

SECTION 6 BENCHMARKS

6.1 INTRODUCTION

For receiving waters with an approved Total Maximum Daily Load (TMDL), the City of Salem is required to establish pollutant load reduction benchmarks and (if applicable) evaluate progress towards achieving previously developed benchmarks. The permit requirements associated with benchmarks as provided in the City's current NPDES MS4 Phase 1 permit, Schedule D(2)(d)(i), are as follows:

i) Progress towards reducing TMDL pollutant loads must be evaluated by the permittee through the use of performance measures and pollutant load reduction benchmarks developed and listed in the SWMP.

In accordance with Schedule D(2)(d)(i)(2) of the permit, a benchmark is defined as follows:

(2) A benchmark is a total pollutant load reduction estimate for each parameter or surrogate, where applicable, for which a [Waste Load Allocation] WLA is established at the time of permit issuance. A benchmark is used to measure the overall effectiveness of the storm water management program in making progress toward the wasteload allocation (this estimate will be related to the statistical variability of the underlying data and may be stated as a range), and is intended to be a tool for guiding adaptive management activities. A benchmark is not a numeric effluent limit; rather it is a goal that is subject to the maximum extent practicable standard. The permittee must provide the rationale for the proposed benchmark, which includes an explanation of the relationship between the benchmarks and the TMDL wasteload allocations. Any limiting factors related to the development of a benchmark, such as data availability and data quality, must also be included in this rationale.

As part of the 2nd Year Annual Report and Stormwater Management Plan (SWMP) Evaluation submittal in 2005, some NPDES Phase I jurisdictions were required to develop benchmarks for TMDLs established at the time of permit issuance (March 2004). This requirement did not apply to the City of Salem because the City did not discharge to any waterbody with a TMDL established in 2004 (i.e., the date of permit issuance) or prior. However, in 2006 a TMDL became effective for the Willamette River and associated tributaries. In accordance with Schedule D(2)(d) of the permit, the following is required:

(iv) If within three (3) years following permit issuance a TMDL is approved by the Environmental Protection Agency (EPA) and the TMDL has wasteload allocations assigned to storm water within the geographic area covered by this permit, the permittee must, at the time of the next permit renewal application, complete a review and strategy development, and propose changes, if appropriate, to the SWMP to address the urban storm water discharges.

In conjunction with a letter of request issued by Greg Geist of the DEQ (January 11, 2008), jurisdictions that discharge to the Willamette River or any tributaries referenced in the Willamette River TMDL should establish benchmarks as part of the permit renewal application.

This section of the permit renewal report provides the following:

- A summary of approved TMDLs that apply within the City of Salem permit boundary (i.e., applicability of the benchmark requirement) – Section 6.2.

- The City of Salem’s general process for developing benchmarks – Section 6.3.
- The specific pollutant load modeling methods, assumptions, and rationale for the development of benchmarks – Section 6.4.
- Results of the benchmark process and relationship between the benchmarks and the TMDL WLAs- Section 6.5.
- References – Section 6.6

6.2 APPLICABILITY OF THE BENCHMARK REQUIREMENT

TMDLs are generally developed as a way to project the maximum pollutant load assimilative capacity of a waterbody so as not to exceed water quality standards. They may be developed for pollutants with direct links to stormwater runoff (aka: metals, nutrients) and also for pollutants for which loads of concern are not typically associated with urban stormwater runoff in the Willamette Watershed (temperature). To translate the TMDL into guidelines for municipalities and industries, wasteload allocations (WLAs) are developed, which allocate a proportion of the Total Maximum Daily Load to contributing sources (industries, reserve capacity for future growth, municipalities, groundwater, CSOs, wastewater treatment plants, etc). WLAs were originally developed as a means to regulate discharges from well-defined point sources (industries and wastewater treatment plants), but with the implementation of NPDES MS4 permits, WLAs are now used to regulate discharges from urban stormwater runoff covered by NPDES MS4 permits, which includes a wide variety of sources that are not well defined. This has resulted in inherent difficulties in applying WLAs to MS4 discharges.

The Willamette River TMDL was more recently approved by EPA and became effective in 2006. As this TMDL was not established at the time of Salem’s permit issuance, benchmarks were not established for the Willamette River as part of the 2nd Year Annual Report submittal. However, benchmarks have been requested by DEQ for the Willamette River (and referenced tributaries) as part of this permit renewal submittal.

The Willamette River TMDL was established for nine of the twelve subbasins within the entire Willamette Basin. The Tualatin Subbasin is not covered under this TMDL for bacteria and temperature since it already has a TMDL in place for those parameters, and the Molalla/ Pudding and Yamhill Subbasins are still under review by DEQ. The WLAs described in the Willamette River TMDL apply to all of the current NPDES MS4 Phase 1 permittees and co-permittees in the State of Oregon.

Basin-wide, the Willamette River TMDL is specific for mercury, bacteria, and temperature, although some tributaries have additional TMDL parameters. Temperature is not considered a stormwater pollutant in the Willamette River TMDL, and consequently is not addressed by the permittees’ NPDES MS4 permits. Mercury is a phased TMDL with monitoring requirements expected for the first phase to support DEQ’s development of waste load allocations for the second phase. Thus, while mercury is considered to be associated with stormwater, permittees are not required to establish benchmarks for the pollutant at this time since waste load allocations have not yet been established. Bacteria is the only basin-wide Willamette River TMDL parameter that requires new benchmarks to be established for the permit renewal, and the only parameter requiring benchmarks for the City of Salem. Three of Salem’s urban streams – Clark,

Mill, and Pringle Creeks – are also specifically cited in the Willamette TMDL, with respective wasteload allocations established for bacteria in the form of required percent reductions.

The Willamette River watershed includes approximately 27,320 acres within the City of Salem’s current city limits. This area represents about 90% of the total city area. The portion of the City’s permit area draining to the Willamette River and associated tributaries was used for the benchmarks analysis, but, state roads were not included, as ODOT is classified separately in the TMDL. In addition, the portion of the City area discharging to the Pudding River Watershed was not included, as that area will be subject to individual specific benchmark requirements when the Molalla/ Pudding Subbasin TMDL becomes effective.

6.3 OVERALL PROCESS FOR DEVELOPING BENCHMARKS

Establishing benchmarks relies on the use of a pollutant loading model to calculate estimates of pollutant loads for select parameters, select scenarios, and under select development conditions. Once loads are generated, both with and without Best Management Practices (BMP) implementation, a comparison between the loads and the WLA identified in the TMDL can be used to estimate the effectiveness of the City’s current stormwater management program; or show progress in how the City’s current stormwater management program is attempting to achieve WLAs. As described in Section 6.1, a benchmark is defined as a pollutant load reduction estimate. Therefore, the differences between loads without BMPs and reduced loads associated with BMPs define the City’s benchmarks.

A general process was developed to assist in the benchmark development effort, and the resulting benchmark process flowchart is shown in Figure 6-1. The flowchart was developed as a template for jurisdictions including the City of Salem to follow when looking at estimated pollutant loads with respect to the TMDL’s WLA. As shown on the flow chart, there are three categories of BMPs that were considered in the evaluation:

- 1) Structural BMP systems or practices where pollutant removals can be reported quantitatively and are based on the results of scientific research (i.e., effluent concentrations).
- 2) Structural and/or source control BMP applications or practices administered where pollutant removals could potentially be reported in objective, quantitative terms but the research has not yet been conducted and information is not yet available.
- 3) Non-structural/source control BMP applications where pollutant removals are not likely to be reported in objective, quantitative terms.

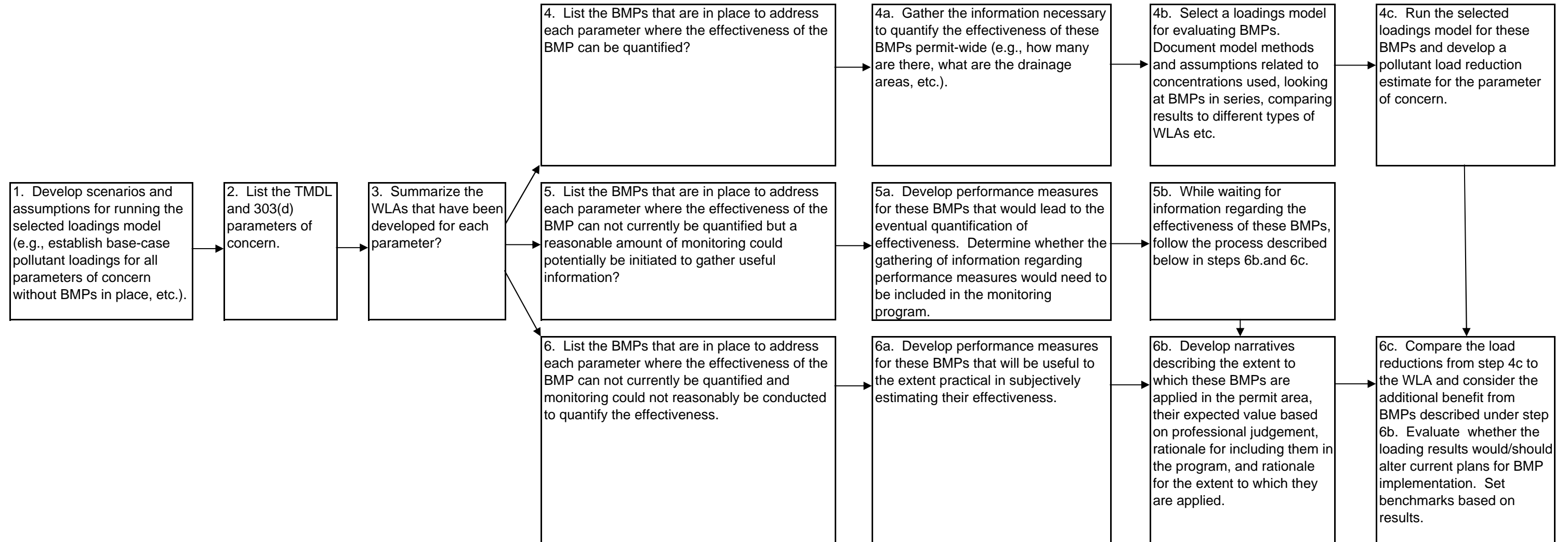
Once a comprehensive BMP inventory was obtained for the City of Salem, the approach illustrated in Figure 6-1 split into three directions, depending on the three BMP types described above. For the type of BMPs described under category 1 above, the approach relied on the use of a pollutant-loadings model to quantify the effectiveness of these BMPs. For the type of BMP described under category 2 above, the approach resulted in a recommendation that some type of monitoring plan or literature review be pursued to eventually obtain information. Until more

comprehensive monitoring is completed for these BMPs, the approach treated them the same as the BMPs described under category 3. For BMPs described under category 3 above, the approach relied on the development of narratives describing the extent to which these BMPs are applied. This three-tiered approach is considered conservative, as it does not estimate pollutant load removals achieved by category 2 and 3 type BMPs. However, it is acknowledged that these BMPs provide some inherent benefit, although not currently documented or tested.

