and lower confidence intervals, are provided in Table 4-4. These values are consistent with 2008 data assumptions. The mean BMP effluent concentration values are provided in Table 4-5. As described previously, these values were collectively developed and reviewed by the ACWA Stormwater Committee in 2014. Analysis of *E coli* is conducted via use of a geomean land use EMC, due to calculation procedures.

Table 4-4. Land Use Concentration Values used in Benchmarking (Bacteria and TSS only)

Parameter	Land use	Count	Bootstrapped mean		
			95% lower confidence level	Mean	95% upper confidence level
Total Suspended Solids (TSS)	Commercial[c]	72	64	82	103
	Industrial	48	117	184	284
	Open space[a]	10	16	31	50
	Residential[b]	65	44	66	99
Parameter	**Land use**	**Count**	**Bootstrapped geomean**		
			95% lower confidence level	**Geomean**	**95% upper confidence level**
Fecal, coliform colony forming units (CFU)/100 milliliters (mL) (geomean)	Commercial[c]	52	707	1,540	2,974
	Industrial	58	190	541	1,240
	Open space[a]	9	96	117	141
	Residential[b]	65	1197	2,045	3,273
E. coli, CFU/100 mL (geomean)	Commercial[c]	52	573	1,247	2,409
	Industrial	58	154	438	1,004
	Open space[a]	9	57	87	124
	Residential[b]	65	970	1,656	2,651

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

a. Land use EMCs for open space are used to simulate vacant land use.

b. Land use EMCs for residential are used to simulate single-family residential and multi-family residential

c. Land use EMCs for commercial are used to simulate commercial uses and public facilities.

Table 4-5. BMP Effluent Concentration Values used in the Benchmark Model (Bacteria, TSS, and Flow Reduction)

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 raingardens
		Mean										
TSS	mg/L	115	42	44	41	24	25	66	5.4	N/A	N/A	42
E. coli	CFU/100 mL	5,587	91	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	0.50	1.00	1.00	0.30

Notes:

Most values are consistent with the ACWA data set (2008) and consistent with 2008 data assumptions.

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.

4.3.2 Land Use and BMP Categories

As stated in Section 4.2, the City generated new land use coverage specific for the 2014 pollutant load modeling effort. Land use coverage was developed by combining the Salem 2014 zoning coverage with the Council of Governments 2014 vacant lands inventory to create coverage representing current land use conditions. Parcel zoning was extended to the centerline of streets so reflect and cover roads previously modeled as transportation land use. Aerial imagery was reviewed to verify vacant lands coverage.

Zoning categories were reviewed and consolidated into those categories for which land use concentration information either specifically existed or could be approximated using another representative land use category from the land use concentration data set. The City maintained land use categories consistent with the 2008 pollutant load reduction evaluation and benchmark effort, with the following exceptions:

1. A new land use category (public facilities) was developed to represent schools, hospitals, and large public properties with lower impervious area coverage than typical commercial development.
2. Transportation is no longer a modeled land use category as it was in 2008. Use of 2014 zoning coverage does not include delineation of transportation corridors (unlike the 2008 land use coverage). Transportation area was not included as a modeled land use category because the transportation land use EMC data are more reflective of arterial roads and highways and not local and collector streets, which comprise a majority of the transportation land use in the City.

Table 4-6 summarizes the modeled land use categories.

Table 4-6. Land Use Categories used in the City's Pollutant Loads Model

City zoning classification	2014 modeled impervious percentage	2008 modeled impervious percentage
Agriculture (AGR)	1	5
Single family residential (SFR)[a]	40	41
Multi-family residential (MFR)[a]	55	52
Commercial (COM)	74	90
Industrial (IND)	63	90
Vacant (VAC)[a]	6	2
Parks and open space (POS)	14	5
Public Facilities (PF)[a]	27	N/A

a. *The land use EMC data listed in Table 4-4 do not include all of the zoning categories. Therefore, some land use categories were modeled using concentration data from a comparable land use category. This occurred for the SFR and MFR categories (modeled using residential concentration data), and the VAC category (modeled using open space concentration data).*

Also as stated in Section 4.2, the City developed a more refined GIS BMP inventory and BMP coverage specific for this (2014) pollutant load reduction evaluation and (2015) TMDL benchmark modeling effort. Development of the BMP inventory and BMP coverage in GIS was a time intensive effort and included the global positioning system of facility locations, facility site inspections, as-built review, and delineation of contributing drainage areas for public and private facilities.

Current (2014) public and private structural BMP information (BMP types and drainage areas) was compiled into one shapefile. Because limited effectiveness information is available for certain structural BMP categories, the structural BMP inventory was reclassified in accordance with BMP categories for which effectiveness information specifically existed or could be approximated using another representative BMP category. Table 4-7 summarizes the structural BMP categories included in the inventory and the results of the reclassification. As mentioned previously, source control and non-structural BMPs were not included in the model simulations.

Table 4-7. Structural BMP Categories used in the City's Pollutant Loads Model

City's structural BMP designation	Modeled BMP category[a]
Settling pond	Ponds, dry vegetated detention ponds
Wetland	Water quality wetland
Bioswale	Swales-vegetated filter strips
WQ pond	Ponds, wet retention basin
Aqua-Swirl Stormceptor separator Contech CDS Contech Vortech separator Downstream Defender	Centrifugal separator, hydrodynamic device
Contech StormFilter Contech Filter CB insert Filterra Kristar Flogard (CB inert)	Filters (leaf, sand, other)
Dry well/UIC	Underground injection control
Pollution control manholes Sumps	Sedimentation manhole
Soakage trench Raingarden Infiltration basin Infiltration swale Pervious planter Pervious pavement WQ soakage trench	Soakage trenches/ infiltration raingardens
Pervious pavement	Porous pavement
Green Roof	Green Roof
Landscape planter	Lined planter/filtration raingarden

a. The BMP effluent concentration data listed in Table 4-5 do not include all of the BMP categories. Therefore, some of the City's actual BMP categories were modeled using concentration data from a comparable BMP category. This column identifies the BMP category from Table 4-5 that was used to represent each of the City's actual BMP categories.

4.3.3 Impervious Values

Using 2011 aerial photography data, for each model land use category, an impervious percentage was directly calculated by overlaying impervious area coverage and the model land use coverage. The resulting impervious percentage by land use specifically reflects 2014 development conditions and updated assumptions from 2008.

The USEPA formula (1) was used to translate between percent impervious and a runoff coefficient, for use in the pollutant loads model:

*(1) Runoff Coefficient = 0.05 * 0.009 (percent impervious)*

The calculated 2014 impervious percentages used in the modeling effort are shown in Table 4-6. For comparison, the 2008 impervious percentages by land use are also shown. The difference in impervious percentage by land use from 2008 to 2014 may largely be due to fact that 2008 impervious data was compiled from three different analyses (i.e., the 2000 SW Master Plan, 2002 SDC Calculation method, and an Impervious Surface Report). The 2008 data sources were dated references.

4.3.4 Modeling BMPs

Throughout the City, there are a number of structural BMPs that work together in series to achieve pollutant removal. Generally these applications consist of a sedimentation-type device (sedimentation manhole) upstream of a filtration or infiltration type system.

For purposes of this pollutant loading analysis, public and private facility drainage area delineations were prepared separately and merged. Public structural BMP drainage areas were delineated based on available asbuilt information and LiDAR data. Private structural BMP drainage areas were identified based on recent asbuilt information and/or maintenance covenant agreements. A site visit was then conducted to verify facility type. For private locations where contributing drainage area could not be determined through asbuilt information or site visit, the total developed property was assumed to be treated.

Following the delineation effort, particularly when current public and private facility drainage areas were merged, some areas are shown as being treated by multiple BMPs. For those drainage areas classified as having multiple structural BMPs, the structural BMP that appears to be the farthest downstream type of facility and provides the better overall treatment was generally selected as the representative BMP for the drainage area. This method does not give credit for additional load removal likely achieved with BMPs that perform in series, which results in an underestimated load reduction estimates.

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 NPDES MS4 permit requires water quality 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 additional flow.

4.4 Model Input Files

The City generated GIS shapefiles to populate the pollutant loads model with areal information reflecting model area, model land use, and BMP coverage. Source GIS files include the following and are specific for each TMDL watershed (Clark Creek is used as an example below):

- Clark_Creek_Direct_Basin: Reflects the total TMDL watershed area within the City limits.
- Clark_Creek_Permit_Area: Reflects the total TMDL watershed area within the City limits minus exclusion areas (ODOT area, waterbody area, 1200-Z and 1200-A NPDES permit area).
- Clark_Creek_Zoning: Reflects the 2014 model land use coverage including vacant lands.
- Modeled_Public_and_Private_BMP_Drainages: Reflects the 2014 public and private BMP coverages with facility categorization.
- FutureBMPs_ClarkCreekBasin: Reflects the additional public BMP coverage anticipated by 2021 for development of TMDL benchmarks.

Subsequent shapefiles were created through unions to reflect BMP coverage by model land use category for each TMDL watershed.

4.5 Model Simulation (Pollutant Load Reduction Evaluation)

In accordance with Schedule D.7.a of the City's NPDES MS4 permit, the City is required to conduct a pollutant load reduction evaluation for all applicable TMDL parameters reflective of development conditions in 2014. The pollutant load reduction evaluation must include an estimate of current pollutant loading without BMP implementation and an estimate of current pollutant loading with BMP implementation. Results of the pollutant load reduction evaluation must be compared to previously established pollutant load reduction benchmarks (applicable for the Middle Willamette Subbasin) and applicable WLAs.

As described in Section 2, the Middle Willamette Subbasin WLAs for bacteria are identified as a single percent reduction of bacteria according to season (summer versus fall, winter, and spring). The Little Pudding Subbasin WLAs for bacteria are identified as a single percent reduction of bacteria applied annually. The Little Pudding Subbasin uses TSS as a surrogate parameter for pesticides, and an instream TSS concentration of 7 mg/L is documented in the TMDL to reflect adherence to the identified pesticide WLA.

An annual rainfall of 39.36 inches was used in the model to simulate annual pollutant loading. Due to the seasonal variation of the WLAs, a summer season rainfall of 2.47 inches was used to simulate summer seasonal loading and a fall, winter, and spring seasonal rainfall of 36.89 inches was used. The modeled rainfall volumes are consistent with assumptions from the 2008 pollutant load evaluation and benchmark development.

Area reflecting current land use and BMP coverage was calculated for each TMDL watershed and input into the spreadsheet loads model. Model scenarios reflecting both BMP implementation and no BMP implementation were simulated to evaluate pollutant load reduction, consistent with requirements of Schedule D.3.c of the NPDES MS4 permit. The BMP implementation scenario reflects implementation of public and private structural facilities. Although rough effectiveness estimates may be assumed for source control and non-structural BMP implementation, quantitative effectiveness information is limited for these BMPs. Thus, non-structural BMPs were not directly simulated in pollutant loadings model. See additional discussion in Section 5.

4.6 Model Simulation (TMDL Benchmarks)

Model simulation assumptions for the pollutant load reduction evaluation (Section 4.5) are consistent for the development of TMDL benchmarks.

To develop TMDL benchmarks, area reflecting current land use and future (2021) BMP coverage was calculated for each TMDL watershed and input into the spreadsheet loads model. The future BMP coverage assumes all current (2014) BMPs are still in place and functioning, and it includes the addition of new, public BMPs anticipated to be constructed during the next 5-year permit term. An additional model scenario reflecting future BMP implementation was simulated to estimate pollutant loads reflective of future BMP coverage and establish the TMDL benchmark, consistent with requirements of Schedule D.4.d.ii of the NPDES MS4 permit.

As with the pollutant load reduction evaluation, the future BMP implementation scenario reflects implementation of public and private structural facilities. Although rough effectiveness estimates could potentially be assumed for source control and non-structural BMP implementation, quantitative effectiveness information is limited for these BMPs. Thus, non-structural BMPs were not directly simulated in the loads model in order to establish the TMDL benchmarks. See additional discussion in Section 6.

4.7 Model Output and Comparison to WLAs

The pollutant load spreadsheet model is capable of calculating loads for a variety of pollutant parameters. Specific for the pollutant load reduction evaluation and the TMDL benchmarks, bacteria loads (as counts) and TSS load (in pounds) are calculated for each model scenario (no-BMP, with BMP (current) and with BMP (future)), based on the TMDL season and associated rainfall volume. Pollutant loads are calculated for the upper confidence limit, the mean (or geomean for bacteria), and the lower confidence limit, to yield a range in the resulting loads. Pollutant loads are graphically shown for the no BMP and with BMP (current) scenarios for the pollutant load reduction evaluation (see Section 5). Pollutant loads are tabulated for the no BMP, the with BMP (current), and with BMP (future) scenarios for purposes of the TMDL benchmarks (see Section 6 and Appendix B).

The WLA is calculated as the specified percent load reduction from the no-BMP pollutant load. The WLA is graphically shown next to the pollutant loads generated for each watershed and scenario for the pollutant load reduction evaluation.

The estimated pollutant load reduction is calculated as the difference between the no-BMP pollutant loads and the with-BMP pollutant loads. The pollutant load reduction evaluation (Section 5) reflects this difference using the with-BMP (current) scenario. The TMDL benchmarks (Section 6) reflect this same difference using the with-BMP (future) scenario as opposed to the with-BMP (current) scenario. Because loads are presented as a range, the pollutant load reduction is also identified as a range, reflecting the difference between the no-BMP and with BMP pollutant load for the upper confidence limit and the difference between the no-BMP and with BMP pollutant load for the lower confidence limit.

Section 5

Pollutant Load Reduction Evaluation

Pollutant load model results, including calculation of the current pollutant load reduction by TMDL watershed, comparison of model results to WLAs, and comparison of model results to the 2013 pollutant load benchmarks, are described below. Section 5.1 presents the model results applicable to the Willamette River TMDL; Section 5.2 presents the model results applicable to the Molalla-Pudding TMDL; and Section 5.3 provides an evaluation of model results with respect to water quality trends and expectations.

It should be emphasized that the Willamette River and Molalla-Pudding River model results portray the incremental improvements that are estimated with the implementation of structural best management practices (BMPs). The City implements a significant number of non-structural BMP activities that are required under the City's current NPDES MS4 permit but are not directly reflected in the model results. These measures include: public education, illicit discharges elimination, spill prevention, catch basin cleaning, erosion control, etc. Discussion related to the conservative nature of the pollutant load modeling results and interpretation of how source control and non-structural BMPs are accounted for in the model results is provided in Section 5.3.

5.1 Pollutant Load Reduction Evaluation – Willamette River TMDL

Current bacteria loads were calculated for six TMDL watersheds within the Middle Willamette Subbasin with specified WLAs. For most watersheds, a separate summer season versus fall, winter, and spring season analysis was conducted. Model results are provided by TMDL waterbody in the subsections below and reflect model assumptions and simulations as described in Section 4.

The WLA is shown for each model scenario. As described in Section 4.6, the WLA is calculated based on the required load reduction applied to the mean bacteria load for the no-BMP pollutant load scenario. Although calculated from the mean, no-BMP load (for graphical purposes), the WLA also may be depicted as a range in reduction from the overall no-BMP load.

5.1.1 Model Results – Clark Creek

Figure 5-1 shows the City's bacteria pollutant load estimates for Clark Creek during the summer season and Figure 5-2 shows the City's bacteria load estimate for Clark Creek during the fall, winter, and spring season. Both no-BMP and with BMP load estimates are shown, and the calculated pollutant load reduction estimate is highlighted on each figure. Loads calculated for each scenario were plotted as a range, given the variability in stormwater data.

The bacteria WLA for discharges to Clark Creek is a 94 percent reduction during the summer season and an 89 percent reduction in the fall, winter, and spring season.

The City shows a mean load decrease of approximately 2.00 x 10^9 counts when comparing conditions with and without BMPs during the summer season and a mean load decrease of 3.00 x 10^{10} counts during the fall, winter, and spring season. Figures 5-1 and 5-2 specify the pollutant load reduction estimate as a range, given the variability of stormwater data.

Structural BMP implementation is more limited in this watershed, as confirmed through the BMP inventory and delineation effort conducted in 2014. In addition, the structural BMPs implemented in this watershed (swales, hydrodynamic separators) generally show limited effectiveness for bacteria removal. Generally, bacteria reduction associated with structural BMPs is due to any flow reduction achieved through the structural BMP (i.e., infiltration) rather than actual removal of the bacteria itself.

Figures 5-1 and 5-2 indicate that the City is not currently estimated to be meeting the WLA for bacteria in the Clark Creek watershed. Additionally, the WLAs defined for this watershed are among the most conservative throughout the entire Willamette River watershed. Significant additional load reduction would be needed beyond the current structural BMP implementation reflected in the range of loading. The WLA is considered to be an ultimate discharge goal.

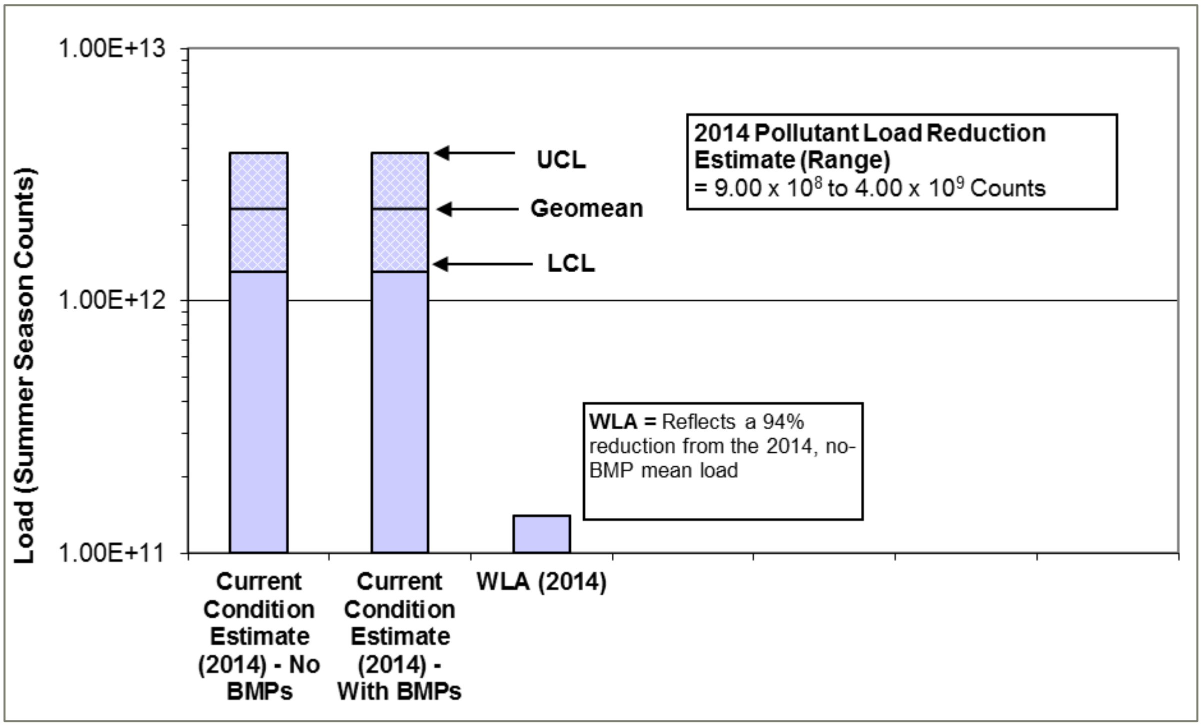

Figure 5-1. Clark Creek–bacteria pollutant load reduction evaluation results (summer)

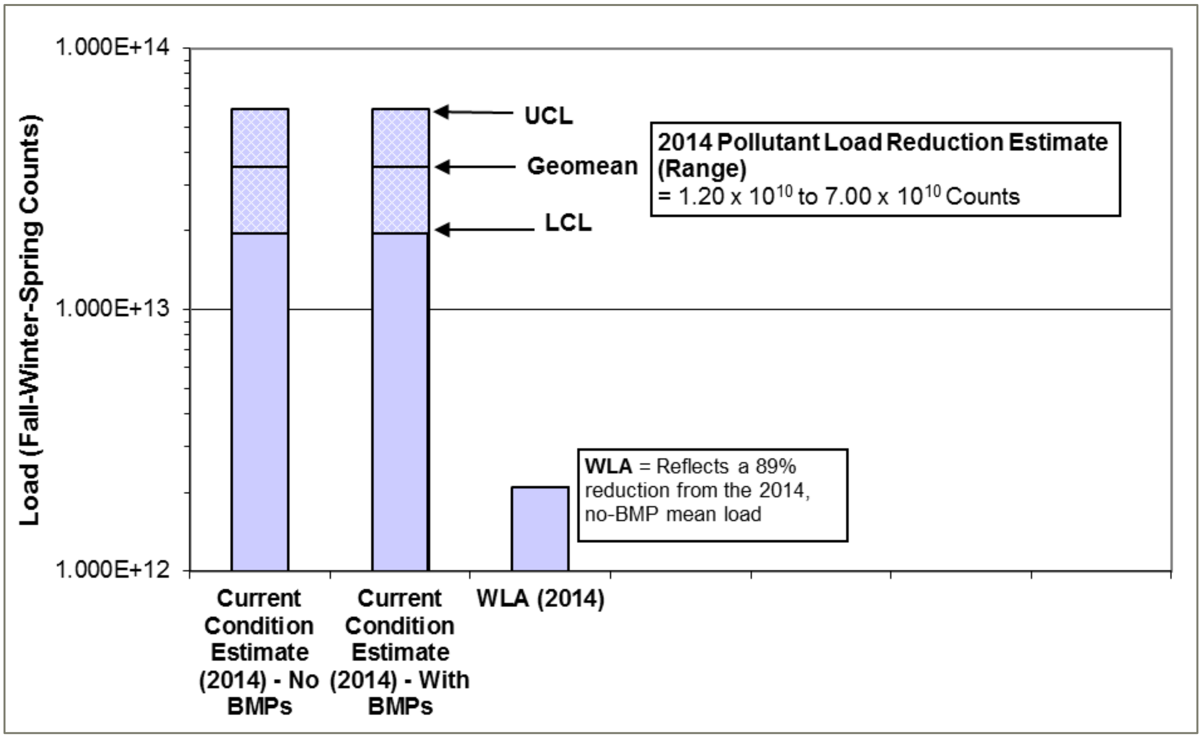

Figure 5-2. Clark Creek–bacteria pollutant load reduction evaluation results (fall, winter, spring)

5.1.2 Model Results – Mill and Battle Creek

Figure 5-3 shows the City's bacteria pollutant load estimates for Mill Creek (including Battle Creek) during the summer season and Figure 5-4 shows the City's bacteria load estimate for Mill Creek (including Battle Creek) during the fall, winter, and spring season. Both no-BMP and with BMP load estimates are shown, and the calculated pollutant load reduction estimate is highlighted on each figure. Loads calculated for each scenario were plotted as a range, given the variability in stormwater data.

The bacteria WLA for discharges to Mill Creek is an 89 percent reduction during the summer season and an 81 percent reduction in the fall, winter, and spring season.

The City shows a mean load decrease of approximately 6.10 x 10^{10} counts when comparing conditions with and without BMPs during the summer season and a mean load decrease of 9.00 x 10^{11} counts during the fall, winter, and spring season. Figures 5-3 and 5-4 specify the pollutant load reduction estimate as a range, given the variability of stormwater data.

Structural BMP implementation is more prevalent in this watershed, as compared with the Clark Creek watershed. However, as with the Clark Creek watershed, the structural BMPs implemented in this watershed (swales, hydrodynamic separators) generally show limited effectiveness for bacteria removal.

Figures 5-3 and 5-4 indicate that the City is not currently estimated to be meeting the WLA for bacteria in the Mill Creek watershed. The WLAs defined for this watershed are conservative, and significant additional load reduction would be needed beyond the current structural BMP implementation reflected in the range of loading. The WLA is considered to be an ultimate discharge goal.

