# City of Salem's Progress
# In Addressing TMDL Benchmarks
# August 19, 2010

## 1. Introduction and Purpose

For receiving waters with established total maximum daily loads (TMDLs), Oregon Phase I municipal separate storm sewer (MS4) National Pollutant Discharge Elimination System (NPDES) permittees are required to establish TMDL pollutant load reduction benchmarks in conjunction with their MS4 NPDES permit requirements. By definition, per Schedule D(2)(d)(i)(2) of the City of Salem's current Phase I MS4 NPDES permit (dated 2004), a TMDL pollutant load reduction 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. A benchmark is used to measure the overall effectiveness of the stormwater management plan 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."*

In September 2008, in accordance with the MS4 NPDES permit renewal submittal, permittees were required to revisit pollutant load reduction benchmarks and assess progress toward achieving the benchmarks. As part of this 2008 permit renewal submittal, the City of Salem (the City) was required to establish benchmarks for newly adopted TMDL water bodies (i.e., the Willamette River and tributaries). The benchmark assessment submitted for the City as part of the 2008 permit renewal submittal addresses the Willamette Basin TMDL (2006), and is included as Attachment A to this document.

On pages 6-19 through 6-27 of Attachment A, graphical depictions of the estimated benchmarks (i.e., pollutant loads) are provided. During the permit renewal process, The Oregon Department of Environmental Quality (DEQ) expressed concern that in some cases for specific TMDL parameters, the modeled data that are depicted in the graphs indicate an increase in estimated total pollutant loads from current (2008) to future (2013) conditions. As a result, for these cases, DEQ requested that permittees submit a document to explain how progress is being made in reducing loads toward the waste load allocations (WLAs) when the pollutant load model indicates that overall loads may be increasing. The purpose of this document is to respond to this request from DEQ. The response in this document addresses the five issues listed below in order to elaborate on the progress being made by the City to further reduce pollutant loads to address TMDL WLAs for the identified parameters of focus.

1. **In-stream Trends:** TMDL water quality parameters of focus have shown either in-stream improvements or no significant changes. Water quality degradation has not been observed.
2. **Conservative Model Assumptions:** Assumptions used in the models to estimate pollutant loads were conservative with respect to anticipated new development and associated best management practice (BMP) implementation in that these assumptions likely underestimate the pollutant load reductions that will be achieved.

3. **Effectiveness of Non-structural or Source Control BMPs:** Modeled pollutant load reduction estimates did not include the effectiveness of non-structural BMPs such as public education, operations and maintenance (O&M), program implementation, illicit discharge inspections and investigations, and erosion control. Therefore, again, pollutant load reductions are likely underestimated.
4. **Increased Pollutant Load Reductions:** The City estimates that the amount of pollutant load reductions will increase over the next permit term.
5. **Sources of Bacteria:** Local and regional DNA studies show the largest sources of bacteria to be associated with birds and rodents, which are more difficult for jurisdictions to address with typical BMPs and may present less of a health risk when compared to human sources of bacteria.

Prior to discussing these issues, Section 2 provides a summary of Salem's relevant TMDLs and associated WLAs and lists the TMDL parameters of focus with respect to this document.

## 2. City of Salem's Applicable TMDL and WLAs

The City of Salem discharges to the following waterbodies with applicable WLAs: Mill Creek, Clark Creek, Pringle Creek, all other tributaries to the Willamette River, and the Willamette River directly. Under the Willamette BasinTMDL (2006), individual WLAs for bacteria *(E. coli)* are provided for each of these waterbodies.

Table 1 summarizes the applicable TMDL, waterbodies, and WLAs for which the City's 2008 benchmark analysis was completed.

Table 1. Summary of Applicable TMDL and WLAs for the City of Salem

| Water body | Parameter | WLA |
|---|---|---|
| Mill Creek TMDL (2006) | Bacteria *(E. coli)* | 81% reduction (winter season)<br>89% reduction (summer season) |
| Clark Creek TMDL (2006) | Bacteria *(E. coli)* | 89% reduction (winter season)<br>94% reduction (summer season) |
| Pringle Creek TMDL (2006) | Bacteria *(E. coli)* | 79% reduction (winter season)<br>90% reduction (summer season) |
| Willamette River Tributaries | Bacteria *(E. coli)* | 75% reduction (winter season)<br>88% reduction (summer season) |
| Willamette River Direct | Bacteria *(E. coli)* | 75% reduction |

With respect to benchmarks developed to address these TMDLs, graphs were provided as part of the 2008 benchmark assessment (see Attachment A). These graphs show pollutant loadings estimated for current (2008) development conditions (both with and without structural BMP implementation), and future (2013) development conditions (both with and without structural BMP implementation). The difference between the no-BMP and the with-BMP pollutant loadings is the estimated pollutant load reduction from structural BMPs. Per requirements of the 2005 MS4 NPDES permit, permittees were required to establish pollutant load reduction benchmarks. As a result, the pollutant load reduction estimated for the future (2013) conditions represents the permittees benchmark developed to meet the benchmark requirement of the 2005 MS4 NPDES permit.

While pollutant load reductions are estimated to increase due to increased structural BMP implementation, the overall bacteria load for all waterbodies with WLAs (Table 1) from 2008 (with BMPs) to 2013 (with BMPs) is also estimated to increase.

The bacteria TMDL and associated benchmarks are the focus of this document. As described in Section 1, the following five sections of this document elaborate on the progress being made by Salem to increasingly reduce pollutant loads towards TMDL WLAs for the identified parameter of focus.

# 3. In-stream Water Quality Trends

The purpose of this section is to compare the estimated pollutant load results for the parameters of focus (i.e., the estimated increase in total loads) to in-stream trends. While pollutant loadings models are appropriate tools for making relative comparisons of loads, they are based on making many simplified assumptions and predictions and they are imperfect tools with respect to analyzing impacts to receiving waters. On the other hand, in-stream trends analyses are not based on assumptions. They are based on in-stream water quality data that represent what has, or is actually occurring in the stream. A trends analysis was conducted in 2008 as part of the City's permit renewal submittal. For this document, the analytical monitoring results, statistical analyses, and trends summary prepared for the 2008 permit renewal submittal were revisited.

The City had adequate data to perform trends analyses for 21 in-stream monitoring locations for *E. coli*. Data were evaluated dated from year 2001 to year 2007 (Geosyntec Consultants 2008). In-stream monitoring sites were located on Mill Creek, Pringle Creek, Glenn Creek (which all discharge to the Middle Willamette River), and Clark Creek and Shelton Ditch (which both discharge to Pringle Creek). The trends analyses showed no detectable change in bacteria concentration during the 6-year period for 16 of the in-stream monitoring locations. However, five in-stream locations showed a downward trend for *E. coli* (i.e., a water quality improvement). Notably, the in-stream data used for these analyses was collected during a period of good economic conditions when development and construction activities were being conducted at peak rates. One would expect similar or improving trends in the in-stream data over the upcoming permit term, given the following conditions:

1. Structural BMPs are expected to be similar or improved over the permit term;
2. Due to an economic downturn that has occurred since 2008, development patterns are expected to decrease compared to years when the in-stream water quality data were collected; and
3. Improved standards for new development are required during the permit term (i.e., prioritize low impact development, optimize onsite retention, address hydromodification) and will help to further offset the associated increases in loads.

The results from the trends analysis, which are based on in-stream data, indicate that the estimates from the loadings model may be conservative and are underestimating the progress being made in load reduction. These issues related to the conservative nature of model assumptions are discussed in the following two sections.