Rather than try to make best professional judgments regarding the quantitative effectiveness of BMPs in categories 2 and 3, the approach is to first compare pollutant loads generated after applying the structural BMPs in category 1 to the TMDL WLAs. This will provide a relative picture as to how close or how far off the permittees are with regards to meeting the WLAs with structural BMPs alone. If the structural BMP program is very close to meeting WLAs, a general statement based on best professional judgment was made as to whether or not the non-structural or non-quantifiable BMPs would be expected to be sufficient or have the potential to achieve the WLAs. That estimate may then be verified by future ambient water quality monitoring.

This process outlined in Figure 6-1 was applied to bacteria (*E. coli*) for the City of Salem MS4 permit area. Assumptions made in developing loading estimates and estimating the effectiveness of BMPs are documented in Sections 6.4 and 6.5.

Figure 6-1: Proposed Process for Developing MS4 NPDES Stormwater Benchmarks



6.4 MODELING METHODS AND ASSUMPTIONS

To conduct the pollutant loading analysis, the City of Salem opted to use a spreadsheet model that utilizes the EPA simple method for pollutant loads generation for each of their TMDL waterbodies. A spreadsheet model was generated using EPA's equations, such that once demographic information is entered into the spreadsheet, loads are automatically calculated. The model was used to estimate current and future condition pollutant loads, assuming no structural BMPs in place and with structural BMPs in place. Quantitative data is not currently available to assess the effectiveness of non-structural BMPs. Therefore, estimates of the relative effectiveness of non-structural BMPs based on best professional judgment are made in the results and discussion sections of this memo (Section 6.5). This section will describe the assumptions and methods associated with developing the model. The subsections below include information regarding the following: modeled areas, model scenarios, model assumptions related to land use and BMP effectiveness, and methods for comparing model results to waste load allocations.

6.4.1 Modeled Areas

The City of Salem defines their permit area as the area within their city limits, as they provide stormwater services only within the City limits. When areas within the UGB are annexed into the City, the City's permit area expands and stormwater services are provided to these newly annexed areas.

The Willamette River watershed as a whole encompasses about 90% of the total existing city area. The TMDL provides individual WLAs for various tributaries and subbasins; therefore the City used GIS to define the portion of their permit area that discharges to each of the tributaries or subbasins of the Willamette River that are specifically referenced in the TMDL for current (2008) and future conditions (2013) (see Table 6-1). The future condition permit area accounts for projected annexations over the next five years that would result in expansion of the City limits. Current and future condition drainage areas for each tributary and subbasin are provided in Tables 6-2 and 6-3.

6.4.2 Model Scenarios

In order to estimate loadings based on current and future development and BMP applications, it is necessary to model various scenarios to depict how pollutant load generation and wasteload allocation comparisons will change with time and with the addition of stormwater management measures. Assumptions and details related to each proposed scenario are described below.

Current Condition Scenarios:

The current condition (2008) model scenarios use the current City limits and current condition land use information, further described in Section 6.4.3, to calculate a pollutant load for bacteria. Structural BMP systems were considered in the "with BMP" scenarios for current conditions. Existing structural BMP drainage areas were delineated for use in the model. Structural BMP systems modeled included both public and private facilities. Although some rough estimates are available for some non-structural BMP categories, specifically street sweeping, sweeping was already being conducted when the land use concentration data were collected (1990-1995).

Therefore, street sweeping should only be included in the model if the frequencies of sweeping have increased since that time. Street sweeping frequencies have not significantly changed within the City of Salem; thus, street sweeping was not explicitly considered in the “with BMP” model scenario. As mentioned earlier, quantitative effectiveness information does not currently exist for other non-structural BMPs; therefore, other non-structural BMPs were not considered in the “with BMP” model simulation. An initial load scenario (no BMPs) and a treatment load scenario (with structural BMPs) were simulated based on the characteristics summarized in Tables 6-2 and 6-3 for current conditions.

Future Scenario

The future conditions model scenarios assume annexations and associated incremental expansion of the City limits and development of current vacant parcels through the year 2013. The future conditions model assumes land use information used in the current conditions model is still accurate for currently developed parcels. To approximate future development conditions, areas anticipated for annexation in the next five years were included in the City’s permit area; a zoning designation was provided for the annexed areas if available, otherwise they were categorized as vacant; and existing vacant parcels that were anticipated for development in the next five years were assigned land use and imperviousness based on zoning. Future development conditions are associated with the year 2013 because the end of the next permit term is expected to be 2014, and the evaluation is due prior to the end of the permit term.

Most current condition structural BMPs were assumed to still be working and in place for the “with BMP” future conditions scenario, unless the property was anticipated to be annexed and/or developed and a more effective BMP would be installed to treat the area (e.g., transition of treatment via sediment manhole to bioswale). Additional capital improvement projects for stormwater quality are currently anticipated for construction for future conditions and these CIPs were accounted for in the future condition “with BMP” simulation. As it is unknown at this time which stormwater treatment (structural BMP) option that new developments will include to comply with development standards, treatment of all annexed property and previously vacant areas that are expected to develop in the next five years is assumed equal to that of a bioswale. Thus, new development (and redevelopment) standards requiring water quality treatment were incorporated into this scenario. However, potential retrofits to provide additional structural BMPs for currently developed properties were not considered, as these will be done on a case-by-case opportunity basis. An initial load scenario (no BMPs) and a treatment load scenario (with structural BMPs) were simulated based on the characteristics summarized in Tables 6-2 and 6-3 for future conditions.

Model Simulations

As discussed above, initial load simulations (no BMPs) and treatment load simulations (with structural BMPs) were conducted given the land use and BMP coverage summarized in Tables 6-2 and 6-3.

For the Willamette River TMDL, WLAs are either defined for year round, for the summer season, and/or for the fall, winter, and spring season. However, unlike other TMDLs (e.g., the Tualatin River TMDL), the Willamette River TMDL does not specify the volume of the summer or winter design storm events or seasonal rainfall event. Therefore, rainfall used in the pollutant

loads model was estimated from the historical annual or seasonal rainfall volumes over a period of 114 years. Specifically, an annual rainfall of 39.36 inches, a summer seasonal rainfall of 2.47 inches, and a fall, winter, spring seasonal rainfall of 36.89 inches was used in the analysis

WLAs are provided in the TMDL that are unique to each reach of the Willamette River (e.g., upper Willamette, middle Willamette, or lower Willamette), but may also be further distinguished by subbasin and by tributary. Salem is located in the Middle Willamette subbasin per the TMDL, and in the case of the Middle Willamette subbasin, WLAs vary depending on whether the discharge is directly to the Willamette River or through a tributary to the Willamette River. As a result, Salem is subject to different WLAs according to their various subbasins and tributaries, and they are required to establish separate benchmarks for each subbasin or tributary that has its own WLA. In accordance with the TMDL, individual WLAs are provided for Clark Creek (a tributary to Pringle Creek), for Pringle Creek, for Mill Creek (including Battle Creek, a tributary), for areas discharging to the Middle Willamette directly (includes Willamette Slough, the East Bank Basin, and the West Bank Basin), and for areas discharging to an (unreferenced) tributary prior to discharge in the Middle Willamette. WLAs for bacteria are represented in terms of a percent reduction. Table 6-1 summarizes the associated bacteria WLAs for each tributary or subbasin.

TABLE 6-1: Summary of Middle Willamette River WLAs applicable to the City of Salem

Tributary/ Subbasin	Time Period	WLA (as a % reduction)
Mill Creek	Summer season	89%
	Fall, Winter, and Spring season	81%
Clark Creek	Summer season	94%
	Fall, Winter, and Spring season	89%
Pringle Creek	Summer season	90%
	Fall, Winter, and Spring season	79%
Willamette River Tributaries (outside Mill, Pringle, and Clark Creeks)	Summer season	88%
Willamette River (Direct)	Fall, Winter, and Spring season	75%

TABLE 6-2: Summary of Model Input Parameters (Land Use) by Watershed within Salem City Limits

	Total Modeled Area (acres) (Excludes ODOT ROW)	Land Use Breakdown (acres)							
		Residential	Commercial	Agricultural	Open Space	Vacant	Multi-family Residential	Industrial	Transportation
Mill Creek and Battle Creek									
Current Condition	8168.0	1611.5	2031.5	78.7	562.0	1044.5	374.0	1001.8	1464.0
Future Condition	8174.7	1670.1	2164.8	78.7	562.0	840.1	692.9	1002.1	1464.0
Pringle Creek									
Current Condition	5032.3	1595.7	544.5	24.3	160.4	923.6	204.4	495.5	1084.0
Future Condition	5111.3	1672.4	695.3	34.0	157.2	665.4	201.7	601.4	1084.0
Clark Creek									
Current Condition	1535.4	802.5	229.0	0.0	34.9	55.0	89.8	6.6	317.4
Future Condition	1535.4	825.8	229.9	0.0	34.9	26.8	94.0	6.6	317.4
Middle Willamette – Direct									
Current Condition	4906.7	1353.3	449.9	743.1	833.0	333.8	200.8	137.9	854.8
Future Condition	4906.7	1451.3	450.3	743.1	833.0	220.0	202.8	151.7	854.5
Other Middle Willamette Tributaries									
Current Condition	7675.5	2769.9	1277.2	175.6	262.9	1203.5	467.5	447.0	1071.9
Future Condition	7691.7	2980.1	1331.1	175.6	262.5	952.2	471.0	447.0	1072.2

TABLE 6-3: Summary of Model Input Parameters (BMP Coverage)

	Total Modeled Area (Excludes ODOT ROW)	Structural BMP Coverage Area (acres by land use)								Total BMP Coverage
		Residential	Commercial	Agricultural	Open Space	Vacant	Multi-family Residential	Industrial	Transportation	Percentage of total area covered by structural BMPs
Mill Creek and Battle Creek										
Current Condition	8168.0	16.4	181.9	0.0	0.0	5.7	3.6	24.4	60.7	3.6%
Future Condition	8174.7	75.9	189.4	0.0	0.0	1.7	22.5	24.4	60.7	4.6%
Pringle Creek										
Current Condition	5032.3	11.9	24.5	0.1	0.0	34.0	1.1	53.2	71.7	3.9%
Future Condition	5111.3	94.0	162.1	0.1	0.0	29.0	3.2	53.2	71.7	8.1%
Clark Creek										
Current Condition	1535.4	0.0	11.5	0.0	0.0	0.0	0.0	0.0	0.0	0.7%
Future Condition	1535.4	23.2	12.3	0.0	0.0	0.0	4.2	0.0	0.0	2.6%
Middle Willamette - Direct										
Current Condition	4906.7	28.5	10.3	0.0	0.0	11.5	6.3	0.0	10.6	1.4%
Future Condition	4906.7	136	10.8	0.0	0.0	1.6	8.9	14.1	10.6	3.7%
Other Middle Willamette Tributaries										
Current Condition	7675.5	37.8	107.2	0.0	0.2	18.6	15.8	16.7	16.9	2.8%
Future Condition	7691.7	251	125.7	0.0	0.2	4.0	19.3	16.7	16.9	5.6%

6.4.3 Model Assumptions and Input Data

A number of assumptions were made with regard to the acquisition, processing, and utilization of land use concentration and BMP effluent concentration data in order to generate pollutant loads. Assumptions were also made with respect to associated input parameters as related to land use categories, BMP categories, and modeling methods. These assumptions are described below.