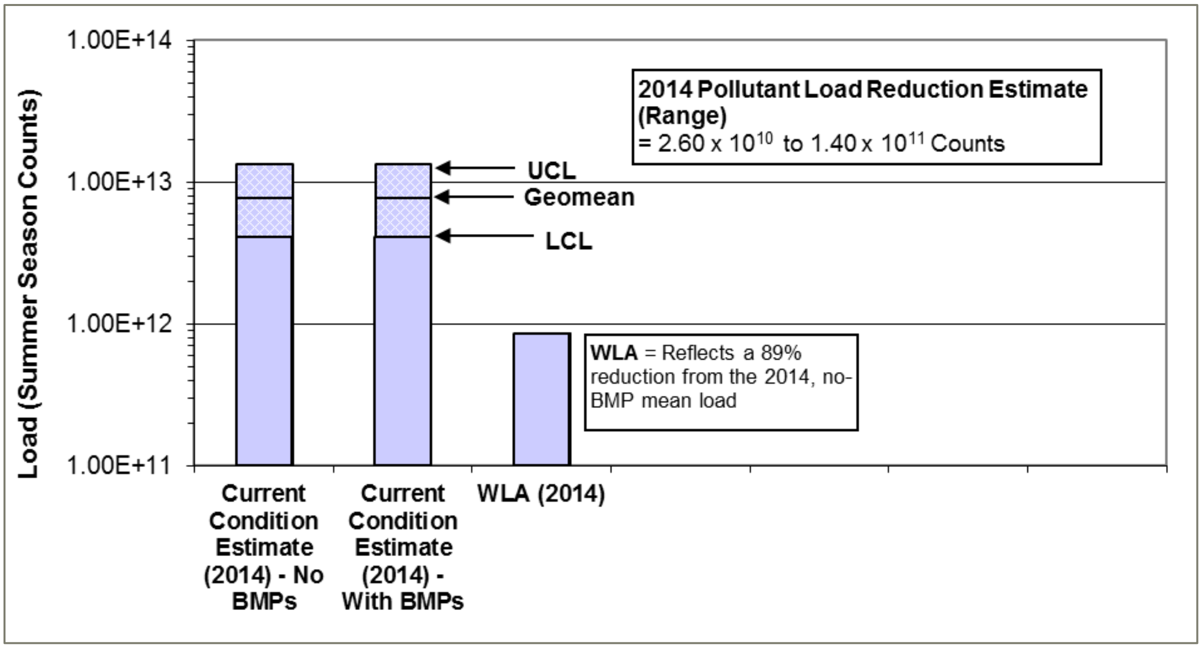

Figure 5-3. Mill Creek (including Battle Creek)–bacteria pollutant load reduction evaluation results (summer)

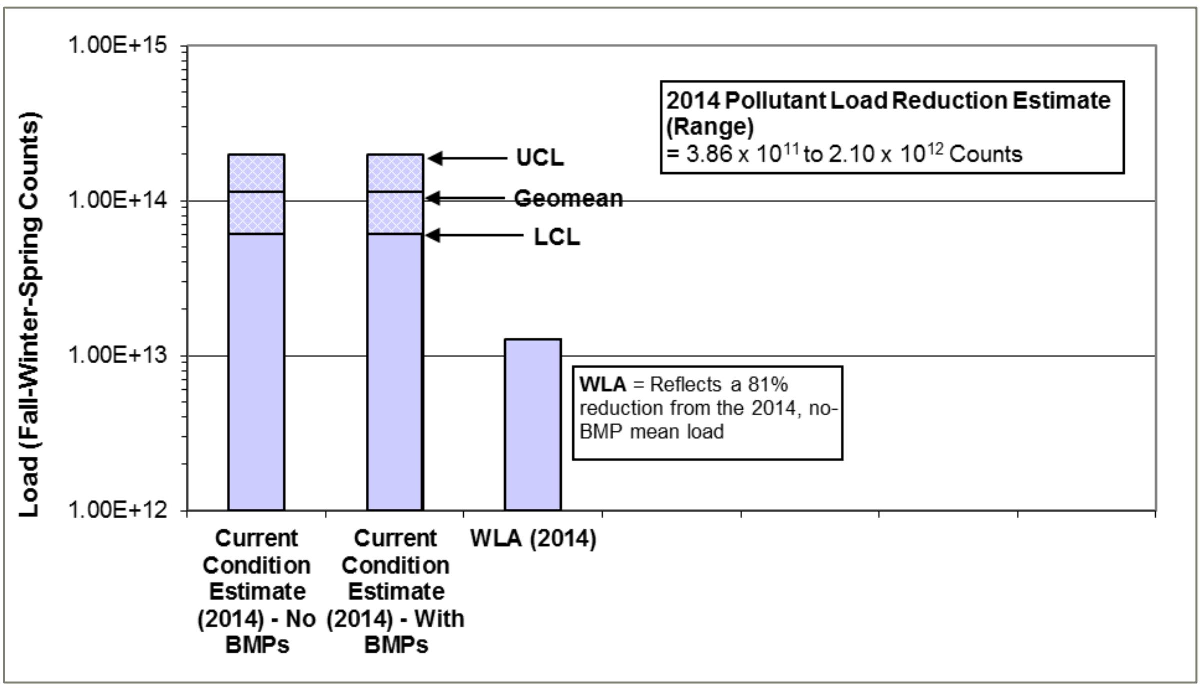

Figure 5-4. Mill Creek (including Battle Creek)–bacteria pollutant load reduction evaluation results (fall, winter, spring)

5.1.3 Model Results – Pringle Creek Tributary

Figure 5-5 shows the City's bacteria pollutant load estimates for the Pringle Creek tributary watershed during the summer season and Figure 5-6 shows the City's bacteria load estimate for the Pringle Creek tributary watershed during the fall, winter, and spring season. Both the no-BMP and with BMP load estimates are shown, and the calculated pollutant load reduction estimate is highlighted on each figure. Loads calculated for each scenario were plotted as a range, given the variability in stormwater data. This TMDL watershed was not specifically modeled in 2008, due to interpretation of the TMDL documents.

The bacteria WLA for discharges to Pringle Creek tributaries is a 92 percent reduction during the summer season and an 84 percent reduction in the fall, winter, and spring season.

The City shows a mean load decrease of approximately 4.70×10^{10} counts when comparing conditions with and without BMPs during the summer season and a mean load decrease of 6.90×10^{11} counts during the fall, winter, and spring season. Figures 5-5 and 5-6 specify the pollutant load reduction estimate as a range, given the variability of stormwater data.

Structural BMP implementation is more prevalent in this watershed, with a more variable distribution of BMP types including ponds, swales, sedimentation/hydrodynamic systems, and infiltration raingardens. Sedimentation-based systems (ponds, hydrodynamic systems) show limited effectiveness for bacteria removal, but implementation of infiltration-related BMPs that achieve flow reduction show increased removal of the bacteria.

Figures 5-5 and 5-6 indicate that the City is not currently estimated to be meeting the WLA for bacteria in the Pringle Creek tributary watershed. The WLAs defined for this watershed are some of the most conservative WLAs in the Willamette River TMDL. As such, significant additional load reduction would be needed beyond the current structural BMP implementation reflected in the range of loading. The WLA is considered to be an ultimate discharge goal.

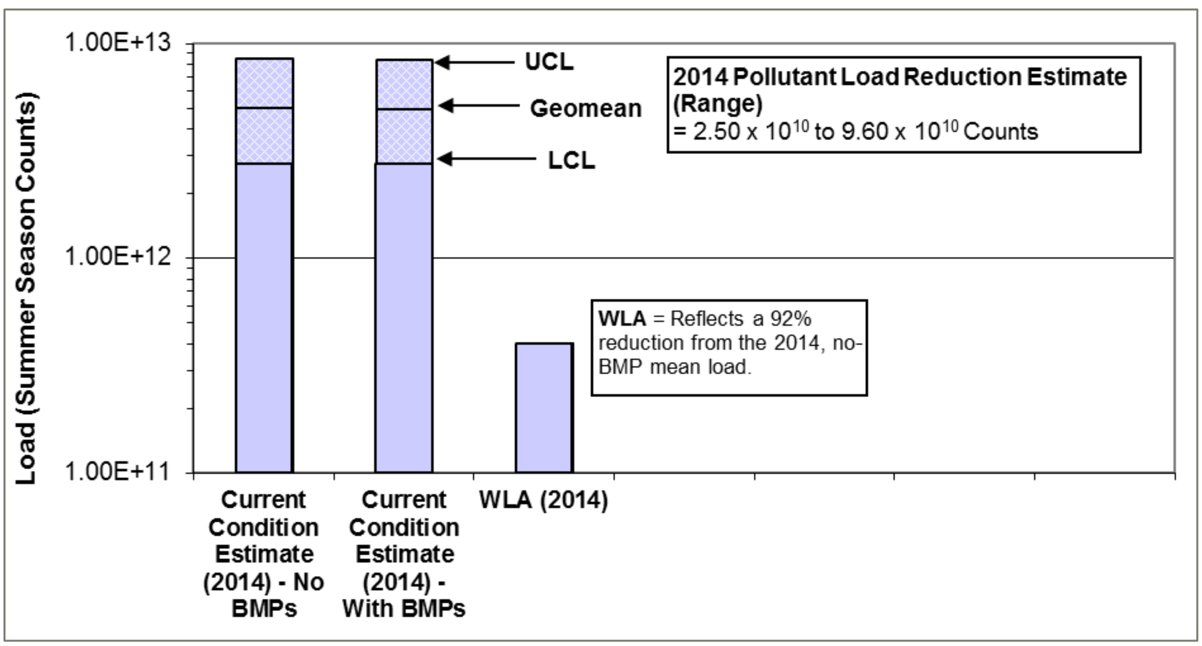

Figure 5-5. Pringle Creek Tributary–bacteria pollutant load reduction evaluation results (summer)

(This watershed was not specifically modeled in 2008.)

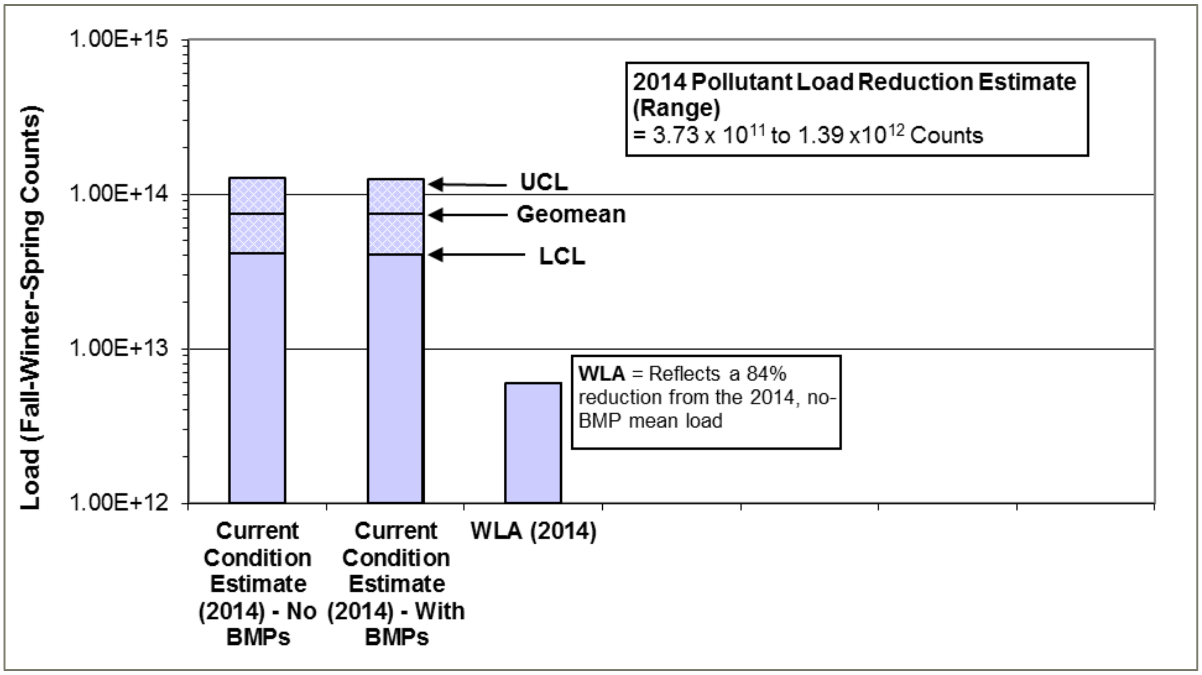

Figure 5-6. Pringle Creek Tributary–bacteria pollutant load reduction evaluation results (fall, winter, spring)

(This watershed was not specifically modeled in 2008.)

5.1.4 Model Results – Pringle Creek Direct

Figure 5-7 shows the City's bacteria pollutant load estimates for the Pringle Creek direct watershed during the summer season and Figure 5-8 shows the City's bacteria load estimate for the Pringle Creek direct watershed during the fall, winter, and spring season. Both the no-BMP and with BMP load estimates are shown, and the calculated pollutant load reduction estimate is highlighted on each figure. Loads calculated for each scenario were plotted as a range, given the variability in stormwater data. As with the Pringle Creek tributary watershed, this TMDL watershed was not specifically modeled in 2008, due to interpretation of the TMDL documents.

The bacteria WLA for discharges to Pringle Creek direct is a 90 percent reduction during the summer season and a 79 percent reduction in the fall, winter, and spring season.

The City shows a mean load decrease of approximately 7.10 x 10^9 counts when comparing conditions with and without BMPs during the summer season and a mean load decrease of 1.06 x 10^{11} counts during the fall, winter, and spring season. Figures 5-7 and 5-8 specify the pollutant load reduction estimate as a range, given the variability of stormwater data.

Structural BMP implementation is generally consistent in this watershed with the coverage of BMPs specified for the Pringle Creek tributary watershed. A variable distribution of BMP types including filters (StormFilters), swales, hydrodynamic systems, and infiltration and filtration raingardens is implemented in this watershed. Sedimentation-based systems (hydrodynamic systems) show limited effectiveness for bacteria removal, but implementation of filters and infiltration-related BMPs that achieve flow reduction show increased removal of the bacteria.

Figures 5-7 and 5-8 indicate that the City is not currently estimated to be meeting the WLA for bacteria in the Pringle Creek direct watershed. Like Clark Creek and Pringle Creek tributaries, the WLAs defined for this watershed are some of the most conservative WLAs in the Willamette River TMDL. As such, significant additional load reduction would be needed beyond the current structural

BMP implementation reflected in the range of loading. The WLA is considered to be an ultimate discharge goal.

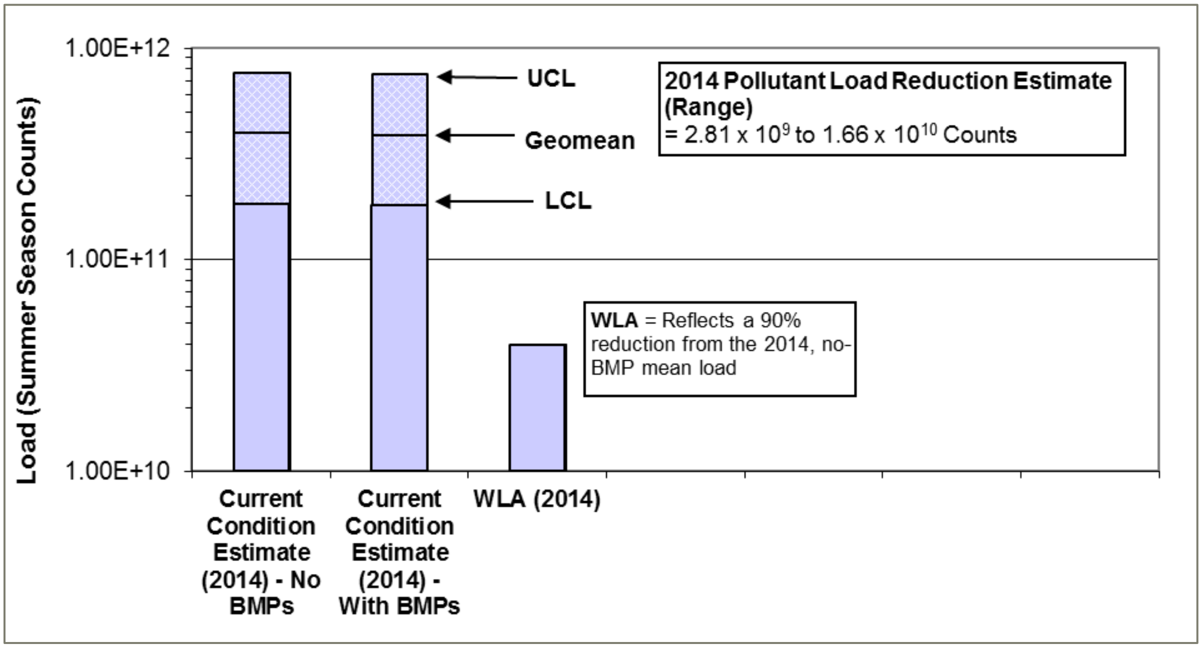

Figure 5-7. Pringle Creek Direct–bacteria pollutant load reduction evaluation results (summer)

(This watershed was not specifically modeled in 2008.)

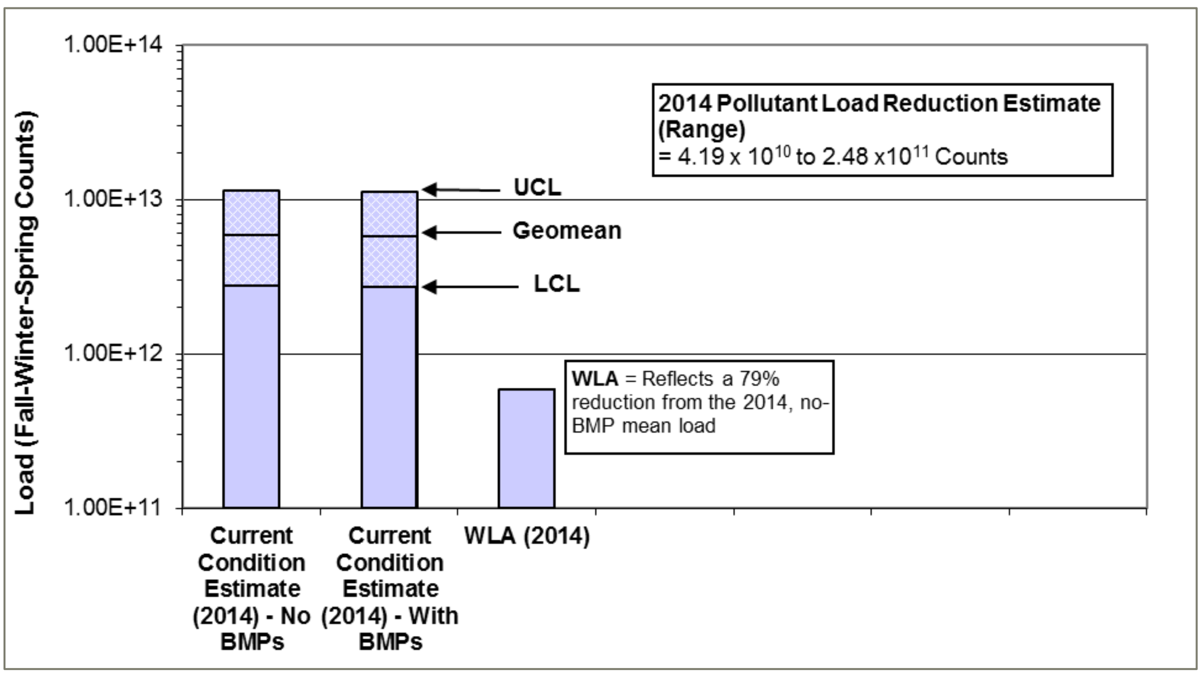

Figure 5-8. Pringle Creek Direct–bacteria pollutant load reduction evaluation results (fall, winter, spring)

(This watershed was not specifically modeled in 2008.)

5.1.5 Model Results – Middle Willamette River Tributary

Figure 5-9 shows the City's bacteria pollutant load estimates for the Willamette River tributary watershed during the summer season and Figure 5-10 shows the City's bacteria load estimate for the Willamette River tributary watershed during the fall, winter, and spring season. Both the no-BMP and with BMP load estimates are shown, and the calculated pollutant load reduction estimate is highlighted on each figure. Loads calculated for each scenario were plotted as a range, given the variability in stormwater data.

The bacteria WLA for discharges to Willamette River tributaries is an 88 percent reduction during the summer season and a 75 percent reduction in the fall, winter, and spring season.

The City shows a mean load decrease of approximately 3.50 x 10^{10} counts when comparing conditions with and without BMPs during the summer season and a mean load decrease of 5.00 x 10^{11} counts during the fall, winter, and spring season. Figures 5-9 and 5-10 specify the pollutant load reduction estimate as a range, given the variability of stormwater data.

Structural BMP implementation in this watershed is consistent with the coverage specified for Pringle Creek and Mill Creek watersheds. However, BMP types are generally limited to swales and hydrodynamic systems, which generally show limited effectiveness for bacteria removal. Although almost 350 acres are being treated by structural BMPs, these types of BMPs are limited in their ability to collect and remove bacteria. Flow reduction achieved through the structural BMPs (i.e., infiltration BMPs) achieves greater removal of the bacteria.

Figures 5-9 and 5-10 indicate that the City is not currently estimated to be meeting the WLA for bacteria in the Willamette River tributary watershed. WLAs defined for this watershed are conservative, and as such, significant additional load reduction would be needed beyond the current structural BMP implementation reflected in the range of loading. The WLA is considered to be an ultimate discharge goal.

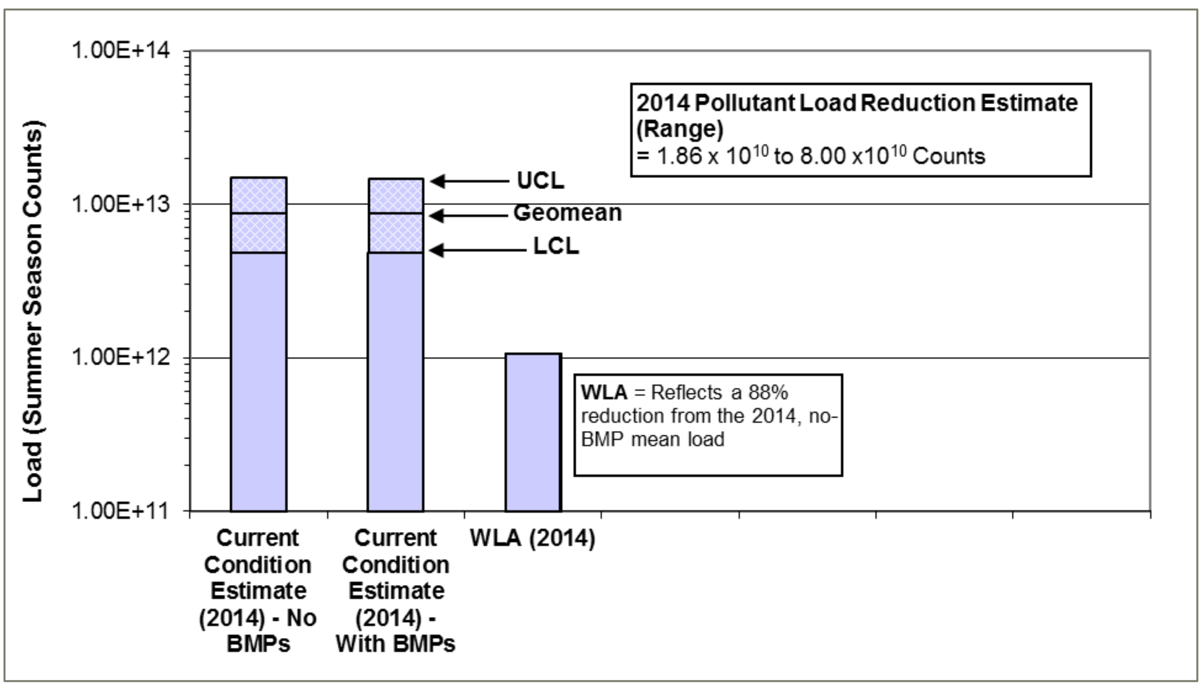

Figure 5-9. Middle Willamette River Tributary–bacteria pollutant load reduction evaluation results (summer)

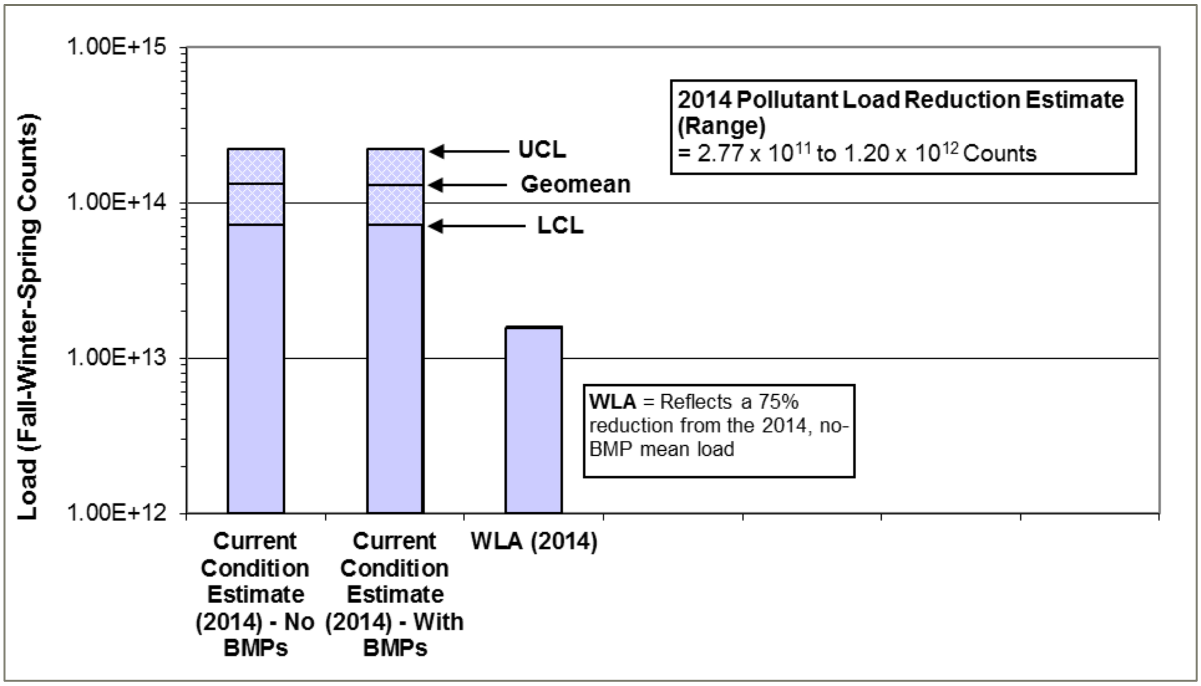

Figure 5-10. Middle Willamette River Tributary–bacteria pollutant load reduction evaluation results (fall, winter, spring)

5.1.6 Model Results – Middle Willamette River Direct

Figure 5-11 shows the City's annual bacteria pollutant load estimates for the Willamette River direct watershed. Both the no-BMP and with BMP load estimates are shown, and the calculated pollutant load reduction estimate is highlighted on each figure. Loads were plotted as a range, given the variability in stormwater data.

