Appendix 3: Water Quality Data and Analysis

Introduction

This white paper summarizes a detailed technical evaluation of water quality issues affecting surface water resources in Olympia. This is an update of the GIS Basin Analysis prepared by staff in 2010. In addition to the initial analyses performed in the 2010 report, staff considered several additional years of monitoring data, a more robust GIS analysis of land use characteristics, as well as numerous studies published by Washington State Department of Ecology and others.

This report was prepared to provide detailed data analysis and background information in support of Chapter 7 (Water Quality) in the Storm and Surface Water Plan.

Data

In order to better understand the pollutants and the water quality problems they cause, we reviewed and analyzed water quality data from numerous sources.

Department of Ecology – 303d. List

Some pollutants are specifically monitored by the Department of Ecology and are used to develop the 303d. list of waters impaired for water quality. The strength of Ecology's data is that it is collected at numerous locations along each stream, allowing individual stream reaches (sections) to be evaluated. A limitation of these data is that in many cases they were collected years ago over a limited time period and may not acknowledge current improvements to water quality, nor provide for conditions to be monitored over time.

Thurston County – Environmental Health Department

Thurston County (under a contract with the City of Olympia), actively monitors specific pollutants (fecal coliform, pH, dissolved oxygen, temperature, turbidity, nitrate+nitrite and total phosphorus), at specific sampling locations along many of our streams. Similar to the monitoring data collected by Ecology, this monitoring data can be used to determine the level of several pollutant impairments that exists in a stream. Unlike Ecology's monitoring data, the County's monitoring is performed more frequently and over a longer period of time. A limitation of the County's monitoring is that it is typically performed at only one sampling location along an entire stream. This limits its ability to differentiate levels of pollution in specific stream reaches.

City of Olympia – Outfall Flow Monitoring

The City monitors stormwater outfalls on streams in Olympia. The outfalls are monitored during late summer (in the absence of rain) with the assumption that monitored flows during this time period indicate flows from an illicit sewer cross connection up stream of the outfall. Because new illicit cross connections are quite rare, this type of monitoring is only performed once every 5 to 10 years. This method of monitoring is highly effective and inexpensive to perform.

Department of Ecology – Characterization of Toxins

Many pollutants are economically infeasible to monitor at a local level. For these "non-monitored" pollutants, Utility staff rely upon studies performed by the Department of Ecology that included detailed monitoring in model watersheds. *(Ecology/King County, 2011).* The results of these characterization studies can then be used to correlate pollutant loads to specific land uses (i.e., residential vs. commercial) and/or watershed characteristics (i.e., percent impervious surface cover). This information is particularly helpful in identifying the potential quantity and source of non-monitored pollutants running off roadways and other impervious surfaces as untreated stormwater.

Data Refinement

Monitoring data were further refined in order to better understand the actual impairment potential of specific pollutants. These refinements included:

- **Water Quality Index (WQI)** – Monitoring data is converted to a multi-variant index, which is valuable for providing a relative comparison to other waterbodies and to monitor changes in water quality over time (trend analysis).
- **Benthic Index of Biotic Integrity (B-IBI)** – Quantity and diversity of benthic macroinvertebrates (i.e., insects, crustaceans, worms, snails and clams), found in or near the stream bed are monitored annually. Samples are then sent to a laboratory for analysis with the resulting data converted into an index score. Similar to Water Quality Index, B-IBI is useful as a relative measure of stream health, compared to other streams and to monitor changes in stream health over time (trend analysis).
- **Fecal Coliform box plots** – Fecal coliform test results are graphed relative to the public health standards. The resulting graph can be used to differentiate chronic vs. infrequent fecal coliform sources and concerns.
- **Nitrogen concentration to load** – Nitrogen concentrations are converted to nitrogen loads by using flow data in addition to concentration data. The resulting load calculations are then used to determine a source's potential contribution to dissolved oxygen problems within Budd Inlet.
- **Linear regression analysis** – Used to identify potential correlations between water quality problems and specific land used characteristics.
- **Impervious surface, traffic counts and stormwater treatment analysis** – Used to identify roadways with the greatest potential pollutant loads based on acres of impervious surfaces, traffic counts and level of stormwater treatment.

Analysis

Run off from pollution generating impervious surfaces

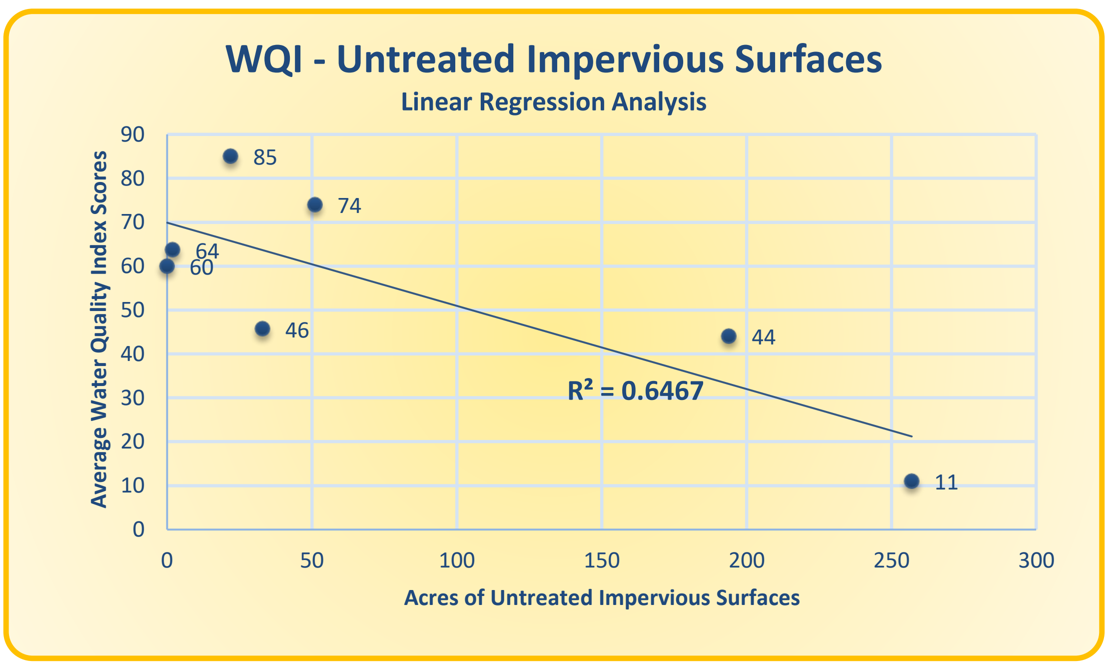
Run off from pollution generating impervious surfaces carries many different pollutants not measured by our local monitoring efforts. The Utility relies upon characterization studies that identify the typical pollutant types and loads found in stormwater entering Puget Sound. Specifically, the Department of Ecology performed a series of Studies of Toxic Chemicals in Puget Sound. *(Ecology/King County, 2011).* These studies correlated specific toxins to various land uses and land covers.