Land Use and BMP Effluent Concentration Data

Numerous jurisdictions, including the City of Salem, are covered under one of the six Oregon Phase I NPDES MS4 permits. Since the 2004 permit became effective, some of these jurisdictions decided to coordinate efforts in order to share ideas and information, maximize the effectiveness of investments in research, and to maintain consistency with respect to interpretation and implementation of the permit requirements. The statewide coordination process was facilitated through the Oregon Association of Clean Water Agencies (ACWA) Stormwater Committee and has continued from 2004 to present day. One item that ACWA has coordinated on is the determination of appropriate, typical land use runoff concentrations and BMP effluent concentrations for use in loads modeling.

Tables of land use and BMP effluent concentrations were originally developed in 2005 for benchmarks due as part of some jurisdictions' Interim Evaluation Report submittals. Salem was not one of those jurisdictions required to develop benchmarks at that time. The concentrations in these tables were developed using data obtained by local jurisdictions in addition to published, statistically verified national data. Data were combined, statistically validated, and provided in terms of means and median values.

For the calculation of new benchmarks prepared for this 2008 SWMP update and Permit renewal submittal, the original values for land use concentrations developed in 2005 were revisited. For land use concentration data, adjustments to the original data set included: 1) the inclusion of additional open space land use samples (Portland's Balch Creek) in order to ensure all analytes under the open space land use category had a sufficient number of data points; 2) revisions to the statistical method of dealing with non-detects; and 3) the accounting for all outliers in the statistical calculations. As was done in 2005, the data were "bootstrapped", a statistical method used to estimate land use concentration ranges. In essence, this method normalizes the data, resulting in more reasonable upper and lower confidence intervals (i.e., non-negative numbers). The model uses the mean, the upper 95% confidence interval, and the lower 95% confidence interval to produce a range of associated pollutant loadings. Revised mean land use concentrations and the associated upper and lower confidence intervals are provided in Table 6-4.

Also for preparation of this 2008 Permit renewal, the original BMP effluent values from 2005 were revisited. The original BMP effluent values from 2005 were based on the national data set of BMP effluent concentrations compiled by GeoSyntec Consultants (see ACWA Rangers 2005). In 2008, the national data were reviewed for inconsistencies and questionable values (e.g., data points where the dissolved concentration was greater than the total concentration; data points where the BMP effluent concentration was greater than local land use Event Mean Concentration – EMCs, etc.). Local data were compiled and compared to the questionable data values from the

TABLE 6-4: Land Use Concentration Values used in Benchmarking

Land Use Concentration Information

Mean values are actual per ACWA

Data Range (+/- 95%) provided by City of Portland

Based on modified ACWA Data Set (2008)

Key:

	EMC value used in the model
	Range value as used in the model

Parameter	Land Use	Bootstrapped MEAN			Bootstrapped MEDIAN		
		95% L-CI	Mean	95% U-CI	95% L-CI	Geomean	95% U-CI
TSS mg/L	C ⁽¹⁾	64	82	103			
	I	117	184	284			
	OP ⁽²⁾	16	31	50			
	R ⁽³⁾	44	66	99			
	T	124	169	227			
Pb,T µg/L	C ⁽¹⁾	37.8	54.0	72.7			
	I	32.7	48.3	67.0			
	OP ⁽²⁾	0.6	0.8	1.1			
	R ⁽³⁾	11.0	17.7	27.6			
	T	37.1	63.1	98.8			
Pb,d µg/L	C ⁽¹⁾	3.2	5.0	7.4			
	I	1.52	2.58	3.77			
	OP ⁽²⁾	0.1	0.118	0.128			
	R ⁽³⁾	1.23	1.8	2.53			
	T	1.26	3.59	7.71			
Zn,T µg/L	C ⁽¹⁾	130	170	217			
	I	283	674	1353			
	OP ⁽²⁾	6.3	7.8	9.5			
	R ⁽³⁾	77	104	134			
	T	146	203	265			
Zn,d µg/L (2005 ACWA D.	C ⁽¹⁾	50	95	113			
	I	165	216	270			
	OP ⁽²⁾	7.8	15.2	26.3			
	R ⁽³⁾	43	60	80			
	T	51	76	123			
Cu, T µg/L	C ⁽¹⁾	20.8	28.6	38.2			
	I	33.8	45.5	58			
	OP ⁽²⁾	2	2.5	3			
	R ⁽³⁾	10.5	13.4	17.1			
	T	25.4	34.6	45.7			
Cu, d µg/L (2005 ACWA D.	C ⁽¹⁾	4.0	8.6	17.4			
	I	6.1	8.7	12.0			
	OP ⁽²⁾	3.0	4.0	4.9			
	R ⁽³⁾	4.8	7.2	9.4			
	T	5.9	8.6	13.2			
BOD mg/L	C ⁽¹⁾	8.5	11.9	16.6			
	I	26.1	39.6	56.1			
	OP ⁽²⁾	2.4	3.3	4.2			
	R ⁽³⁾	5.9	8.1	10.8			
	T	10	17.9	29.1			
COD mg/L	C ⁽¹⁾	51.8	65.1	81.5			
	I	76.8	102.6	134.1			
	OP ⁽²⁾	11.1	19.6	27.6			
	R ⁽³⁾	37.4	50.9	66			
	T	40.6	100	185			
TP mg/L	C ⁽¹⁾	0.28	0.38	0.50	0.23	0.28	0.31
	I	0.40	0.51	0.64	0.36	0.47	0.65
	OP ⁽²⁾	0.095	0.12	0.15	0.079	0.086	0.089
	R ⁽³⁾	0.23	0.34	0.48	0.16	0.21	0.23
	T	0.29	0.37	0.46	0.24	0.31	0.41
Fecal Coliform CFU/100 mL (geomean)	C ⁽¹⁾	707	1540	2974			
	I	190	541	1240			
	OP ⁽²⁾	96	117	141			
	R ⁽³⁾	1197	2045	3273			
	T	847	1860	3657			
E. coli CFU/100 mL (geomean) FC (E. coli = FC and rounded)	C ⁽¹⁾	573	1247	2409			
	I	154	438	1004			
	OP ⁽²⁾	57	87	124			
	R ⁽³⁾	970	1656	2651			
	T	686	1507	2962			
Mercury No data available	C ⁽¹⁾						
	I						
	OP ⁽²⁾						
	R ⁽³⁾						
	T						

Notes

- 1 Land use EMCs for Commercial are equal to Agriculture
- 2 Land use EMCs for Open Space are equal to Vacant
- 3 Land use EMCs for Residential are equal to Multi family Residential

TABLE 6-5: BMP Effluent Concentration Values used in the Benchmark Model

MEDIANS											
Parameter	Units	Centrifugal Separator Hydrodynamic devices	Filters (Leaf/Sand/Other)	Ponds, Dry Vegetated Detention Pond	Ponds - Wet Retention Basin	Swales - Vegetated Filter Strips	Wetlands - Constructed Surface Flow	Sed MH	Green Roofs (4" substrate)	Porous Pavement	Soakage Trenches/ Raingardens
TSS	mg/L	57	13	33	16	23	7	50	—	—	—
TP	mg/L	0.13	0.12	0.29	0.14	0.24	0.08	0.14	—	—	—
E. coli	CFU/100 mL	3550	98	2950	430	2950	430	3550	—	—	—
Cu, d	µg/L	6.9	3.1	12	2.9	5.1	7.1	4.9	—	—	—
Cu, T	µg/L	12	5.3	20	7.1	11.9	3	11.5	—	—	—
Pb,d	µg/L	1.1	0.13	1.5	0.1	0.42	0.1	0.16	—	—	—
Pb,T	µg/L	5.7	3	18	1.88	7.43	1	7.3	—	—	—
Zn,d	µg/L	25	6.4	44	8.7	19	11	32	—	—	—
Zn,T	µg/L	70	14	83	31.7	47	17	74	—	—	—
Flow Reduction	% as decimal	0	0	0.23	0.05	0.29	0	0	0.6	0.77	0.99999
BOD	mg/L	6	2.5	6	6	5	6	6	—	—	—
Mercury	mg/L	—	—	—	—	—	—	—	—	—	—

MEANS											
Parameter	Units	Centrifugal Separator Hydrodynamic devices	Filters (Leaf/Sand/Other)	Ponds, Dry Vegetated Detention Pond	Ponds - Wet Retention Basin	Swales - Vegetated Filter Strips	Wetlands - Constructed Surface Flow	Sed MH	Green Roofs (4" substrate)	Porous Pavement	Soakage Trenches/ Raingardens
TSS	mg/L	115.00	43.00	43.00	29.0	24.00	25.00	67.00	—	—	—
TP	mg/L	0.22	0.15	0.35	0.2	0.21	0.16	0.22	—	—	—
E. coli	CFU/100 mL	5587	79.00	1922	499	1922	499	5587	—	—	—
Cu, d	µg/L	14.00	3.70	14.00	3.2	5.90	3.2	6.20	—	—	—
Cu, T	µg/L	15.00	5.70	22.50	7.7	12.50	7.6	14.7	—	—	—
Pb,d	µg/L	2.10	0.13	2.40	0.1	0.50	0.13	0.26	—	—	—
Pb,T	µg/L	14.00	7.60	32.00	2.5	7.80	3.30	9.10	—	—	—
Zn,d	µg/L	35.00	8.30	59.00	30.0	20.60	14.00	38	—	—	—
Zn,T	µg/L	103.00	15.00	123.00	74.0	55.00	32.00	92	—	—	—
Flow Reduction	%	0%	0%	23%	5%	29%	0%	0%	60%	77%	100%
BOD	mg/L	6.0	3.4	6.1	6.1	5.4	6.1	6.0	—	—	—
Mercury	mg/L	—	—	—	—	—	—	—	—	—	—

NOTES

Values in **RED** are from the ACWA Ranger Memo (2005)

Values in **GREEN** are values from City of Portland (2008) reanalysis of BMP effectiveness

- 1 Dry pond BOD numbers based on wet pond BOD numbers
- 2 Dry pond Ecoli numbers based on wet pond Ecoli numbers
- 3 Wetland BOD numbers based on wet pond BOD numbers
- 4 Wetland Ecoli numbers based on wet pond Ecoli numbers
- 5 Sediment manhole BOD numbers based on hydrodynamic devices

Values in **Purple** are City of Portland values for BMPs/ parameters where there was a large discrepancy between the City values and Ranger values.