# 4. Conservative Model Assumptions

Based on the modeling and graphical methods used to portray pollutant loads and pollutant load reductions, it was necessary for permittees to make assumptions related to anticipated development activities, annexations, and BMP implementation over the upcoming 5-year permit period (i.e., from 2008 to 2013). Such assumptions made by permittees influence how pollutant loads are calculated and graphed and whether the results imply an increase in pollutant loads generated from current to future conditions. Development and annexations result in an increase in impervious surface, pollutant load generating surface, and overall permit area, all of which relate to the pollutant loadings. Because development, annexation, and BMP implementation activities cannot be predicted with 100 percent certainty, these assumptions made in 2008 may not have depicted actual conditions correctly, especially considering the current (as of 2010) housing market, unemployment, and overall economic conditions. In addition, assumptions were intentionally selected to be conservative so as not to overestimate progress.

To outline the conservative nature of assumptions made with respect to development, annexations, and BMP implementation, pollutant loads modeling assumptions were revisited and are described in the following sub-sections.

**Assumed Development Activities:** For their 2008 benchmark analysis, the City of Salem estimated approximately 102 acres of annexations and 856 acres of new development that would occur during the period between 2008 and 2013. This estimated new development represented the conversion of vacant land to an urban land use. The City revisited these assumptions for the purposes of this memo. The City expects annexations to occur as expected, however, given the national economic conditions and slow construction that has occurred over the last two years, the City expects that only approximately twenty to twenty-five percent of this anticipated new development will occur by 2013.

Modification to these original assumptions related to new development would impact the pollutant loading calculations. Pollutant loads increase in the pollutant loadings model as a result of changes in impervious surface and changes in land use. Transitioning from vacant land use to a developed land use increases the pollutant load generation because 1) additional runoff is generated (a result of an increase in impervious surface coverage) and 2) additional pollutant loading is assumed (a result of the change in an undeveloped land use category (e.g., vacant) to a developed land use category (e.g., commercial or residential). As a result of the reduction in anticipated development activities, the implied increase in pollutant loading from current condition to future condition is expected to be significantly reduced based on the amount calculated for the 2008 benchmarks.

**Impervious Percentages Used for Vacant Areas:** As part of the pollutant load modeling conducted to establish pollutant load reduction benchmarks in 2008, the City had to estimate impervious percentage values associated with developed land use categories (i.e., residential, commercial, industrial, agricultural, etc.) and undeveloped (i.e., vacant ) land use categories. As described above, development activities result in additional runoff volume and associated pollutant loading proportional to the difference between the undeveloped and proposed developed impervious percentage assumed.

The City based their impervious percentages on a variety of sources including a recent impervious surface analysis, the City's Stormwater Master Plan (2000), and their Stormwater SDC Methodology Study (2002). Both vacant and agricultural land uses were assumed to be highly pervious (i.e., two percent and five percent impervious, respectively).

Areas are classified as vacant land use if they have the potential to be newly developed. However, parcels identified by the City as vacant (and thus modeled using the assumed two percent vacant impervious percentage) may actually be better reflected by a higher impervious percentage. These vacant areas are typically not pristine forest but include lawn or other impacted/compacted urban surfaces. These urban impacted lands could be assumed to be as high as fifteen percent impervious. With a higher undeveloped impervious percentage (for vacant lands), the net difference in runoff volumes between undeveloped and proposed developed imperviousness would be less and thus, the associated pollutant loading would not increase by the same proportion when modeling development activities. The two percent imperviousness is considered to be a conservative model assumption.

**BMPs Assumed for Private Developments:** As described in the City of Salem's benchmark assessment (Attachment A), when new development occurs, the City assumes that development standards for stormwater treatment will be required. However, as it is unknown the specific type of stormwater treatment that the new development would select, the City assumed that all new development would have treatment equal to that of a swale. Swales typically do not provide much infiltration and associated runoff volume reduction which can significantly increase pollutant load reduction.

This assumption was revisited by City staff. Given the City's current process to update their stormwater design standards manual, the City is expecting increased implementation of low impact development type water quality facilities such as planter boxes and rain gardens, both of which achieve pollutant load reduction through infiltration (runoff volume reduction) and treatment processes. Specifically, planters and rain gardens are expected to achieve between 50 and 100 percent runoff volume reduction. Swales were estimated in the pollutant load reduction model to achieve 30 percent runoff volume reduction. Therefore, the treatment efficiency and flow reduction capabilities of the structural BMPs actually applied for new development during the upcoming years are expected to exceed those that were assumed for new development as part of the 2008 benchmark assessment. Use of swales was a conservative assumption made for the 2008 benchmark assessment, and pollutant removal capabilities of structural BMPs (i.e., planter boxes and rain gardens) applied during development activities are expected to exceed those assumed in the model.

**Effectiveness of BMPs in Series:** Many structural and non-structural BMPs may apply to the same drainage area. The loadings model included only structural BMPs and for structural BMPs operating in series, only the most effective BMP was credited. In other words, credit was not given for the fact that two or more BMPs in series may provide improved effluent quality as compared to the most effective BMP by itself.

All of these conservative assumptions have likely led to underestimating the progress being made to reduce pollutant loads. Another significant conservative assumption was related to the incorporation of non-structural BMPs into the benchmark analyses. This is discussed in the following section.

# 5. Effectiveness of Non-Structural or Source Control BMPs

Many elements of the City's Stormwater Management Plan involve the use of non-structural or source control BMPs. Such BMPs include public education, O&M activities, program implementation, illicit discharge inspections and investigations, and implementation of an erosion control program. Numeric effectiveness of non-structural and source control BMPs was not included in the pollutant loads modeling effort to estimate benchmarks. A decision was made not to include these practices in the model given the overall lack of objective, quantitative effectiveness information related to the various non-structural or source control BMPs. In addition, many of these practices are applied in overlapping areas and information regarding combined effectiveness is not available.

Section 6.3 of the City's benchmark assessment (Attachment A) outlines the established process for addressing the effectiveness of non-structural and source control BMPs in the benchmark analyses. First, the models were developed to evaluate the effectiveness of structural BMPs implemented by the City. The resulting pollutant loads were then compared to the WLA. Comparing the calculated pollutant loadings results to the WLAs provided a relative picture of how close or far the City was from meeting the WLA, considering only structural BMP implementation. If the estimated pollutant loads with structural BMP implementation were close to the WLA, a general statement was made, based on best professional judgment, as to whether or not the non-structural or source control BMPs would be expected to result in the additional load reduction necessary to fully meet the WLAs.

This process or approach is conservative with respect to the pollutant loadings graphs (i.e., underestimates load reductions) because assumptions related to the specific, quantitative effectiveness of various non-structural or source control BMPs were not made. Instead, only validated effectiveness information for structural controls was used in the loadings model and a narrative was provided as to the relative effectiveness of non-structural or source control BMPs with respect to the City's ability to meet WLAs.

While specific numeric values were not selected to account for the effectiveness of non-structural BMPs in the City's model, the U.S. Environmental Protection Agency (USEPA) is currently supporting the use of a loads model that includes these specific values. Specifically, the Watershed Treatment Model (WTM) (Caraco, 2010) is a planning level model developed by the Center for Watershed Protection. Development of the model was funded by the USEPA Office of Wetlands Oceans and Watersheds, Altria Foundation, and Cooperative Institute for Coastal and Estuarine Environmental Technology. It is a simple spreadsheet model used to estimate pollutant loading (nutrients, sediment, and bacteria) under current watershed conditions, determine the effects of existing management practices on minimizing these pollutant loads, evaluate the effects of proposed structural and non-structural management practices on current pollutant loads, and evaluate the effects of 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. For non-structural practices including street sweeping, riparian buffer protection, catch basin cleanouts, and erosion and sediment control, their efficiencies are provided in the form of percent removals (Table 3).