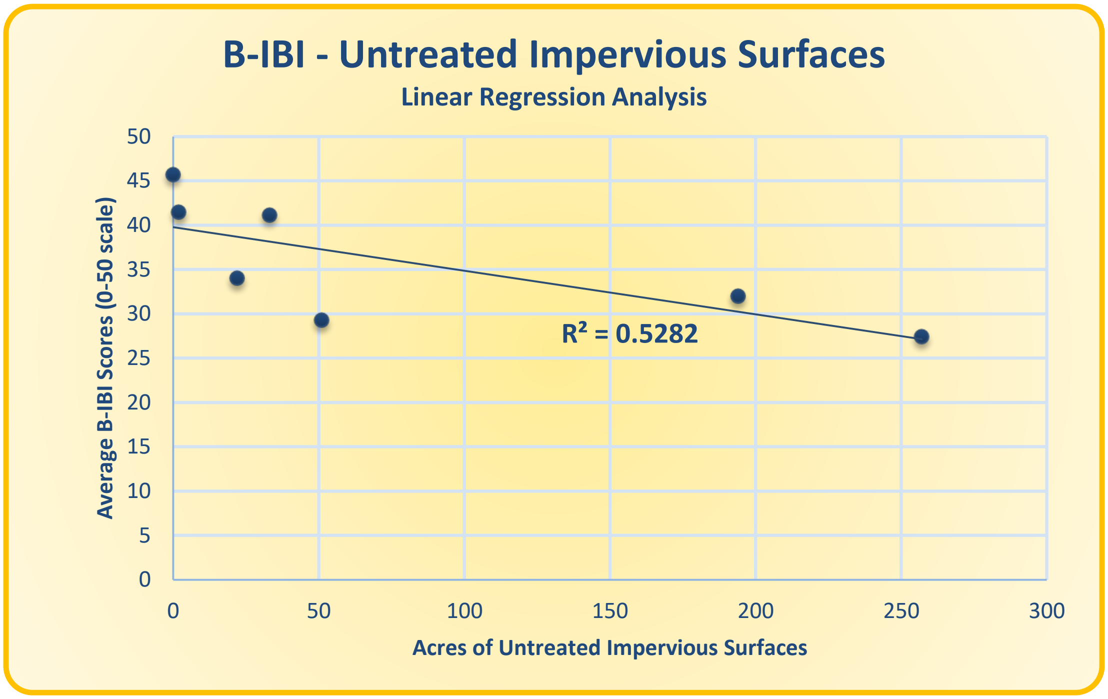
The top five toxic chemicals in Puget Sound (ranked by total releases in tons/year) are oils & grease, petroleum, zinc, copper and arsenic. The sources for most of these have been linked back to residential non-point sources, such as motor vehicle use and maintenance, wood stoves/fireplaces, roofing materials and some pesticides, with surface runoff being the primary pathway. (See table 1 on next page.)

Table 1 - Toxic Chemical Releases and Loading in the Puget Sound Basin (top 5 by loading quantity)

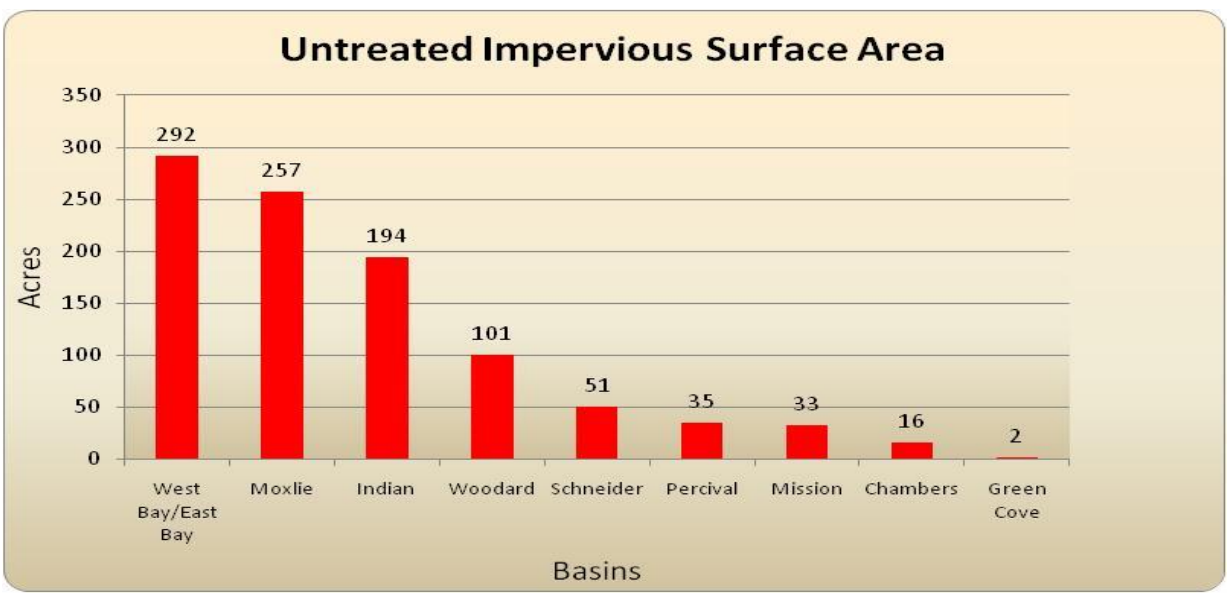
Pollutant	Major Sources	Total Load to Puget Sound (Metric Tons/year	Major Pathway
Oil and Grease	Unspecified Most likely motor vehicles, restaurants and automotive related businesses.	8,500-11,000	Surface Runoff
Petroleum	Motor oil drips and leaks, used oil improper disposal, gasoline spillage during fueling	330-500	Surface Runoff
Zinc	Roofing material leaching Vehicle tire abrasion	140-200	Surface Runoff
Copper	Roofing material leaching, Brake pad abrasion Pesticides use on urban lawns and gardens	33-80	Surface Runoff
Arsenic	CCA treated wood, Industrial air emissions, roofing material leaching	14-25	Surface Runoff

The results of this study are also supported by the City of Olympia's 2010 Basin Analysis. *(Roush, 2010)* In the 2010 analysis, a single variant linear regression model was used to evaluate the quantity of untreated impervious surfaces against both the average Water Quality Index (WQI) and the average Benthic Index of Biotic Integrity (B-IBI). In both cases relatively strong correlations were found to exist between the quantity of untreated impervious surfaces and worsening water quality as indicated by both WQI (R^2 value of 0.65) and B-IBI (R^2 value of 0.53).