Blue dashes are placeholders for Mercury, where no data is available yet.

Orange dashes are placeholders where no data is available yet.

national data set. If the local data set contained sufficient data points and appeared to better represent local conditions, best professional judgment was used to adjust the questionable BMP effluent concentrations. The mean BMP effluent concentration values are provided in Table 6-5.

Pollutants of Concern

Per the Willamette River TMDL, the applicable parameter requiring load calculations as part of the Permit Renewal Submittal is bacteria (E. coli). The bacteria WLAs are presented as a percent reduction in bacteria load. Bacteria was modeled for the City and compared to the WLAs as reported in Section 6.5.

Land Use Categories

Existing land use information was combined with GIS layers representing parks, open space, and vacant properties to create an existing condition land use coverage. The future land use coverage was created from the existing land use coverage, with the exception that previously vacant areas that are expected to develop by 2013 were assigned future condition land uses based on their zoning classification and annexed properties (or anticipated annexations by 2013) were also included.

Land use categories were processed and consolidated into only those land use categories for which concentration and impervious percentage information either specifically existed or could be approximated using another representative land use category. Table 6-6 summarizes the modeled land use categories.

Impervious Values

Impervious percentages for select land use categories were based on a variety of sources provided by the City of Salem, including an impervious surface report, the City’s Stormwater Master Plan (2000), and their Stormwater SDC Methodology Study (2002). The EPA formula (1) was used to translate between percent impervious and a runoff coefficient for use in the spreadsheet model. Table 6-6 shows the associated impervious values used for select land use types.

(1) $\text{Runoff Coefficient} = 0.05 * 0.009 (\% \text{ Impervious})$

TABLE 6-6: Land Use and Impervious Categories used in the City of Salem’s Pollutant Loads Model ⁽¹⁾

Modeled Zoning or Land Use Classification	Modeled Impervious Percentage
AGR ⁽²⁾	5%
RES	41%
MRES ⁽²⁾	52%
COM	90%
VAC ⁽²⁾	2%
IND	90%
OSP	5%
TRA	85%

Note 1 = Key for land use abbreviations:

Land Use Category	Referenced Abbreviation
RES	Residential (Single Family)
COM	Commercial
MRES	Multi-family Residential
OSP	Open Space
AGR	Agricultural
IND	Industrial
VAC	Vacant
TRA	Transportation

Note 2 = The land use concentration data shown in Table 6-4 does not include all of the City’s land use categories. Therefore, some land use categories were modeled using concentration data from a comparable land use category. This occurred for the Salem MRES category (modeled using RES concentration data); AGR category (modeled using COM concentration data); and VAC category (modeled using OSP concentration data).

BMP Categories

Because the ACWA study resulted in limited effectiveness information for certain structural BMP types, the City of Salem categorized and classified their structural BMPs in accordance with categories where effectiveness information either specifically existed or could be approximated using another representative BMP category for all modeled BMPs. Once the BMP categories were defined, City staff estimated the respective BMP drainage areas. Table 6-7 summarizes the actual structural BMP categories and the modeled BMP category, if BMP effectiveness information was not available for the actual BMP category. As mentioned previously, non-structural BMPs were not included in the model simulations.

TABLE 6-7: Structural BMP Categories used in the City of Salem’s Pollutant Loads Model

Salem Actual Structural BMP Category	Salem Modeled BMP Category ⁽¹⁾
Pond	Either Dry Vegetated Detention Pond or Wet Retention Pond
Swales	Swales- Vegetated Filter Strips
Wetlands	Wetlands
Stormceptors, CDS, Vortechincs	Hydrodynamic Separators
StormFilters	Filters (Sand Filters, StormFilters)
Pollution Control Manholes	Sedimentation Manholes
Raingardens	Soakage Trench/ Raingardens

Note 1 = The BMP effluent concentration data shown in Table 6-5 does not include all of the Salem BMP categories. Therefore, some of Salem’s actual BMP categories were modeled using concentration data from a comparable BMP category. This column identifies the BMP category from Table 6-5 that was used to represent each of Salem’s actual BMP categories.

Modeling BMPs

Throughout the City of Salem, there are a number of situations where the BMP drainage areas overlap. Generally these situations occur when a sedimentation type device (pollution control manhole) is located upstream of a more regional type pond or wetland facility or when two or

more relatively efficient BMPs are treating the same area (treatment train application). For purposes of the benchmark analysis, typically the furthest downstream BMP system was selected as the representative BMP for drainage areas where more than one BMP is applied. The BMP drainage area was delineated by City staff as only that of the furthest downstream BMP. This method does not give credit for additional load removal likely achieved with BMPs in series. Therefore the results are expected to be conservative for load reduction estimates.

In addition, 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. For example, a typical water quality design storm in the Portland metropolitan area is the 6-month/24 hour design storm (67-72% of the 2-year/24 hour design storm), which is generally deemed to account for treatment of 80% of the average annual rainfall. BMPs included in the model were assumed to capture and treat 80% of the average annual rainfall and bypass additional flow. Therefore, for seasonal or annual rainfall, BMP bypass was accounted for in the loadings model.

6.4.4 Comparison of Model Results to Waste Load Allocations (WLAs)

The Willamette River TMDL reports wasteload allocations as a percent reduction achieved. As mentioned previously, for the City of Salem, bacteria was the only parameter modeled and compared to the wasteload allocations. The spreadsheet model is capable of reporting pollutant loads in terms of a concentration (based on the runoff generated for the particular storm event), a load generated (for the specific storm event), or a percent reduction achieved when comparing loads generated both with and without BMP implementation. For consistency with other local Phase 1 jurisdictions, the model results were graphed as a total load for the designated storm event (rainfall volume), and the WLA was graphed as the associated load necessary to yield the percent reduction required.

In accordance with the TMDL, the City of Salem is located in the Middle Willamette River watershed. As described in Section 6.4.2 and shown in Table 6-1, the Middle Willamette River watershed has separate WLAs based on whether the area directly discharges directly to the Willamette River or discharges first to a specified or unspecified tributary and then to the Willamette River. If discharge is to a specified or unspecified tributary, the TMDL includes different WLAs for the summer season (July 1 – September 30) and fall-winter-spring (October 1 – June 30).

A current condition and a future condition model were generated for Salem, using land use and structural BMP characteristics described in Tables 6-2 through 6-7. The spreadsheet model calculates a pre-BMP pollutant load for bacteria. Then, using the BMP drainage areas, the type of BMP facilities, and the relative breakdown of land uses inside the BMP drainage areas, the model calculates a post-BMP pollutant load for bacteria.

For bacteria, loads (as counts) were calculated for current condition (2008) and future condition (2013), both with and without structural BMPs, based on the City-specific rainfall volume (whether annual or seasonal). Loads were individually calculated for the upper confidence limit, the mean, and the lower confidence limit, in order to yield a range in the resulting loads. The

WLA as described in the TMDL was plotted on the same graph in order to directly compare the estimated load being generated and the wasteload allocation. The difference between the predicted load with no structural BMPs in 2013 and the predicted load with structural BMPs in 2013 indicates the amount of load reduction anticipated with the currently implemented stormwater program (reflects structural BMPs only) and is representative of the City's benchmarks.

6.5 MODEL RESULTS AND RATIONALE FOR THE DEVELOPMENT OF BENCHMARKS

Figures 6-2 through 6-10 include the pollutant loading plots resulting from the model assumptions and simulations, as described in previous sections for the City of Salem.

Prior to summarizing the results, it should be emphasized that the results portray the incremental improvements that are estimated or anticipated with the implementation of structural BMPs. The City implements a significant number of non-structural BMPs that are not reflected in the results, including public education, illicit discharges elimination, spill prevention, catchbasin cleaning, erosion control, etc.

6.5.1 Model Load Results Summary

In summary for the Willamette River, the City does not appear to be reducing loads to achieve their WLAs for bacteria as specified in the TMDL. However, the model results are conservative in that the model doesn't account for non-structural BMP implementation. With the consideration of non-structural BMP implementation, specifically pet waste programs and public education, the City is likely closer to meeting the WLA than the model results indicate.

Specific results for each of the sub watersheds are provided in the following text, followed by a description of how benchmarks are defined.

6.5.2 Model Load Results for the Willamette River

As described previously, new benchmarks were calculated for the Willamette River as part of this permit renewal submittal. Bacteria (E. coli) is the only parameter currently requiring benchmarks. Per the Willamette River TMDL, different reaches of the Willamette River have different WLAs. Therefore, the following subsections are categorized based on reach instead of parameter.

Clark Creek

The following graphs (Figures 6-2 and 6-3) portray the annual bacteria load comparison plots for the Clark Creek subbasin, a tributary to Pringle Creek and to the Middle Willamette River that is specified separately in the TMDL. The WLA for discharge to Clark Creek is a 94% reduction in loading during the summer season and an 89% reduction in loading during the fall-winter-spring season; both are assumed to be a reduction from the calculated no-BMP load. Because the current (2008) and future (2013) no BMP loads differ, the WLA was calculated for the current and future conditions individually.

In the summer season future condition (2013), the City shows a mean load decrease of approximately 1.1×10^{10} counts when comparing future condition estimates with and without BMPs in the Clark Creek subbasin. In the fall-winter-spring season future condition (2013), the City shows a mean load decrease of approximately 1.6×10^{11} counts when comparing future condition estimates with and without BMPs.

Given that structural BMPs generally show limited effectiveness for bacteria removal (whether fecal coliform or *E. coli*), there does not appear to be a substantial decrease in loads due to implementation of structural BMPs. Generally, bacteria reduction associated with structural BMPs is due to flow reduction that the structural BMP achieves rather than actual removal of bacteria itself.

The plots suggest that the City is not expected to meet the WLA in the Clark Creek subbasin for either season during the next permit term. The low value of the *E. coli* benchmark range for the summer season is 6.3×10^9 counts and the upper value of the *E. coli* benchmark range is 2.9×10^{10} counts. The low value of the *E. coli* benchmark range for the fall-winter-spring season is 9.4×10^{10} counts and the upper value of the *E. coli* benchmark range is 4.4×10^{11} counts. The low value of the range was calculated by taking the difference between the 2013 LCL with no BMPs and the 2013 LCL with BMPs. The upper value of the range was calculated by taking the difference between the 2013 UCL with no BMPs and the 2013 UCL with BMPs. Table 6-8 at the end of Section 6.5.4 provides a summary for all of the benchmarks.

Using the results of the Evaluation of the City of Salem's Ambient Urban Stormwater Monitoring Data, prepared by GeoSyntec Consultants as part of this permit renewal package, the results of the benchmark analysis appear consistent with the instream monitoring data collected by the City. The ambient monitoring results indicate that a majority of the instream monitoring stations (19 of 21) have had exceedances of the single sample criterion (406 MPN/100 mL), used to develop the TMDL WLAs. Monitoring results for Clark Creek specifically also show that significant exceedances occur.