Table 3. Percent Removal Efficiency of Non-Structural BMPs (from WTM)

| Street sweeping | Efficiencies, residential | | Efficiencies, other roads | |
|---|---|---|---|---|
| **Sweeper type** | **Nutrients** | **TSS** | **Nutrients** | **TSS** |
| Mechanical | 24% | 30% | 4% | 5% |
| Regenerative air | 51% | 64% | 18% | 22% |
| Vacuum assisted | 62% | 78% | 63% | 79% |
| | **Efficiency** | | | |
| **Riparian buffers** | **TP** | **TSS** | **TN** | |
| | 10% | 70% | 30% | |
| | **Efficiency** | | | |
| **Catch basin cleanouts** | **Nutrients** | **TSS** | | |
| Monthly cleaning | 15% | 25% | | |
| Semi-annual cleaning | 8% | 13% | | |
| **Erosion and Sediment Control** | **Efficiency** | | | |
| | 70% | | | |

For other non-structural practices such as lawn care education, pet waste education, impervious cover disconnection, marina pump-outs, septic system education, land reclamation, impervious cover reduction, stormwater retrofits , illicit connection removal, combined sewer overflow repair/abatement, sanitary sewer overflow repair/abatement, septic system inspection/repair, septic system upgrade, channel protection and point source reduction, removal efficiencies are included in the model based on treatability and discount factors provided as user input. For non-structural practices, treatability is the fraction of the population that can be reached for education programs. Discount factors are applied to potential load reductions to account for imperfect practice application and upkeep, inability of educational programs to reach all citizens, and inadequate funding to implement all practices, to name a few. The pollutant removal efficiencies associated with the non-structural stormwater management practices used in the model are based on existing research and studies by CWP (1999) and Winer (2000).

There are many simplifying assumptions made by the WTM, and the model results are not calibrated. Therefore, the results of the model simulations should be compared on a relative basis rather than used as absolute values. However, the research that went into the development of this model and USEPA's approval, provide documentation that non-structural practices are expected to play a significant role in the removal of pollutants. Up to 79 percent removal efficiencies were estimated depending on the parameter and the non-structural practice implemented. This indicates that if numerical credit had been taken for these practices in developing benchmarks, significant additional pollutant load reduction would have been estimated. In addition to the discussion regarding conservative model assumptions (Section 4), the discussion in this section is intended to reflect additional progress being made by Salem that is not reflected in the benchmark estimates.

Again, these conservative assumptions have all likely led to underestimating the progress being made to reduce pollutant loads for the parameters of focus. The benchmark graphs in Attachment A also mask the progress being made in reducing pollutant loads as discussed in Section 6.

# 6. Increased Pollutant Load Reductions

For the City of Salem, DEQ's concern with the graphs in Figures 6-2 through 6-10 of Attachment A is that the overall pollutant load, assuming the implementation of structural BMPs, is shown to increase from 2008 to 2013. The purpose of this section is to note that progress is being made by the City to increasingly reduce pollutant loads, and that progress is somewhat masked by the format of the benchmark graphs. Figures 1 through 9 present the same information from Attachment A, graphs 6-2 through 6-10 in a different format in order to better illustrate the increase in pollutant load reductions that are estimated. These figures illustrate the City's estimated increasing progress in achieving pollutant load reductions for the parameters of focus. During the permit term, the City plans to reduce more/additional pollutant loads in 2013 than they did in 2008.

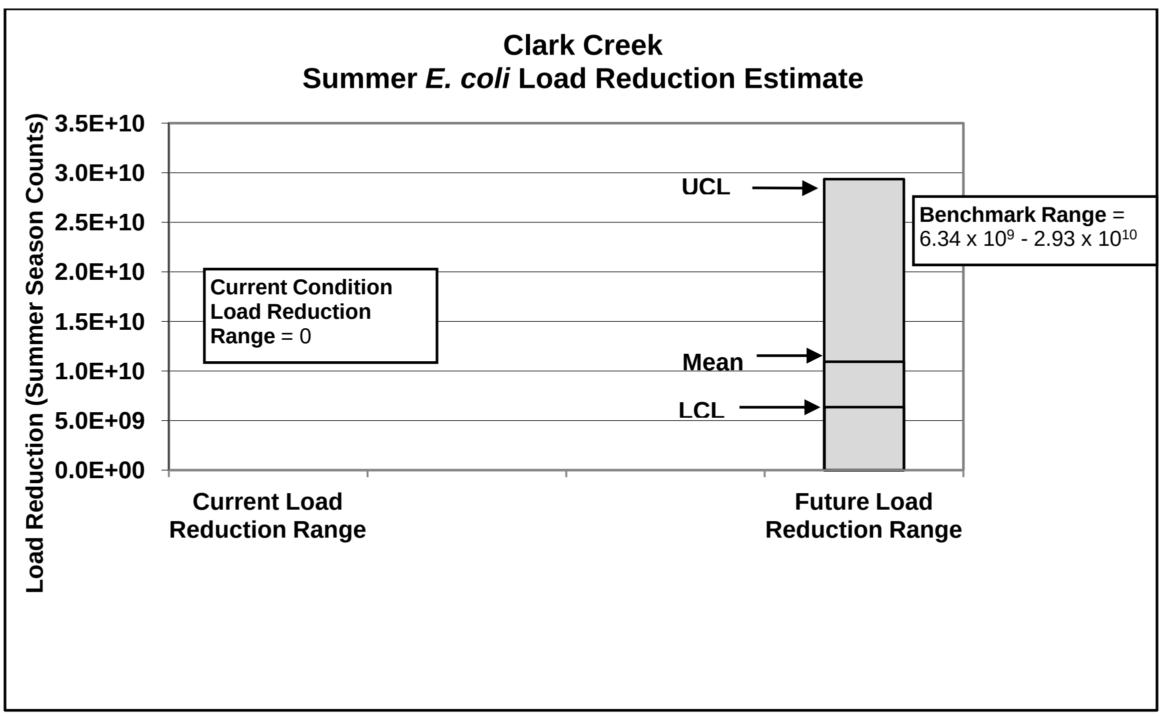


Figure 1. Bacteria – Clark Creek (summer season)