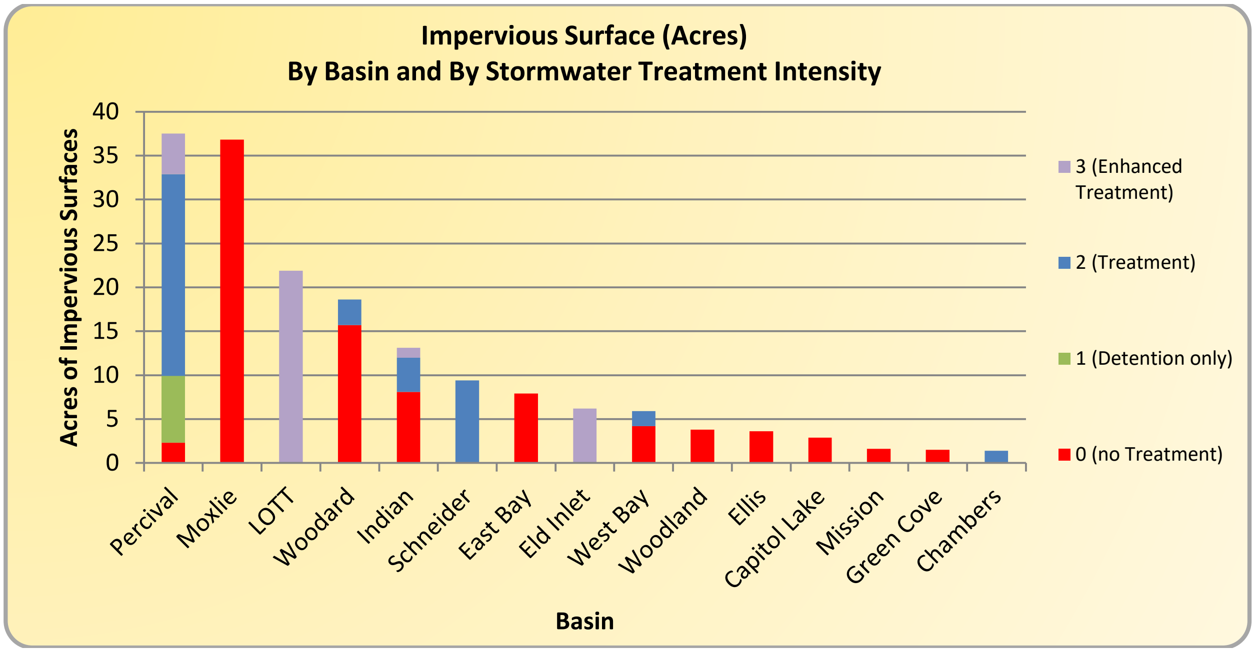




Given the relationship between vehicle use, surface water runoff and stormwater treatment (or lack thereof), the utility quantified those portions of basins with untreated impervious surface. The results of this delineation are shown in the chart below.



More recent refinement to this work, included the quantifying of impervious surfaces from high traffic roadways (arterial and commercial roads) basin and by stormwater treatment type. The results are shown in the chart below.



3 - Enhanced Treatement = stormfilters, wetponds, full infiltration or treatment through LOTT facility.

2 - Treatment = Similar to enhanced treatment but undersized for large events

1 - Detention only = Designed flow control only

0 - No treatment – No or limited flow control an no treatment

This information from both of these analyses are being used to prioritize construction of future stormwater infrastructure as well as street sweeping, system cleaning, source control and public outreach programs.

Fecal Contamination

Both Ecology's 303 d. list of impaired waters and the ambient water quality monitoring data collected by Thurston County indicate some degree of fecal contamination in most of the tributary streams in Olympia.

Bacteria criteria are set to protect people who work and play in and on the water and consumers of shellfish and other foods from waterborne illnesses. In Washington State's water quality standards (WAC 173-201A-200 Freshwater Designated Uses and Criteria), fecal coliform is used as an "indicator bacteria" for the state's freshwaters. Fecal coliform in water indicates the presence of waste from humans and/or other warm-blooded animals.

Table 2 is a summary of fecal coliform testing from 1992 to 2015. There are two public health standards that bacteria levels are measured against. Not meeting a standard is indicated as a "fail" in this table.

Table 2 - Summary of fecal coliform testing from 1992 to 2015

	Chambers		Ellis		Green Cove		Indian		Mission		Moxlie		Percival		Schneider		Woodard	
Water Year	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
1992-1993	Fail	Fail	Fail	Fail	Pass	Pass	Fail	Fail	Fail	Fail	Fail	Fail	Fail	Fail	Pass	Fail	Pass	Pass
1995-1996	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Fail	Fail	Fail	Fail	Fail	Pass	Fail	Pass	Fail	Pass	Pass
1996-1997	Pass	Pass	Pass	Pass	Fail	Fail	Fail	Fail	Pass	Fail	Pass	Fail	Pass	Pass	Pass	Pass	Pass	Pass
1997-1998	Pass	Pass	Pass	Fail	Pass	Pass	Fail	Fail	Fail	Fail	Fail	Fail	Pass	Pass	Pass	Pass	Pass	Fail
2002-2003	Pass	Fail	Pass	Fail	Pass	Pass	Fail	Fail	Fail	Fail	Fail	Fail	Pass	Pass	Pass	Fail	Pass	Pass
2003-2004	Pass	Fail	Pass	Fail	Pass	Pass	Fail	Fail	Fail	Fail	Fail	Fail	Pass	Pass	Pass	Fail	Pass	Pass
2004-2005	Pass	Fail	Pass	Fail	Pass	Pass	Fail	Fail	Fail	Fail	Fail	Fail	Pass	Pass	Pass	Pass	Fail	Fail
2006-2007	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Fail	Pass	Fail	Fail	Fail	Pass	Fail	Pass	Pass	Pass	Pass
2007-2008	Pass	Pass	NA	NA	Pass	Pass	NA	NA	NA	NA	NA	NA	Pass	Fail	NA	NA	Pass	Pass
2008-2009	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Fail	Pass	Fail	Fail	Fail	Pass	Pass	Pass	Pass	Pass	Pass
2009-2010	Pass	Pass	Pass	Pass	Fail	Fail	Fail	Fail	Pass	Fail	Fail	Fail	Pass	Pass	Pass	Pass	Pass	Pass
2010-2011	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Fail	Fail	Fail	Fail	Fail	Pass	Pass	Pass	Pass	Pass	Pass
2011-2012	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Fail	Fail	Fail	Fail	Pass	Pass	Pass	Pass	Pass	Pass
2012-2013	Pass	Fail	Pass	Pass	Pass	Pass	Pass	Fail	Fail	Fail	Fail	Fail	Pass	Fail	Pass	Pass	Pass	Pass
2013-2014	Pass	Fail	NA	NA	Pass	Pass	Fail	Fail	NA	NA	Fail	Fail	Pass	Pass	NA	NA	Pass	Pass
2014-2015	Pass	Pass	NA	NA	Pass	Fail	Fail	Fail	NA	NA	Fail	Fail	Pass	Fail	NA	NA	Pass	Pass

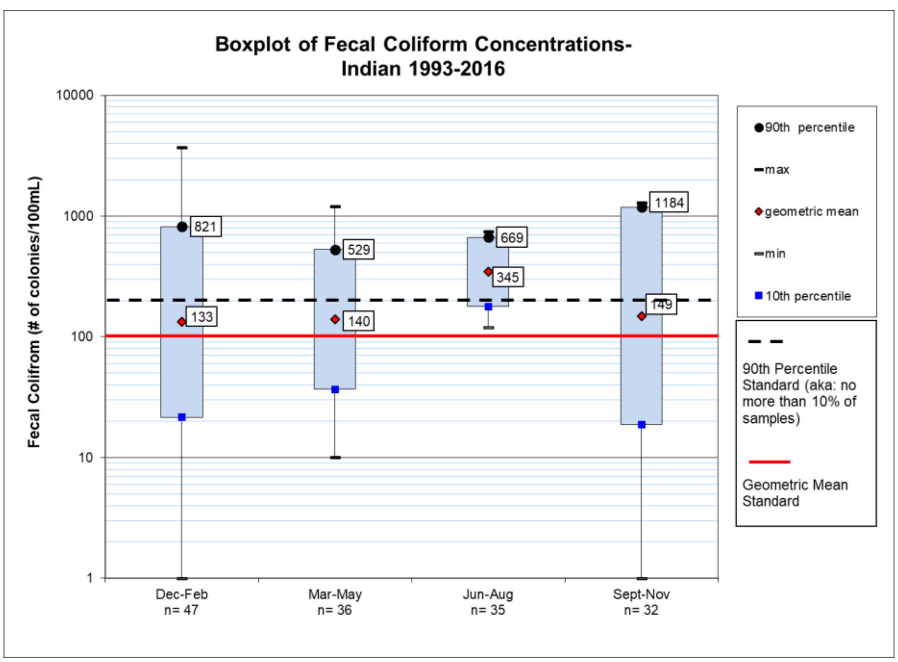
Most of the watersheds in Olympia are required to meet the following standards:

- Standard 1 - The geometric mean of samples must be less than 100 FC/100 ml.
- Standard 2 - No more than 10% of the samples taken can exceed 200 FC/100mL.