It should be noted that potential human sources of bacteria may include infiltration from the sanitary sewer system, illicit connections, illegal dumping, and faulty septic systems. However, regionally available bacteria source tracking studies have shown that bacterial sources in urban environments have a very small human-derived component. Human sources have typically been shown to represent between 0% and 8% of the total bacteria count. In a recent local study in Washington County, human sources in the streams represented an average of about 6% of the bacteria, and in the storm sewers human sources represented 0% of the bacteria counts. The more predominant sources of bacteria include wildlife (avian and rodent) and/or domestic pets. Non-structural controls to address human sources of bacteria loading are important, even though human sources are not predominant, but such controls are unlikely to achieve significant reductions in bacteria loads. It is difficult to develop a benchmark for this parameter because the WLA includes all sources of *E. coli*, including those over which the City has no control (i.e., the goal would not be to reduce wildlife such as avians). As locally and regionally available bacteria source tracking studies have shown that bacterial sources in urban environments are not predominantly human, the City of Salem's bacteria benchmark for the Middle Willamette River

subbasin will be focused on continued activities to reduce human and pet sources of bacteria and less focused on loads.

Figure 6-2: Clark Creek Summer Season E. coli Loading

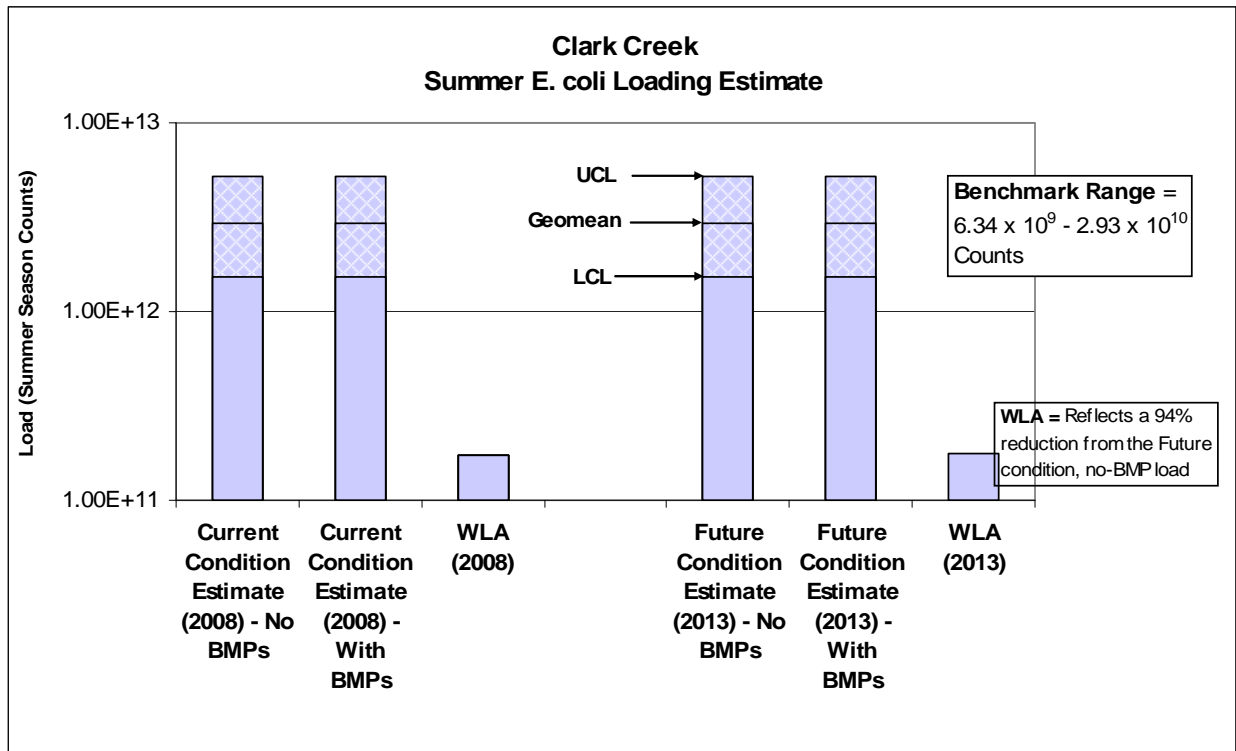
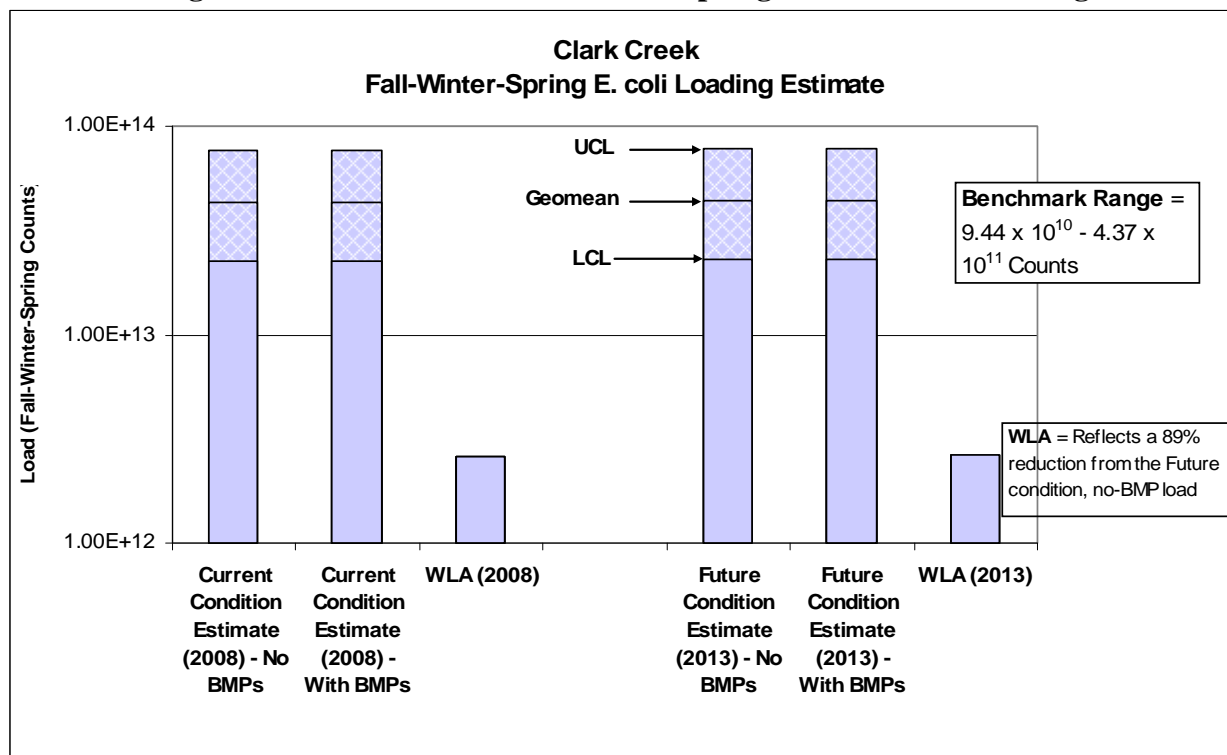


Figure 6-3: Clark Creek Fall-Winter-Spring Season E. coli Loading



UCL = Upper Confidence Interval

LCL = Lower Confidence Interval

Pringle Creek

The following graphs (Figures 6-4 and 6-5) portray the annual bacteria load comparison plots for the Pringle Creek subbasin. Pringle Creek is also a tributary to the Middle Willamette River that is specified separately in the TMDL. The WLA for discharge to Pringle Creek is a 90% reduction in loading during the summer season and a 79% reduction in loading during the fall-winter-spring season; both are assumed to be a reduction from the no-BMP load. Because the current (2008) and future (2013) no BMP loads differ, the WLA was calculated for the current and future condition individually.

In the summer season future condition (2013), the City shows a mean load decrease of approximately 1.4×10^{11} counts when comparing future condition estimates with and without BMPs in the Pringle Creek subbasin. In the fall-winter-spring season future condition (2013), the City shows a mean load decrease of approximately 2.1×10^{12} counts when comparing future condition estimates with and without BMPs.

The plots suggest that the City is not expected to meet the WLA in the Pringle Creek subbasin for either season during the next permit term. The low value of the E. coli benchmark range for the summer season is 6.6×10^{10} counts and the upper value of the E. coli benchmark range is 4.1×10^{11} counts. The low value of the E. coli benchmark range for the fall-winter-spring season is 9.8×10^{11} counts and the upper value of the E. coli benchmark range is 6.1×10^{12} counts. The low value of the range was calculated by taking the difference between the 2013 LCL with no BMPs and the 2013 LCL with BMPs. The upper value of the range was calculated by taking the

difference between the 2013 UCL with no BMPs and the 2013 UCL with BMPs. Table 6-8 at the end of Section 6.5.4 provides a summary for all of the benchmarks.

Using the results of the Evaluation of the City of Salem’s Ambient Urban Stormwater Monitoring Data, prepared by GeoSyntec Consultants as part of this permit renewal package, the results of the benchmark analysis appear consistent with the instream monitoring data collected by the City. The ambient monitoring results indicate that a majority of the instream monitoring stations (19 of 21) have had exceedances of the single sample criterion (406 MPN/100 mL), used to develop the TMDL WLAs. Monitoring results for Pringle Creek specifically also show moderate to frequent exceedances (20-56%) of the single sample criterion.

Again, it should be noted that bacterial sources in urban environments have a very small human-derived component, with the more predominant sources of bacteria being wildlife (avian and rodent) and/or domestic pets. It is difficult to develop a benchmark for this parameter because the WLA includes all sources of E. coli, including those that the City would not be responsible for reducing (i.e., the goal would not be to reduce wildlife such as avians). As described previously, the City of Salem’s bacteria benchmark for the Middle Willamette River subbasin will be focused on continued activities to reduce human and pet sources of bacteria and less focused on loads.