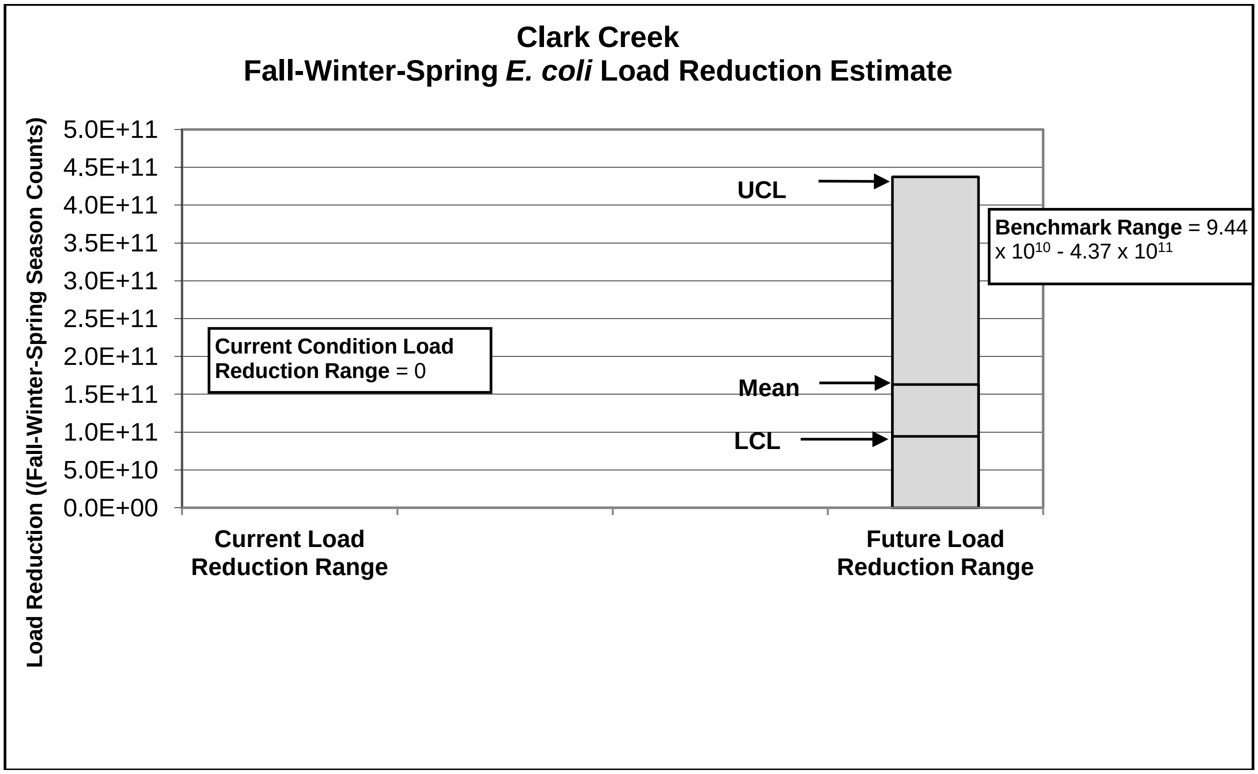


Figure 2. Bacteria – Clark Creek (winter season)

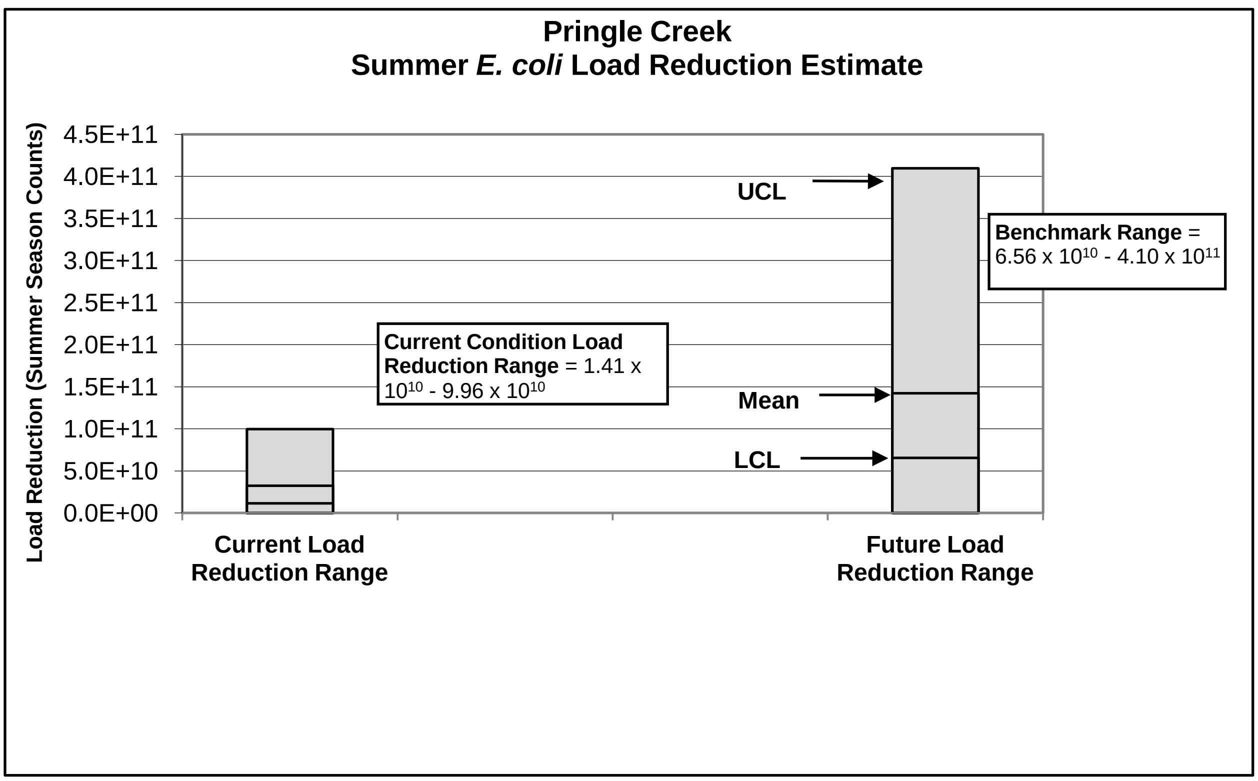


Figure 3. Bacteria – Pringle Creek (summer season)