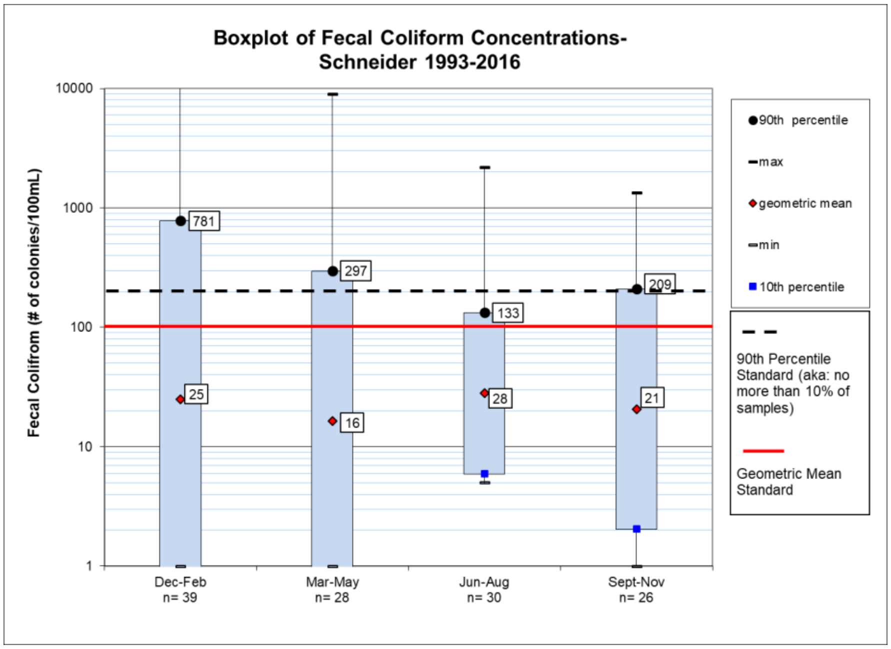
Percival Creek and its tributaries, however, are required to meet higher standards:

- Standard 1 - The geometric mean of samples must be less than 50 FC/100 ml.
- Standard 2 - No more than 10% of the samples taken can exceed 100 FC/100mL.

A boxplot analysis was performed to better understand the fecal coliform test results. As a general rule, when the geomean (red diamond) is above the standard (red line) as shown below, it is indicative of a chronic source, such as failing on-site septic systems, or cross connections with the sewer system. *(Mathieu, 2011)* Boxplots developed for Mission, Moxlie and Indian creeks all were indicative of chronic sources of fecal coliform pollutants. The example below is for Indian Creek.



In contrast when the 90th percentile (black dot) is above the standard (black dashed line) and the geomean (red diamonds) are below the red line, it is indicative of contributions from stormwater and/or other infrequent sources. *(Mathieu, 2011)* Boxplots created from Schneider, Chambers, Ellis, Greencove, Percival and Woodard creeks all presented data in this fashion. The example below is for Schneider Creek.



Outfall reconnaissance or dry weather flow analysis was conducted in 2010, 2011 and 2012 for Percival, Mission, Indian, Moxlie and Ellis creeks. This type of monitoring was performed specifically to identify potential cross connections with the wastewater system, with the assumption that late summer flows from stormwater outfalls should be negligible or non-existent in the absence of rain. During monitoring, if an outfall had any flows it was suspected of being a wastewater cross connection and was then tested for fecal coliform.

In all cases when outfall reconnaissance was performed, no dry weather flows were observed from stormwater outfalls. This suggests that chronic fecal coliform problems in these streams are more likely failing on-site septic systems. It is possible, especially in the piped sections of Moxlie Creek, that some outfalls were not identified during the outfall reconnaissance work effort.

Nutrients / Temperature / Dissolved Oxygen

Given the relationship between them, these three constituents are presented together. Excess nutrients and increased water temperatures can contribute to low dissolved oxygen. When dissolved oxygen levels fall below minimum standards aquatic organisms may alter their behavior, become stressed and/or die.

Temperature

As discussed, water temperature plays a role in low dissolved oxygen. Black Lake Ditch and Percival Creek specifically have had stream reaches listed in Ecology's 303 d. list for low dissolved oxygen. The analysis performed by Ecology, in the Deschutes TMDL, indicates that lack of riparian shade is contributing to increased temperatures and subsequent low dissolved oxygen in these systems.

Nutrients

In general, when nutrients are in excess in aquatic systems, they contribute to excess algae growth. When the algae dies and decomposes, it uses up the available oxygen in the water resulting in low dissolved oxygen. This can be exacerbated by increased water temperature because as water warms it loses capacity for holding dissolved oxygen.

Specifically in freshwater systems (i.e., streams and lakes), phosphorus is the limiting nutrient for algal growth, so when there is excess phosphorus it contributes to algae blooms and subsequent low dissolved oxygen. Excess phosphorus has been identified as a likely cause of localized water quality problems in lakes and other freshwater systems in Olympia. In one recent study, a primary source of phosphorus loading to freshwater systems has been linked to pet waste *(Hobbie, 2017).*

Other probable sources include lawn fertilizers and household detergents.

In marine systems (i.e., Budd Inlet), nitrogen is the limiting nutrient, meaning that excess nitrogen contributions in Budd Inlet is a primary contributor to algae blooms and subsequent low dissolved oxygen conditions. Other conditions, such as temperature, circulation and the contribution of other nutrients can also effect dissolved oxygen levels. This suggests further analysis of potential sources of nitrogen and nitrogen-loading estimates should be performed.

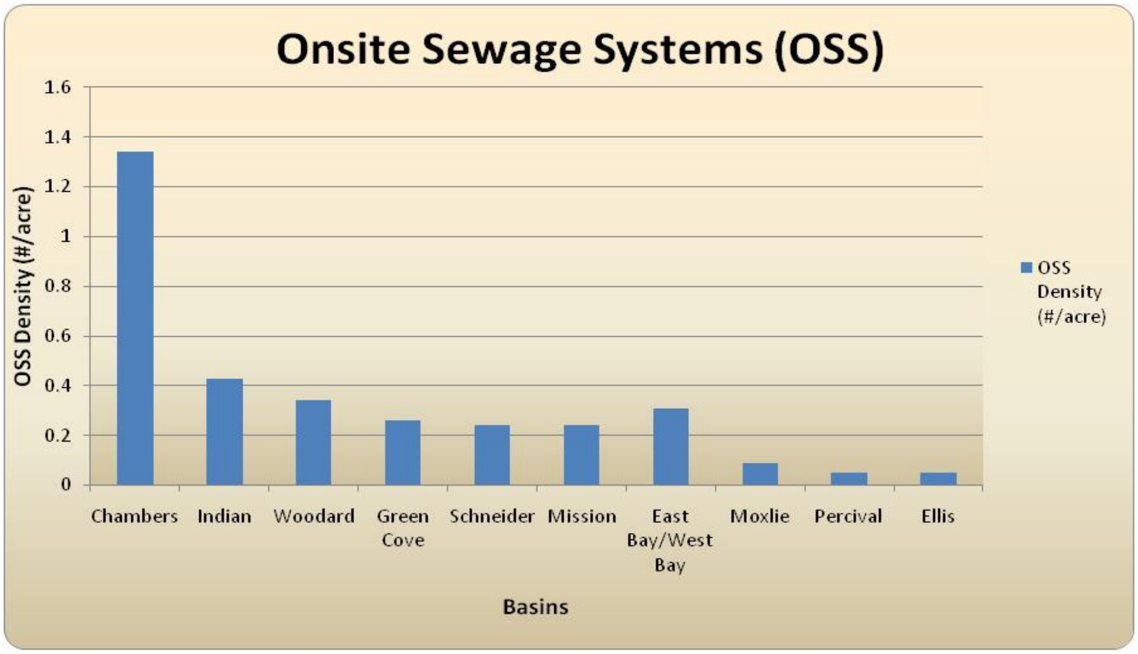
One potential source of nitrogen is from on-site septic systems (OSS). On-site septic systems are designed to reduce pollution by treating the solids, pathogens, organics, and ammonium (a form of nitrogen) in human waste before it is discharged to the soil. By design, bacteria consume ammonium and convert it to nitrate either in the drain-field or through aeration.