Figure 6-4: Pringle Creek Summer Season E. coli Loading

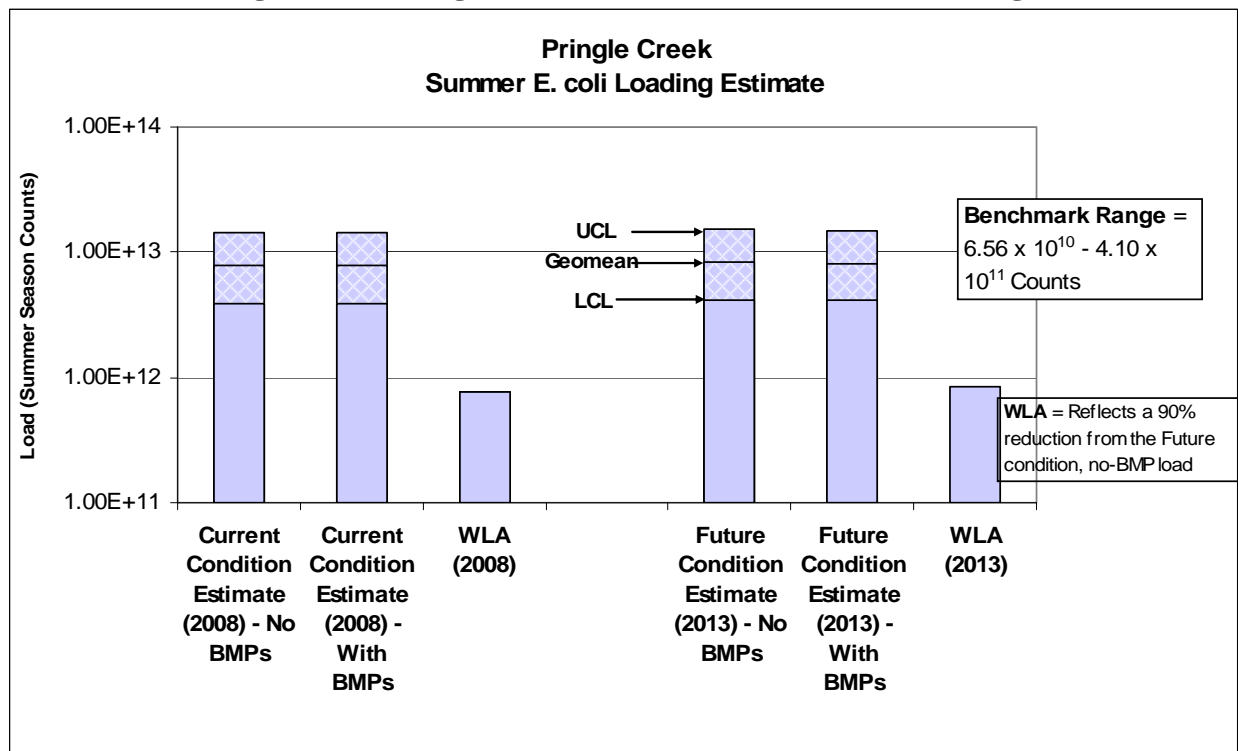
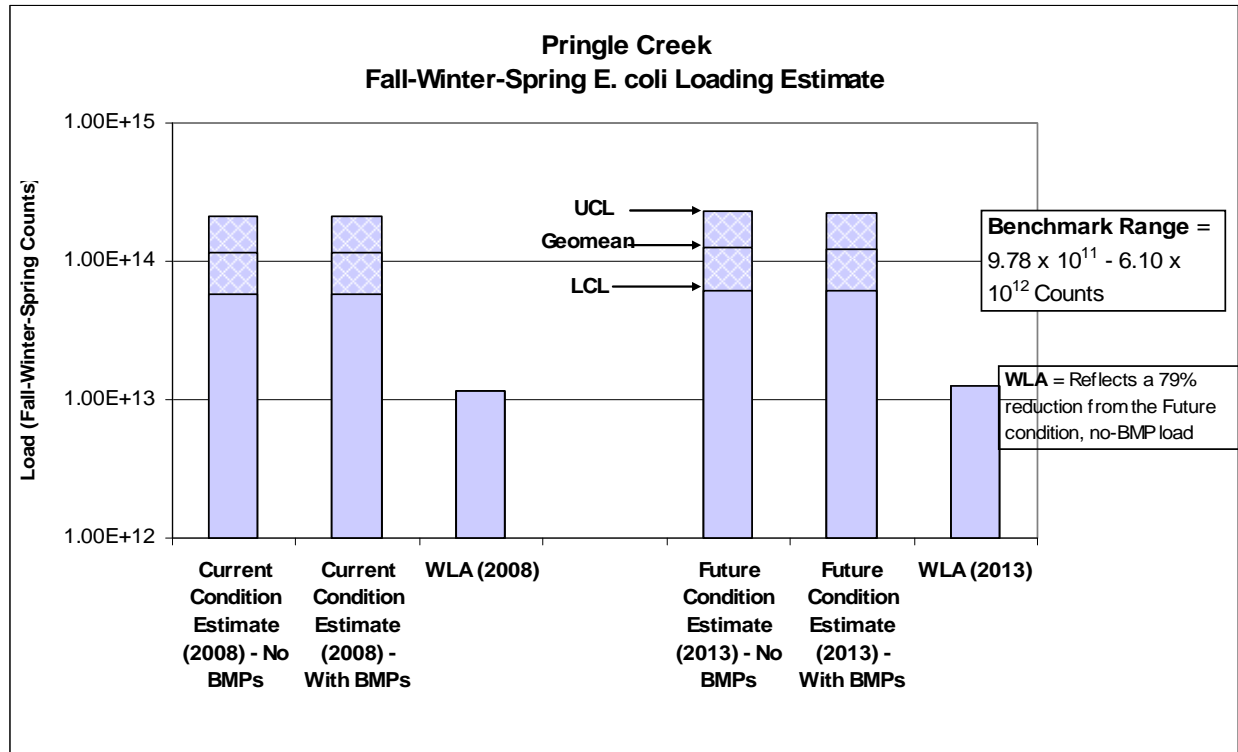


Figure 6-5: Pringle Creek Fall-Winter-Spring Season E. coli Loading



UCL = Upper Confidence Interval

LCL = Lower Confidence Interval

Mill Creek Watershed

The following graphs (Figures 6-6 and 6-7) portray the annual bacteria load comparison plots for the Mill Creek subbasin, which includes the Battle Creek subbasin as well. Like for Pringle and Clark Creeks, Mill Creek is also a tributary to the Middle Willamette River that is separately identified in the TMDL. The WLA for the Mill Creek subbasin is an 89% reduction in loading during the summer season and an 81% reduction in loading during the fall-winter-spring season; both are assumed to be a reduction from the future condition no-BMP load. Because the current (2008) and future (2013) no BMP loads differ, the WLA was calculated for the current and future conditions individually.

In the summer season future condition (2013), the City shows a mean load decrease of approximately 1.6×10^{11} counts when comparing future condition estimates with and without BMPs in the Mill Creek subbasin. In the fall-winter-spring season future condition (2013), the City shows a mean load decrease of approximately 2.5×10^{12} counts when comparing future condition estimates with and without BMPs.

The plots suggest that the City is not expected to meet the WLA in the Mill Creek subbasin for either season during the next permit term. The low value of the E. coli benchmark range for the summer season is 6.1×10^{10} counts and the upper value of the E. coli benchmark range is 4.4×10^{11} counts. The low value of the E. coli benchmark range for the fall-winter-spring season is 9.2×10^{11} counts and the upper value of the E. coli benchmark range is 6.6×10^{12} counts. The low value of the range was calculated by taking the difference between the 2013 LCL with no

BMPs and the 2013 LCL with BMPs. The upper value of the range was calculated by taking the difference between the 2013 UCL with no BMPs and the 2013 UCL with BMPs. Table 6-8 at the end of Section 6.5.4 provides a summary for all of the benchmarks.

Using the results of the Evaluation of the City of Salem’s Ambient Urban Stormwater Monitoring Data, prepared by GeoSyntec Consultants as part of this permit renewal package, the results of the benchmark analysis appear consistent with the instream monitoring data collected by the City. The ambient monitoring results indicate that a majority of the instream monitoring stations (19 of 21) have had exceedances of the single sample criterion (406 MPN/100 mL), used to develop the TMDL WLAs. Monitoring results for Mill Creek specifically also show moderate to frequent exceedances of the single sample criterion.

Again, it should be noted that bacterial sources in urban environments have a very small human-derived component, with the more predominant sources of bacteria being wildlife (avian and rodent) and/or domestic pets. It is difficult to develop a benchmark for this parameter because the WLA includes all sources of E. coli, including those that the City would not be responsible for reducing (i.e., the goal would not be to reduce wildlife such as avians). As described previously, the City of Salem’s bacteria benchmark for the Middle Willamette River subbasin will be focused on continued activities to reduce human and pet sources of bacteria and less focused on loads.