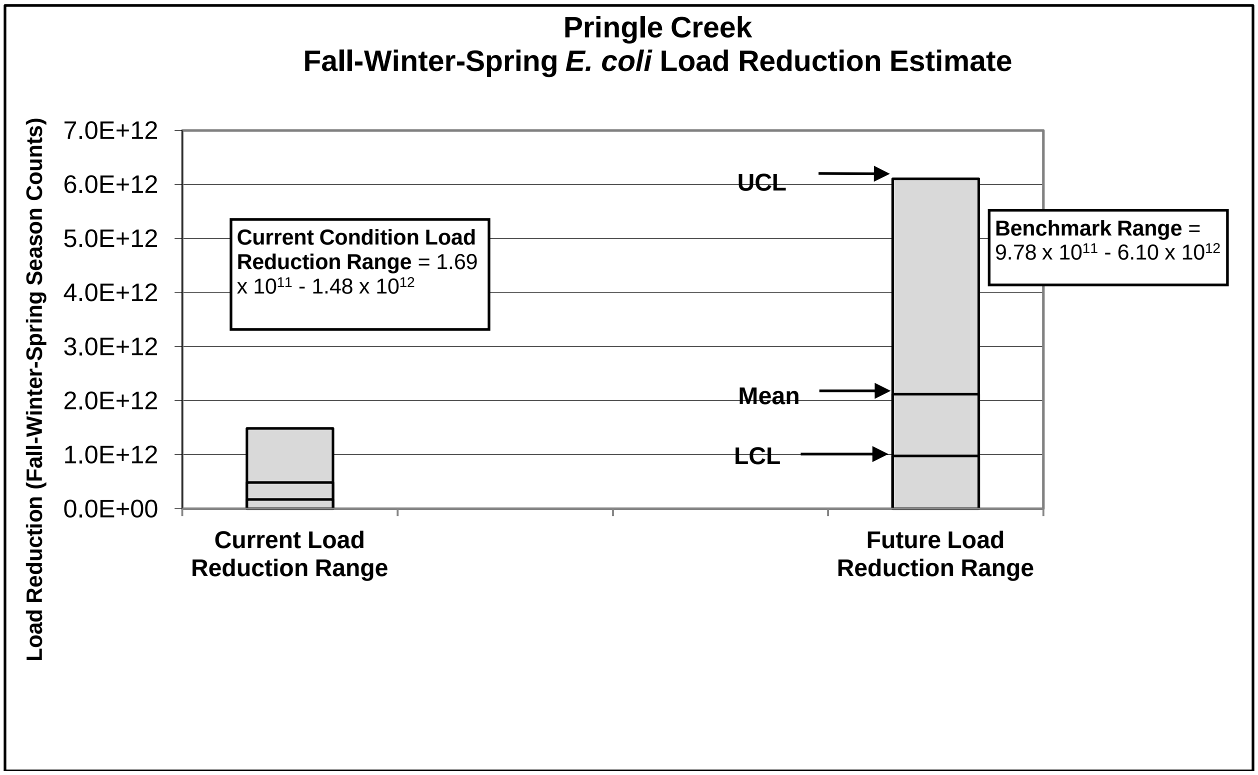


Figure 4. Bacteria – Pringle Creek (winter season)

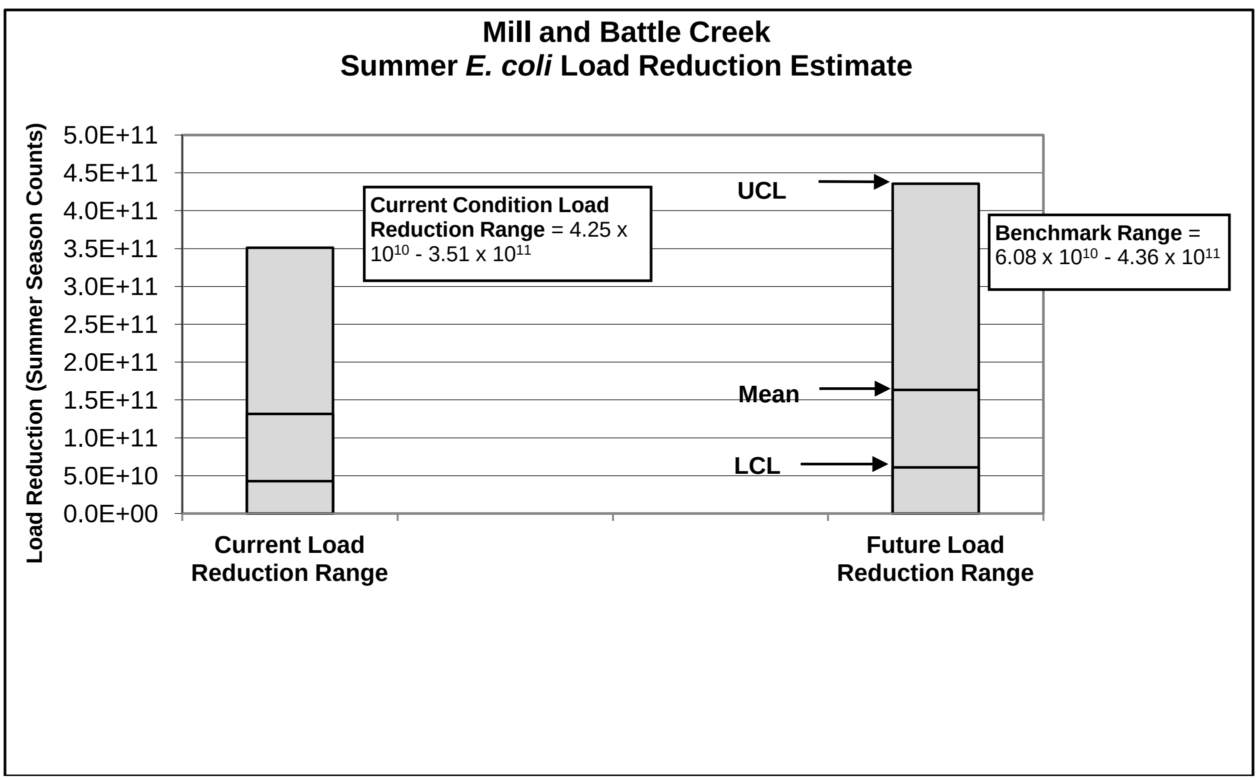


Figure 5. Bacteria – Mill Creek (summer season)

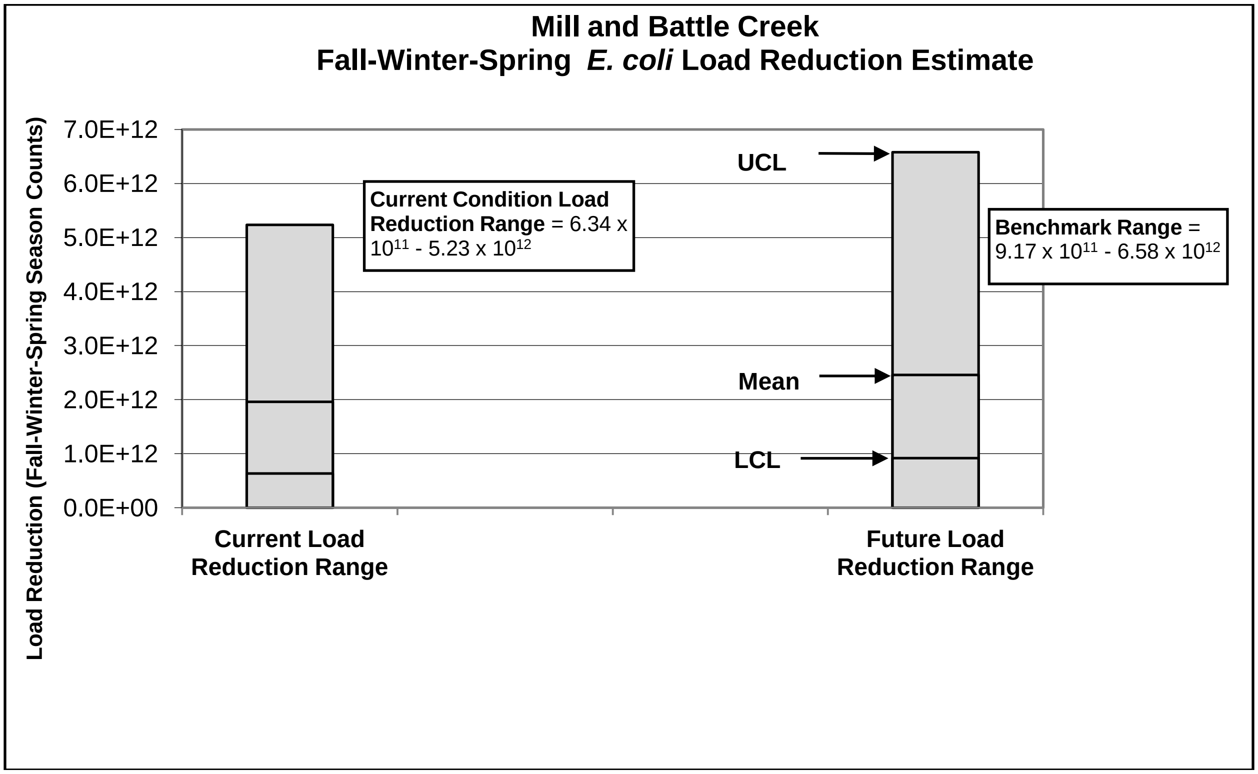


Figure 6. Bacteria – Mill Creek (winter season)