Wastewater treated, even by a properly functioning OSS contains significant amounts of nitrate. After leaving a properly functioning drain-field, nitrified effluent flows through soil, where it may be consumed by bacteria, flow to ground water, be used by plants and/or flow to surface water. *(Washington State Department of Health, 2014)*

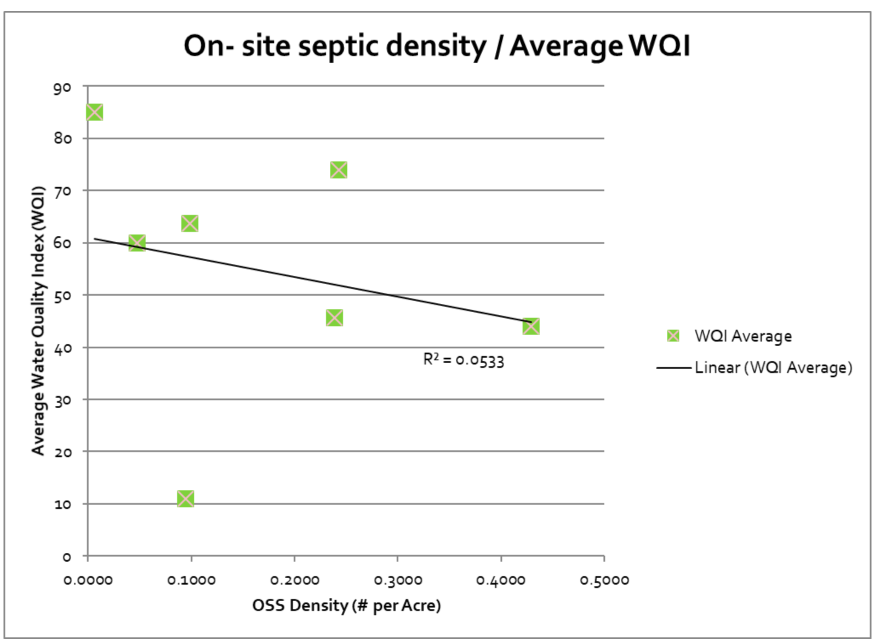
To gauge the potential impact of on-site septic systems (OSS) on low dissolved oxygen conditions in Puget Sound, the number of OSS were quantified and then converted to OSS density by basin. Table 3 and the figure below summarize this assessment.

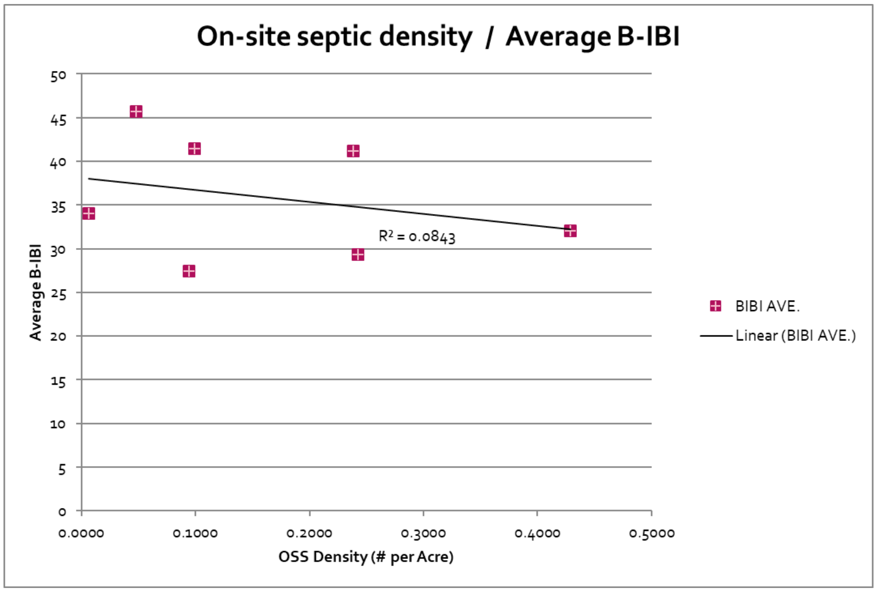
Table 3 - Onsite Sewage Systems (OSS)

BASIN	Size (Acres)	OSS (#)	OSS Density (#/acre)
Chambers	1,251	1673	1.34
Indian	1,338	574	0.43
Woodard	1,802	606	0.34
Green Cove	943	249	0.26
Schneider	634	154	0.24
Mission	407	97	0.24
East Bay/West Bay	980	305	0.31
Moxlie	1,560	147	0.09
Percival	637	31	0.05
Ellis	1,467	70	0.05



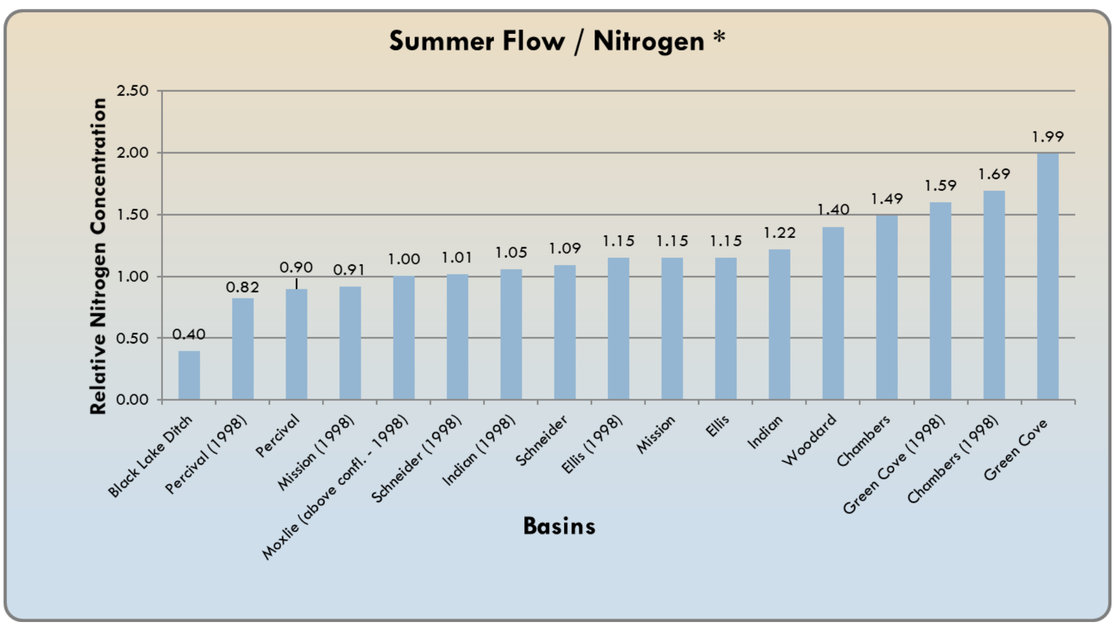
The OSS densities were then compared to water quality parameters. Linear regression analysis failed to show a correlation between OSS density and water quality impairments in the streams (as measured by average WQI and B-IBI).