Figure 6-6: Mill Creek Watershed Summer Season E. coli Loading

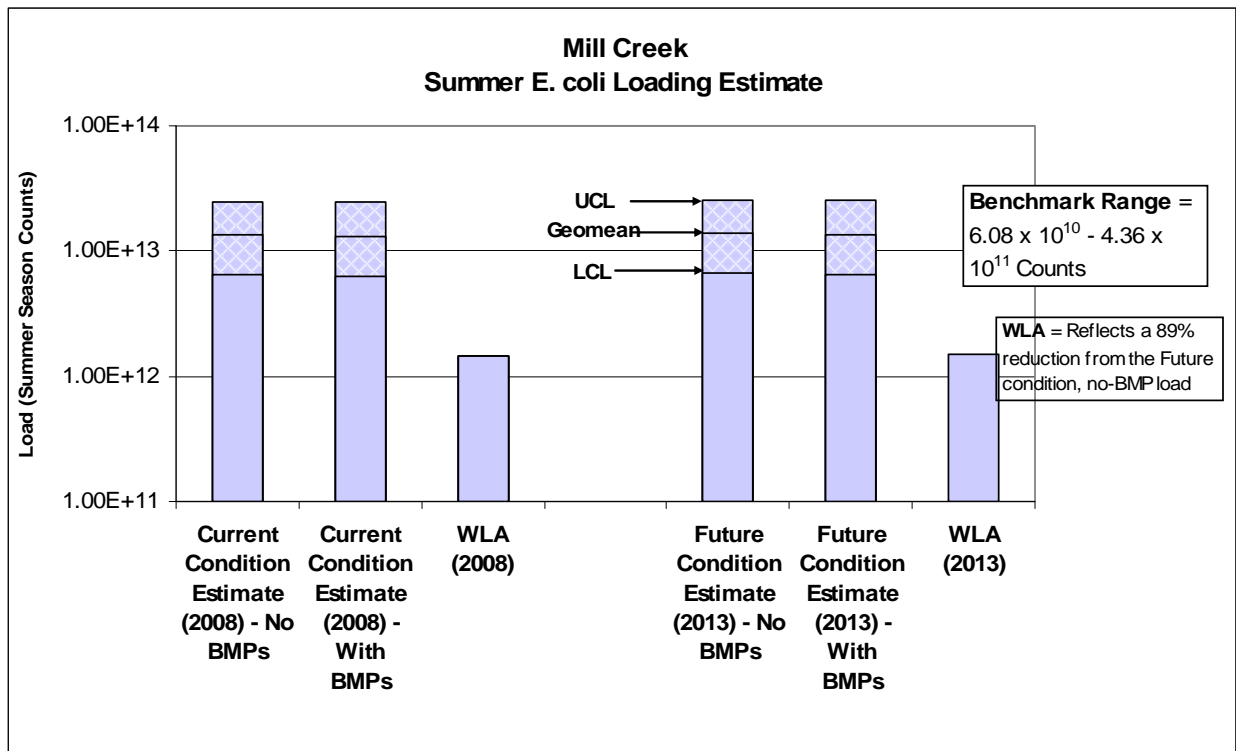
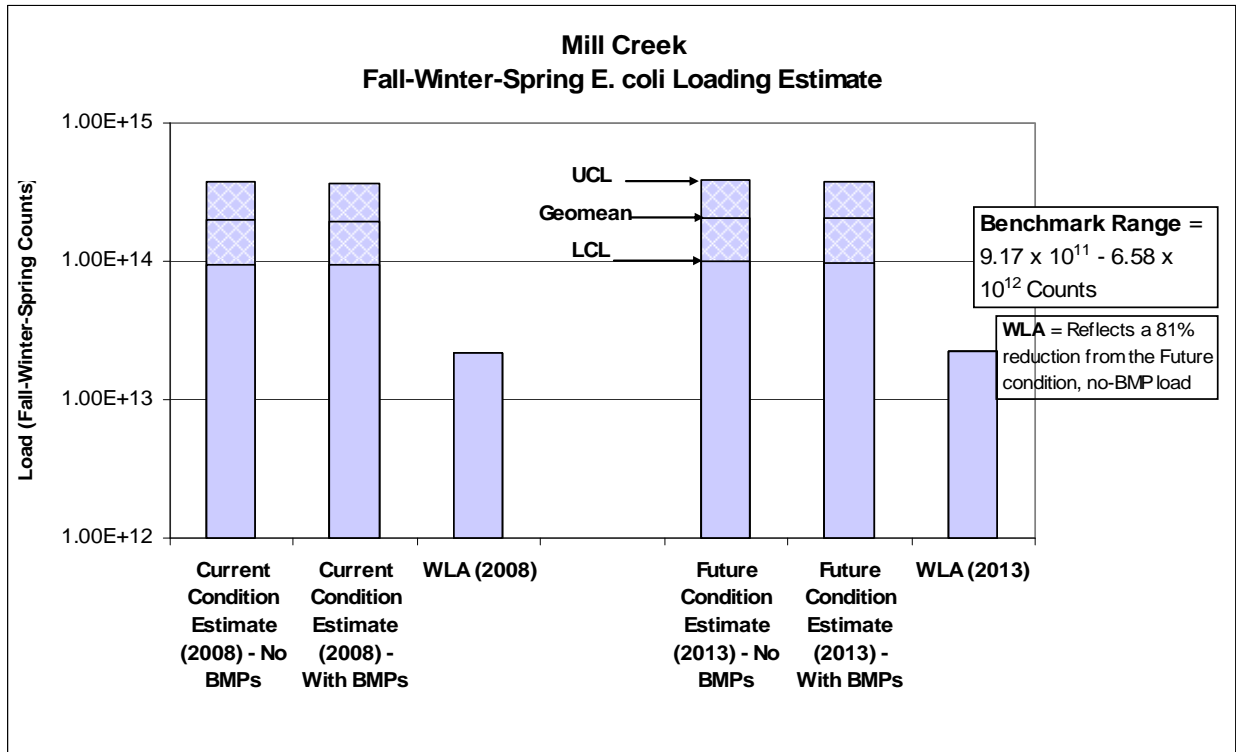


Figure 6-7: Mill Creek Watershed Fall-Winter-Spring Season E. coli Loading



UCL = Upper Confidence Interval

LCL = Lower Confidence Interval

Other Middle Willamette River Tributaries

The Middle Willamette watershed has separate WLAs based on whether the discharge is directly to the Willamette River or to a tributary prior to discharge in the Willamette River. There are some tributaries (such as Mill Creek, Clark Creek, and Pringle Creek described above) that have individual WLAs as described in the TMDL. However the TMDL has also assigned WLAs to all other tributaries to the Middle Willamette River that are not specifically mentioned in the TMDL. Per the TMDL, if the discharge is to a tributary prior to discharge to the Willamette River, the TMDL specifies a summer seasonal WLA as an 88% load reduction in the no-BMP load; and a fall, winter, spring seasonal WLA as a 75% reduction in the no-BMP load. As for the other waterbodies described above, because the current (2008) and future (2013) no BMP loads differ, the WLA was calculated for the current and future conditions individually. The following graphs (Figures 6-8 and 6-9) portray the annual load comparison plots for Salem’s remaining Middle Willamette River tributaries.

In the summer season future condition (2013), the City shows a mean load decrease of approximately 1.4×10^{11} counts when comparing future condition estimates with and without BMPs for Middle Willamette tributaries. In the fall-winter-spring season future condition (2013), the City shows a mean load decrease of approximately 2.1×10^{12} counts when comparing future condition estimates with and without BMPs.

The plots suggest that the City is not expected to meet the WLA in the Middle Willamette tributary subbasin for either season during the next permit term. The low value of the E. coli

benchmark range for the summer season is 5.9×10^{10} counts and the upper value of the E. coli benchmark range is 3.7×10^{11} counts. The low value of the E. coli benchmark range for the fall-winter-spring season is 8.8×10^{11} counts and the upper value of the E. coli benchmark range is 5.5×10^{12} counts. The low value of the range was calculated by taking the difference between the 2013 LCL with no BMPs and the 2013 LCL with BMPs. The upper value of the range was calculated by taking the difference between the 2013 UCL with no BMPs and the 2013 UCL with BMPs. Table 6-8 at the end of Section 6.5.4 provides a summary for all of the benchmarks.

Using the results of the Evaluation of the City of Salem’s Ambient Urban Stormwater Monitoring Data, prepared by GeoSyntec Consultants as part of this permit renewal package, the results of the benchmark analysis appear consistent with the instream monitoring data collected by the City. The ambient monitoring results indicate that a majority of the instream monitoring stations (19 of 21) have had exceedances of the single sample criterion (406 MPN/100 mL), used to develop the TMDL WLAs.

Again, it should be noted that bacterial sources in urban environments have a very small human-derived component, with the more predominant sources of bacteria being wildlife (avian and rodent) and/or domestic pets. As described previously, the City of Salem’s bacteria benchmark for the Middle Willamette River subbasin will be focused on continued activities to reduce human and pet sources of bacteria and less focused on loads.

Figure 6-8: Middle Willamette Tributaries Summer Season E. coli Loading

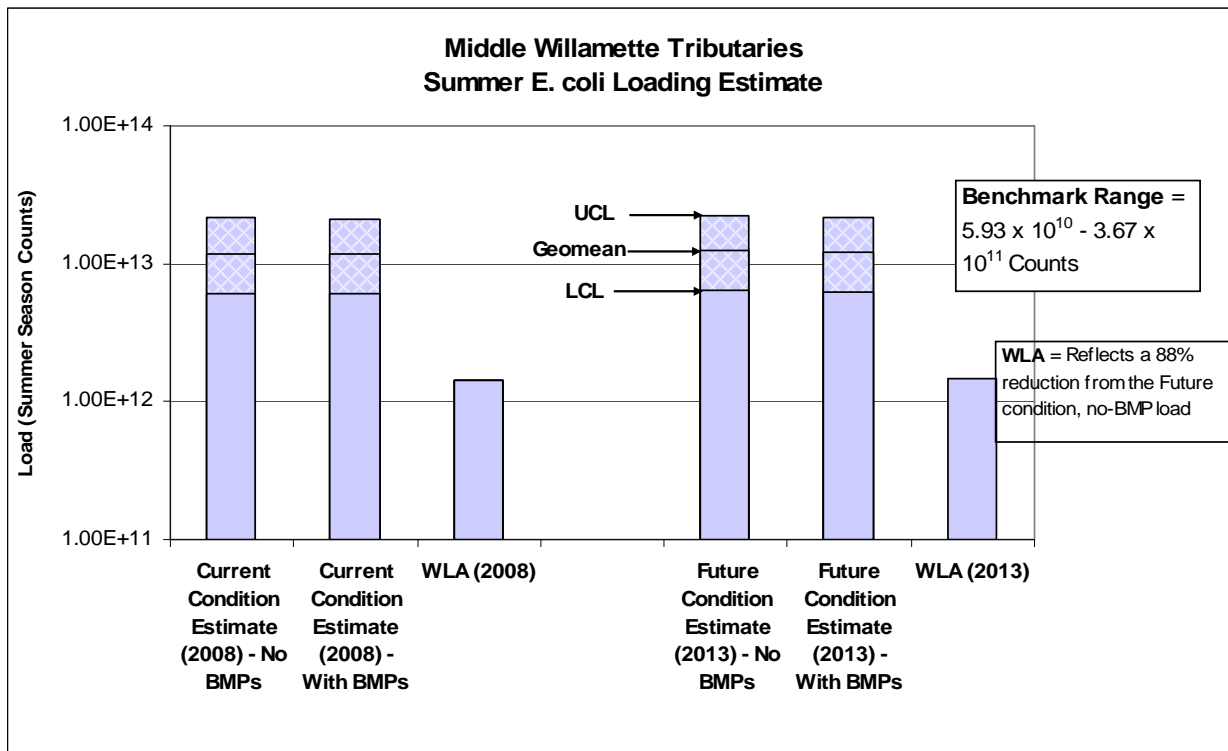
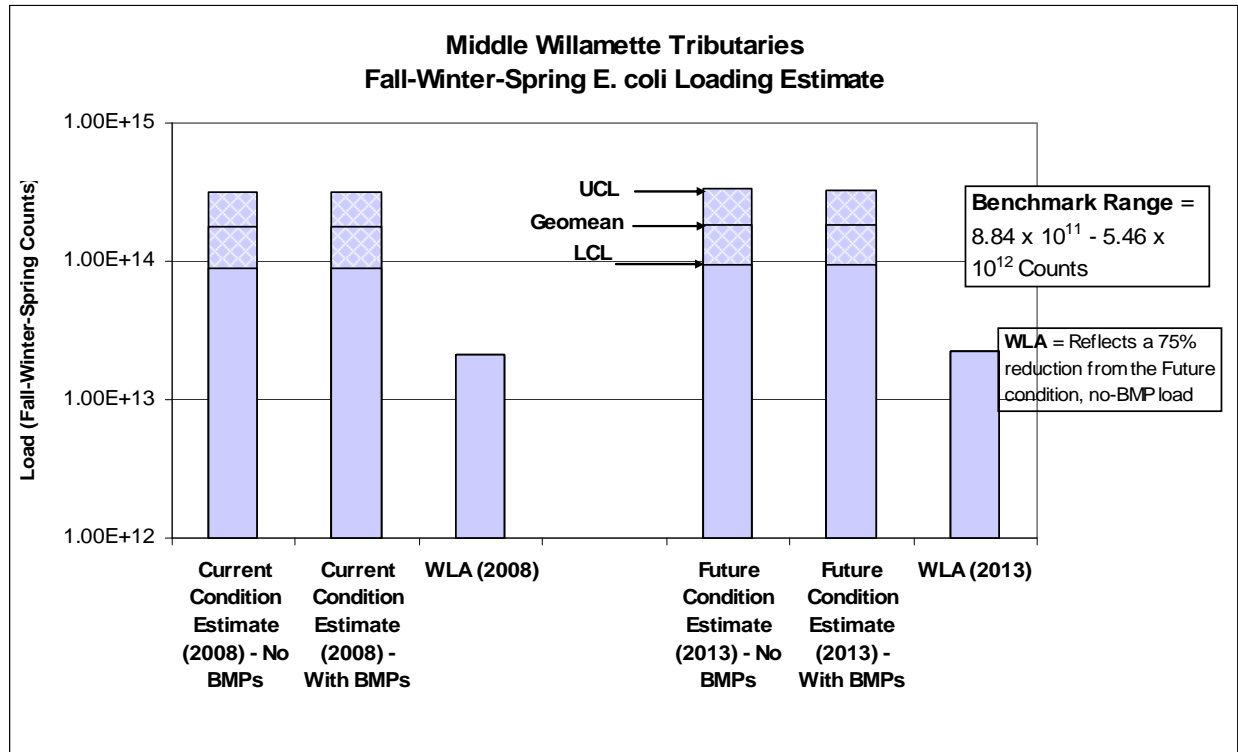