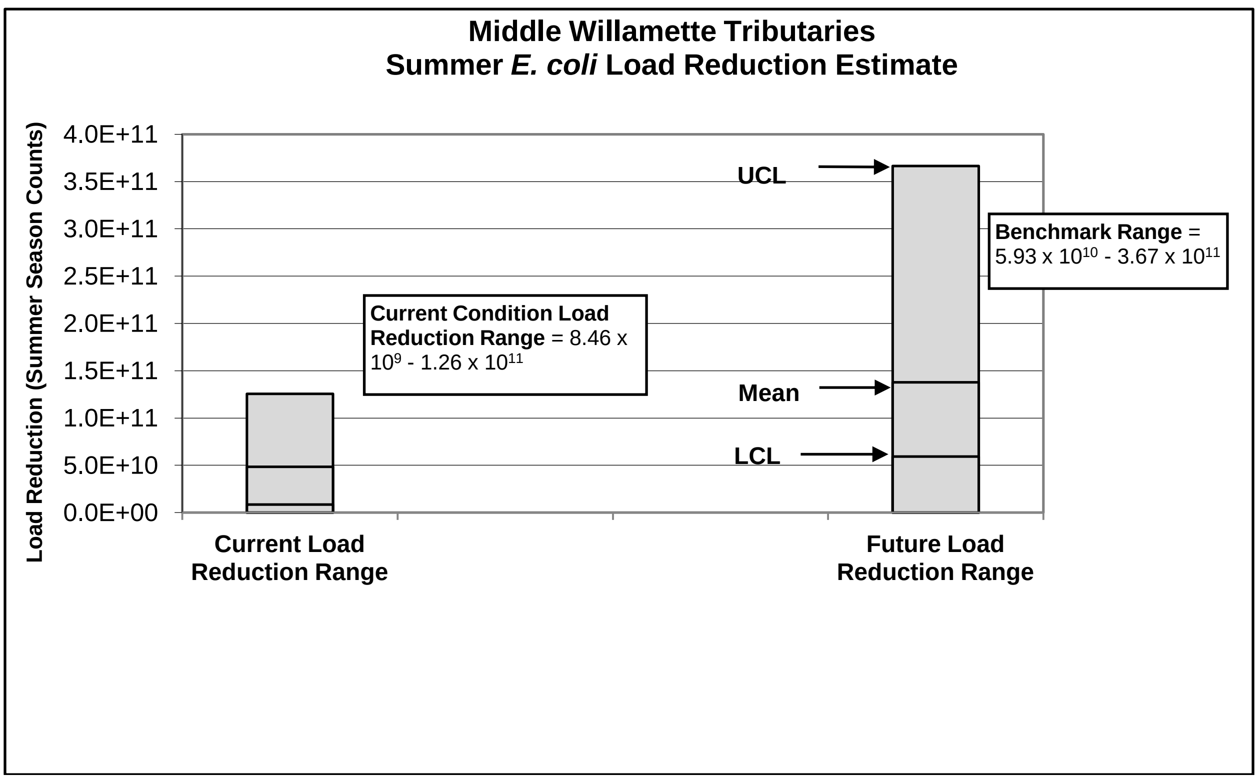


Figure 7. Bacteria – Middle Willamette River Tributaries (summer season)

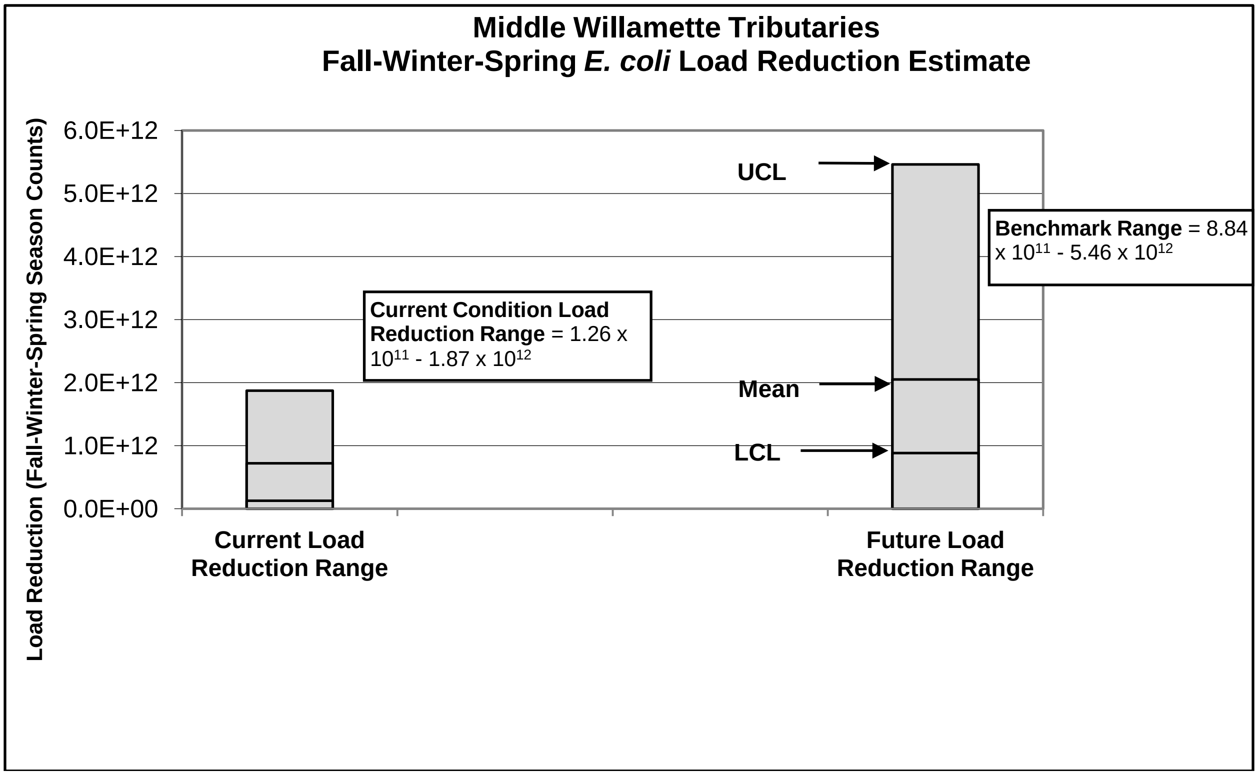


Figure 8. Bacteria – Middle Willamette River Tributaries (winter season)