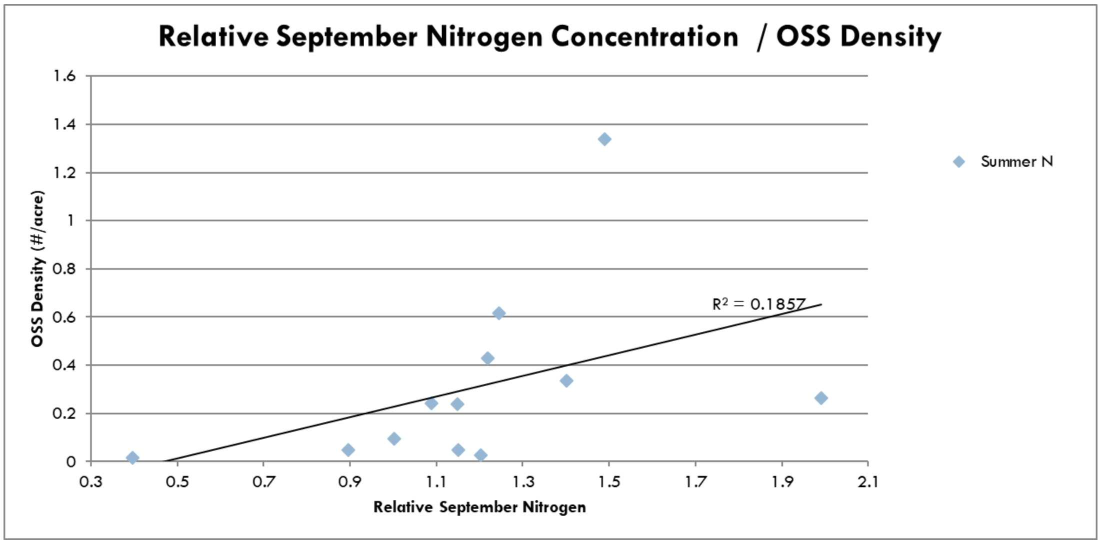
Subsequently, we performed an analysis comparing nitrogen concentrations measured in September to the average nitrogen concentrations measured over the entire year in streams. The assumption being that higher-than-average September concentration could be indicative of nitrogen contributions from OSS.

The figure below illustrates the results. Values above one indicate a September nitrogen concentration that is greater than the average nitrogen concentration for the year. This is indicative of OSS and/or sewer contributions to the base flow of a stream.



* The nitrogen concentration as measured in September (low summer flow) divided by the average annual nitrogen concentration. When the resulting number is greater than one, it illustrates which basins have base flows with relatively higher nitrogen concentrations than their average.

A relationship appears to exist between OSS density and high relative September nitrogen concentrations. However, linear regression analysis failed to demonstrate a strong correlation between high relative September nitrogen concentrations and OSS density.

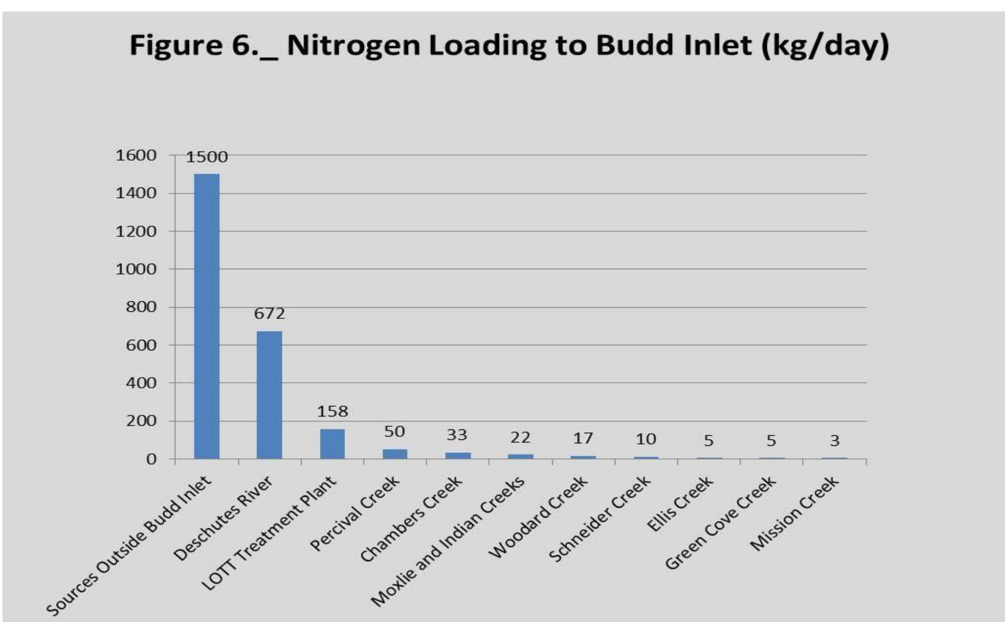


Even without a demonstrated correlation, the analysis does provide some insight regarding one potential source of nitrogen in streams.

Nitrogen Loading

Ecology's Deschutes River, Capitol Lake, and Budd Inlet Temperature, Fecal Coliform Bacteria, Dissolved Oxygen, pH, and Fine Sediment Total Maximum Daily Load Technical Report Water Quality Study Findings dated June 2012 evaluated nutrient loading to Budd Inlet.

Using methodology consistent with this study, nitrogen loads have been estimated for each stream from monitoring data obtained from Thurston County in addition to data from Ecology. The presented figure illustrates the nitrogen loads into Budd Inlet from tributary streams, the Deschutes River, the LOTT Clean Water Alliance treatment plant and sources outside of Budd Inlet. A key finding of Ecology's study was that human sources of nitrogen from outside (north) of Budd Inlet were by far the largest contribution to nitrogen loading in Budd Inlet. *(Roberts 2015) (Roberts, 2008).*



Even though our analysis has determined that tributary streams (i.e., Schneider, Mission, Ellis, Indian, Woodard and Chambers) demonstrate higher than typical nitrogen concentrations, the nitrogen loading appears to be relatively insignificant compared to other sources (i.e., Deschutes River, and sources external to Budd Inlet).

Dissolved Oxygen (DO) –Budd Inlet

Although there is a direct relationship between nitrogen loading and DO problems in Budd Inlet, it is not a perfectly linear relationship. Budd Inlet DO problems are also highly dependent on other variables, such as circulation and temperature.

Earlier modeling by Ecology *(Roberts, 2008)* focused almost exclusively on the relationship between nitrogen loading and DO. More recent modeling, considers the complex impacts of other variables showing the calculated DO deficits from these sources rather than just nitrogen loading. The graphic below demonstrates the DO deficits in the critical East Bay cell in Budd Inlet. *(Roberts, 2015).*