The bacteria WLA for discharge to the Willamette River direct watershed is a 75 percent reduction annually.

The City shows a mean load decrease of approximately 7.30 x 10^{11} counts when comparing conditions with and without BMPs annually. Figure 5-11 specifies the pollutant load reduction estimate as a range, given the variability of stormwater data.

Structural BMP implementation in this watershed is consistent with the coverage specified for the Willamette River tributary watershed, but BMP types are much more variable. BMP implementation includes filters, detention ponds, swales, and sedimentation/hydrodynamic systems. Sedimentation-based systems (hydrodynamic systems) show limited effectiveness for bacteria removal, but implementation of filters and infiltration-related BMPs that achieve flow reduction show increased removal of the bacteria.

Figure 5-11 indicates that the City is not currently estimated to be meeting the WLA for bacteria in the Willamette River direct watershed. WLAs defined for this watershed are conservative, and as such, significant additional load reduction would be needed beyond the current structural BMP implementation reflected in the range of loading. The WLA is considered to be an ultimate discharge goal.

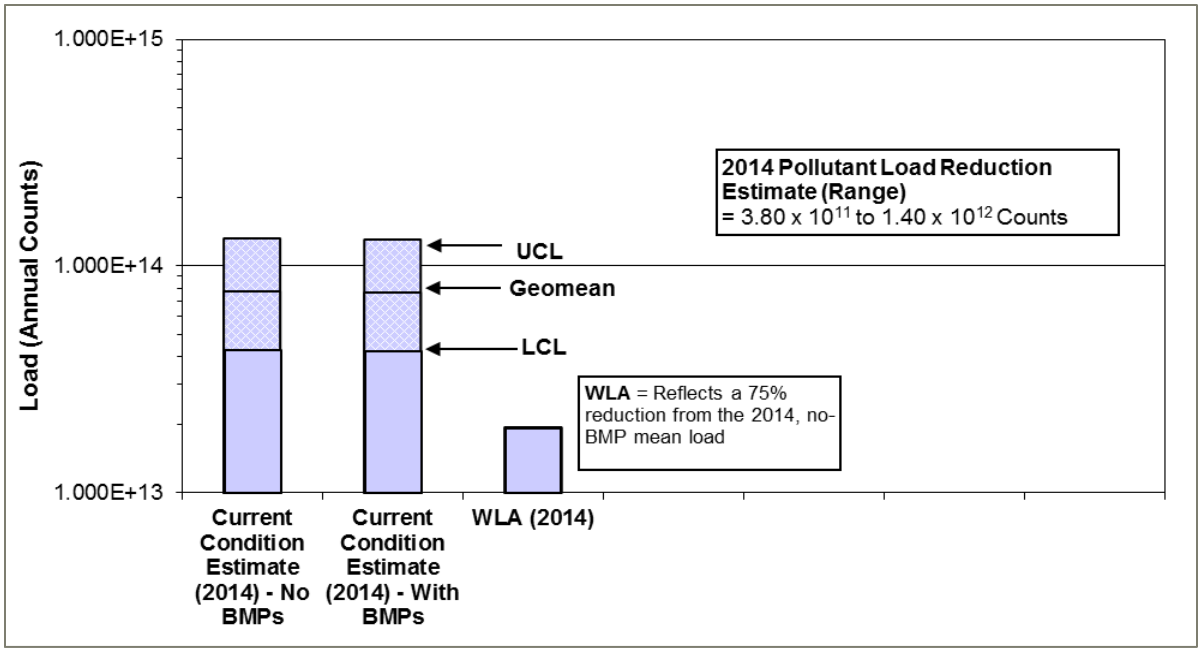

Figure 5-11. Middle Willamette River Direct–bacteria pollutant load reduction evaluation results (annual)

5.1.7 Benchmark Comparison

As part of the pollutant load evaluation effort, pollutant load reduction estimates must be compared to previously established pollutant load reduction benchmarks as applicable. Pollutant load reduction benchmarks were established by the City for select TMDL watersheds within the Middle Willamette Subbasin in 2008. The pollutant load reduction benchmarks were intended to represent development and BMP implementation conditions in 2013. Pollutant load reduction benchmarks were established for Clark Creek, Mill Creek (including Battle Creek), the Willamette River tributaries, and the Willamette River direct. Pollutant load reduction benchmarks were not established for the Pringle Creek tributary or Pringle Creek direct watershed due to interpretation of the TMDL language in 2008.

Calculation of pollutant load reduction benchmarks in 2008 required the City to project where annexations would occur (change in permit coverage area), where development would occur (change in land use conditions), and where future BMPs would be implemented (based on projected development and retrofit activities). With the economic downturn in 2008, such activities did not occur. As a result, the 2008 model assumptions for permit area, land use area, and BMP coverage area are not directly reflected in the 2014 pollutant load reduction evaluation.

Tables 5-1 and 5-2 show the difference in model area and BMP coverage area between the 2008 modeling effort and the current 2014 modeling effort. Such differences in assumptions directly affect the pollutant load reduction results and the ability of the City to meet their pollutant load reduction benchmarks.

Table 5-1. Model Area Comparison			
Waterbody	2008 Benchmark effort – model area (ac)		2014 pollutant load reduction evaluation – model area (ac)
	2008 (actual)	2013 (projected)	2014 (actual)
Clark	1535.4	1535.4	1531.5
Mill + Battle	8168.0	8174.7	6620.3
Pringle Creek Tribs	5032.3	5111.3	4501.3
Pringle Creek			468.8
Middle Willamette Tribs	7675.5	7691.7	7613.5
Middle Willamette Direct	4906.7	4906.7	4295.4
Little Pudding	not modeled		2575.9

Table 5-2. BMP Coverage Comparison			
Waterbody	2008 benchmark effort – BMP coverage (%)		2014 pollutant load reduction evaluation – BMP coverage (%)
	2008 (actual)	2013 (projected)	2014 (actual)
Clark	0.7	2.6	0.4
Mill + Battle	3.6	4.6	4.2
Pringle Creek Tribs	3.9	8.1	5.0
Pringle Creek			4.0
Middle Willamette Tribs	2.8	5.6	4.6
Middle Willamette Direct	1.4	3.7	5.0
Little Pudding	not modeled		19.3

In addition to differences between 2008 and 2014 assumptions related to model area and BMP coverage for this pollutant load reduction evaluation, a number of additional modeling methods were changed. These changes, which are discussed in Section 4, were undertaken because the City developed completely new land use coverage and BMP inventory and drainage area delineation in 2014 for this pollutant load modeling effort. GIS files from 2008 were no longer available for use, and therefore new GIS coverages needed to be developed. Model changes included the following:

- Removal of NPDES 1200-Z and 1200-A permitted areas and waterbody surface area from the model area. Permitted areas have effluent discharge benchmarks already assigned. Waterbody surface areas do not include MS4 and would not contribute pollutants associated with stormwater runoff.
- Revised land use categories. Public facility is a new land use category. Transportation is no longer an individual, modeled land use category.
- Revised impervious percentages by land use. 2008 model assumptions used general, documented impervious percentages from previous planning documents. The 2014 pollutant load modeling effort included direct calculation of impervious percentages by modeled land use.
- Updated BMP categories and effluent concentrations. In an effort to refine model input data, the ACWA Stormwater Committee expanded the structural BMP categories for inclusion in the model and updated BMP effluent concentration data based on recent literature and monitoring data.

Based on changes in modeling assumptions and methods (described above), direct comparison of the 2014 pollutant load reduction estimates to the pollutant load reduction benchmarks projected for the 2013 condition is not possible. However, the City is providing results of the benchmark comparison effort to specifically meet permit requirements outlined in Schedule D.3.c.iv. Results of the comparison effort are documented in Table 5-3 and reflect the 2014 pollutant load reduction range versus the 2013 pollutant load reduction benchmark (defined as a range).

Table 5-3. Middle Willamette Subbasin – Comparison to 2013 Benchmarks

Waterbody	Season	2014 pollutant load reduction estimate (bacteria counts)			2013 benchmarks (bacteria counts), as a range	Met bench-marks[a]
		Upper confidence limit (UCL)	Mean	Lower confidence limit (LCL)		
Clark Creek	summer	4.00×10^{9}	2.00×10^{9}	9.00×10^{8}	6.34×10^{9} to 2.93×10^{10}	
	fall, winter, spring	7.00×10^{10}	3.00×10^{10}	1.20×10^{10}	9.44×10^{10} to 4.37×10^{11}	
Mill + Battle Creek	summer	1.40×10^{11}	6.10×10^{10}	2.60×10^{10}	6.08×10^{10} to 4.36×10^{11}	likely met
	fall, winter, spring	2.10×10^{12}	9.00×10^{11}	3.86×10^{11}	9.17×10^{11} to 6.58×10^{12}	possibly met
Pringle Creek Tributary	summer	9.60×10^{10}	4.70×10^{10}	2.50×10^{10}	N/A	N/A
	fall, winter, spring	1.39×10^{12}	6.90×10^{11}	3.73×10^{11}	N/A	N/A
Pringle Creek Direct	summer	1.66×10^{10}	7.10×10^{9}	2.81×10^{9}	N/A	N/A
	fall, winter, spring	2.48×10^{11}	1.06×10^{11}	4.19×10^{10}	N/A	N/A
Middle Willamette River Tributary	summer	8.00×10^{10}	3.50×10^{10}	1.86×10^{10}	5.93×10^{10} to 3.67×10^{11}	possibly met
	fall, winter, spring	1.20×10^{12}	5.00×10^{11}	2.77×10^{11}	8.84×10^{11} to 5.46×10^{12}	possibly met
Middle Willamette River Direct	annual	1.40×10^{12}	7.30×10^{11}	3.80×10^{11}	4.32×10^{11} to 2.09×10^{12}	likely met

a. This column is provided to comply with a permit requirement. However, the City believes that refined GIS files, altered evaluation methods, and changes in development projections have more impact on the ability to simulate pollutant reductions representative of the benchmarks than changes in BMP implementation commitments.

For purposes of this benchmark comparison effort, the mean 2014 pollutant load reduction estimate was compared to the 2013 pollutant load reduction benchmark range. Where the mean 2014 pollutant load reduction estimate falls within the benchmark range, the benchmarks are interpreted to likely be met. Where the 2014 pollutant load reduction range falls within the benchmark range, the benchmarks are interpreted to potentially be met.

Adherence to the pollutant load reduction benchmark seems to be greatly influenced by the BMP coverage within a TMDL watershed and the relative type of BMP used. As shown in Table 5-2, the percentage BMP coverage estimated for 2013 conditions is higher than 2014 actual conditions, with the exception of the Willamette River direct watershed. The percentage BMP coverage estimated for 2013 was based on a generalized BMP inventory and reflects additional BMP implementation associated with development from 2008 to 2013. BMP coverage information was greatly refined for the 2014 modeling effort and, in some watersheds, resulted in BMP coverage percentages that

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differ from even the 2008 assumptions (see Clark Creek). Clark Creek's BMP coverage decreased in 2014 from model assumptions used in 2008. As a result, Clark Creek's 2014 pollutant load reduction estimate range is less than the benchmark and additional BMP coverage would be necessary to meet benchmarks. In other words, the City believes that refined GIS files, altered evaluation methods, and changes in development projections have more impact on the ability to simulate pollutant reductions representative of the benchmarks than changes in BMP implementation commitments.

5.2 Pollutant Load Reduction Evaluation – Molalla-Pudding TMDL

Bacteria and TSS loads were calculated for the Little Pudding tributary watershed within the Little Pudding River Subbasin. As described in Section 2.2, significant interpretation of the TMDL was required because MS4 sources were not specifically referenced as having a WLA or an LA.

The Little Pudding tributary watershed was simulated for annual loading (seasonal WLAs are not specified). Model results are provided by parameter in the subsections below and reflect model assumptions and simulations as described in Section 4.

5.2.1 Model Results – Bacteria

Figure 5-12 shows the City's annual bacteria pollutant load estimates for the Little Pudding tributary watershed. Both the no-BMP and with BMP load estimates are shown, and the calculated pollutant load reduction estimate is highlighted on each figure. Loads were plotted as a range, given the variability in stormwater data.

The assumed bacteria WLA for discharge to the Little Pudding tributary watershed is an 86 percent reduction annually. As described in Section 4.6, the WLA is calculated based on the required load reduction applied to the mean bacteria load for the no-BMP pollutant load scenario. Although calculated from the mean, no-BMP load (for graphical purposes), the WLA also may be depicted as a range in reduction from the overall no-BMP load.

The City shows a mean load decrease of approximately 3.43×10^{12} counts when comparing conditions with and without BMPs annually. Figure 5-12 specifies the pollutant load reduction estimate as a range, given the variability of stormwater data.

Structural BMP implementation in this watershed is significant in comparison to other TMDL watersheds. Approximately 500 acres of the watershed (or greater than 10 percent of the total watershed area) is covered with structural BMPs. A majority (80 percent) of this BMP coverage is associated with wetlands, which are shown to be effective for bacteria removal in accordance with available BMP effectiveness data.

Figure 5-12 indicates that the City is not currently estimated to be meeting the WLA for bacteria in the Little Pudding tributary watershed, even though significant increases in BMP coverage are observed for this watershed. WLAs defined for this watershed are conservative, and as such, significant additional load reduction would be needed beyond the current structural BMP implementation reflected in the range of loading. The WLA is considered to be an ultimate discharge goal.

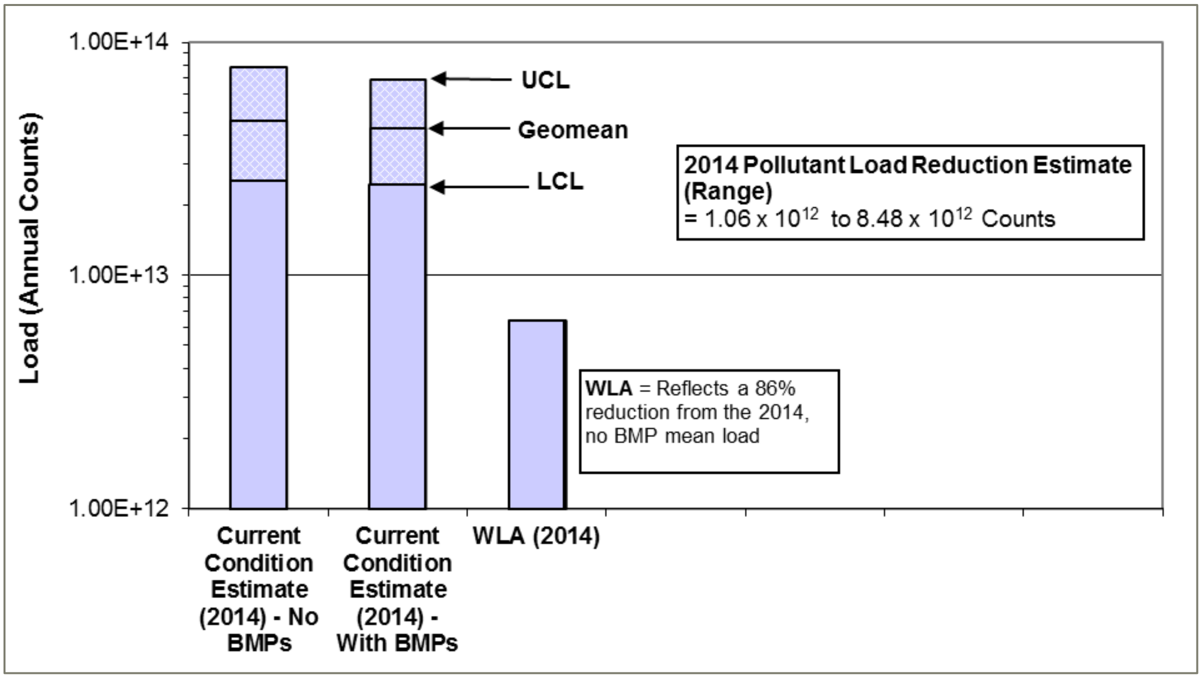

Figure 5-12. Little Pudding Tributary–bacteria pollutant load reduction evaluation results (annual)

5.2.2 Model Results – TSS (surrogate for pesticides)

Figure 5-13 shows the City's annual TSS pollutant load estimates for the Little Pudding tributary watershed. As described in Section 2, TSS was the pollutant parameter recommended by DEQ for the pollutant load reduction evaluation. Both the no-BMP and with BMP load estimates are shown, and the calculated pollutant load reduction estimate is highlighted on each figure. Loads were plotted as a range, given the variability in stormwater data.

No TSS WLA is provided in the TMDL. Instead an instream concentration target of 7 mg/L TSS is listed for the Little Pudding River as a concentration target needed to partially meet the prescribed pesticide WLAs for DDT and dieldrin. Use of an instream concentration target does not translate to a WLA because it does not account for dilution or dispersion that would otherwise impact an instream concentration target. As a result, the equivalent TSS load associated with a discharge concentration of 7 mg/L was plotted and used for comparison for the pollutant load reduction evaluation (thereby referenced as the TSS load target). The equivalent TSS load target roughly translates to a 90 percent reduction from the mean TSS load for the no-BMP pollutant load scenario. Although calculated from the mean, no-BMP load (for graphical purposes), the target TSS load also may be depicted as a range in reduction from the overall no-BMP load.

The City shows a mean load decrease of approximately 69,600 pounds when comparing conditions with and without BMPs annually. Figure 5-13 specifies the pollutant load reduction estimate as a range, given the variability of stormwater data.

As described for the bacteria model results for the Little Pudding tributary watershed, structural BMP implementation in this watershed is significant in comparison to other TMDL watersheds. Approximately 500 acres of the watershed is covered with structural BMPs and a majority of BMP coverage is associated with wetlands, which are shown to be effective for TSS removal in accordance with available BMP effectiveness data.

Figure 5-13 indicates that the City is not currently estimated to be meeting the equivalent pollutant load associated with a target TSS concentration of 7 mg/L, even though significant increases in BMP coverage are observed for this watershed. Significant additional load reduction would be needed beyond the current structural BMP implementation reflected in the range of loading.

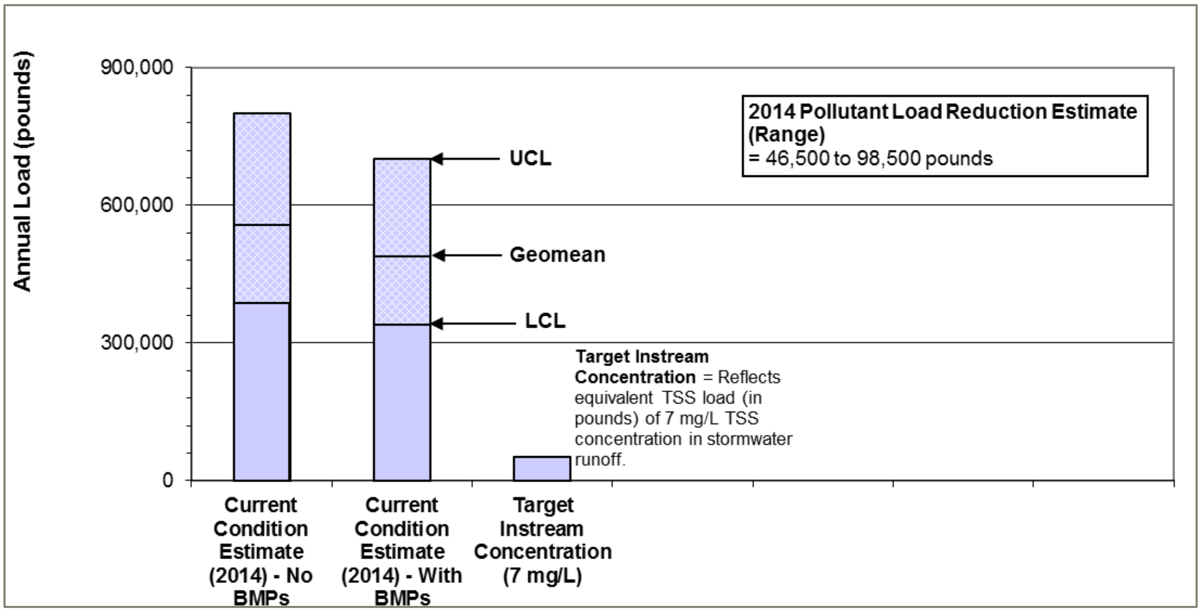

Figure 5-13. Little Pudding Tributary–TSS pollutant load reduction evaluation results (annual)

5.3 Pollutant Load Reduction Evaluation Discussion

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 or LAs to MS4 discharges and quantitatively tracking pollutant load discharges to ensure that progress towards the WLA or LA is being made.

As reflected in the Willamette River TMDL for bacteria, when the WLAs or LAs are documented as large percentage reductions, achieving such a collective, large percentage pollutant reduction would require widespread BMP implementation, which is generally not possible considering typical constraints with respect to constructability, funding, etc. The effectiveness of traditional stormwater treatment practices is also limited for bacteria with respect to the unit removal processes typically employed with passive treatment systems.

Additionally, based on review of the Willamette River and Molalla-Pudding River TMDLs, it is unclear how the TMDL intended to regulate MS4 sources (i.e., by holding MS4 sources accountable to a specific pollutant discharge limit). MS4 sources are actually assigned LAs for pollutant parameters, which is a typical practice for non-point source pollutants, as opposed to WLAs that are typical for point source pollutants addressed under a permit (i.e., NPDES permit). As such, the TMDL does not appear to be developed with the assumption that detailed, quantitative pollutant discharge accounting would be required for sources with LAs, as typical non-point pollutant sources (agriculture, forestry, etc.) are not required to show quantitative progress towards a LA.

In conducting a quantitative pollutant load reduction evaluation, the City has chosen a conservative approach to avoid overestimating the effectiveness of its program. The pollutant load reduction estimates reflect the maximum extent practicable standard, as the City is currently able to foresee, and direct implementation of structural BMPs. With adaptive management efforts, and the recent adoption of stormwater development standards that promote more infiltration-based stormwater facilities, it is expected that pollutant load reductions will increase as more information and/or new, more cost-effective technologies become available.

The pollutant load reduction estimates, as detailed in Sections 5.1 and 5.2, are expected to be conservative (i.e., greater reductions are likely achieved) for several reasons, as described below.

5.3.1 Non-Structural BMP Effectiveness

While numeric values for non-structural or source control BMP effectiveness were not specifically accounted for in the City's pollutant loads model, pollutant loads are presented as a range, and this range may be partially dependent on the variable nature of stormwater runoff (and the associated non-structural and source control practices implemented upstream).

The estimated range of pollutant load reductions in this report is anticipated to reflect the City's implementation of their overall stormwater management program. Structural BMP implementation (as directly accounted for in pollutant modeling) comprises a small component of the overall program. However, measuring the effectiveness of source control and non-structural practices requires significant assumptions in order to determine how to reflect pollutant reduction associated with a behavioral or conditional practice and how to translate that interim practice into reduction of a singular pollutant over the course of a season or year (depending on how the TMDL is developed). Thus, the City has chosen to account for the effectiveness of source control and non-structural BMPs in narrative form only.

The City conducts a variety of programmatic activities that are directly attributable to bacteria and TSS 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. Pollutants potentially addressed are referenced in the City's SWMP in accordance with each BMP or activity.

Research has been conducted related to literature values for non-structural BMP effectiveness. One such data source is the Watershed Treatment Model (WTM) (Caraco, 2010), a planning level model developed by the Center for Watershed Protection. The model is a simple spreadsheet used to estimate pollutant loading (nutrients, sediment, and bacteria) and evaluate effects of proposed structural and non-structural management practices and future development on pollutant loads.

The WTM provides default values for the effectiveness of certain non-structural BMPs while it encourages the user to input values for others. In each case, the model provides guidance to select appropriate values. Although not directly used in this pollutant loads modeling effort, the efficiencies of non-structural practices including street sweeping, riparian buffer protection, catch basin cleanouts, and erosion and sediment control, are provided in the form of percent removals in Tables 5-4 and 5-5 for additional background.