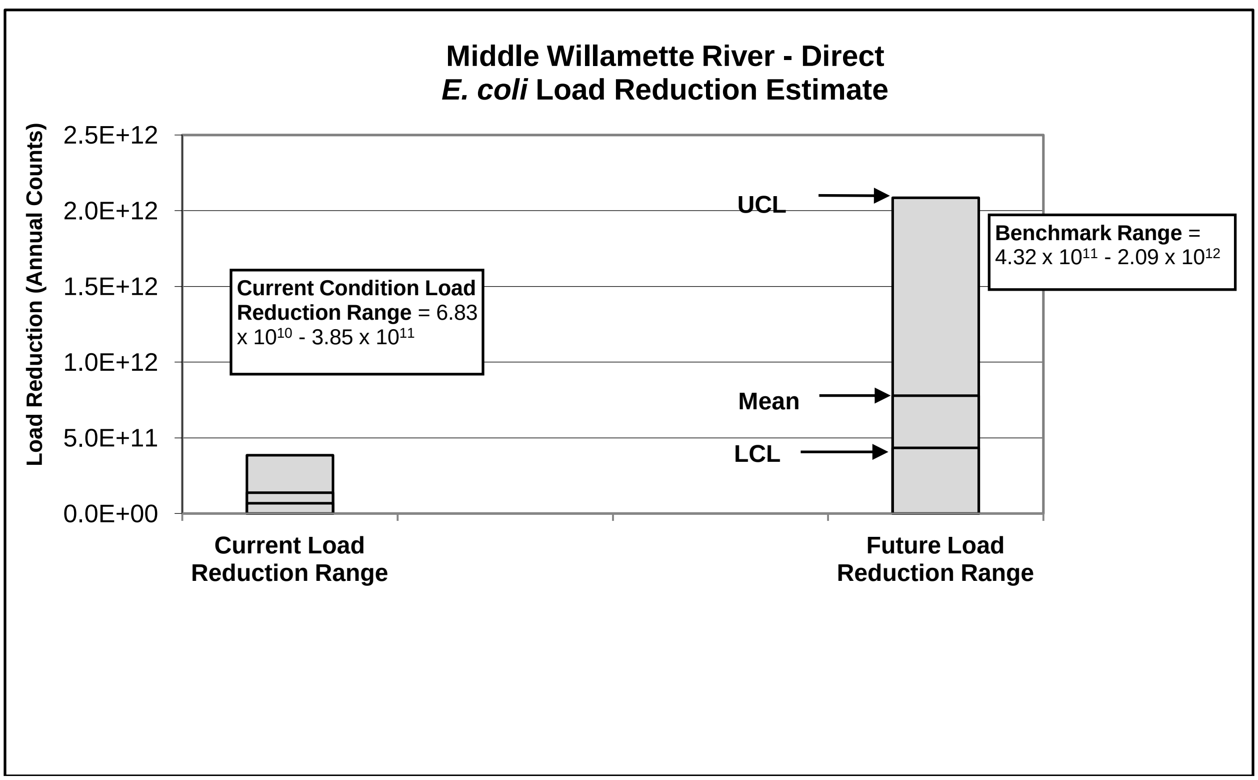


Figure 9. Bacteria – Willamette River (annual)

# 7. Limitations Related to Bacteria Load Reduction

Water bodies contaminated by fecal matter can contain a wide variety of pathogenic organisms such as salmonella, shigella, cryptosporidium, and hepatitis A. However, it is impractical to analyze water samples for the full range of pathogens that could be present in a water body. Therefore, the Oregon state water quality standards are based on an indicator bacteria, *E. coli,* which is found in the guts (and feces) of all warm-blooded animals. The water quality standards assume that *E. coli* concentrations are generally correlated with human pathogens. The *E. coli* standards are intended to ensure that water bodies are safe for swimming, wading, and other uses where skin contact or ingestion could occur.

Exceedances of *E. coli* standards are common in urban water bodies. In addition to humans, pets, livestock, birds, rodents, and other wildlife can contribute *E. coli* to urban waters. Although animal feces can contain pathogens harmful to humans, waters contaminated by human feces are generally considered to be a greater risk to human health than waters contaminated by animal feces (Scott et al. 2002).

Microbial Source Tracking (MST) techniques have been developed to identify the specific sources of fecal contamination and support development of control measures. According to USEPA, “Although they are still experimental, (MST) methods represent the best tools available to determine pathogen TMDL load allocations and TMDL implementation plan development” (EPA, 2002, Wastewater Technology Fact Sheet). A variety of MST methods have been developed. The four MST studies reviewed for this document were conducted in the Pacific Northwest (PNW) using the genetic fingerprinting method developed by Dr. Mansour Samadpour of the Institute of Environmental Health in Seattle, Washington. This method involves isolating, ribotype strains from water samples and matching these ribotypes to one of the *E. coli* strains in a library of source ribotypes (e.g., human, canine, feline, rodent, avian, equine, bovine, rabbit, raccoon). The MST method has been used to successfully identify the sources of fecal pollution in more than 80 studies throughout North America. The IEH Laboratories & Consulting Group library contains approximately 120,000 sources.

Table 4 summarizes the results of the four MST studies. Figure 10 shows the average contribution from the sources identified in the four studies listed above. Table 4 and Figure 10 indicate that only a small percentage of the *E. coli* came from humans and human-related sources (e.g., pets and livestock). Waters contaminated by non-human sources are generally considered to be a lesser risk to human health than waters contaminated by human feces (Scott et al, 2002). Most of the fecal contamination came from non-human sources such as birds and rodents, over which jurisdictions have little or no control. For example, the Clarks Creek study (Brown and Caldwell and URS, 2005) noted that fecal matter from birds and rodents in riparian areas does not pass through the municipal storm system.

Table 4. Typical Sources of Bacteria Identified in Four PNW Microbial Source Tracking Studies

| Study | Region | Human | Avian | Canine/Feline | Rodent | Farm/Livestock | Wildlife | Unknown/Other |
|---|---|---|---|---|---|---|---|---|
| Thurston County | WA | 7% | 42% | 7% | 7% | 7% | 22% | 8% |
| Tualatin River | OR | 6% | 51% | 14% | 16% | - | 6% | 9% |
| Olympic Peninsula | WA | 8% | 39% | 8% | - | 10% | 26% | 8% |
| City of Puyallup | WA | 5% | 41% | 12% | 28% | 1% | 8% | 7% |
| Average of PNW regions | | 7% | 43% | 10% | 17% | 6% | 16% | 8% |