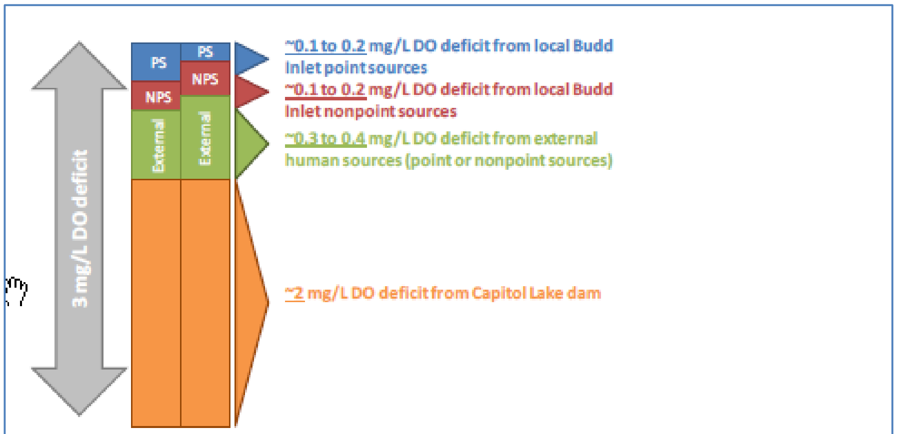
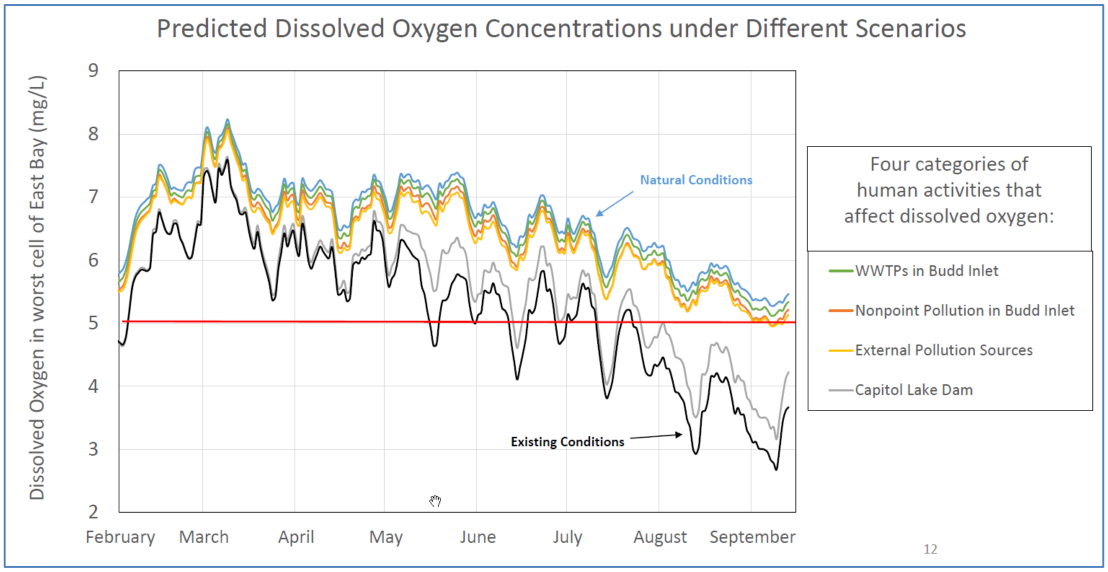


Figure 31. The estimated range of contributions to DO depletion at the critical cell in East Bay from anthropogenic activities due to various alternatives for the order of addition to, or subtraction from, other sources.

Additional modelling by Ecology in 2015-2016, further quantified the DO depletion attributed to these other sources. The chart below shows the relationship between these sources and DO depletion over the course of a year. The red line indicates the minimum standard for DO in Budd Inlet. This chart was from a presentation by Ecology staff to the Deschutes Advisory Group in summer and fall of 2016. Ecology continues to refine their models and anticipate drafting allocations by the end of 2017.



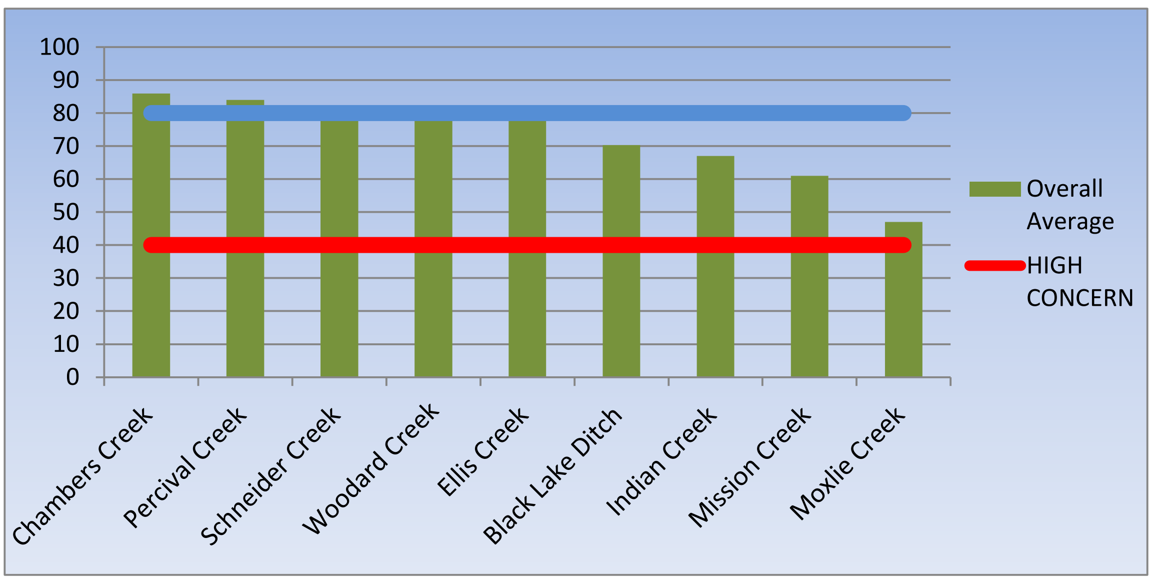
Indexing and Trend Analysis

Water Quality Index

Water Quality Index (WQI) scores are created using Ecology's guidelines and water quality data collected by Thurston County Environmental Health. WQI is a unitless number ranging from one to 100. Higher numbers are indicative of better water quality. For temperature, pH, fecal coliform bacteria and dissolved oxygen, the index expresses results relative to levels required to maintain beneficial uses according to criteria specified in WAC 173-201A. Results are expressed relative to expected conditions for nutrient and sediment measurements in a given ecoregion, where standards are not specific. Multiple constituents are combined and results aggregated over time to produce a single score for each sample station. The following table provides water quality index (WQI) data for each of Olympia's streams.

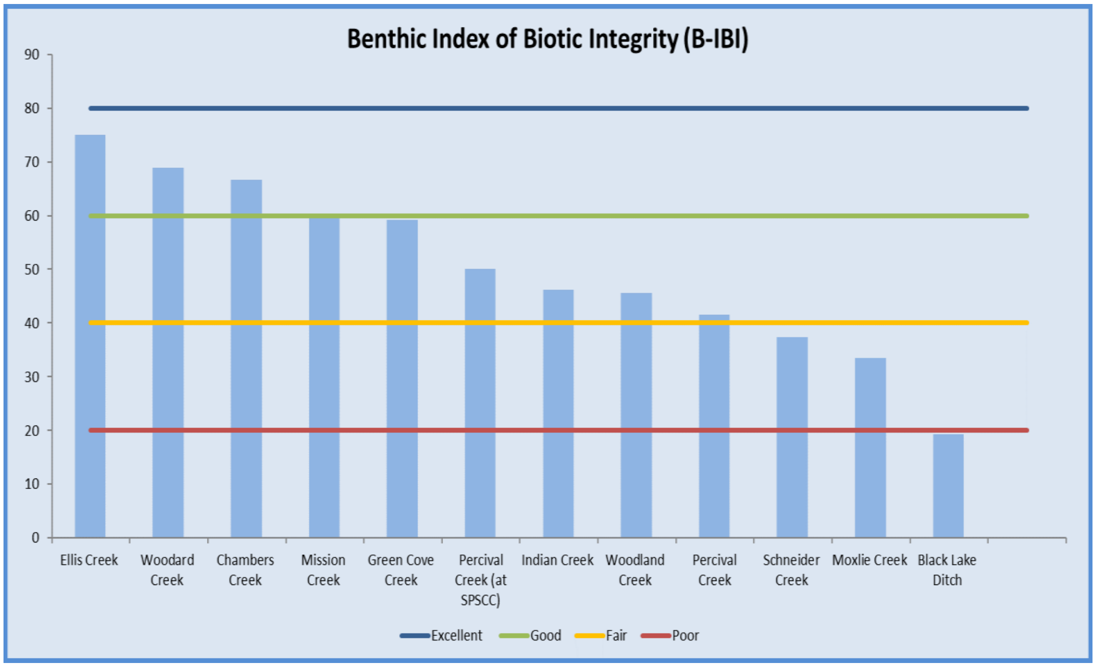
Given that Water Quality Index scores are a combination of numerous constituents, weighted through a complex algorithm, the scores are best used as a measure of relative stream water quality (an index), as opposed to a specific indicator of impairment.