Table 5-4. Example Pollutant Load Removal Efficiencies of Non-Structural BMPs (Street Sweeping)

Sweeper type	Efficiency (%)			
	Residential		Other roads	
	Nutrients	TSS	Nutrients	TSS
Mechanical	24	30	4	5
Regenerative air	51	64	18	22
Vacuum assisted	62	78	63	79

Source: WTM

Table 5-5. Example Pollutant Load Removal Efficiencies of Non-Structural BMPs (Other)

BMP	Efficiency (%)		
Erosion and sediment control	70		
Catch basin cleanouts	Nutrients	TSS	
Monthly cleaning	15	25	
Semi-annual cleaning	8	13	
	TP	TSS	TN
Riparian buffers	10	70	30

Source: WTM

For other non-structural practices, removal efficiencies are included in the WTM based on treatability and discount factors that the user inputs into the model. Treatability is defined as the fraction of the population that can be reached for education programs. Discount factors account for imperfect practice application and upkeep, inability of educational programs to reach all citizens, and inadequate funding to implement all practices, for example. The pollutant removal efficiencies associated with the non-structural stormwater management practices used in the model are based on existing research and studies by the Center for Watershed Protection (1999) and Winer (2000) and are not locally based.

There are many simplifying assumptions made by the WTM, and the model is not calibrated. Therefore, the results of the model simulations should be compared on a relative basis rather than used as absolute values. Per results of the WTM, up to 79 percent removal efficiency was estimated depending on the parameter and the non-structural practice implemented. It should be noted that for bacteria the efficiency is more limited than for other parameters (e.g., TSS). Also, any non-structural BMP effectiveness estimate needs to be qualified based on a best professional judgment and continued ability to update and refine the effectiveness numbers based on improved non-structural practices. This information is presented to show the potential significance and additional load reduction that may be achieved through the City's non-structural practices. These additional load reductions are not reflected in the City's quantitative analysis.

5.3.2 Water Quality Trends Analysis

In accordance with Schedule D.3.c.vii of the NPDES MS4 permit, the pollutant load reduction evaluation includes a water quality trends analysis. The City prepared its water quality trends analysis, and full documentation is included in Appendix A.

Water quality trends were calculated on the City's 21 instream sites that are monitored monthly. Monitoring has been conducted since 2001. Per ACWA guidance, the Mann-Kendall test was used for analysis on datasets containing a minimum of 30 data points recorded over a 5-year period. A total of 351 datasets (separated by site, parameter, and precipitation [no rain or rain event] were evaluated).

Of the datasets associated with rainfall/ precipitation events (to evaluate potential water quality trends associated with MS4 discharge to receiving waters), 57 datasets showed significant or somewhat significant trends. General results by TMDL watersheds are as follows:

- Battle Creek – BOD, turbidity, and nitrate data showed a trend towards improved water quality. The upstream Battle Creek site showed a trend towards decreasing dissolved oxygen concentrations (a sign of degraded water quality).
- Clark Creek –Nitrate data showed a trend towards improved water quality. The upstream Clark Creek site showed a trend towards increased bacteria concentrations (a sign of degraded water quality).
- Middle Willamette Tributaries – Specific waterbodies include Claggett Creek, Croisan Creek, Gibson Creek, Glenn Creek and Shelton Ditch. Tributaries generally showed no trend; select parameters showed a trend towards improved water quality (nitrate, dissolved oxygen, turbidity). None of the specified waterbodies showed trends indicating degrading water quality.
- Mill Creek - Bacteria data showed a slight trend towards improved water quality. No trends indicated degrading water quality.
- Pringle Creek - Nitrate data showed a slight trend towards improved water quality. No trends indicated degrading water quality.
- West Fork Little Pudding – Dissolved oxygen data showed a slight trend towards improved water quality. No trends indicated degrading water quality.

Monitoring data evaluated for the water quality trends consists of grab samples, which capture a specific moment in time and can reflect the influence of a variety of factors. Results should be viewed as a piece of information and not a conclusive statement as to the overall condition of sampled streams. Based on the results from this trends analysis, instream water quality trends collectively were not observed or showed improvement. Deteriorating trends were observed for select parameters and select locations, but were mostly observed during dry weather conditions and thus less associated with stormwater runoff conditions.

Section 6

Pollutant Load Reduction Benchmarks

Based on results of the pollutant load reduction evaluation (Sections 5.1 and 5.2), the City of Salem is not estimated to meet TMDL WLAs for bacteria in any of the modeled TMDL watersheds. Thus, the City is required to establish TMDL pollutant load reduction benchmarks for bacteria for the next permit term. As stated in Section 2.2.2, the target instream TSS concentration of 7 mg/L (used as a surrogate for toxics in the Little Pudding River Subbasin) is not considered a WLA and thus is not subject to development of TMDL benchmarks.

Section 6.1 describes the assumptions related to development of TMDL benchmarks for the upcoming permit term, including the identification of additional or modified BMPs to result in further reduction of bacteria loads. Section 6.2 provides the results of the future BMP implementation model simulation, including the pollutant load reduction estimates reflective of the TMDL benchmarks. Discussion related to how SWMP implementation contributes to the overall reduction of TMDL pollutants is provided in Section 6.3.

6.1 TMDL Benchmark Development

By definition, TMDL benchmarks are estimates of pollutant load reduction in the future. They reflect current BMP implementation and projected BMP implementation over the next permit term.

In accordance with Schedule D.3.d.i of the City's NPDES MS4 permit, TMDL benchmarks shall reflect additional pollutant load reductions necessary to achieve the 2013 benchmarks if those were not met (as evaluated during the pollutant load reduction evaluation in Section 5) and additional progress toward the TMDL WLA to be achieved during the next permit term. As the City's current NPDES MS4 permit expires December 29, 2015, the next 5-year permit term is anticipated to be 2016–2021.

TMDL benchmarks are required for bacteria in each of the seven modeled TMDL watersheds. Table 6.1 summarizes the applicable TMDL waterbody and current status in meeting the 2013 benchmarks and the overall TMDL WLA, as interpreted from Table 5-3.

To identify additional BMPs that will result in further TMDL pollutant reduction and to establish TMDL benchmarks, Salem public works and engineering staff collaborated to define future public stormwater facility installations in conjunction with public works projects, stormwater capital improvement projects, and stormwater retrofits through 2021. The strategy and proposed implementation schedule for these projects is outlined in the City's 2014 Stormwater Retrofit Plan and the City's 5-year Capital Improvement Plan (CIP). A total of 15 future capital projects are identified, as shown by the future BMP drainage areas outlined in Figures 4-2 to 4-8. Staff collaborated to identify the location, type(s), and anticipated drainage area(s) for these projects. Table 6-1 lists the proposed stormwater facility installation by TMDL watershed, facility type, and drainage area.

It should be noted that the TMDL benchmarks are based solely on proposed public structural BMP installations. This conservative assumption is due in part to the variable schedule of the private development activities (and private structural BMP installation schedules) and the unknown content and issuance date for the City's reissued NPDES MS4 permit.

Table 6-1. 2015 TMDL Benchmark Status and Future Stormwater Facility Installations

Waterbody	Season	2014 pollutant load reduction estimate results (bacteria)		2015 TMDL benchmark development	
		Met TMDL WLA? (Y/N)	Met (2013) benchmark? (Y/N)	Future BMP installation	Total drainage area (ac)
Clark Creek	Summer	N	Unlikely	None. See Section 6.3.	N/A
	Fall, winter, spring	N	Unlikely		
Mill + Battle Creek	Summer	N	Y	Wet pond	6.5
	Fall, winter, spring	N	Y		
Pringle Creek Tributary	Summer	N	Y	• Treatment train (filtration planter, swale, filter)[a] • Swale • Swale • Swale • Swale • Swale • Treatment train (planter, pollution control manhole)	30.3
	Fall, winter, spring	N	Y		
Pringle Creek Direct	Summer	N	Y	• Treatment train (filtration planter, swale, filter)[a]	1.8
	Fall, winter, spring	N	Y		
Middle Willamette River Tributary	Summer	N	Y	• Treatment train (swale, filter) • Lined, filtration planter • Swale • Wetland retrofit[b]	13.2
	Fall, winter, spring	N	Y		
Middle Willamette River Direct	annual	N	Y	• Wetland retrofit[b] • Pollution control manhole • Lined, filtration planter	14.3
Little Pudding Tributaries[c]	annual	N	N/A	• Treatment train (filtration planter, filter) • Treatment train (swale, hydromodynamic separator, pollution control manhole	37.0

a. *This CIP drainage area falls within the Pringle Creek direct and Pringle Creek tributary TMDL watersheds. Therefore, this project is shown pertaining to both watersheds.*

b. *This CIP drainage area falls within the Middle Willamette direct and Middle Willamette tributary TMDL watersheds. Therefore, this project is shown pertaining to both watersheds.*

c. *The Little Pudding TMDL became effective in 2008. No benchmarks were previously developed for this TMDL watershed.*

6.2 TMDL Benchmark Results

The same spreadsheet loads model used for the pollutant load reduction evaluation was used to simulate future BMP implementation in accordance with modeling methods and assumptions described in Section 4 and additional future-planned BMPs per Section 6.1.

For consistency with 2008 methods and assumptions, TMDL benchmarks are calculated as the difference between the modeled loads associated with the no-BMP scenario and the (future) with-BMP scenario. Because of the variability in stormwater data, pollutant loads themselves are typically calculated and presented as a range. Pollutant load estimates reflecting the no-BMP, the with-BMP (current), and the with-BMP (future) scenarios are provided in Appendix B.

Table 6-2 provides TMDL benchmarks both as a load reduction and as a percentage load reduction. Calculation of the TMDL benchmarks is based on the pollutant load estimates in Appendix B. Because the pollutant load estimates are presented as a range, the TMDL benchmarks are also presented as a range. Calculation of the TMDL benchmarks as a load reduction will allow for comparison of the TMDL benchmarks to future pollutant load reduction evaluations. Calculation of the TMDL benchmarks as a percentage load reduction allows for direct comparison between the WLA and the TMDL benchmarks per Schedule D.3.d.ii.1 of the City's NPDES MS4 permit. The WLA is also shown in Table 6-2.

Table 6-2. TMDL Benchmarks (2016–2021)

Waterbody	Season	WLA (%)[a]	TMDL benchmarks (% load reduction)[b], range	TMDL benchmarks (counts)[b], range
Clark Creek	Summer	94%	None. See Section 6.3.	None. See Section 6.3.
	Fall, winter, spring	89%	None. See Section 6.3	None. See Section 6.3.
Mill + Battle Creek	Summer	89%	0.6 to 1.0%	2.59×10^{10} to 1.39×10^{11}
	Fall, winter, spring	81%	0.6 to 1.0%	3.86×10^{11} to 2.10×10^{12}
Pringle Creek Tributary	Summer	92%	1.2 to 1.5%	3.18×10^{10} to 1.23×10^{11}
	Fall, winter, spring	84%	1.2 to 1.4%	4.75×10^{11} to 1.80×10^{12}
Pringle Creek Direct	Summer	90%	1.6 to 2.3%	2.94×10^{9} to 1.79×10^{10}
	Fall, winter, spring	79%	1.6 to 2.3%	4.39×10^{10} to 2.67×10^{11}
Middle Willamette River Tributary	Summer	88%	0.4 to 0.6%	2.07×10^{10} to 8.45×10^{10}
	Fall, winter, spring	75%	0.4 to 0.6%	3.08×10^{11} to 1.30×10^{12}
Middle Willamette River Direct	annual	75%	1.1 to 1.4%	4.59×10^{11} to 1.81×10^{12}
Little Pudding Tributaries	annual	86%	4.2 to 10.9%	1.07×10^{12} to 8.49×10^{12}

a. *Bacteria WLA are expressed as a percent load reduction.*

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

6.3 Discussion and Conclusions

The TMDL benchmarks are conservative estimates of the pollutant load reduction anticipated during the upcoming MS4 permit term with the use of public structural BMPs alone. However, the city's overall stormwater program is comprised of non-structural BMPs, programmatic activities and the ongoing implementation of structural BMPs, through adherence to stormwater design standards and capital improvement project installations.

This section provides detail related to the conservative nature of the TMDL benchmarks in conjunction with the City's stormwater program and outlines qualitative benchmarks, documented in the form of non-structural BMPs, specific for the Clark Creek basin. This section also provides additional discussion and conclusions related to the interpretation of TMDL benchmarks.

6.3.1 Non-Structural BMP Implementation and Qualitative TMDL Benchmarks

Measuring the effectiveness of non-structural practices requires significant assumptions in order to reflect pollutant reduction associated with a behavior or conditional practice. As such, the City chose a conservative approach to the quantitative pollutant load modeling and TMDL benchmark development and opted to account for the effectiveness of non-structural BMPs in narrative form only.

The City implements a variety of non-structural BMPs activities that are directly attributable to bacteria and TSS reduction including erosion control, illicit discharge detection and elimination, street sweeping, catch basin cleaning, facility maintenance, system operations and maintenance, pet waste management, and public education. Discussion of nonstructural BMP effectiveness is outlined in Section 5.3.1.

Over the next permit term, the City anticipates opportunities to enhance their stormwater program with the renewed NPDES MS4 permit and updated SWMP. Programmatic efforts will continue to target bacteria as one of the primary pollutants of concern. Specific to the Clark Creek basin, quantitative benchmarks were not defined (see Section 6.2). This was due to limited property availability for retrofits and no anticipated capital improvement projects for this area. Instead, enhanced programmatic efforts are proposed in order to target source identification and source tracking for bacteria.

In 2015, the City implemented a targeted outfall monitoring effort to investigate elevated (above the 406 MPN/100mL acute water quality criterion) levels of E coli in stormwater discharge. This effort was conducted in conjunction with the City's *Dry Weather Outfall and Illicit Discharge Screening Plan* and documented in the City's *Microbial Source Tracking Using qPCR Pilot Project Plan (2015)* (Pilot Plan). The Pilot Plan was developed to help determine the viability of using quantitative Real-time Polymerase Chain Reaction (qPCR), an analytical testing method to identify sources of E coli bacteria during dry weather inspections. The Pilot Plan included additional bacteria monitoring at select priority (high pollutant potential) dry weather field screening locations. From that effort, 6 monitoring locations (3 in the Clark Creek Basin) were selected for the qPCR analysis. Results of the qPCR analysis indicated that samples collected from the Clark Creek basin at Electric Avenue (Location D42466227) were positive for human fecal biomarkers during two independent sampling events.

Building on information collected in 2015, the City has committed to conducting the following activities as their qualitative (programmatic) TMDL bacteria benchmark specific for the Clark Creek basin:

- Dry weather outfall inspections at all 97 outfalls in the Clark Creek Basin, to identify high priority outfalls with dry weather flows. Field monitoring efforts will be conducted at outfalls with detected flow to confirm whether upstream source tracking and/or follow up bacteria monitoring is required.
- Follow-up source identification efforts upstream of Location D42466227, to trace potential sources of human fecal populations.
- Targeted TV inspections of storm and sanitary sewer pipe, to identify whether failing infrastructure, inflow and infiltration (I&I), and/or cross connections may be a pollutant source.

- Refined pipeshed delineations, in order to aid in source tracking and investigations.
- Ongoing GIS and database compilation of dry weather inspection results, in order to aid in source tracking and investigations.

6.3.2 Structural BMP Implementation and Effectiveness

In addition to the fact that the TMDL benchmark pollutant loads models do not account for non-structural BMP implementation, the forecasted structural BMP implementation and coverage used to develop the TMDL benchmarks is also conservative. Structural BMPs are required for public and private redevelopment activities city-wide in accordance with the City's Stormwater Design Standards (January 2014). However, because TMDL benchmarks require a five year projection, only those foreseeable planned public structural BMP installations can reasonably be committed to by the City at this time.

Privately owned and maintained stormwater facilities associated with redevelopment activities are not accounted for. The City anticipates a growing number of private structural BMP in conjunction with implementation of the 2014 City of Salem Stormwater Design Standards. The omission of future private structural BMPs from the TMDL benchmarks is intentional, due to the unknown nature of future development activities and facility selection.

As shown in Table 6-2, the City's TMDL benchmarks reflect the installation of 15 independent capital improvement projects, covering approximately 100 acres of previously untreated area. The City anticipates that additional, currently unscheduled public BMP/CIP installations may occur over the next NPDES MS4 permit term. These additional public structural BMPs/CIPs may be installed in conjunction with other public-works projects (in accordance with the stormwater development standards), or as opportunistic stormwater retrofits as part of other programs and initiatives. Over the next permit term, the City is actively working on completion of the Battle Creek Basin Plan, the first in a series of planned basin-level stormwater master plans. Additional capital improvement projects targeted at water quality improvement will be developed as part of the basin plans and incorporated into the 5-year CIP. This basin planning effort is reflected in the City's SWMP.

6.3.3 Interpretation and Conclusions

As shown by the TMDL benchmarks presented in Section 6.2, bacteria and TSS load reduction is anticipated, but the reductions are far less than what is needed to meet TMDL WLAs. Although additional load reductions are likely to be achieved through structural and non-structural BMP implementation (not reflected in the model), these reductions are not estimated to be significant enough to achieve WLAs.

The City's water quality trends analysis (Section 5.3.2) indicates that instream water quality conditions for bacteria and turbidity are generally not changing (from a statistically significant standpoint). This is consistent with pollutant load modeling results that show limited pollutant load reduction for bacteria with the use of BMPs and some load reduction for TSS. However, from 2001 to 2014 (the timeframe for the trends analysis), the population in the City of Salem grew by approximately 15,000 people. Given that level of population growth and the potential impacts associated with the resulting development, seeing no trend in water quality may be considered a positive result.

The City also prepared a WLA attainment assessment for DEQ in November 2014, which indicated that achieving the WLA would require construction and maintenance costs that far exceed the City's definition of MEP. As such, progress toward the WLA, and not achievement of the WLA, is Salem's goal for the TMDL benchmarks. Such progress is reflected in Tables 6-1 and 6-2 and the base pollutant load estimates used to develop the TMDL benchmarks in Appendix B.

Section 7

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Section 8

Limitations

This document was prepared solely for the City of Salem 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 March 12, 2014. 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.

Appendix A: Water Quality Trends Analysis

City of Salem

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

Water Quality Trends Analysis

TMDL Pollutant Load Reduction Evaluation

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November 1, 2014

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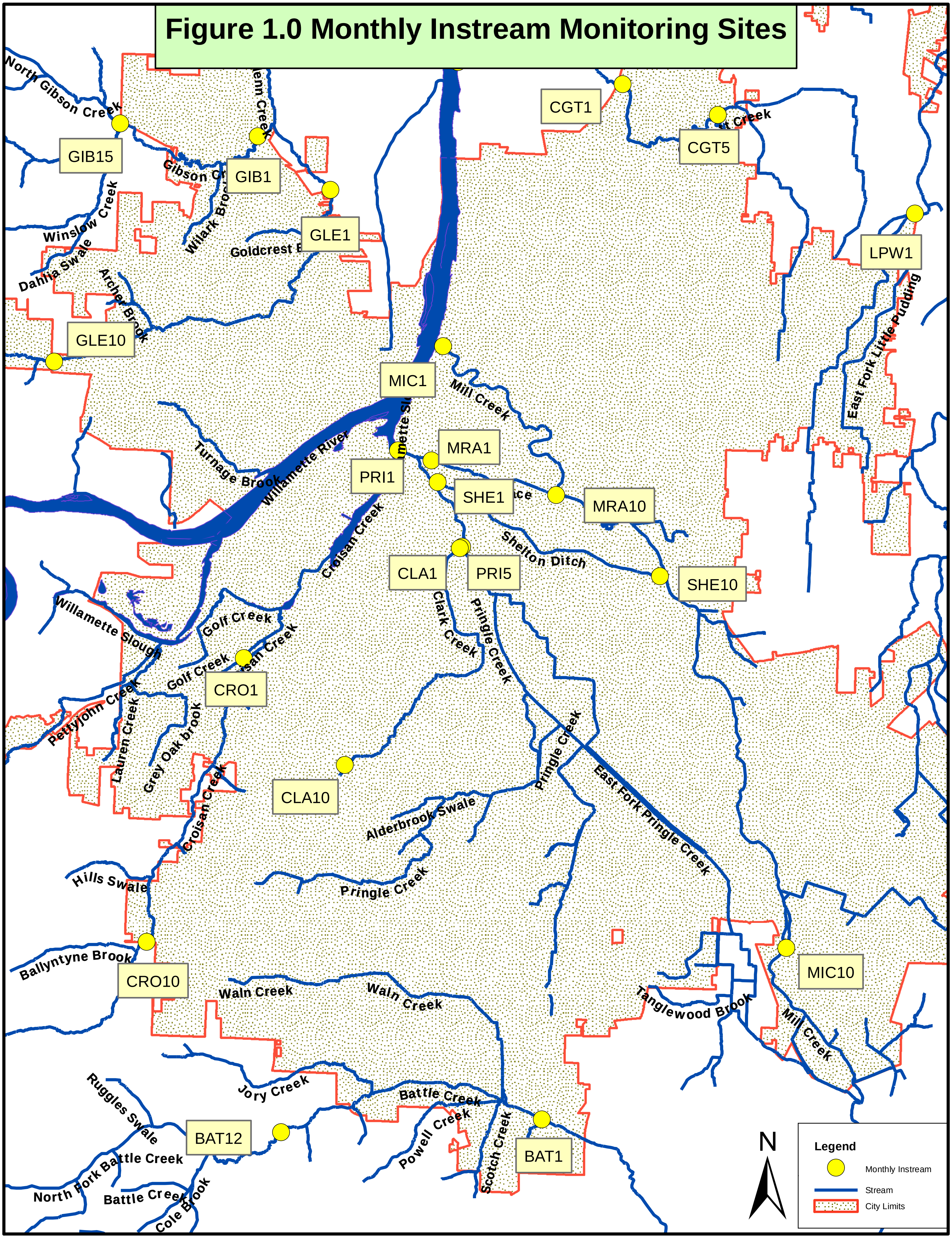

Introduction

The City of Salem (City) was issued its first National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) Phase 1 Permit by the Oregon Department of Environmental Quality (DEQ) in 1997. The most recent permit was issued on December 30, 2010, with a renewal date of December 29, 2015. A water quality trends analysis to evaluate the changes of stormwater discharges over time is due November 1, 2014, as part of the Total Maximum Daily Load (TMDL) Pollutant Load Reduction Evaluation.

Schedule D(3)(c)(vii) of the City's NPDES MS4 Permit states that the TMDL Pollutant Load Reduction Evaluation report must contain the following:

> *"A water quality trends analysis, as sufficient data are available, and the relationship to stormwater discharges for receiving waterbodies within the permittee's jurisdictional areas with an approved TMDL. If sufficient data to conduct a water quality trend analysis is unavailable for a receiving waterbody, the permittee must describe the data limitations. The collection of sufficient data must be prioritized and reflected as part of the monitoring project/task proposal required in Schedule B.6.d."*

Unlike many of the other Phase 1 permittees in Oregon, this is the first instance that the City of Salem has been required to conduct a water quality trends analysis. Therefore, the *ACWA Stormwater Committee Trends Report 10-26-07*, the *Cities of Gresham and Fairview, and Multnomah County Trend Analysis* the *Oregon City Water Quality Trend Analysis,* and the *City of Portland Water Quality Trend Analysis (as part of TMDL 5th Year Annual Report)* were used as guidance to determine the best methodology and statistical approach for development of the City's trends analysis.

1.0 Methodology and Analysis

1.1 Monthly Instream Monitoring

In July 2001, the City began conducting Monthly Instream Monitoring at 21 sites on 11 of Salem's MS4 receiving streams. Ten of these streams have paired upstream and downstream monitoring locations, which are located at or near where the stream enters or exits City limits. The eleventh stream has a single monitoring site, because it is located on the West Fork Little Pudding River, which starts in the greater Salem area and runs dry during the summer months. Figure 1 denotes the locations of each site.

Monthly Instream Monitoring is conducted once a month on a predetermined schedule, and includes the collection of grab samples and field measurements. Water quality parameters collected at all sites include:

- Biochemical Oxygen Demand (BOD_{stream})
- Dissolved Oxygen (DO)
- *Escherichia coli (E. coli)*bacteria
- Nitrate + Nitrite as Nitrogen (NO_3+NO_2-N)
- pH
- Specific Conductivity
- Temperature
- Turbidity

Additional water quality parameters were collected for the sites within the Pringle Creek Watershed (PRI1, PRI5, CLA1, and CLA10) and the West Fork Little Pudding River (LPW1) to meet the MS4 Permit Environmental Monitoring requirements. These additional parameters include:

- Copper – total recoverable and dissolved: (CLA1, CLA10, PRI1, PRI5)
- Hardness: (CLA1, CLA10, PRI1, PRI5)
- Lead – total recoverable and dissolved: (CLA1, CLA10, PRI1, PRI5)
- Total Suspended Solids (TSS): (LPW1)
- Zinc – total recoverable and dissolved: (CLA1, CLA10, PRI1, PRI5)

The data from the Monthly Instream Monitoring element of the City's stormwater monitoring program constitute the longest continuing data set that the City has for ambient stream monitoring.