Figure 6-9: Middle Willamette Tributaries Fall-Winter-Spring Season E. coli Loading



UCL = Upper Confidence Interval

LCL = Lower Confidence Interval

Willamette River Direct

The following graph (Figure 6-10) contains the annual bacteria load comparison plots for City area discharging directly to the Willamette River. The WLA for discharge directly to the Willamette River is a 75% reduction in annual loading. Because the current (2008) and future (2013) no BMP loads differ, the WLA was calculated for the current and future conditions individually.

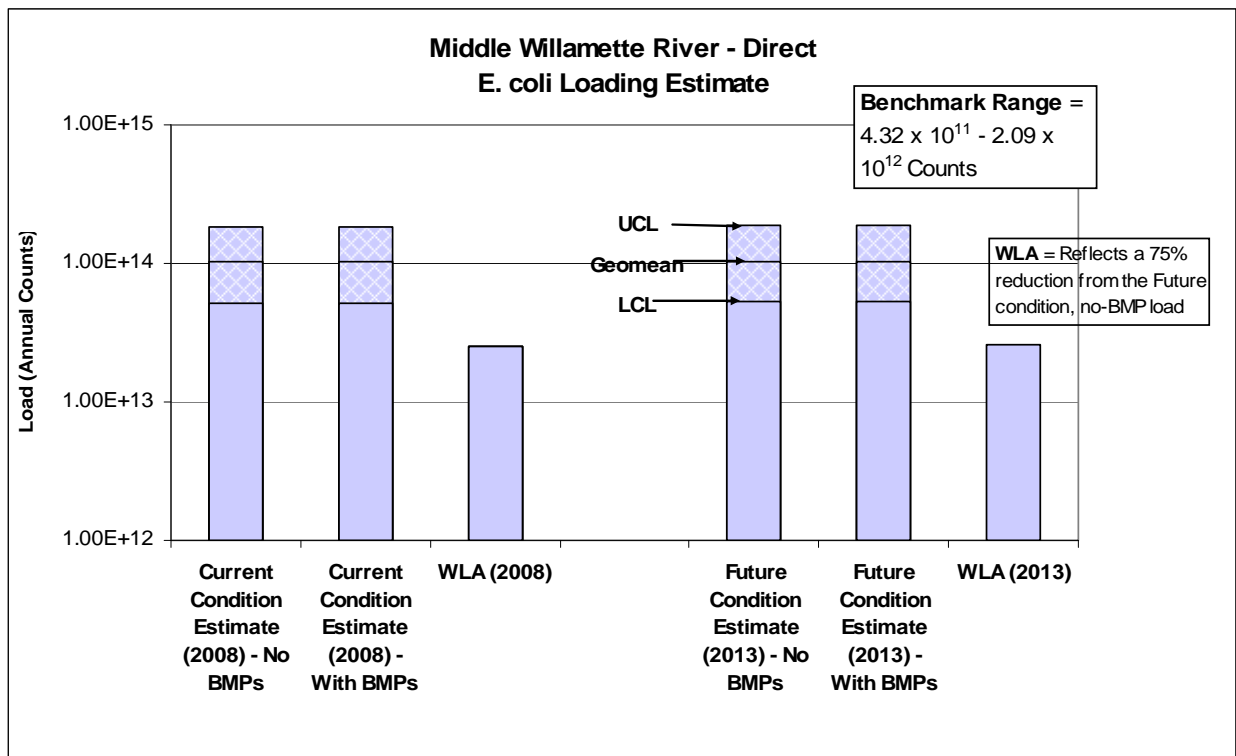
In the future condition (2013), the City shows a mean load decrease of approximately 7.8×10^{11} counts annually when compared to conditions estimated without BMPs for areas draining directly to the Willamette River. Given that structural BMPs generally show limited effectiveness for bacteria removal (whether fecal coliform or E. coli), there does not appear to be a substantial decrease in loads due to implementation of structural BMPs. Generally, bacteria reduction associated with structural BMPs is due to flow reduction that the structural BMP achieves rather than actual removal of bacteria itself.

The plots suggest that the City is not expected to meet the WLA for areas discharging directly into the Willamette River during the next permit term. The low value of the E. coli benchmark range is 4.3×10^{11} counts and the upper value of the E. coli benchmark range is 2.1×10^{12} counts. The low value of the range was calculated by taking the difference between the 2013 LCL with no BMPs and the 2013 LCL with BMPs. The upper value of the range was calculated by taking the difference between the 2013 UCL with no BMPs and the 2013 UCL with BMPs. Table 6-8 at the end of Section 6.5.4 provides a summary for all of the benchmarks.

Using the results of the Evaluation of the City of Salem’s Ambient Urban Stormwater Monitoring Data, prepared by GeoSyntec Consultants as part of this permit renewal package, the results of the benchmark analysis appear consistent with the instream monitoring data collected by the City. The ambient monitoring results indicate that a majority of the instream monitoring stations (19 of 21) have had exceedances of the single sample criterion (406 MPN/100 mL), used to develop the TMDL WLAs.

Given the very small human-derived component of bacteria load, the City of Salem’s bacteria benchmark for the Middle Willamette River subbasin will be focused on continued activities to reduce human and pet sources of bacteria and less focused on loads.

Figure 6-10: Middle Willamette (Direct to River) Annual E. coli Loading



6.5.4 Benchmarks

The City of Salem’s MS4 NPDES permit defines a benchmark as follows:

A benchmark is a total pollutant load reduction estimate for each parameter or surrogate, where applicable, for which a WLA is established at the time of permit issuance. ...

Figures 6-2 through 6-10 show the City of Salem’s current (2008) and future (2013) pollutant loadings for the Middle Willamette River watershed. Loadings are shown for conditions assuming no structural controls and for conditions with structural controls. The WLAs were calculated as a load, based on the percent reduction as defined in the TMDL. Modeled load results and the associated loading range based on the variability in data were plotted in

comparison to the WLAs. Pollutant load reduction estimates associated with non-structural controls are not included on the graphs.

Based on these estimates, it appears that the City is not currently meeting their WLAs for bacteria in the Middle Willamette River subbasin. This can be attributed to a number of reasons including the fact that structural BMPs are not generally effective for bacteria and the WLA described in the Willamette River TMDL is strictly a percent reduction over existing (no BMP) conditions. The TMDL (and associated WLA) requires a flat reduction in bacteria based on an undefined point in time. The percent load reduction requirement (upwards of 75%) is difficult to meet given the limited BMP effectiveness data available and the fact that the bacteria sources are generally those that can not be managed by the City (see discussions above).

For the City of Salem, the pollutant reductions shown are representative of the implementation of development standards, public structural BMPs, and some private structural BMPs. The structural BMP inventory used for the modeling may not include all structural BMPs that exist in the City. Therefore, the model results are conservative and refinement of the structural BMP inventory is recommended for future benchmark calculations. In all, future condition structural BMPs cover 4% of the total City area draining to the Middle Willamette. The range around the difference between the 2013 no-BMP loads and the 2013 with-BMP loads are the City's benchmarks for the 2009 – 2014 permit cycle. A summary of the benchmarks is provided in Table 6-8. The benchmarks are expected to be conservative (i.e., greater reductions are probably achieved) for several reasons including the following:

- 1) It is expected that further load reductions would be achieved through the application of the many non-structural controls that the City is implementing;
- 2) Whenever an assumption is made in the methods for developing benchmarks, the most conservative assumption was chosen;
- 3) Structural BMPs operating in series were given the effectiveness of only the most downstream BMP. BMPs operating in series are likely to be increasingly effective; and
- 4) The inventory of structural BMPs used in the modeling may not include all structural BMPs in the City.

The City chose a conservative approach to avoid overestimating the effectiveness of its program. It is anticipated that future monitoring and literature review results will be used to further refine the estimates over time.

The benchmarks reflect the maximum extent practicable standard, as the City is currently able to foresee. However, with adaptive management efforts, the load reductions are anticipate to improve in the future as more information and/or new, more cost effective technologies become available.

TABLE 6-8: City of Salem Benchmarks⁽¹⁾

	Lower Value of the Range	Upper Value of the Range
Clark Creek TMDL		
E. coli (Winter) (Counts)	9.4×10^{10}	4.4×10^{11}
E. coli (Summer) (Counts)	6.3×10^9	2.9×10^{10}
Pringle Creek TMDL		
E. coli (Winter) (Counts)	9.8×10^{11}	6.1×10^{12}
E. coli (Summer) (Counts)	6.6×10^{10}	4.1×10^{11}
Mill Creek TMDL		
E. coli (Winter) (Counts)	9.2×10^{11}	6.6×10^{12}
E. coli (Summer) (Counts)	6.1×10^{10}	4.4×10^{11}
Middle Willamette TMDL (via Other Tributaries)		
E. coli (Winter) (Counts)	8.8×10^{11}	5.5×10^{12}
E. coli (Summer) (Counts)	5.9×10^{10}	3.7×10^{11}
Middle Willamette TMDL (Direct to River)		
E. coli (Annual) (Counts)	4.32×10^{11}	2.1×10^{12}

⁽¹⁾ Benchmarks are the difference between the 2013 Pollutant Loads “no Structural BMPs” and the 2013 Pollutant Loads “with Structural BMPs”. The low value of the range was calculated by taking the difference between the 2013 LCL with no structural BMPs and the 2013 LCL with structural BMPs. The upper value of the range was calculated by taking the difference between the 2013 UCL with no structural BMPs and the 2013 UCL with structural BMPs.

6.6 REFERENCES

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