The table below presents the overall average WQI (2009-2015) of streams monitored in Olympia. Most streams (Chambers, Percival, Schneider, Woodard and Ellis) fall in range of "low concern" (80 or above). The remaining monitored streams fall in the range of "moderate concern" (between 40 and 80).



Benthic Index of Biotic Integrity (B-IBI)

Thurston County Environmental Health Department and the Stream Team collective agencies collect benthic macro invertebrate (B-IBI) data for select streams. These data have been collected consistently on most of our streams every year since 2003. The addition of this biological evaluation of surface waters provides a broader approach to water quality monitoring supplementing the chemical evaluation (WQI). The macro invertebrate populations respond to the range of conditions throughout the year giving a more holistic indication of overall stream integrity. Similar to WQI, the B-IBI is most useful as a relative measure between streams and/or to measure stream health over time.



Scores above 80 have excellent biological integrity, comparable to least disturbed reference condition; overall high taxa diversity, particularly of mayflies, stoneflies, caddis flies, long-lived, clinger, and intolerant taxa. Relative abundance of predators high. There are currently no streams in Olympia that meet these criteria.

Scores between 60 and 80 have "good" biological integrity, slightly divergent from least disturbed condition; absence of some long-lived and intolerant taxa; slight decline in richness of mayflies, stoneflies, and caddis flies; proportion of tolerant taxa increases. Ellis, Woodard, Chambers and Mission creeks all meet these criteria.

Scores between 40 and 60 have "fair" biological integrity, with intolerant, long-lived, stonefly, and clinger taxa reduced; relative abundance of predators declines; proportion of tolerant taxa increases. Percival, Indian and Woodland Creeks all meet these criteria.

Scores less than 40 have "poor" biological integrity, with overall taxa diversity depressed; proportion of predators greatly reduced as is long-lived taxa richness; few stoneflies or intolerant taxa present; dominance by three most abundant taxa often very high. Schneider and Moxlie Creeks are within these criteria.

Scores less than 20 have "very poor" biological integrity, Overall taxa diversity very low and dominated by a few highly tolerant taxa; mayfly, stonefly, caddis fly, clinger, long-lived, and intolerant taxa largely absent; relative abundance of predators very low. Black Lake Ditch falls in this category. (Morley, 2000)

Conclusions & Recommendations

After reviewing and analyzing the available monitoring data and reviewing available research performed by Ecology and others, three primary surface water quality problems have become apparent.

- Run off from pollution generating impervious surfaces
- Fecal contamination
- Excess nutrients / temperature / dissolved oxygen

Pollution Generating Impervious Surfaces:

Our own analysis demonstrates a strong correlation between vehicle use and downstream water quality problems. This is consistent with research performed by Ecology and others.

Sediment entering and captured by the stormwater system is considered a surrogate for pollutants being generated by impervious surfaces. Some pollutants attach to sediment particles and are transported and removed as sediment is managed and collected.

As such, the Utility proposes to focus program efforts on reducing or eliminating pollutants before they enter the roadway and/or storm system. These include:

- Targeted business pollution prevention (specifically restaurants and automotive related)
- Raising general environmental awareness and behavior changes with individuals (car repair, lawn care, pet waste management)
- Spill awareness, reporting and cleanup response.

Similarly, construction of new stormwater infrastructure and maintenance programs can be focused on reducing, capturing and removing sediment (and their associated pollutants) from the stormwater system. Tons of sediment removed annually is proposed as a tangible metric to measure the Utility's effectiveness in managing the impacts of pollution generating impervious surfaces on downstream water quality.

Programmatically this will include:

- Targeted construction of new stormwater treatment in areas with highest traffic counts
- Enhanced street sweeping to prevent sediment and pollutants from entering the system
- Strategic catch basin and storm system cleaning
- Enforcement of sediment and erosion control requirements on construction sites
- Inspection and maintenance compliance on private storm water systems

Fecal Contamination

Through analysis of monthly fecal coliform testing data, boxplot analysis and outfall reconnaissance, the Utility feels relatively confident that we understand the sources of our worst fecal contamination. Although the Utility acknowledge the continued possibility of finding cross connections with the wastewater system, it appears that the chronic sources of fecal contamination are most likely failing on-site septic systems in the Mission, Indian and Moxlie creek basins. Other infrequent contributions found in all basins will most likely be linked back to non-point sources such as pet waste that end up being transported into the streams via the stormwater system.

We anticipate that chronic fecal coliform contamination problems will be primarily solved through collaborative efforts with the Wastewater Utility, LOTT Clean Water Alliance, neighboring jurisdictions, as well as individual property owners, through some type of on-site septic inspection and maintenance program.

Other infrequent fecal contamination problems are likely associated with stormwater runoff from pollution generating surfaces and/or domestic animal/wildlife sources. The Utility anticipates continuation of residential non-point pollution prevention programs (e.g. pet waste pickup education programs), improvements in stormwater treatment, and enhanced street sweeping to reduce fecal coliform pollutant loading from these sources.

Nutrients / Temperature / Dissolved Oxygen

Phosphorus concentrations have at times been identified as a cause of localized water quality problems primarily in freshwater systems (i.e., streams and lakes). As discussed, pet waste, household detergents and fertilizers are believed to be the primary sources of excess phosphorus.

Recent regulations have reduced or eliminated phosphorus from household detergents (RCW 15.54.500) and lawn fertilizers (RCW 70.95L) throughout Puget Sound. The utility intends to enhance our current pet waste management programming to be more targeted in specific basins. These changes and programs are expected to greatly reduce water quality problems in freshwater systems.

As previously discussed, Ecology continues to refine their modeling of DO in Budd Inlet, expanding their initial analysis to a more complex model that evaluates DO deficits.

A water cleanup plan (TMDL) with specific DO waste load allocations based on this analysis is forthcoming from Ecology.

Besides the low dissolved oxygen problems in Budd Inlet, Black Lake Ditch, Percival Creek, Woodard Creek, Woodland Creek have all been listed on the 303.d list for dissolved oxygen. Dissolved oxygen problems in Black Lake Ditch and Percival Creek are assumed to be associated with higher stream temperatures. Proposed solutions focus on increased or enhanced shade along these streams, while recognizing the constraints associated with warmer water draining from Black Lake. Tree planting and other riparian enhancements along all of the streams within Olympia are warranted.

Although beyond the scope of this white paper, the Utility intends to further develop basin specific recommendations to address the three primary pollutions problems:

- Pollution generating impervious surfaces;
- Fecal coliform contamination; and
- Nutrients, temperature, dissolved oxygen.

These basin specific implementation plans are proposed to be developed after the adoption of the Storm and Surface Water Master Plan.

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