1.1.1 Statistical Analysis

Per ACWA guidance, the monotonic Mann-Kendall test was chosen for this water quality trends analysis, because it is a non-parametric test that allows for missing values; is not affected significantly by outliers; and some non-detects can be present (*Oregon City Water Quality Trends Analysis*). Data were first processed for seasonality (rain vs. no rain), and then the Mann-Kendall test was run using Minitab 17. Following the ACWA guidance, the Mann-Kendall test was run on datasets containing a minimum of at least 30 data points recorded over a 5-year period, unless otherwise noted.

The null and alternative hypotheses for this trend analysis were:

H_o (Null Hypothesis): No trend exists

H_a (Alternative Hypothesis): Upward *or* Downward trend exists

A rejection of the null hypothesis indicates that there is a significant trend in the data. The direction of the trend can then be determined by the sign of the Z statistic. A negative Z-value (-Z) indicates a downward trend, while a positive Z-value (+Z) indicates an upward trend.

1.1.2 Data Processing / Datasets / Data Gaps

An initial analysis of the data was conducted to determine the length of data set for each site and parameter, number of censored values, and number of observations during rain and no rain conditions. Tables 3.1.1 through 3.11.1 provide the summaries of these data for each Monthly Instream Monitoring site, and are included within the results section for each monitored creek.

All parameters for Monthly Instream Monitoring met the ACWA guidance of 5 years and 30 data points, except for metals and TSS, since data collection began in January 2011. However, upon review of other Oregon Phase 1 trends analyses from 2008, the City chose to run the trends analysis on the metals and TSS data if a minimum of 10 uncensored data points were available in each set.

The Monthly Instream Monitoring grab samples and field measurements are scheduled for the third Tuesday of each month. On rare occasions, the sampling event had to be rescheduled by up to a week. Some sites run dry during the summer, while others are inaccessible when water levels get too high in the winter. As such, some locations have less data points than others. For those sites, the value was left blank for that date.

1.1.3 Seasonality/Rainfall

The City has a network of rain gauges across Salem that provides rainfall data in 15-minute increments. A total rainfall report of the 24 hours prior to the time of sampling for each of the 21 Monthly Instream

Monitoring sites was run using Aquarius, the City's comprehensive database for storing and processing environmental data. If the total rainfall in that previous 24 hours was less than 0.1 inches (<0.1 inches), it was considered a "no rain" event; and if there was greater than or equal to 0.1 inches (≥ 0.1 inches) of rainfall, it was considered a "rain" event. The Mann-Kendall test was then run on both the "rain" and "no rain" data sets.

1.1.4 Method Reporting Limits (MRL)

A review of the data found that for the entirety of the data record, no changes had been made to the Method Reporting Limit (MRL) for any of the parameters. Consequently, data did not have to be omitted or adjusted to compensate for this.

1.1.5 Censored Values

A censored value is any value that is less than or greater than the reporting limit and is provided from the laboratory with a less than (<) or greater than (>) symbol. For Monthly Instream Monitoring data, parameters with censored values included *E. coli*, BOD, NO_2+NO_3, and all of the metals. The number of censored values were tracked in Table 4.0 (at the end of the document) for each parameter and location. Following Brown and Caldwell guidance, if greater than 50% of the values in a dataset were censored, then the Mann-Kendall test was not run for that dataset.

The ACWA Guidance had no recommendation for handling censored values, and each of the other Oregon Phase 1 municipalities chose their own method for considering these values. For Salem's trends analysis, the < or > symbol was removed from all censored values, and the numerical value was left as is (set at the reporting limit).

1.1.6 Significance Level

A significance level (α) of 0.05 (95% confidence a trend exists) was chosen to establish that a *significant* increasing or decreasing trend exists, while a significance level of 0.1 (90% confidence a trend exists) established that there was a *somewhat significant* increasing or decreasing trend. For the trends analysis summary tables (included with the results section for each creek), ▲ was used to show a *significant* increasing trend, ▼ shows a *significant* decreasing trend, ⇧ shows a *somewhat significant* increasing trend, and ⇩ shows a *somewhat significant* decreasing trend.

1.2 Other Data

The City's NPDES MS4 permit lists all environmental monitoring requirements under Schedule B, Table B-1. In addition to the Monthly Instream Monitoring element, there are also requirements for Continuous Instream Monitoring, Instream Storm Monitoring, Stormwater Monitoring, Mercury Monitoring, Benthic Macroinvertebrate Monitoring, and Pesticide Monitoring.

The City installed the first continuous instream monitoring stations in 2006, and continued to expand the network of continuous monitoring stations to the current 11 stations. Each station collects five (5) basic water quality parameters and stream height (stage). For this analysis, 10 of the stations have been in operation long enough to provide data (minimum of 5 years). However, due to the sheer number of data points per station, accurately separating the data between "rain" and "no rain" events and using a daily median was not a viable option at this time. Separating the data by "wet" (November-April) and "dry" (May-October) seasons provided very different trends (often opposite) from those seen when separated by "rain" or "no rain" for the same test data set. This could be attributed to the fact that the City often receives rainfall during the "dry" season, thus influencing the trends analysis. The City, however, will be providing a thorough analysis of the Continuous Instream Monitoring element, as well as the other environmental data collected, as part of the City's permit renewal package in July 2015.

During the previous permit cycle (2004-2010), the City collected instream grab samples (during storm events) upstream and downstream of selected stormwater outfalls as part of the Stormwater Monitoring requirements. In the current permit (2010), collection of instream grab samples (during storm events) was added as its own monitoring element, Instream Storm Monitoring, in addition to the existing requirement of Stormwater monitoring of the piped storm system. The instream grab data collected during 2004-2010 and the data from the current permit (Instream Storm Monitoring) were collected at different locations and therefore cannot be combined. Furthermore, there are insufficient data points available this permit term to do a trends analysis on data from the Instream Storm Monitoring element (less than 5 years). The Instream Storm Monitoring element is expected to continue beyond the current permit; ultimately providing a robust dataset for long-term trending and spatial analyses.

The other required monitoring elements listed in Schedule B, Table B-1 of the MS4 permit pertain to either: 1) stormwater and mercury monitoring within the piped system during storm events, which does not provide instream data; or 2) have an insufficient number of data points for conducting a trends analysis (Pesticide and Macroinvertebrate Monitoring).

2.0 Results

Of the 386 datasets, thirty-five (35) datasets were not analyzed due to either having greater than 50% of the values censored or less than 10 recorded data points. The remaining 351datasets were run through Minitab for the Mann-Kendall test; of those 57 showed *significant* or *somewhat significant* trends during rain conditions, and 99 datasets showed *significant* or s*omewhat significant* trends during dry (no rain) conditions (see Legend below). Tables with trends analysis data are provided in the sections below and are organized by creek. Table 5.0 (at the end of the document) provides a summary of significant trends during rain events for those parameters that may indicate an improvement or deterioration in water quality.

Since the emphasis of the water quality trends analysis is focused primarily on the relationship of stormwater discharges from the MS4 to receiving waterbodies, discussion of the results for each creek focuses on trends that exist during rain conditions. Trends identified during dry (no rain) conditions are not addressed in the discussion. Specific conductivity and pH trends were not included in Table 5.0, nor addressed in the discussions below since although they may be useful for interpreting the data, they do not by themselves indicate an improvement or deterioration in water quality.

Legend for Tables 3.1.1 through 3.11.1

Rain	= ≥ 0.1 inches of rainfall in the 24 hours prior to sampling
No Rain	= < 0.1 inches of rainfall in the 24 hours prior to sampling
▲	= Significant increasing trend ($p \leq 0.05$)
▼	= Significant decreasing trend ($p \leq 0.05$)
⇧	= Somewhat significant increasing trend ($0.05 < p < 0.1$)
⇩	= Somewhat significant decreasing trend ($0.05 < p < 0.1$)
(blue)	= Improvement in water quality indicator parameter
(orange)	= Deterioration in water quality indicator parameter
(pink)	= Not enough data for analysis
NA	=Not enough uncensored values for analysis (< 10)
	= No trend was detected

2.1 Battle Creek

Tables 3.1.1 shows data from the analysis of BAT1 and BAT12 for the period of July 1, 2001 to June 30, 2014. In keeping with previous methodologies employed by consulting firms, data from the original site, BAT10 (data collected July 2001-June 2003), was combined with data from the current site, BAT12 (July 2003-present), to create a singular, continuous dataset.

Table 3.1.1 Seasonal Mann-Kendall Trends Analysis for Battle Creek (7/1/2001-6/30/2014)

BAT1 (downstream)						BAT12 (upstream)				
		Rain		No Rain			Rain		No Rain	
Parameter	**Date Range**	**N**	**Trend**	**N**	**Trend**	**Date Range**	**N**	**Trend**	**N**	**Trend**
BOD	2001-2014	36		119	▼	2001-2014	35	▼	120	▼
Conductivity	2001-2014	36	▲	119	▲	2001-2014	35	▲	120	▲
Dissolved Oxygen	2001-2014	36		119	▲	2001-2014	35	▼	120	
E. coli	2001-2014	36		119	▼	2001-2014	35		120	▼
NO3-NO2	2001-2014	36	▼	118	▼	2001-2014	35	▼	119	
pH	2001-2014	36	▲	117	▲	2001-2014	35	⇧	119	▲
Temperature	2001-2014	36		119		2001-2014	35		120	
Turbidity	2001-2014	36	▼	119	▼	2001-2014	35		120	

The downstream site, BAT1, showed improvement in water quality for Nitrate-Nitrite and turbidity (both have decreasing trends) during rain events. The upstream site, BAT12, showed improvement in water quality for BOD and Nitrate-Nitrite (both have decreasing trends) and deterioration in water quality for Dissolved Oxygen (a decreasing trend) during rain events.

2.2 Claggett Creek

Table 3.2.1 shows data from the analysis of CGT1 and CGT5 for the period of July 1, 2001 to June 30, 2014.

Table 3.2.1 Seasonal Mann-Kendall Trends Analysis for Claggett Creek (7/1/2001-6/30/2014)

CGT1 (downstream)						CGT5 (upstream)				
		Rain		No Rain			Rain		No Rain	
Parameter	**Date Range**	**N**	**Trend**	**N**	**Trend**	**Date Range**	**N**	**Trend**	**N**	**Trend**
BOD	2001-2014	30		125		2001-2014	30		92	
Conductivity	2001-2014	29		125	▲	2001-2014	31		92	▲
Dissolved Oxygen	2001-2014	29		124		2001-2014	31		91	⇧
E. coli	2001-2014	30		124		2001-2014	31		92	⇧
NO3-NO2	2001-2014	30	▼	124	▼	2001-2014	31		92	▼
pH	2001-2014	29		122	▲	2001-2014	31	⇧	92	▲
Temperature	2001-2014	29		125		2001-2014	31		92	
Turbidity	2001-2014	30		125	▼	2001-2014	30		92	

The downstream site, CGT1, showed an improvement in water quality for nitrate-nitrite (decreasing trend) during rain events. There were no *significant* trends at the upstream site CGT5 during rain events for water quality indicator parameters.

2.3 Clark Creek

Table 3.3.1 shows data from the analysis of CLA1 and CLA10 for the period of July 1, 2001 to June 30, 2014.

Table 3.3.1 Seasonal Mann-Kendall Trends Analysis for Clark Creek (7/1/2001-6/30/2014)

CLA1 (downstream)						CLA10 (upstream)				
		Rain		No Rain			Rain		No Rain	
Parameter	**Date Range**	**N**	**Trend**	**N**	**Trend**	**Date Range**	**N**	**Trend**	**N**	**Trend**
BOD	2001-2014	36		119	▼	2001-2014	33		122	
Conductivity	2001-2014	36		117	▲	2001-2014	32	▲	122	▲
Dissolved Oxygen	2001-2014	36		117	▲	2001-2014	33		122	▲
E. coli	2001-2014	36		119	▼	2001-2014	33	▲	122	
NO3-NO2	2001-2014	36	▼	118	▼	2001-2014	33	▼	120	
pH	2001-2014	36	▲	118	▲	2001-2014	33	⇧	121	▲
Temperature	2001-2014	36		117		2001-2014	33		122	
Turbidity	2001-2014	36		118	▼	2001-2014	33		122	▼
Copper (dissolved)	2011-2014	>50% censored				2011-2014	>50% censored			
Copper (total)	2011-2014	>50% censored				2011-2014	>50% censored			
Lead (dissolved)	2011-2014	>50% censored				2011-2014	>50% censored			
Lead (total)	2011-2014	>50% censored				2011-2014	>50% censored			
Zinc (dissolved)	2011-2014	11		31		2011-2014	11		31	
Zinc (total)	2011-2014	11		31	▲	2011-2014	11		31	

The downstream site, CLA1, showed an improvement in water quality for Nitrate-Nitrite (decreasing trend) during rain events. The upstream site, CLA10, showed an improvement in water quality for Nitrate-Nitrite (decreasing trend), and a deterioration in water quality for *E. coli* bacteria (an increasing trend) during rain events. The only metals parameters that had enough uncensored data to be analyzed were Zinc (total and dissolved) for both Clark Creek sites. The data showed no metals trends for either site during rain events.

2.4 Croisan Creek

Table 3.4.1 shows data from the analysis of CRO1 and CRO10 for the period of July 1, 2001 to June 30, 2014.

Table 3.4.1 Seasonal Mann-Kendall Trends Analysis for Croisan Creek (7/1/2001-6/30/2014)

CRO1 (downstream)						CRO10 (upstream)				
		Rain		No Rain			Rain		No Rain	
Parameter	**Date Range**	**N**	**Trend**	**N**	**Trend**	**Date Range**	**N**	**Trend**	**N**	**Trend**
BOD	2001-2014	34		121	▼	2001-2014	34		120	▼
Conductivity	2001-2014	34	▲	121	▲	2001-2014	34	▲	120	▲
Dissolved Oxygen	2001-2014	34		121	▲	2001-2014	34	⇧	120	▲
E. coli	2001-2014	34		121		2001-2014	34		120	
NO3-NO2	2001-2014	34	⇩	120		2001-2014	34	⇩	119	
pH	2001-2014	34	▲	120	▲	2001-2014	34		119	▲
Temperature	2001-2014	34		121		2001-2014	34		120	
Turbidity	2001-2014	34		121	⇩	2001-2014	34		120	

Neither site had any *significant* trends for water quality indicator parameters, however both had a *somewhat significant* (p <0.1) trend for water quality improvement for Nitrate-Nitrite (decreasing trend) during rain events. The upstream site, CRO10, also showed an improvement in water quality for Dissolved Oxygen (*somewhat significant* increasing trend).

2.5 Gibson Creek

Table 3.5.1 shows data from the analysis of GIB1 and GIB15 for the period of July 1, 2001 to June 30, 2014.

Table 3.5.1 Seasonal Mann-Kendall Trends Analysis for Gibson Creek (7/1/2001-6/30/2014)

GIB1 (downstream)						GIB15 (upstream)				
		Rain		No Rain			Rain		No Rain	
Parameter	Date Range	N	Trend	N	Trend	Date Range	N	Trend	N	Trend
BOD	2001-2014	32		122	▼	2001-2014	31	▼	121	▼
Conductivity	2001-2014	32	▲	121	▲	2001-2014	31		120	▲
Dissolved Oxygen	2001-2014	32		120	▲	2001-2014	31		119	⇧
E. coli	2001-2014	32		123	▼	2001-2014	31		121	⇧
NO3-NO2	2001-2014	32	▼	121		2001-2014	31		120	▼
pH	2001-2014	32	▲	121	▲	2001-2014	31	▲	120	▲
Temperature	2001-2014	31		121		2001-2014	31		120	
Turbidity	2001-2014	32		122	▼	2001-2014	30		120	

The downstream site, GIB1, showed improvement in water quality for Nitrate-Nitrite (decreasing trend), and the upstream site, GIB15, showed an improvement in water quality for BOD (decreasing trend) during rain events.

2.6 Glenn Creek

Table 3.6.1 shows data from the analysis of GLE1 and GLE10 for the period of July 1, 2001 to June 30, 2014.

Table 3.6.1 Seasonal Mann-Kendall Trends Analysis for Glenn Creek (7/1/2001-6/30/2014)

GLE1 (downstream)						GLE10 (upstream)				
		Rain		No Rain			Rain		No Rain	
Parameter	Date Range	N	Trend	N	Trend	Date Range	N	Trend	N	Trend
BOD	2001-2014	33		119		2001-2014	31		115	▼
Conductivity	2001-2014	33	▲	118	▲	2001-2014	31	▲	114	▲
Dissolved Oxygen	2001-2014	33		117		2001-2014	31	▲	113	▲
E. coli	2001-2014	33		119	▼	2001-2014	31		115	▲
NO3-NO2	2001-2014	33	▼	118		2001-2014	31	▼	114	▼
pH	2001-2014	33	▲	118	▲	2001-2014	31	▲	113	▲
Temperature	2001-2014	33		118		2001-2014	30		114	
Turbidity	2001-2014	33	⇩	119	▼	2001-2014	31		113	

The downstream site, GLE1, showed improvement in water quality for Nitrate-Nitrite (decreasing trend), and the upstream site, GLE10, showed improvement in water quality for Dissolved Oxygen (increasing trend) and Nitrate-Nitrite (decreasing trend).

2.7 West Fork Little Pudding River

Table 3.7.1 shows data from the analysis of LPW1 for the period of July 1, 2001 to June 30, 2014.

Table 3.7.1 Seasonal Mann-Kendall Trends Analysis for West Fork Little Pudding River (7/1/2001-6/30/2014)

LPW1							
		Rain		No Rain			
Parameter	**Date Range**	**N**	**Trend**	**N**	**Trend**		**No Upstream Site**
BOD	2001-2014	30		79			
Conductivity	2001-2014	32		79	▲		
Dissolved Oxygen	2001-2014	32	⇧	79			
E. coli	2001-2014	31		79			
NO3-NO2	2001-2014	31		78	▼		
pH	2001-2014	31		78	▲		
Temperature	2001-2014	32		79			
TSS	2011-2014	9	NA	23			
Turbidity	2001-2014	30		78	⇧		

There is only a downstream site due to the fact that the West Fork Little Pudding River weaves in and out of city limits, and is often dry during the summer. The monitoring parameters for this site also include TSS, but because data collection for this site started in 2011, there were not enough samples collected during rain events to conduct a trends analysis. The LPW1 site had one improvement in water quality for Dissolved Oxygen (*somewhat significant* increasing trend).

2.8 Mill Creek

Table 3.8.1 shows data from the analysis of MIC1 and MIC10 for the period of July 1, 2001 to June 30, 2014.

Table 3.8.1 Seasonal Mann-Kendall Trends Analysis for Mill Creek (7/1/2001-6/30/2014)

MIC1 (downstream)						MIC10 (upstream)				
		Rain		No Rain			Rain		No Rain	
Parameter	**Date Range**	**N**	**Trend**	**N**	**Trend**	**Date Range**	**N**	**Trend**	**N**	**Trend**
BOD	2001-2014	34		119	▼	2001-2014	31		123	▼
Conductivity	2001-2014	34		119	▲	2001-2014	31	▲	123	▲
Dissolved Oxygen	2001-2014	34		119		2001-2014	31		122	
E. coli	2001-2014	34	▼	119	▼	2001-2014	31	⇩	123	▼
NO3-NO2	2001-2014	34		118		2001-2014	31	▼	122	
pH	2001-2014	34	▲	118	▲	2001-2014	32	⇧	121	▲
Temperature	2001-2014	34		119		2001-2014	31		122	
Turbidity	2001-2014	34		119	▼	2001-2014	32		123	

The downstream site, MIC1, showed improvement in water quality for *E. coli* bacteria (decreasing trend), and the upstream site, MIC10, showed improvement in water quality for Nitrate-Nitrite (decreasing trend) during rain events.

2.9 Mill Race

Table 3.9.1 shows data from the analysis of MRA1 and MRA10 for the period of July 1, 2001 to June 30, 2014.

Table 3.9.1 Seasonal Mann-Kendall Trends Analysis for Mill Race (7/1/2001-6/30/2014)

MRA1 (downstream)						MRA10 (upstream)				
		Rain		No Rain			Rain		No Rain	
Parameter	**Date Range**	**N**	**Trend**	**N**	**Trend**	**Date Range**	**N**	**Trend**	**N**	**Trend**
BOD	2001-2014	34		119	▼	2001-2014	30	▼	124	▼
Conductivity	2001-2014	35		117	▲	2001-2014	30	▲	123	▲
Dissolved Oxygen	2001-2014	35		117		2001-2014	30		124	
E. coli	2001-2014	35		118		2001-2014	30	▼	124	
NO3-NO2	2001-2014	35		118		2001-2014	30		123	
pH	2001-2014	34	▲	118	▲	2001-2014	30	▲	123	▲
Temperature	2001-2014	35		117		2001-2014	30		124	
Turbidity	2001-2014	35		119	▼	2001-2014	30		124	

The downstream site, MRA1, had no *significant* water quality trends during rain events for water quality indicator parameters, but the upstream site, MIC10, had an improvement in water quality for BOD (decreasing trend) and *E. coli* bacteria (decreasing trend) during rain events.

2.10 Pringle Creek

Table 3.10.1 shows data from the analysis of PRI1 and PRI5 for the period of July 1, 2001 to June 30, 2014.

Table 3.10.1 Seasonal Mann-Kendall Trends Analysis for Pringle Creek (7/1/2001-6/30/2014)

PRI1 (downstream)						PRI5 (upstream)				
		Rain		**No Rain**			**Rain**		**No Rain**	
Parameter	**Date Range**	**N**	**Trend**	**N**	**Trend**	**Date Range**	**N**	**Trend**	**N**	**Trend**
BOD	2001-2014	29		115	▼	2001-2014	36		119	▼
Conductivity	2001-2014	29	⇧	114	▲	2001-2014	36	⇧	117	▲
Dissolved Oxygen	2001-2014	29		115	▲	2001-2014	36		116	
E. coli	2001-2014	29		115		2001-2014	36		118	▼
NO3-NO2	2001-2014	29		114		2001-2014	36	▼	118	
pH	2001-2014	29	▲	114	▲	2001-2014	36	▲	118	▲
Temperature	2001-2014	29		115		2001-2014	36		117	
Turbidity	2001-2014	29		115		2001-2014	36		119	▼
Copper (dissolved)	2011-2014	>50% censored				2011-2014	>50% censored			
Copper (total)	2011-2014	>50% censored				2011-2014	>50% censored			
Lead (dissolved)	2011-2014	>50% censored				2011-2014	>50% censored			
Lead (total)	2011-2014	>50% censored				2011-2014	>50% censored			
Zinc (dissolved)	2011-2014	10	NA	30		2011-2014	11		31	
Zinc (total)	2011-2014	10	NA	30		2011-2014	11		31	

The downstream site, PRI1, had no *significant* trends during rain events for water quality indicator parameters, but the upstream site, PRI5, had an improvement in water quality for Nitrate-Nitrite (decreasing trend) during rain events. Similar to the Clark Creek sites, the only metals parameter that had enough uncensored data to be analyzed was Zinc (total) for PRI1 and Zinc (total and dissolved) for PRI5. Neither of the Pringle Creek sites showed any trends for metals.

2.11 Shelton Ditch

Table 3.11.1 shows data from the analysis of SHE1 and SHE10 for the period of July 1, 2001 to June 30, 2014.

Table 3.11.1 Seasonal Mann-Kendall Trends Analysis for Shelton Ditch (7/1/2001-6/30/2014)

SHE1 (downstream)						SHE10 (upstream)				
		Rain		No Rain			Rain		No Rain	
Parameter	**Date Range**	**N**	**Trend**	**N**	**Trend**	**Date Range**	**N**	**Trend**	**N**	**Trend**
BOD	2001-2014	35		120	▼	2001-2014	32		121	▼
Conductivity	2001-2014	35		118	▲	2001-2014	33		120	▲
Dissolved Oxygen	2001-2014	35		118		2001-2014	33		121	
E. coli	2001-2014	35		120	▼	2001-2014	33	▼	121	
NO3-NO2	2001-2014	35		119		2001-2014	33	⇩	120	
pH	2001-2014	35	▲	119	▲	2001-2014	33	▲	120	▲
Temperature	2001-2014	35		118		2001-2014	33		121	
Turbidity	2001-2014	35		120		2001-2014	33		121	

The downstream site, SHE1, had no *significant* trends for water quality indicator parameters, but the upstream site, SHE10, showed an improvement in water quality for *E. coli* bacteria (decreasing trend) during rain events.

3.0 Conclusions

The Monthly Instream monitoring consists of grab samples and field measurements, which capture a specific moment in time and location within the stream that can be influenced by many factors. Therefore the results provided within should be considered as one piece of information, and not a conclusive statement of overall quality of the sampled streams. Results from this trend analysis and analyses to be conducted as part of the City's 2015 permit renewal process will help to inform the goals and elements of the next permit cycle's monitoring plan. Results of the trends analysis may be used to inform aspects of other stormwater management programs, like the Stormwater Retrofit Plan, the Illicit Discharge Detection and Elimination program, and the City's Education and Outreach Plan.