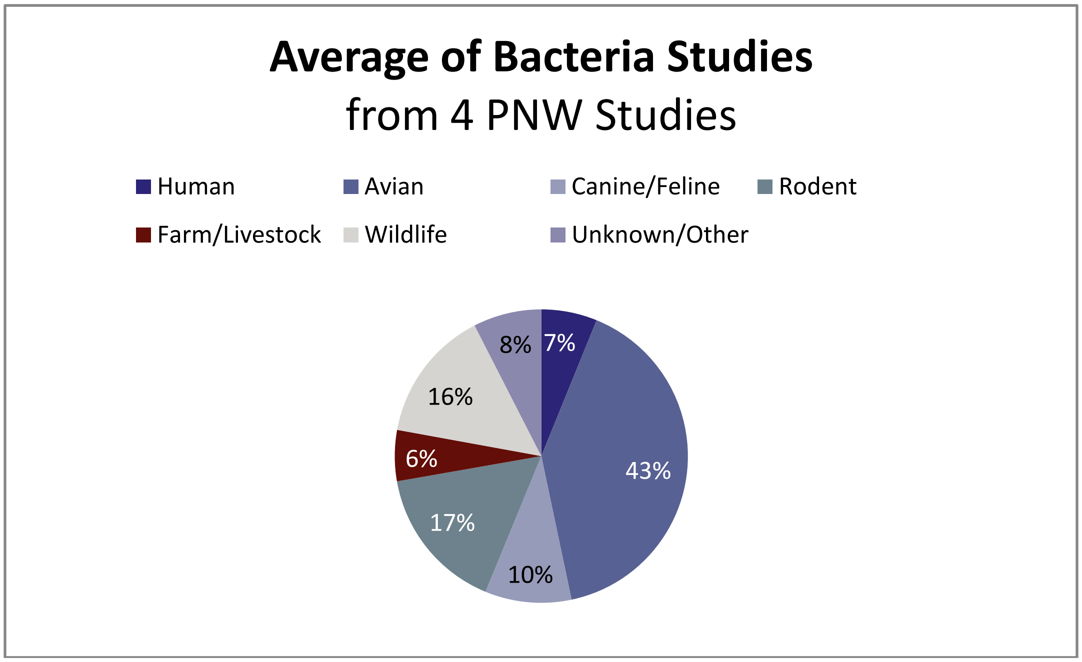


**Figure 10. Typical Sources of Bacteria Identified in Four PNW Microbial Source Tracking Studies**

The City has TMDL wasteload allocations for bacteria for the Willamette River and its tributaries. The WLA would require a 75 to 94 percent reduction in the total *E. coli* load. However, the regional MST data summarized above suggest that human sources may account for only about seven percent of the *E. coli* load and anthropogenic sources (humans, pets and farm animals) may account for only about 23 percent of the *E. coli* load. Figure 11 below shows the progress that the City has made in reducing *E. coli* compared to the WLA; and, it shows the portion of the WLA that would be difficult, if not infeasible to control.

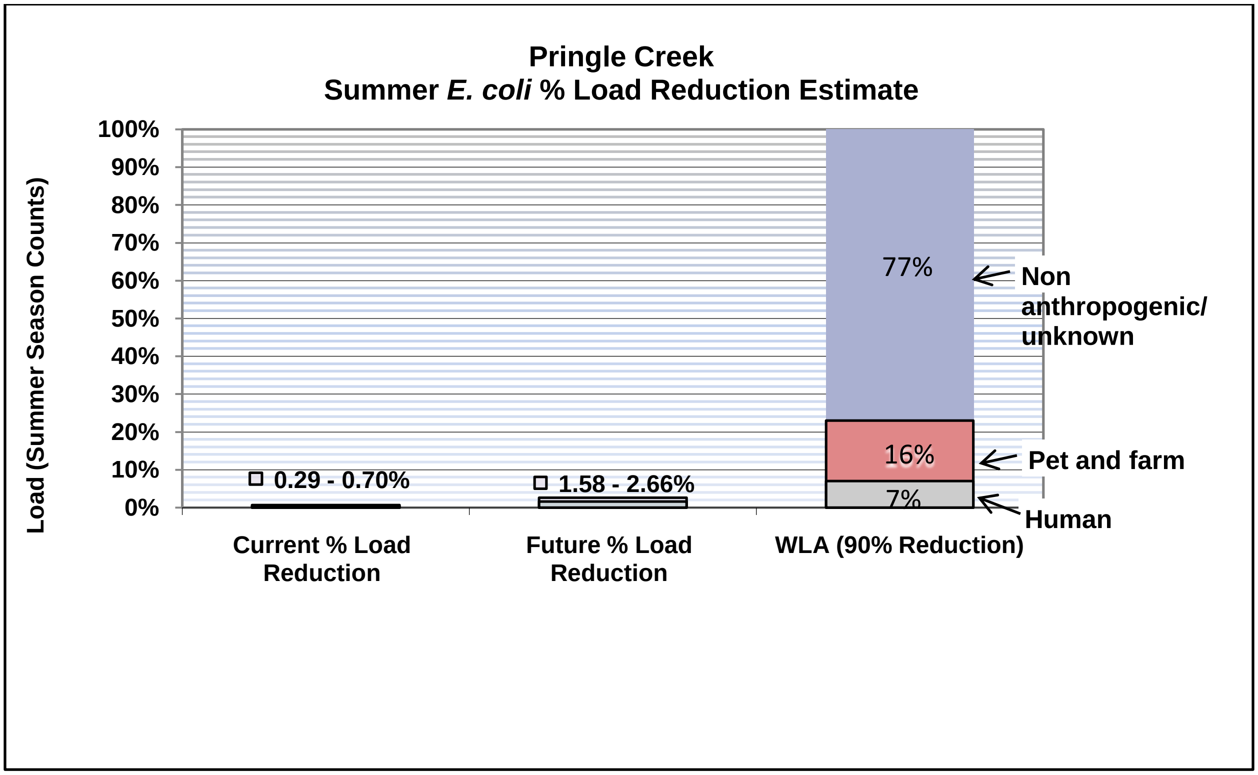


**Figure 11. Comparison of Load Reductions to Estimated Sources Associated with the WLA**

# 8. Summary and Conclusions

In 2008, the City of Salem submitted pollutant load reduction benchmarks towards addressing their TMDL WLAs. While the City's pollutant load reductions are estimated to increase, the overall load from 2008 to 2013 is also estimated to increase. When conducting the loads modeling in 2008, it was estimated that the City's load reductions, while increasing by 2013, were not sufficient to offset increased loads from annexations and new development. DEQ expressed concern regarding this issue and requested submittal of this document to explain how progress is being made towards addressing WLAs.

While pollutant load models are good tools for estimating and making relative comparisons of loads, they are based on many simplified assumptions and predictions. In addition, pollutant loads models, may not accurately reflect the conditions in receiving water and are not an appropriate tool for analyzing receiving water impacts or predicting receiving water concentrations. Data have been collected in-stream in Salem, and exhibit improving trends in-stream for bacteria. Given the high rate of development that occurred when trending data were collected, this is a positive result. One would expect trends to be similar or improved over the upcoming permit term given reduced rates of development and increased implementation of low impact development practices for private development activities.

Inconsistencies between what the in-stream data are showing and the pollutant load model estimates for future conditions are likely based on the conservative nature of the models. The models likely predicted more development activities than what is likely to occur given economic conditions, the effectiveness of non-structural BMPs was not accounted for, credit was not given for the increased effectiveness of BMPs when they operate in series, and assumptions regarding private BMP implementation associated with new development were conservative (i.e., the model assumed BMPs with minimal infiltration). In addition, new permit requirements will result in improved development standards over the permit term resulting in the prioritization of low impact development (LID) and the optimization of on-site retention.

With respect to bacteria, it should be noted that there are limitations in the City's ability to reduce loads based on their sources. Given the consistency in regional studies, an average of 77 percent of the WLA for bacteria is likely to be associated with avian and wildlife sources over which jurisdictions have little or no control. In addition, although animal feces can contain pathogens harmful to humans, waters contaminated by human feces are generally considered to be a greater risk to human health than waters contaminated by animal feces (Scott et al. 2002). The City does implement management practices to reduce anthropogenic sources of bacteria, including illicit discharge elimination programs, inspections related to potential cross-connections, and public education associated with pet wastes. As can be seen in Figure 11, progress is being made with respect to increasing the reduction of bacteria loads.

The information presented in this document, illustrates the City of Salem's progress towards the WLAs. The City is demonstrating that it is continuing to increase its pollutant load reductions. Additionally, over the permit term the City will be continuing to improve water quality management practices that are implemented for private development through the prioritization of LID and optimizing on-site retention.

# 9. References

Brown and Caldwell, URS, *Clarks Creek Watershed Pollution Reduction Project: Submittal Report,* City of Puyallup, Washington, 2005.

Caraco, D., *Watershed Treatment Model (WTM) 2010 Users Guide*, Prepared for USEPA Office of Wetlands Oceans and Watersheds, Altria Foundation, and Cooperative Institute for Coastal and Estuarine Environmental Technology, Center for Watershed Protection, Ellicott City, Maryland, 2010.

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