3.1 Considerations

A trend analysis can provide useful information on changes in water quality over time (by season). However, it is important to note the following considerations when evaluating the results of a water quality trends analysis:

- An increasing/decreasing trend can show an improvement or deterioration in water quality, depending on the parameter that is being analyzed. For example, an increasing trend in dissolved oxygen would be considered an improvement in water quality while an increasing trend in *E. coli* would be considered deterioration in water quality.
- An increasing or decreasing trend does not automatically imply causation from anthropogenic activities, some changes could be tied to natural events.
- Because the Mann-Kendall test is a monotonic analysis, it is an overall trend generated from a discrete starting and ending point. As a result, the analysis could reveal no overall trend for the entire dataset, but in reality there could be periods of increasing and/or decreasing trends during particular time periods within the dataset. It is also possible that the analysis wouldn't reflect recent improvement/deterioration in water quality that shows an opposite trend from the overall trend.
- For the four sites that monitored for metals and the one site that monitored for TSS, the Mann-Kendall test was run only when there were >10 data points with <50% censored data. One of the datasets, total zinc for CLA1, showed a significant increasing trend when no rain was present. With so few data points this may not reflect a true long-term trend, but as more metals and TSS data points are collected, the accuracy and robustness of this analysis will improve.

Table 4.0 Data Summary for Monthly Instream Monitoring Sites

Battle Creek

Location	Parameter	Total		Rain[1]		No Rain[2]	
		N	# of Censored values (< or >)	N	Use Mann-Kendall Test?[3]	N	Use Mann-Kendall Test?[3]
BAT1	BOD	155	3	36	Yes	119	Yes
BAT1	Conductivity	155		36	Yes	119	Yes
BAT1	Dissolved Oxygen	155		36	Yes	119	Yes
BAT1	E. coli	155	9	36	Yes	119	Yes
BAT1	NO2-NO3	154		36	Yes	118	Yes
BAT1	pH	153		36	Yes	117	Yes
BAT1	Temperature	155		36	Yes	119	Yes
BAT1	Turbidity	155		36	Yes	119	Yes
BAT12	BOD	155	5	35	Yes	120	Yes
BAT12	Conductivity	155		35	Yes	120	Yes
BAT12	Dissolved Oxygen	155		35	Yes	120	Yes
BAT12	E. coli	155	1	35	Yes	120	Yes
BAT12	NO2-NO3	154		35	Yes	119	Yes
BAT12	pH	154		35	Yes	119	Yes
BAT12	Temperature	155		35	Yes	120	Yes
BAT12	Turbidity	155		35	Yes	120	Yes

Claggett Creek

Location	Parameter	Total		Rain[1]		No Rain[2]	
		N	# of Censored values (< or >)	N	Use Mann-Kendall Test?[3]	N	Use Mann-Kendall Test?[3]
CGT1	BOD	155	4	30	Yes	125	Yes
CGT1	Conductivity	154		29	Yes	125	Yes
CGT1	Dissolved Oxygen	153		29	Yes	124	Yes
CGT1	E. coli	154	5	30	Yes	124	Yes
CGT1	NO2-NO3	154	9	30	Yes	124	Yes
CGT1	pH	151		29	Yes	122	Yes
CGT1	Temperature	154		29	Yes	125	Yes
CGT1	Turbidity	155		30	Yes	125	Yes
CGT5	BOD	122	2	30	Yes	92	Yes
CGT5	Conductivity	123		31	Yes	92	Yes
CGT5	Dissolved Oxygen	122		31	Yes	91	Yes
CGT5	E. coli	123	4	31	Yes	92	Yes
CGT5	NO2-NO3	123	6	31	Yes	92	Yes
CGT5	pH	123		31	Yes	92	Yes
CGT5	Temperature	123		31	Yes	92	Yes
CGT5	Turbidity	122		30	Yes	92	Yes

[1] Rain = ≥ 0.1 inches rainfall in previous 24 hrs

[2] No Rain = < 0.1 inches rainfall in previous 24 hours

[3] Mann-Kendall Test only used if > 10 obersvations (N) and < 50% of data is censored

Clark Creek

Location	Parameter	Total		Rain[1]		No Rain[2]	
		N	# of Censored values (< or >)	N	Use Mann-Kendall Test?[3]	N	Use Mann-Kendall Test?[3]
CLA1	BOD	155	4	36	Yes	119	Yes
CLA1	Conductivity	153		36	Yes	117	Yes
CLA1	Dissolved Oxygen	153		36	Yes	117	Yes
CLA1	E. coli	155	7	36	Yes	119	Yes
CLA1	NO2-NO3	154		36	Yes	118	Yes
CLA1	pH	154		36	Yes	118	Yes
CLA1	Temperature	153		36	Yes	117	Yes
CLA1	Turbidity	154		36	Yes	118	Yes
CLA1	Copper (dissolved)	42	37	11	NO	31	NO
CLA1	Copper (total)	42	30	11	NO	31	NO
CLA1	Lead (dissolved)	42	38	11	NO	31	NO
CLA1	Lead (total)	42	31	11	NO	31	NO
CLA1	Zinc (dissolved)	42	3	11	Yes	31	Yes
CLA1	Zinc (total)	42	1	11	Yes	31	Yes
CLA10	BOD	155	4	33	Yes	122	Yes
CLA10	Conductivity	154		32	Yes	122	Yes
CLA10	Dissolved Oxygen	155		33	Yes	122	Yes
CLA10	E. coli	155	5	33	Yes	122	Yes
CLA10	NO2-NO3	153		33	Yes	120	Yes
CLA10	pH	154		33	Yes	121	Yes
CLA10	Temperature	155		33	Yes	122	Yes
CLA10	Turbidity	155		33	Yes	122	Yes
CLA10	Copper (dissolved)	42	40	11	NO	31	NO
CLA10	Copper (total)	42	36	11	NO	31	NO
CLA10	Lead (dissolved)	42	42	11	NO	31	NO
CLA10	Lead (total)	42	32	11	NO	31	NO
CLA10	Zinc (dissolved)	42	2	11	Yes	31	Yes
CLA10	Zinc (total)	42	1	11	Yes	31	Yes

[1] Rain = ≥ 0.1 inches rainfall in previous 24 hrs

[2] No Rain = < 0.1 inches rainfall in previous 24 hours

[3] Mann-Kendall Test only used if > 10 obersvations (N) and < 50% of data is censored

Croisan Creek

Location	Parameter	Total		Rain[1]		No Rain[2]	
		N	# of Censored values (< or >)	N	Use Mann-Kendall Test?[3]	N	Use Mann-Kendall Test?[3]
CRO1	BOD	155	4	34	Yes	121	Yes
CRO1	Conductivity	155		34	Yes	121	Yes
CRO1	Dissolved Oxygen	155		34	Yes	121	Yes
CRO1	E. coli	155	3	34	Yes	121	Yes
CRO1	NO2-NO3	154		34	Yes	120	Yes
CRO1	pH	154		34	Yes	120	Yes
CRO1	Temperature	155		34	Yes	121	Yes
CRO1	Turbidity	155		34	Yes	121	Yes
CRO10	BOD	154	5	34	Yes	120	Yes
CRO10	Conductivity	154		34	Yes	120	Yes
CRO10	Dissolved Oxygen	154		34	Yes	120	Yes
CRO10	E. coli	154	1	34	Yes	120	Yes
CRO10	NO2-NO3	153	1	34	Yes	119	Yes
CRO10	pH	153		34	Yes	119	Yes
CRO10	Temperature	154		34	Yes	120	Yes
CRO10	Turbidity	154		34	Yes	120	Yes

Gibson Creek

Location	Parameter	Total		Rain[1]		No Rain[2]	
		N	# of Censored values (< or >)	N	Use Mann-Kendall Test?[3]	N	Use Mann-Kendall Test?[3]
GIB1	BOD	154	4	32	Yes	122	Yes
GIB1	Conductivity	153		32	Yes	121	Yes
GIB1	Dissolved Oxygen	152		32	Yes	120	Yes
GIB1	E. coli	155	3	32	Yes	123	Yes
GIB1	NO2-NO3	153		32	Yes	121	Yes
GIB1	pH	153		32	Yes	121	Yes
GIB1	Temperature	152		31	Yes	121	Yes
GIB1	Turbidity	154		32	Yes	122	Yes
GIB15	BOD	152	3	31	Yes	121	Yes
GIB15	Conductivity	151		31	Yes	120	Yes
GIB15	Dissolved Oxygen	150		31	Yes	119	Yes
GIB15	E. coli	152	7	31	Yes	121	Yes
GIB15	NO2-NO3	151		31	Yes	120	Yes
GIB15	pH	151		31	Yes	120	Yes
GIB15	Temperature	151		31	Yes	120	Yes
GIB15	Turbidity	150		30	Yes	120	Yes

[1] Rain = ≥ 0.1 inches rainfall in previous 24 hrs

[2] No Rain = < 0.1 inches rainfall in previous 24 hours

[3] Mann-Kendall Test only used if > 10 obersvations (N) and < 50% of data is censored

Glenn Creek

Location	Parameter	Total		Rain[1]		No Rain[2]	
		N	# of Censored values (< or >)	N	Use Mann-Kendall Test?[3]	N	Use Mann-Kendall Test?[3]
GLE1	BOD	152	4	33	Yes	119	Yes
GLE1	Conductivity	151		33	Yes	118	Yes
GLE1	Dissolved Oxygen	150		33	Yes	117	Yes
GLE1	E. coli	152	1	33	Yes	119	Yes
GLE1	NO2-NO3	151		33	Yes	118	Yes
GLE1	pH	151		33	Yes	118	Yes
GLE1	Temperature	151		33	Yes	118	Yes
GLE1	Turbidity	152		33	Yes	119	Yes
GLE10	BOD	146	7	31	Yes	115	Yes
GLE10	Conductivity	145		31	Yes	114	Yes
GLE10	Dissolved Oxygen	144		31	Yes	113	Yes
GLE10	E. coli	146	4	31	Yes	115	Yes
GLE10	NO2-NO3	145	3	31	Yes	114	Yes
GLE10	pH	144		31	Yes	113	Yes
GLE10	Temperature	144		30	Yes	114	Yes
GLE10	Turbidity	144		31	Yes	113	Yes

West Fork Little Pudding River

Location	Parameter	Total		Rain[1]		No Rain[2]	
		N	# of Censored values (< or >)	N	Use Mann-Kendall Test?[3]	N	Use Mann-Kendall Test?[3]
LPW1	BOD	109		30	Yes	79	Yes
LPW1	Conductivity	111		32	Yes	79	Yes
LPW1	Dissolved Oxygen	111		32	Yes	79	Yes
LPW1	E. coli	110	6	31	Yes	79	Yes
LPW1	NO2-NO3	109	1	31	Yes	78	Yes
LPW1	pH	109		31	Yes	78	Yes
LPW1	Temperature	111		32	Yes	79	Yes
LPW1	TSS	32		9	NO	23	Yes
LPW1	Turbidity	108		30	Yes	78	Yes

[1] Rain = ≥ 0.1 inches rainfall in previous 24 hrs

[2] No Rain = < 0.1 inches rainfall in previous 24 hours

[3] Mann-Kendall Test only used if > 10 obersvations (N) and < 50% of data is censored

Mill Creek

Location	Parameter	Total		Rain[1]		No Rain[2]	
		N	# of Censored values (< or >)	N	Use Mann-Kendall Test?[3]	N	Use Mann-Kendall Test?[3]
MIC1	BOD	153	5	34	Yes	119	Yes
MIC1	Conductivity	153		34	Yes	119	Yes
MIC1	Dissolved Oxygen	153		34	Yes	119	Yes
MIC1	E. coli	153	2	34	Yes	119	Yes
MIC1	NO2-NO3	152		34	Yes	118	Yes
MIC1	pH	152		34	Yes	118	Yes
MIC1	Temperature	153		34	Yes	119	Yes
MIC1	Turbidity	153		34	Yes	119	Yes
MIC10	BOD	154	4	31	Yes	123	Yes
MIC10	Conductivity	154		31	Yes	123	Yes
MIC10	Dissolved Oxygen	153		31	Yes	122	Yes
MIC10	E. coli	154	1	31	Yes	123	Yes
MIC10	NO2-NO3	153		31	Yes	122	Yes
MIC10	pH	153		32	Yes	121	Yes
MIC10	Temperature	153		31	Yes	122	Yes
MIC10	Turbidity	155		32	Yes	123	Yes

Mill Race

Location	Parameter	Total		Rain[1]		No Rain[2]	
		N	# of Censored values (< or >)	N	Use Mann-Kendall Test?[3]	N	Use Mann-Kendall Test?[3]
MRA1	BOD	153	4	34	Yes	119	Yes
MRA1	Conductivity	152		35	Yes	117	Yes
MRA1	Dissolved Oxygen	152		35	Yes	117	Yes
MRA1	E. coli	153	3	35	Yes	118	Yes
MRA1	NO2-NO3	153		35	Yes	118	Yes
MRA1	pH	152		34	Yes	118	Yes
MRA1	Temperature	152		35	Yes	117	Yes
MRA1	Turbidity	154		35	Yes	119	Yes
MRA10	BOD	154	3	30	Yes	124	Yes
MRA10	Conductivity	153		30	Yes	123	Yes
MRA10	Dissolved Oxygen	154		30	Yes	124	Yes
MRA10	E. coli	154	1	30	Yes	124	Yes
MRA10	NO2-NO3	153	1	30	Yes	123	Yes
MRA10	pH	153		30	Yes	123	Yes
MRA10	Temperature	154		30	Yes	124	Yes
MRA10	Turbidity	154		30	Yes	124	Yes

[1] Rain = ≥ 0.1 inches rainfall in previous 24 hrs

[2] No Rain = < 0.1 inches rainfall in previous 24 hours

[3] Mann-Kendall Test only used if > 10 obersvations (N) and < 50% of data is censored

Pringle Creek

Location	Parameter	Total		Rain[1]		No Rain[2]	
		N	# of Censored values (< or >)	N	Use Mann-Kendall Test?[3]	N	Use Mann-Kendall Test?[3]
PRI1	BOD	144	4	29	Yes	115	Yes
PRI1	Conductivity	143		29	Yes	114	Yes
PRI1	Dissolved Oxygen	144		29	Yes	115	Yes
PRI1	E. coli	144	2	29	Yes	115	Yes
PRI1	NO2-NO3	143		29	Yes	114	Yes
PRI1	pH	143		29	Yes	114	Yes
PRI1	Temperature	144		29	Yes	115	Yes
PRI1	Turbidity	144		29	Yes	115	Yes
PRI1	Copper (dissolved)	40	37	10	NO	30	NO
PRI1	Copper (total)	40	30	10	NO	30	NO
PRI1	Lead (dissolved)	40	40	10	NO	30	NO
PRI1	Lead (total)	40	35	10	NO	30	NO
PRI1	Zinc (dissolved)	40	13	10	NO	30	Yes
PRI1	Zinc (total)	40	9	10	NO	30	Yes
PRI5	BOD	155	4	36	Yes	119	Yes
PRI5	Conductivity	153		36	Yes	117	Yes
PRI5	Dissolved Oxygen	152		36	Yes	116	Yes
PRI5	E. coli	154	2	36	Yes	118	Yes
PRI5	NO2-NO3	154		36	Yes	118	Yes
PRI5	pH	154		36	Yes	118	Yes
PRI5	Temperature	153		36	Yes	117	Yes
PRI5	Turbidity	155		36	Yes	119	Yes
PRI5	Copper (dissolved)	42	39	11	NO	31	NO
PRI5	Copper (total)	42	29	11	NO	31	NO
PRI5	Lead (dissolved)	42	42	11	NO	31	NO
PRI5	Lead (total)	42	33	11	NO	31	NO
PRI5	Zinc (dissolved)	42	7	11	Yes	31	Yes
PRI5	Zinc (total)	42	1	11	Yes	31	Yes

[1] Rain = ≥ 0.1 inches rainfall in previous 24 hrs

[2] No Rain = < 0.1 inches rainfall in previous 24 hours

[3] Mann-Kendall Test only used if > 10 obersvations (N) and < 50% of data is censored

Shelton Ditch

Location	Parameter	Total		Rain[1]		No Rain[2]	
		N	# of Censored values (< or >)	N	Use Mann-Kendall Test?[3]	N	Use Mann-Kendall Test?[3]
SHE1	BOD	155	4	35	Yes	120	Yes
SHE1	Conductivity	153		35	Yes	118	Yes
SHE1	Dissolved Oxygen	153		35	Yes	118	Yes
SHE1	E. coli	155	1	35	Yes	120	Yes
SHE1	NO2-NO3	154		35	Yes	119	Yes
SHE1	pH	154		35	Yes	119	Yes
SHE1	Temperature	153		35	Yes	118	Yes
SHE1	Turbidity	155		35	Yes	120	Yes
SHE10	BOD	153	4	32	Yes	121	Yes
SHE10	Conductivity	153		33	Yes	120	Yes
SHE10	Dissolved Oxygen	154		33	Yes	121	Yes
SHE10	E. coli	154		33	Yes	121	Yes
SHE10	NO2-NO3	153		33	Yes	120	Yes
SHE10	pH	153		33	Yes	120	Yes
SHE10	Temperature	154		33	Yes	121	Yes
SHE10	Turbidity	154		33	Yes	121	Yes

[1] Rain = ≥ 0.1 inches rainfall in previous 24 hrs

[2] No Rain = < 0.1 inches rainfall in previous 24 hours

[3] Mann-Kendall Test only used if > 10 obersvations (N) and < 50% of data is censored

Table 5.0: Summary of Significant Trends During Rain Events by Parameter

Parameter	Improving Trend	Deteriorating Trend
BOD	BAT12, GIB15, MRA10	
Dissolved Oxygen	GLE10, MIC1	BAT12
E. coli	MRA10, SHE10	CLA10
Nitrate-Nitrite (NO3-NO2)	BAT1, BAT12, CGT1, CLA1, CLA10, GIB1, GLE1, GLE10, MIC10, PRI5	
Turbidity	BAT1	

Appendix B: Bacteria Load Summary

Appendix B. Bacteria Load Summary
(for use with the Pollutant Load Reduction Estimate and TMDL Benchmarks)

Waterbody	Season	WLA (%)	Pollutant Loading Estimate									Pollutant Load Reduction Estimate [c]								
			Current, no BMPs (counts) [a]			Current, with BMPs (counts) [a]			Future, with BMPs (counts) [b]			Current conditions (counts)[d]			Future conditions (counts)[e]			Future Conditions (%)[e]		
			Upper confidence limit (UCL)	Mean	Lower confidence limit (LCL)	UCL	Mean	LCL	UCL	Mean	LCL	UCL	Mean	LCL	UCL	Mean	LCL	UCL	Mean	LCL
Clark Creek	Summer	94%	3.88×10^{12}	2.33×10^{12}	1.31×10^{12}	3.88×10^{12}	2.33×10^{12}	1.31×10^{12}	Same as current, with BMPs			4.00×10^{9}	2.00×10^{9}	9.00×10^{8}	N/A			N/A		
	Fall, winter, spring	89%	5.80×10^{13}	3.48×10^{13}	1.95×10^{13}	5.79×10^{13}	3.48×10^{13}	1.95×10^{13}	Same as current, with BMPs			7.00×10^{10}	3.00×10^{10}	1.20×10^{10}	N/A			N/A		
Mill + Battle Creek	Summer	89%	1.33×10^{13}	7.68×10^{12}	4.10×10^{12}	1.32×10^{13}	7.62×10^{12}	4.08×10^{12}	1.32×10^{13}	7.62×10^{12}	4.08×10^{12}	1.40×10^{11}	6.10×10^{10}	2.59×10^{10}	1.39×10^{11}	6.08×10^{10}	2.59×10^{10}	1.04%	0.79%	0.63%
	Fall, winter, spring	81%	1.99×10^{14}	1.15×10^{14}	6.13×10^{13}	1.97×10^{14}	1.14×10^{14}	6.09×10^{13}	1.97×10^{14}	1.14×10^{14}	6.09×10^{13}	2.10×10^{12}	9.00×10^{11}	3.86×10^{11}	2.10×10^{12}	9.02×10^{11}	3.86×10^{11}	1.05%	0.79%	0.63%
Pringle Creek Tributary	Summer	92%	8.44×10^{12}	4.99×10^{12}	2.76×10^{12}	8.34×10^{12}	4.95×10^{12}	2.74×10^{12}	8.32×10^{12}	4.93×10^{12}	2.73×10^{12}	9.60×10^{10}	4.70×10^{10}	2.50×10^{10}	1.23×10^{11}	5.98×10^{10}	3.18×10^{10}	1.46%	1.20%	1.15%
	Fall, winter, spring	84%	1.26×10^{14}	7.46×10^{13}	4.13×10^{13}	1.25×10^{14}	7.39×10^{13}	4.09×10^{13}	1.24×10^{14}	7.37×10^{13}	4.08×10^{13}	1.39×10^{12}	6.90×10^{11}	3.73×10^{11}	1.80×10^{12}	8.91×10^{11}	4.75×10^{11}	1.15%	1.19%	1.42%
Pringle Creek Direct	Summer	90%	7.67×10^{11}	3.95×10^{11}	1.84×10^{11}	7.50×10^{11}	3.88×10^{11}	1.81×10^{11}	7.49×10^{11}	3.88×10^{11}	1.81×10^{11}	1.66×10^{10}	7.10×10^{9}	2.81×10^{9}	1.79×10^{10}	7.65×10^{9}	2.94×10^{9}	2.34%	1.94%	1.60%
	Fall, winter, spring	79%	1.15×10^{13}	5.90×10^{12}	2.75×10^{12}	1.12×10^{13}	5.80×10^{12}	2.70×10^{12}	1.12×10^{13}	5.79×10^{12}	2.70×10^{12}	2.48×10^{11}	1.06×10^{11}	4.19×10^{10}	2.67×10^{11}	1.14×10^{11}	4.39×10^{10}	2.33%	1.93%	1.60%
Middle Willamette River Tributary	Summer	88%	1.48×10^{13}	8.76×10^{12}	4.83×10^{12}	1.47×10^{13}	8.73×10^{12}	4.82×10^{12}	1.47×10^{13}	8.72×10^{12}	4.81×10^{12}	8.00×10^{10}	3.50×10^{10}	1.86×10^{10}	8.45×10^{10}	3.97×10^{10}	2.07×10^{10}	0.57%	0.45%	0.43%
	Fall, winter, spring	75%	2.21×10^{14}	1.31×10^{14}	7.22×10^{13}	2.20×10^{14}	1.30×10^{14}	7.19×10^{13}	2.20×10^{14}	1.30×10^{14}	7.19×10^{13}	1.20×10^{12}	5.00×10^{11}	2.77×10^{11}	1.30×10^{12}	6.21×10^{11}	3.08×10^{11}	0.59%	0.47%	0.43%
Middle Willamette River Direct	Annual	75%	1.32×10^{14}	7.73×10^{13}	4.24×10^{13}	1.30×10^{14}	7.66×10^{13}	4.20×10^{13}	1.30×10^{14}	7.64×10^{13}	4.19×10^{13}	1.40×10^{12}	7.30×10^{11}	3.80×10^{11}	1.81×10^{12}	9.25×10^{11}	4.59×10^{11}	1.37%	1.20%	1.08%
Little Pudding Tributaries	Annual	86%	7.79×10^{13}	4.59×10^{13}	2.55×10^{13}	6.94×10^{13}	4.25×10^{13}	2.45×10^{13}	6.94×10^{13}	4.24×10^{13}	2.45×10^{13}	8.48×10^{12}	3.43×10^{12}	1.06×10^{12}	8.49×10^{12}	3.44×10^{12}	1.07×10^{12}	10.91%	7.51%	4.19%

a. The current (2014) no-BMP and with-BMP bacteria load estimates are presented in graphical form in Figures 5-1 to 5-13.

b. The future (2021) with-BMP bacteria 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 the TMDL Benchmarks.

c. 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.

d. The current condition pollutant load reduction estimate is reflected in Section 5 in graphical and tabular form.

e. The future condition pollutant load reduction estimate is considered to be the TMDL Benchmark, as described in Section 6. The TMDL Benchmarks have been calculated as a load reduction and as a percentage load reduction, to allow for comparison to the WLA (defined as a percent load reduction) and future pollutant load reduction estimates (defined as a load reduction).

Appendix D: Proposed Monitoring Plan

City of Salem
National Pollutant Discharge Elimination System (NPDES)
Municipal Separate Storm Sewer System (MS4)

Surface Water and Stormwater Monitoring Plan

Prepared by: City Salem Public Works
Stormwater Services

December 29, 2015

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Attachments

Attachment 1:............................ City of Salem Surface Water and Stormwater Monitoring Matrix

1.0 Introduction

1.1 Introduction and Purpose

As a condition of its Oregon Department of Environmental Quality (DEQ) issued National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit, the City of Salem developed this "Surface Water and Stormwater Monitoring Plan", which implements the monitoring elements identified in Schedule B of the permit.

Data collected through the implementation of this monitoring plan will undergo review and analysis before becoming an integral component of the NPDES MS4 Annual Reporting and Permit Renewal process. Statistical summaries of monitoring data will assist the City in an ongoing assessment of the effectiveness of the Best Management Practices (BMPs) that have been identified in the City's Stormwater Management Plan (SWMP). The City will ultimately utilize the collected data to evaluate and adaptively manage its Stormwater Management Program, thereby limiting the amount of pollutants entering receiving streams from the MS4 to the Maximum Extent Practicable (MEP). The long-term goal of this monitoring plan is to maintain permit compliance while providing high quality data to assist in decision-making and the adaptive management process.

1.2 Monitoring Objectives

Requirements of the monitoring program are listed in Schedule B of the City's NPDES MS4 permit, issued December 29, 2010, and monitoring activities must address the following six objectives:

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

This monitoring plan describes six different monitoring elements the City of Salem will utilize to meet these objectives. They include:

1. Instream Storm monitoring
2. Stormwater monitoring
3. Continuous Instream monitoring
4. Macroinvertebrate monitoring
5. Monthly Instream monitoring
6. Dry Weather Outfall monitoring

The City of Salem Stormwater Monitoring Matrix (Attachment 1) identifies how each monitoring element will be used to address the six permit objectives. The City will implement these monitoring elements during the new NPDES MS4 permit term.

1.3 Data Quality Objectives

As described in the introduction above, the intent of this monitoring plan is that all environmental data collected will be used to support adaptive management of the stormwater monitoring program, as well as demonstrate the effectiveness of BMPs in reducing the discharge of pollutants to MS4 receiving streams. This plan documents the minimum data quality standards for both field and laboratory data. Field data quality criteria can be found under each monitoring element. Section 1.4 below documents the analytical methods and the associated reporting limits for all samples analyzed by the City of Salem Willow Lake Water Pollution Control Facility Laboratory (Willow Lake Laboratory).

General data quality objectives are that the data are representative, of known precision and accuracy, will withstand scientific scrutiny, and are generated using field equipment and instrumentation that follow approved calibration procedures and analytical methods.

1.4 Analytical Procedures – Laboratory

All composite and grab samples collected for Instream Storm, Stormwater, and Monthly Instream will be submitted to the Willow Lake Laboratory for analysis. All samples will be analyzed following procedures documented in the current version of the Willow Lake Laboratory Quality Manual and 40 CFR 136. Table 1 below shows the analytical method for each parameter, hold time, collection container, and reporting limit (Limit of Quantification).

Table 1: Willow Lake Laboratory Analytical Information

Parameter	Analytical Method	Hold Time	Collection container	Reporting limit
E. coli	SM9223B	6 hours	Glass/sterile specimen cup (plastic)	1 E. coli/100 mL
Hardness	SM2340C	6 months	Plastic	5 mg/L
Copper (Total Recoverable & Dissolved)	EPA 200.7 v 4.4	6 months	Plastic (acid rinsed)	0.0025 mg/L
Lead (Total Recoverable & Dissolved)	SM3113B			0.0005 mg/L
Zinc (Total Recoverable & Dissolved)	EPA 200.7 v 4.4			0.0025 mg/L
BOD ('stream' and 5 day)	SM5210B	24 hours	Plastic	2 mg/L
Ammonia Nitrogen	SM4500NH3-F	7 days	Plastic	0.1 mg/L
Nitrate+Nitrite as Nitrogen	SM4500NO3-F	48 hours (28 days if acidified)	Plastic	0.05 mg/L
Total Phosphorus	SM4500PO4-BE	28 days	Plastic	0.01 mg/L
TSS	SM2540D	7 days	Plastic	1 mg/L

1.5 Adaptive Management

By adaptively managing (e.g., implementing, evaluating, and adjusting) its stormwater management program, the City of Salem is better able to reduce the discharge of pollutants from its stormwater sewer (MS4) system to the maximum extent practicable.

Stormwater quality data are characteristically highly variable, limiting the value and confidence of statistical analyses performed on small datasets. As a result, there is limited ability for data analyses to support short-term (e.g. *within* the 5-year NPDES MS4 permit cycle) decision-making and adaptive management processes. However, the City recognizes that some monitoring activities described in this plan, like the continuous instream monitoring element, may provide some opportunity to do so. For instance, short-term trends in continuous water quality monitoring data could indicate the presence of discharges that could potentially require follow-up through the City's Illicit Discharge Detection and Elimination Program or Erosion Prevention and Sediment Control Program.

Data collected through implementation of this monitoring plan will contribute largely to the preparation of the City's NPDES MS4 permit renewal application, where the City of Salem will evaluate the overall effectiveness of its Stormwater Management Program. These analyses will support decision-making and proposed improvements to the SWMP and associated BMPs for the upcoming NPDES MS4 permit cycle.

If at any point the City needs to modify this monitoring plan due to adaptive management or other conditions, changes and notification to the DEQ would occur in accordance with NPDES MS4 permit Schedule B.2.e.

2.0 Storm Event Based Monitoring Elements

The City of Salem has two monitoring elements that require sample collection during defined storm events that meet specific storm criteria. The defined storm criteria varies by monitoring element and is based on the permit requirements, however, for all storm event based monitoring, the predicted storm event must produce more than 0.1 inch of rainfall to be considered.

Weather Forecasting Service

The City of Salem utilizes several weather forecasting services to monitor precipitation forecasts, including the National Weather Service and a private meteorological service. The quantitative precipitation forecast (QPF) provided by each of these services is used to select storm events to sample, and to determine a flow interval quantity (FIQ) that is used for flow paced storm sampling.

The private weather service provides daily weather forecasts during the workweek, which include a written summary of the expected weather conditions for the upcoming week and a detailed 3-hour QPF that extends out a minimum of 72 hours. This information is used to select a potential storm event, create a general plan for timing of sample collection, and program samplers to collect composite samples.

Storm Sampling Response Team

For each storm event chosen for sampling, one of the City's two Flow Monitoring Analysts will act as the Responsible Sampling Coordinator. This person will be responsible for coordination with the laboratory, organizing the sampling teams, serving as the contact person for the private weather service, and ensuring all sampling equipment is ready before the start of the storm event. The Storm Sampling Response Team will consist of either two or four people, including the Storm Sampling Lead.

Once a potential sampling storm has been identified, the Storm Sampling Lead will monitor the forecast and make the final decision to sample. Once the decision has been made to sample a storm, the Storm Sampling Lead will coordinate with Willow Lake Laboratory to ensure everything is in order. Before the rainfall event is predicted to begin, the Storm Sampling Response Team will program and deploy portable samplers filled with ice, and prepare all other equipment and field collection forms. The private weather service will provide an updated QPF every 6 hours, and will call the Responsible Sampling Coordinator to provide notification prior to the start of the storm event (typically one hour prior to the predicted start of the rainfall), thus ensuring the collection of grab samples and field measurements during the first three hours of the storm event (permit requirement). The Storm Sampling Lead will be responsible for contacting the rest of the Storm Sampling Response Team.

The City has five staff that are trained to collect samples during a storm event, and who are responsible for the following:

- Proper calibration procedures for field instruments and programming of automated samplers, as well as the troubleshooting of basic equipment problems.
- Ensuring all field data sheets and chain of custody documents are filled out properly and completely.
- Ensuring that all grab and composite samples are collected, stored, and delivered to the laboratory in accordance with this monitoring plan and the applicable analytical methods.
- Ensuring that all appropriate traffic control measures and necessary personal protective equipment are used.

2.1 Instream Storm

2.1.1 Project / Task Organization

Instream Storm refers to the monitoring of MS4 receiving streams, where sampling is to occur during defined storm events. The City's Stormwater Monitoring Analyst will serve as the Responsible Sampling Coordinator. The City's Stormwater Services workgroup will perform sampling and collect field data. The City's Willow Lake Laboratory will perform all analytical laboratory analyses.

2.1.2 Monitoring Objectives

Instream Storm monitoring will contribute to monitoring objectives i, ii, iii, iv, v, and vi, as identified in Section 2.1 above. A more detailed explanation of how this monitoring element addresses each objective can be found in the City of Salem Surface Water and Stormwater Monitoring Matrix (Attachment 1).

2.1.3 Background

Instream Storm monitoring is a relatively new monitoring element, with implementation starting with the last permit cycle (December 29, 2010). This monitoring element was developed to help the City expand its understanding of receiving waters within the Pringle Creek Watershed during storm events. By continuing to sample the same sites, it is expected that sufficient data will be collected over time to determine if any long term or spatial trends exist. Three separate sites were selected for sampling, as described in 3.1.4.1.

2.1.4 Study Design / Sampling Process

2.1.4.1 Study Design

The study design is a spatial layout of the three different sites that are to be monitored during storm events only. The name of each site, the receiving stream, and location are included in Table 2, and are identified in Figure 1. Relevant characteristics for each site are as follows:

- **PRI12-** This site is located at the City's jurisdictional boundary, where the East Fork Pringle Creek enters city limits, and represents an upstream catchment area with little influence from the City's MS4 system.

- **CLK1-** This site on Clark Creek is located just upstream of the confluence with Pringle Creek, and represents an older portion of town, with the majority of the catchment being built-out and having limited stormwater structural controls. As identified in the City's 2014 Pollutant Load Reduction Evaluation, 0.4% of the CLK1 catchment has structural best management practices (BMPs) in place.

- **PRI3-** This site on the main fork of Pringle Creek is located just before the confluence of Shelton Ditch with Pringle Creek, and represents a portion of the city with a larger percentage of catchment being treated by stormwater structural controls. As identified in the City's 2014 Pollutant Load Reduction Evaluation, 4.0% of the catchment area has structural BMPs in place (the tributaries feeding into the main fork of Pringle Creek have another 5.0% of BMP coverage).

Data collected by way of this monitoring element will help guide Salem's stormwater management strategies in the Pringle Creek Watershed and watersheds throughout the city.

Table 2: Instream Storm Monitoring Sites

Site ID	Creek Name	Site Location
PRI3	Pringle Creek	Pringle Park
PRI12	East Fork Pringle Creek	Trelstad Ave SE
CLK1	Clark Creek	Bush Park

2.1.4.2 Frequency and Duration / Storm Selection Criteria

Instream Storm monitoring will be conducted during fifteen storm events at each of the three sites throughout the duration of the permit term. Storms of varying intensity and duration will be targeted. Each storm event will be chosen based on the following criteria:

- Storm event must be greater than 0.1 inch of rainfall
- A minimum of 50% of the water quality sample events must be collected during the wet season (October 1 to April 30)
- Each unique sample event must occur at a minimum of 14 days apart

Although it is anticipated that fifteen samples from each of the three sites will be collected over the five year permit term, unanticipated circumstances including, but not limited to, weather, personnel illness and turnover, vehicular malfunction, equipment malfunction, and various safety issues could prevent the collection of some of the samples If such a situation exists, Oregon DEQ will be informed following notification procedures listed in the MS4 permit.

2.1.4.3 Sample Collection Method

Sample collection methods will include grab samples, field measurements, and flow-weighted composites[1]. All grab samples and field measurements will be collected during the first three hours of the sampled storm event. Samples will be collected directly from the stream where the water is well mixed and representative of the ambient conditions. Portable sampling units will be programmed to collect a flow-weighted composite sample based on the predicted

[1] If stream gauging equipment fails and it is infeasible to repair equipment before a targeted storm event starts, a time-composite sample will be collected in lieu of a flow-paced sample.

precipitation depth total for the storm event. This will be calculated prior to the sampling event using the private weather service forecast (see Section 3.0), with cessation of the calculation being identified by the first predicted 6-hour dry period or at the end of 24 hours of runoff, whichever comes first. The portable sampling units will remain in the field until the program is completed or 24 hours from the start of the runoff event, whichever comes first. Collection method for each Instream Storm parameter can be found in Table 3 below.

Table 3: Instream Storm Parameter List and Collection Method

Instream Storm Parameters	Collection Method
TSS	Composite
BOD ('stream')	Composite
Total Phosphorus	Composite
Nitrate+Nitrite as Nitrogen	Composite
Ammonia Nitrogen	Composite
Copper (Total Recoverable & Dissolved)	Composite
Lead (Total Recoverable & Dissolved)	Composite
Zinc (Total Recoverable & Dissolved)	Composite
Hardness	Composite
Specific Conductivity	Field and Composite
Dissolved Oxygen	Field
Temperature	Field
pH	Field
E. coli	Grab

Note: BOD 'stream' analytical method is not identified in 40 CFR 136; however, this method has been identified as an acceptable method under Table B-1 Special Condition #5 in the City's current NPDES MS4 permit.

2.1.5 Data Quality Criteria

2.1.5.1 Data Quality Objectives

The minimum data quality objectives for field measurements are detailed in Table 4. Analytical methods for composite and grab samples analyzed at Willow Lake Laboratory are identified in 40 CFR 136 or otherwise identified in Table B-1 Special Conditions of the NPDES MS4 permit. Analytical methods for field parameters can be found in the City's "Stormwater and Instream (Storm Only) Monitoring Standard Operating Procedures" (2011).

Table 4: Instream Storm Field Quality Objectives

Field Parameters	Accuracy	Precision
Temperature	± 0.5 °C	± 0.5 °C
pH	± 0.2 SU	± 0.3 SU
Dissolved Oxygen	± 0.2 mg/L	± 0.3 mg/L
Specific Conductivity	± 7% of standard value	± 10% of standard value

2.1.5.2 Comparability

Field, grab, and composite samples will utilize the same handling requirements and laboratory procedures that are used for the Stormwater and Monthly Instream monitoring elements. The field quality objectives for field measurements are also the same for Stormwater, Monthly Instream, and Continuous Instream. This uniformity increases the validity of the data for analyses and comparison with other data collected within the scope of this plan.

2.1.6 Quality Assurance / Quality Control / Record Keeping

2.1.6.1 Duplicate and Blank Samples

Duplicates will be taken for a minimum of ten percent of the total number of grab samples and field measurements. For composite sampling, an equipment blank (water that has been run through pump tubing, suction line tubing, strainer, and sample container vessel) will be collected at the beginning of each sampling season.

2.1.6.2 Instrument Calibration / Inspection / Maintenance

Instruments will be inspected and calibrated prior to each sampling event. Instrument calibration, inspection, and maintenance procedures are all documented in the City's "Stormwater and Instream (Storm Only) Monitoring Standard Operating Procedures" (2011).

2.1.6.3 Sample Handling and Chain of Custody Procedures

Field measurements will be taken directly in the stream using calibrated and NIST traceable equipment. Grab samples will be collected using a sterilized beaker, transferred to appropriate bottles, and transported to Willow Lake Laboratory to be processed within their hold times. As soon as the portable samplers have completed their programs, the flow-weighted composite samples will be taken to Willow Lake Laboratory. All grab and composite samples will have a chain of custody form associated with them.

2.1.6.4 Documentation and Records

A field data sheet will be filled out for each site during a sampling event. All field measurements and metadata pertinent to the sampling event will be recorded on this sheet, and then stored electronically and in the permit sampling binder. A copy of each chain of custody form, lab results, and other necessary information will be kept in the sampling binder and organized by storm event date.

2.1.6.5 Data Management

All laboratory analytical results provided by Willow Lake Laboratory will be kept in the Willow Lake Laboratory's Laboratory Information Management System (LIMS) database and duplicated in the Stormwater Services' Aquarius database. In addition to the lab results, field measurements will also be entered into the Aquarius database.

2.1.6.6 Data Validation and Verification

The Responsible Sampling Coordinator will review all field and laboratory data. It will be the responsibility of the Responsible Sampling Coordinator to perform the final review and verification of information on the field data sheets and chain of custody forms. In addition, the Responsible Sampling Coordinator will follow up with Willow Lake Laboratory on any laboratory-generated data that has fallen outside an expected range, and make the decisions to accept, qualify, or reject any data collected under this monitoring element.

2.1.7 Long-term Strategy

This monitoring element supports the long-term monitoring program strategy by providing data that will contribute to the understanding of the relationship between post-construction stormwater controls (outlined in the stormwater design standards) and the water quality of receiving streams. The sites selected for sampling in this monitoring element have catchments with various levels of stormwater controls. Evaluating data by these catchment characteristics is intended to provide the City a basis to assess the aggregate effectiveness of stormwater controls. Understanding this effectiveness will help the City prioritize its stormwater retrofit efforts and evaluate progress towards pollutant reduction in MS4 receiving streams. This monitoring element was first implemented with the last permit starting in June 2011 (when the City's monitoring plan was approved by DEQ), and it is expected that this element will continue beyond this permit cycle; ultimately providing a long term dataset for time and spatial trends analyses.

2.2 Stormwater

2.2.1 Project / Task Organization

Stormwater monitoring refers to the monitoring of MS4 stormwater runoff during defined storm events. The City's Stormwater Monitoring Analyst(s) will serve as the Responsible Sampling Coordinator. The Stormwater Services workgroup will perform sampling and collect field measurements. The City's Willow Lake Laboratory will perform all analytical laboratory analyses.

2.2.2 Monitoring Objectives

Stormwater monitoring will contribute, at least in part, to monitoring objectives i, ii, iii, iv, v, and vi, as identified in Schedule B.1 of the City of Salem's NPDES MS4 Permit. Refer to the City of Salem Surface Water and Stormwater Monitoring Matrix (Attachment 1) for a more detailed explanation of how this monitoring element addresses each objective.

2.2.3 Background

The City of Salem began collecting stormwater samples from four land use based monitoring sites (Redleaf, Edgewater, Cottage, Commercial) in January 1995. The City's first NPDES MS4 permit was subsequently issued in 1997. Annual stormwater sampling continued at these four sites through the winter of 2005. In 2006, the City discontinued these sites and began sampling four new stormwater sites. These new sites were selected to represent stormwater discharges to 303(d) listed streams and were identified by the associated stream name (Clark Storm, Mill Storm, Pringle Storm, Glenn Storm).

During the last NPDES MS4 permit term (December 2010 - December 2015) the City resumed land use based stormwater sampling with three sites, Electric, Hilfiker, and Salem Industrial, which represent residential, commercial, and industrial land use in Salem, respectively. The commercial and industrial sites were new locations, while the residential site was the Clark Storm location from the previous permit.

For the proposed permit cycle the industrial and commercial sites will remain the same as they were for the last permit cycle. The previous residential site (Electric), however, no longerallows for accurate or reliable flow-paced sampling, due to the hydraulics of water in the pipe, and therefore will be replaced with the 1995-2005 residential land use site located on Redleaf Dr S.

2.2.4 Study Design / Sampling Process

2.2.4.1 Study Design

The study design for this monitoring element provides for the characterization of MS4 stormwater runoff on commercial, industrial, and residential land uses within the City's MS4. Two of the three sites will remain the same as those sampled during the last MS4 permit cycle (2010–2015) to create a long-term data set, which can then be used to analyze and calculate, among other things, the pollutant load concentration values. These two sites are located in designated industrial and commercial land use areas. As stated in 3.2.3, the site location within the residential land use area (Electric) will revert to its original residential location on Redleaf Dr S. These sites are identified in Figure 1 and described in Table 5.

Table 5: Stormwater Monitoring Sites

Dominant Land Use	Residential	Industrial	Commercial
Site Identifier	Redleaf	Salem Industrial	Hilfiker
Manhole Number	D33450-212	D51488-226	D42456-234
Number of Events	15 total storm events	15 total storm events	15 total storm events
Watershed	Battle Creek	Upper Claggett	Pringle Creek
Receiving Stream	Waln Creek	Claggett Creek	West Fork Pringle Creek

2.2.4.2 Frequency and Duration / Storm Selection Criteria

Stormwater monitoring will be conducted during fifteen storm events at each of the three sites throughout the duration of the permit term. Storms of varying intensity and duration will be targeted. Each storm event will be chosen based on the following criteria:

- Storm event must produce more than 0.1 inch of rainfall
- When possible, samples must be collected after an antecedent dry period of less than 0.1” in previous 24-hour period

Although it is anticipated that fifteen samples from each of the three sites will be collected over the five year permit term, unanticipated circumstances including, but not limited to, weather, personnel illness and turnover, vehicular malfunction, equipment malfunction, and various safety issues could prevent the collection of all of the samples. If such a situation exists, Oregon DEQ will be informed following notification procedures outlined in the MS4 permit.

2.2.4.3 Sample Collection Method

Sample collection methods will include grabs samples, field measurements, and flow-weighted composites[2]. All grab samples and field measurements will be taken during the first three hours of the sampled storm event. Portable sampling units and flow modules will be programmed to perform a flow-weighted composite sample based on the predicted precipitation total for the storm event. This will be calculated prior to the sampling event using the latest forecast from the private weather service forecast (see Section 3.0), with cessation of the event being identified by the first predicted 6 hour dry period or at the end of 24 hours, whichever comes first. The portable sampling units will remain in the field until the program is completed or 24 hours from the start of the event, whichever comes first. Collection method for each Stormwater parameter can be found in Table 6 below.

Table 6: Stormwater Parameter List

TSS	Composite
$BOD_{5\text{-day}}$	Composite
Total Phosphorus	Composite
Nitrate+Nitrite as Nitrogen	Composite
Ammonia Nitrogen	Composite

[2] If flow equipment fails and it is infeasible to repair equipment before a targeted storm event starts, samplers will be programmed to take a time-composite sample in place of a flow paced sample.

Stormwater Parameters	Collection Method
Copper (Total Recoverable & Dissolved)	Composite
Lead (Total Recoverable & Dissolved)	Composite
Zinc (Total Recoverable & Dissolved)	Composite
Hardness	Composite
Specific Conductivity	Field and Composite
Temperature	Field
pH	Field
Dissolved Oxygen	Field
E. coli	Grab

2.2.5 Data Quality Criteria

2.2.5.1 Data Quality Objectives

The minimum data quality objectives for field measurements are detailed in Table 7. Analytical methods for composite and grab samples analyzed at Willow Lake Laboratory will follow methods indentified in 40 CFR 136 or otherwise identified in Table B-1 Special Conditions of the NDPES MS4 permit. Analytical methods for field measurements can be found in the City's "Stormwater and Instream (Storm Only) Monitoring Standard Operating Procedures" (2011).

Table 7: Stormwater Field Measurement Quality Objectives

Field Parameters	Accuracy	Precision
Temperature	± 0.5 °C	± 0.5 °C
pH	± 0.2 SU	± 0.3 SU
Dissolved Oxygen	± 0.2 mg/L	±0.3 mg/L
Specific Conductivity	± 7% of standard value	± 10% of standard value

2.2.5.2 Comparability

Field, grab, and composite samples for this monitoring element will utilize the same handling requirements and laboratory procedures that are used for the Instream Storm and Monthly Instream monitoring elements. The field quality objectives for field measurements are also the same for Instream Storm, Monthly Instream, and Continuous Instream. This uniformity increases the validity of the data for analyses and comparisons with other data collected within the scope of this plan.

2.2.6 Quality Assurance / Quality Control / Record Keeping

2.2.6.1 Duplicates and Blank Samples

Duplicates will be taken for a minimum of ten percent of the total number of grab samples and field measurements. For composite sampling, an equipment blank (water that has been run through the pump tubing, suction line tubing, and sample container vessel) will be collected at the beginning of each sampling season.

2.2.6.2 Instrument Calibration / Inspection / Maintenance

Instruments will be inspected and calibrated prior to each sampled storm event. Instrument calibration, inspection, and maintenance procedures are all documented in the City's "Stormwater and Instream (Storm Only) Monitoring Standard Operating Procedures" (2011).

2.2.6.3 Sample Handling and Custody Procedures

Grab samples will be collected using a sterilized beaker, transferred to appropriate bottles, put on ice, and transported immediately to Willow Lake Laboratory so they can be processed within their hold times. Field measurements will be taken directly from the same sterilized beaker after the grab samples have been collected, using calibrated and NIST traceable instruments. As soon as the portable samplers have completed their programs, the flow-weighted composite sample(s) will be kept on ice and taken to Willow Lake Laboratory. All grab and composite samples will have a chain of custody form associated with them.

2.2.6.4 Documentation and Records

A field data sheet will be filled out for each site during a sampling event. All field measurements and metadata pertinent to the sampling event will be put on this sheet. This sheet will be stored electronically and in the permit sampling binder. A copy of each chain of custody, as well as lab results and any other necessary information will also be kept in the sampling binder, organized by storm event date.

2.2.6.5 Data Management

All laboratory analytical results provided by Willow Lake Laboratory will be kept in the Willow Lake Laboratory's Laboratory Information Management System (LIMS) database and duplicated in the Stormwater Services' Aquarius database. In addition to the lab results, field measurements will also be entered into the Aquarius database.

2.2.6.6 Data Validation and Verification

The Responsible Sampling Coordinator will review all field and laboratory data. It will be the responsibility of the Responsible Sampling Coordinator to perform the final review and verification of the information on the field data sheets and chain of custody forms. In addition, the Responsible Sampling Coordinator will follow up with Willow Lake Laboratory on any laboratory-generated data that has fallen outside an expected range, and make the decisions to accept, qualify, or reject any data collected under this monitoring element.

2.2.7 Long-term Strategy

This monitoring element contributes to the long-term monitoring program strategy by providing data that characterizes the quality of MS4 discharges, and supports long-term evaluation of the effectiveness of the City's Stormwater Management Program. Datasets can be utilized for comparison between ACWA concentration values used for estimating total annual pollutant loads and benchmark analysis completed as part of the 2008 and 2015 permit renewal packages; thus, providing a gauge of the effectiveness of both structural and non-structural stormwater controls. Additionally, seasonal and geographic characterization will also be evaluated to help identify future stormwater control facility implementation priorities.

2.3 Pesticides

The City incorporated pesticide monitoring as a new stormwater monitoring element in its last permit cycle. Pesticide screens were performed at the three Stormwater sites identified in the last monitoring plan. The commercial and industrial sites listed in Table 5 above were sampled, along with a residential site in the Clark Creek basin. A total of 188 different types of pesticides were analyzed as part of each screening process. Of the 188 pesticides, five different pesticides were detected at the residential site, four at the commercial site, and seven at the industrial site. This data was submitted to the DEQ upon request in August of 2015.

The City is in the process of updating its Integrated Pest Management (IPM) Plan and geodatabase of pesticide applications. The updated plan will likely inform the type of pesticide monitoring that is most applicable for monitoring the City's pesticide use. Secondly, the DEQ analysis of all the pesticide results from the Phase I permittees may influence the permit requirements when the new permit is issued. Therefore, the City will wait until the new NPDES MS4 permit is issued to the City, and will modify the monitoring plan at that time to address the specific pesticide monitoring element requirements listed in Table B-1.

3.0 Non-Storm Event Monitoring Elements

The City has three monitoring elements that do not require sample collection during storm events, and are intended to provide the City with a snapshot of overall stream health and long-term trends within the city. These include Continuous Instream, Monthly Instream, and Macroinvertebrate monitoring.

3.1 Continuous Instream

3.1.1 Project / Task Organization

Continuous Instream monitoring refers to the continuous monitoring of MS4 receiving streams at fixed sites (monitoring stations). The City's Stormwater Monitoring Analyst will serve as the Responsible Sampling Coordinator. The City's Stormwater Services monitoring workgroup will perform all operation/maintenance and quality assurance/quality control procedures.

3.1.2 Monitoring Objectives

Continuous Instream monitoring will contribute, at least in part, to monitoring objectives i, ii, iii, iv, v, and vi, as identified in Schedule B.1 of the City of Salem's NPDES MS4 Permit. Refer to the City of Salem Surface Water and Stormwater Monitoring Matrix (Attachment 1) for a more detailed explanation of how this monitoring element addresses each objective.

3.1.3 Background

Continuous Instream monitoring began in 2006 with a total of six stations, including: two on Mill Creek, two on Pringle Creek, and two on Clark Creek. In 2007, three more stations were added, two on Glenn Creek, and one on Mill Creek. In 2008, two stations were added on Battle Creek. Due to concerns with data quality and maintenance, the furthest downstream station on Mill Creek, just before the creeks flows into the Willamette River, was removed in 2012 and a new station was put in on Shelton Ditch. Also in 2012, two stage only monitoring stations were added, one on Pringle Creek and one on the West Fork Little Pudding River.

3.1.4 Study Design / Sampling Process

3.1.4.1 Study Design

A total of thirteen continuous monitoring stations are installed on Battle Creek, Clark Creek, Glenn Creek, Mill Creek, Pringle Creek, Shelton Ditch, and West Fork Little Pudding River. With the exception of Shelton Ditch and West Fork Little Pudding River, there are two stations on each stream, positioned in an upstream/downstream configuration. The upstream sites are adjacent to where the stream enters the City, and the downstream sites are either above the confluence with another stream or where the stream exits the City's jurisdictional boundary. The positioning of these sites are identified in Figure 1 and described in Table 8.

Table 8: Continuous Instream Monitoring Sites

Site ID	Stream Location	Creek Name	Station Monitoring Type	Site Location
BAT3	Downstream	Battle Creek	Water Quality and Stage	Commercial St SE
BAT12	Upstream	Battle Creek	Water Quality and Stage	Lone Oak Rd SE
CLK1	Downstream	Clark Creek	Water Quality and Stage	Bush Park
CLK12	Upstream	Clark Creek	Water Quality and Stage	Ewald St SE
GLE3	Downstream	Glenn Creek	Water Quality and Stage	Wallace Rd NW
GLE12	Upstream	Glenn Creek	Water Quality and Stage	Hidden Valley Dr NW
MIC3	Downstream	Mill Creek	Water Quality and Stage	North Salem High School
MIC12	Upstream	Mill Creek	Water Quality and Stage	Turner Rd SE
PRI3	Downstream	Pringle Creek	Water Quality and Stage	Pringle Park
PRI4	Middle	Pringle Creek	Stage Only	Salem Hospital
PRI12	Upstream	Pringle Creek	Water Quality and Stage	Trelstad Ave SE
SHE3	Downstream	Shelton Ditch	Water Quality and Stage	Winter St Bridge
LPW1	Upstream (at city limit)	West Fork Little Pudding River	Stage Only	Cordon Rd

All monitoring equipment was installed so that it collects a representative dataset within each stream that describes the ambient conditions during both storm and non-storm conditions. This study design allows for long-term, time-based, and spatial trends analyses.

Additionally, the continuous monitoring stations aid in the Illicit Discharge Detection and Elimination (IDDE) program by utilizing near real-time monitoring capabilities to detect parameter readings that may be the result of an illicit discharge and send an alarm to notify staff.

3.1.4.2 Frequency and Duration

The City's network of thirteen continuous monitoring stations are designed to run 24 hours a day, 365 days a year and collect and log data every 15 minutes. Infrequent disruptions to data collection can result from station maintenance, power outages, or equipment failures, creating 'gaps' in the continuous data time series record.

3.1.4.3 Collection Method

Data are collected in-situ using automated datasondes for the following water quality parameters: temperature, pH, dissolved oxygen, specific conductivity, and turbidity. Stage readings are also measured in-situ using automated equipment. Data are sent from the field to a base station via radio telemetry and stored in a database on the City's IT network. Provisional flow measurements are also computed in real-time. Finalized flow measurements are computed by the Flow Monitoring Analyst using proprietary rating curve software (Aquarius). Table 9 details each of the parameters and the sample collection method.

Table 9: Continuous Instream Parameter List and Collection Method

Continuous Instream Parameters	Collection Method
Temperature	In-situ with datasonde
pH	In-situ with datasonde
Dissolved Oxygen	In-situ with datasonde
Specific Conductivity	In-situ with datasonde
Turbidity	In-situ with datasonde
Stage	In-situ with datasonde

3.1.5 Data Quality Criteria

3.1.5.1 Data Quality Objectives

The minimum data quality objectives for continuous in-situ measurements are detailed in Table 10 below. More information, including analytical methods for each parameter, can be found in the City's "Continuous Water Quality Monitoring Program QAPP".

Table 10: Continuous Instream In-Situ Quality Objectives

Parameters	Accuracy	Precision
Temperature	± 0.5 °C	± 0.5 °C
pH	± 0.2 SU	± 0.3 SU
Dissolved Oxygen	± 0.3 mg/L	± 0.5 mg/L
Turbidity	± 5% or 2 NTU (whichever is greater)	± 5% or 3 NTU (whichever is greater)
Specific Conductivity	± 7% of standard value	± 10%

3.1.5.2 Comparability

Field parameters for this monitoring element use the same field quality objectives as are used for Instream Storm, Stormwater, and Monthly Instream. This uniformity increases the validity of the data for analyses and comparisons with other data collected within the scope of this plan.

For comparability between stations, all stations utilize the same brand of multiparameter datasondes for collecting in-situ measurements.

3.1.6 Quality Assurance / Quality Control / Record Keeping

3.1.6.1 Instrument Calibration / Inspection / Maintenance

All datasonde sensors will be inspected, maintained, and calibrated according to documented procedures in the "Continuous Water Quality Monitoring Program QAPP". Basic replacement parts and sensors will be kept on hand as appropriate to minimize down time of a station in the event of equipment malfunction.

3.1.6.2 Documentation and Records

Field sheets will be completed for each station visit, and each monitoring station has a separate binder that the sheets are stored in. Further information about what is recorded on these field sheets is available in the "Continuous Water Quality Monitoring Program QAPP".

3.1.6.3 Data Management

Field technicians are responsible for completion of the field sheets. Data will be stored in the Stormwater Services Aquarius database.

3.1.6.4 Data Validation and Verification

The Stormwater Monitoring Analyst will perform a review of all information provided on the field sheets following procedures documented in the "Continuous Water Quality Monitoring Program QAPP". All collected data will be audited and assigned a grade value to describe the quality of each datum recorded. A verification process of all data collected between audit periods is completed on a quarterly basis. Once the verification process is complete, the data can be distributed to City staff and the public as requested.

3.1.7 Long-Term Strategy

All monitoring sites for this element are at fixed locations that are either on City-owned property or located within City easements. This ensures that sites will continue to be operated and maintained for stream discharge and water quality monitoring into the future.

This monitoring element provides data that will support multiple long-term monitoring program strategies. Examples for intended use of the data include: aiding and showing progress in the IDDE program (by use of station alarms); studying the impacts of hydromodification and strategies to address hydromodification (stream flow/stage data); continued evaluation of receiving stream status (water quality data); examining the cumulative effects (chemical, physical, and biological) of the City's MS4 stormwater runoff on receiving streams; and assessing progress towards meeting TMDL load reduction benchmarks.

3.2 Macroinvertebrate

3.2.1 Project / Task Organization

Macroinvertebrate monitoring will consist of collection of benthic macroinvertebrates, fish sampling, and physical habitat collection on Waln and Battle Creeks within the Battle Creek Watershed. The City's Stormwater Monitoring Analyst will serve as the Responsible Sampling Coordinator. The City's Stormwater Services workgroup will be responsible for the completion of this monitoring element.

3.2.2 Monitoring Objectives

Macroinvertebrate monitoring will contribute, at least in part, to monitoring objectives iv and v as identified in Schedule B of the City of Salem's NPDES MS4 Permit. Refer to City of Salem Stormwater Monitoring Matrix (Attachment 1) for a more detailed explanation of how this monitoring element addresses each objective.

3.2.3 Background

Macroinvertebrate monitoring was a new monitoring element prescribed in the City's NPDES MS4 permit (2010-2015), and it was designed to help the City assess the biological effects of MS4 discharges on receiving waters. Since the City had collected macroinvertebrate data within the Pringle Creek Watershed as part of a non-permit-related project in 2000 and 2001, three sites within the Pringle Creek watershed were selected for this new monitoring element. This was done so that the City could compare the data from the 2000-2001 macroinvertebrate study and the data collected in the last permit term (2010-2015) to determine changes in macroinvertebrate populations within the Pringle Creek Watershed.

In addition to sampling the three sites within the Pringle Creek Watershed as part of the prescribed monitoring requirements of the last permit, the City also chose to perform macroinvertebrate sampling at four additional sites on Waln and Battle Creeks within the old Battle Creek golf course. This sampling was conducted in the fall of 2011, before a large mitigation project that realigned the creek, added woody debris, restored the replanting of riparian area within the reach, and add detention. The sampling effort assessed the type of habitat that existed prior to the construction of the mitigation project. It was the City's intent to complete a follow-up sampling of Waln and Battle Creeks five years after the completion of the project. As such, the four previously sampled sites on Waln and Battle Creeks will be used for macroinvertebrate sampling during this permit term, as it falls within the five years since completion of the mitigation project.

3.2.4 Study Design / Sampling Process

3.2.4.1 Study Design

The study design for this monitoring element is a targeted approach, where macroinvertebrates will be collected at the same four sites that were sampled in the fall of 2011 – two on Waln Creek and two on Battle Creek. The intent of this study design is to collect data on benthic macroinvertebrate communities, fish presence, and physical habitat characteristics, which can be compared to the baseline data collected in 2011. This study design will help the City to determine ultimately whether the mitigation and realignment of Waln Creek was successful at increasing the biological integrity of the stream reach.

3.2.4.2 Frequency and Duration

Macroinvertebrate sample collection will be completed during the first and last year of the five permit years for a total of two samples per site. Sampling collection will occur in the fall.

3.2.4.3 Sample Collection Method

The *Oregon DEQ Benthic Macroinvertebrate Protocol for Wadeable Rivers and Streams* will be followed for each monitoring event. A qualified taxonomist will process all macroinvertebrate samples. The technical memo prepared by Pacific Habitat Services in February 2012 (*Results of Benthic Macroinvertebrate Sampling, Fish Sampling, and Physical Habitat Data Collection for Waln Creek and Battle Creek in Salem, Oregon*) will be followed for all data collection efforts.

3.2.5 Quality Criteria

3.2.5.1 Comparability

Targeted sampling at the same time of year at the same four sites using recognized sampling procedures will reduce the potential for spatial and temporal sample variation while increasing the comparability of data in the long term. Data collection methods used during this permit cycle will be comparable to those used at the same locations in 2011.

3.2.6 Quality Assurance / Quality Control / Record Keeping

3.2.6.1 Duplicate Samples

Field and laboratory duplicates will be collected for 10% of all samples.

3.2.6.2 Handling / Custody Procedures

All samples will be preserved in the field using a 70-95% ethanol concentration and labeled with sample collection information. This information will also be documented in pencil on waterproof paper and placed inside the preserved sample jar. If the sample is not immediately sent off to the lab for identification, the preservative will be replaced with fresh solution within one week of sample collection. Chain of custody forms will be completed for each monitoring event.

3.2.6.3 Documentation and Records

Field sheets documenting the site, date, and sampling personnel will be completed for each macroinvertebrate sampling event. This information will be combined with a set of additional field sheets designed to document the associated physical habitat data. It is the responsibility of the Responsible Sampling Coordinator to ensure that these documents are correctly completed during each monitoring event.

3.2.6.4 Data Management

All field documents and data received from the laboratory will be kept as a paper and electronic copy.

3.2.6.5 Data Validation and Verification

Macroinvertebrate samples will be preserved in the field, with sorting and identification conducted by a qualified taxonomist. Identification of organisms will be performed following the Oregon DEQ Benthic Macroinvertebrate Protocol for Wadeable Rivers and Streams.

3.2.7 Long-term Strategy

The macroinvertebrate monitoring completed this permit term will provide a measure of the biological conditions at targeted sites within the Battle Creek Watershed. This data could potentially be compared with data collected from the only Battle Creek site sampled (BAT01-01), which was sampled during the 2001 Bioassessment effort, however different BIBI scoring indexes were used, which may make it draw direct conclusions. Nevertheless, the 2011 data and future data collected at these sites will provide a long-term assessment of changes in macroinvertebrate communities, and help to evaluate the overall effectiveness of the City's Stormwater Management Program. Performing macroinvertebrate monitoring at or near the same sites during subsequent permit cycles will continue to be a key element of the long-term monitoring program strategy.

3.3 Monthly Instream

3.3.1 Project / Task Organization

Monthly Instream refers to the monitoring of MS4-receiving streams, where sampling is to occur once a month on a schedule that is determined at the beginning of each calendar year. The City's Stormwater Program Coordinator will serve as the Responsible Sampling Coordinator. The City's Stormwater Services workgroup will collect all field measurements and grab samples. The City's Willow Lake Laboratory will perform all analytical laboratory analyses.

3.3.2 Monitoring Objectives

Monthly Instream monitoring will contribute, at least in part, to monitoring objectives i, ii, iii, iv, v, and vi, as identified in Schedule B.1 of the City of Salem's NPDES MS4 Permit. Refer to the City of Salem Surface Water and Stormwater Monitoring Matrix (Attachment 1) for a more detailed explanation of how this monitoring element addresses each objective.

3.3.3 Background

Monthly Instream monitoring began in 2001 with 21 sampling sites on local streams and all but one has remained at the same location. The exception is the upstream Battle Creek site which was moved in 2003 due to lack of access. Additionally, in July of 2013 the City added three sampling sites on the Willamette River, bringing the total number of sites to 24. The sampling sites are identified in Figure 1 and locations are described in Table 11 below.

3.3.4 Study Design / Sampling Process

3.3.4.1 Study Design

The study design for this monitoring element is a paired design, where samples are collected monthly at upstream and downstream sites on Battle Creek, Claggett Creek, Clark Creek, Croisan Creek, Gibson Creek, Glenn Creek, Mill Creek, Mill Race, Pringle Creek, and Shelton Ditch, as well as the Willamette River (there is a third, mid-way sampling point on the Willamette). The eleventh MS4 receiving stream, West Fork Little Pudding River, has only one monitoring site because it begins as a trickle outside of Salem city limits, and tends to run dry during the summer months, so an upstream site was not selected. Dates for sampling are determined at the beginning of each calendar year and are therefore independent of weather conditions.

Due to the number of sites needing to be collected in one day, a narrowed set of parameters were chosen for this monitoring element. When initiated in 2001, this monitoring element was intended to produce a dataset that could provide an index of stream quality, as well as data for spatial and trend analyses. During the last permit cycle, 303(d) and TMDL listed parameters were added to the study design. Refer to Table 12 for a list of parameters for all sites.

Table 11: Monthly Instream Monitoring Sites

Site ID	Creek Name	Site Location
BAT1	Battle Creek	Commercial St SE
BAT12	Battle Creek	Rees Hill Rd SE
CGT1	Claggett Creek	Mainline Dr NE
CGT5	Claggett Creek	Hawthorne St NE @ Hyacinth St NE
CLA1	Clark Creek	Bush Park
CLA10	Clark Creek	Ewald St SE
CRO1	Croisan Creek	Courthouse Athletic Club
CRO10	Croisan Creek	Ballantyne Rd S
GIB1	Gibson Creek	Wallace Rd NW
GIB15	Gibson Creek	Brush College Rd NW
GLE1	Glenn Creek	River Bend Rd NW
GLE10	Glenn Creek	Hidden Valley Dr NW
MIC1	Mill Creek	Front St Bridge
MIC10	Mill Creek	Turner Rd SE
MRA1	Mill Race	High St SE
MRA10	Mill Race	Mill Race Park
PRI1	Pringle Creek	Riverfront Park
PRI5	Pringle Creek	Bush Park
SHE1	Shelton Ditch	Church St SE
SHE10	Shelton Ditch	State Printing Office
LPW1	West Fork Little Pudding River	Cordon Rd NE
WR1	Willamette River	Sunset Park (Keizer)-River Mile 81
WR5	Willamette River	Railroad Bridge-River Mile 83
WR10	Willamette River	Halls Ferry-River Mile 91

3.3.4.2 Frequency and Duration

The sampling frequency will be once a month at all of the 24 sites. Two of the sites (LPW1 and CGT5) typically run dry during the summer months, resulting in fewer samples at these sites.

Per Table B-1 in the City's NPDES MS4 permit, a minimum of 48 samples, from each of the 24 sites, will be collected. However, Table B-1 Special Condition #3 states that the minimum number of samples may be reduced to thirty-six if insufficient flow does not allow for sample collection. In addition, personnel illness and turnover, vehicular malfunction, equipment malfunction, and various safety issues, including flooding and/or high flows and debris (in particular on the Willamette River) could prevent the collection of some of the samples. If such a situation exists, Oregon DEQ will be informed following notification procedures listed in the MS4 permit.

3.3.4.3 Sample Collection Method

Sample collection will include grab samples and field measurements. For the 21 monitoring sites on streams (not including Willamette River sites), grab samples and field measurements will be collected directly from the stream where the water is well mixed and representative of the ambient conditions. For the three Willamette River monitoring sites, samples will be collected from within fifty feet of the bank of the Willamette River (west bank for upstream site, east bank for the midway and downstream sites). The sample collection method for each parameter can be found in Table 12, below.

Table 12: Monthly Instream Parameter List and Collection Method

Monthly Instream Parameters	Collection Method	Site
BOD ('stream')[1]	Grab samples	All 24 sites
Nitrate+Nitrite as Nitrogen		
E. coli		
Copper (Total & Dissolved)[2]		
Lead (Total & Dissolved)[2]		
Zinc (Total & Dissolved)[2]		
Hardness[1]		
TSS		
Dissolved Oxygen	Field measurement	
Temperature		
Specific Conductivity		
pH		
Turbidity		

Notes:
[1] BOD 'stream' analytical method is not identified in 40 CFR 136; however; this method has been identified as an acceptable method under Table B-1 Special Condition #5 in the City's NPDES MS4 permit.
[2] Grab samples will be collected and analyzed for metals and hardness at all sites for the months of October through April. For the months of May through September, samples will be collected and analyzed for metals and hardness only if greater than 0.1 inches of rain fall at anytime in the 24 hours prior to the start of sampling.

3.3.5 Data Quality Criteria

3.3.5.1 Data Quality Objectives

The data quality objectives for field measurements are detailed in Table 13 below. All analytical methods for grab samples analyzed at Willow Lake Laboratory are identified in 40 CFR 136. More information, including analytical methods for each parameter, can be found in the City of Salem "Monthly Instream Water Quality Monitoring Program QAPP".

Table 13: Monthly Instream Field and In-Situ Quality Objectives

Parameters	Accuracy	Precision
Temperature	± 0.5 °C	± 0.5°C
pH	± 0.2 SU	± 0.3 SU
Dissolved Oxygen	± 0.2 mg/L	± 0.3 mg/L
Turbidity	± 5%	± 5%
Specific Conductivity	± 7% of standard value	± 10%

3.3.5.2 Comparability

Field and grab samples for this monitoring element will utilize the same handling requirements and laboratory procedures that are used for the Instream Storm, Stormwater, and Continuous Instream monitoring. This uniformity increases the validity of the data for analyses and comparisons with other data collected within the scope of this plan.

3.3.6 Quality Assurance / Quality Control / Record Keeping

3.3.6.1 Duplicate Samples

Duplicate field measurements and duplicate grab samples will be taken at a minimum of ten percent of the sites each month. These sites will be randomly selected prior to the sampling event.

3.3.6.2 Instrument Calibration / Inspection / Maintenance

All field meters will be inspected and calibrated prior to collecting samples. Routine maintenance will be performed before going into the field. Each meter will be calibrated according to procedures outlined in its user manual. Basic replacement parts will be kept on hand or made available. Willow Lake Laboratory maintains, operates, and performs all required laboratory equipment calibrations following their QA/QC protocols to maintain laboratory certifications.

3.3.6.3 Handling / Custody Procedures

Field measurements will be taken in-situ or using a clean stainless steel beaker for sample collection. These measurements will be completed immediately after collection of the water sample. Grab samples will be collected directly in-situ or using a clean stainless steel beaker, transferred to appropriate bottles, stored in a cooler on ice, and taken to Willow Lake Laboratory at the end of the day once all samples have been collected. A chain of custody will be provided to the lab for each set of samples that come in.

3.3.6.4 Documentation and Records

A field data sheet will be completed for each set of monthly sites. Information to be recorded on these field data sheets includes project name, sampler's name, date and time of sample collection, site ID, field measurement results for temperature, pH, dissolved oxygen, turbidity, and specific conductivity, and check boxes to verify all necessary grab samples were collected.

3.3.6.5 Data Management

The sampling team is responsible for completion of the field data sheet. The Laboratory Manager at the Willow Lake Laboratory will provide laboratory results, which will be stored in the Willow Lake Laboratory's LIMS database, as well as duplicated in the Aquarius Database. Field measurement data will also be entered into the Aquarius database.

3.3.6.6 Data Validation and Verification

The Responsible Sampling Coordinator will do a review of all information on field data sheets. Once the data have been entered into the database, the Responsible Sampling Coordinator or other monitoring staff will compare the data in the database to the field sheets, and then have a second person do the same. Errors in data entry will be corrected at that time. Outliers and inconsistencies will be flagged for further review. It is the responsibility of the Responsible Sampling Coordinator to investigate further and determine validity of the data. Data quality issues will be addressed as they occur, and will be identified in any dataset that is distributed to City staff and the public.

3.3.7 Long-term Strategy

By providing the oldest continuous dataset of instream water quality data, the Monthly Instream monitoring element is essential to the long-term monitoring program strategy. Data collected through this monitoring element have been used (and will continue to be used) for long-term trending, spatial analysis, and observations of seasonal differences.

4.0 Dry Weather Outfall Sampling

In support of the Illicit Discharge Detection and Elimination program (IDDE), and to satisfy requirements of the City's NPDES MS4 permit, the City will continue to conduct annual dry-weather outfall inspections, as described in the "City of Salem's Dry Weather Outfall and Illicit Discharge Screening Plan". The locations will be chosen based on a prioritization process and the inspections will follow the "City of Salem's Dry Weather Outfall and Illicit Discharge Standard Operating Procedures" document. Stormwater Services monitoring staff will work cooperatively with Environmental Services Compliance Specialists to attempt to identify the source of any illicit discharges that are found.

5.0 Data Analysis Methodology

Once data have been processed using the QA/QC checks associated with each monitoring element, data will be categorized to account for variables such as rainfall, stream levels, and seasonality. Basic summary statistics will be provided for each type of monitoring data, and will be included in an annual report that will be submitted by November 1st of each year.

Additionally, data from some of the monitoring elements (i.e. Monthly Instream, Continuous Instream, Stormwater, and Instream Storm) will be used for statistical analysis to attempt to determine trends in water quality. A normality test will be done on each data set to select the proper statistical hypothesis test to conduct time and spatial trend analyses. Seasonal observations will be addressed using descriptive statistics and graphical illustration. At a minimum, trends analyses will be done every five years or more frequently if data exists to update the trend analysis effort, or in order to support a programmatic change.

Figure 1. City of Salem Environmental Monitoring Sites