# STATE OF THE ISLAND'S WATERS

Second Edition – 2019

Dripping Water (*C'txa*) Creek, Restored Streambed

CITY OF
BAINBRIDGE ISLAND

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# 1 EXECUTIVE SUMMARY

Welcome to the second edition of the State of the Island's Waters Report. This report provides an update to the first edition State of the Island's Waters, 2012 [1], by presenting a 'snapshot' of water quality, quantity and biologic health of the surface and marine water resources in Bainbridge Island's 12 watersheds during water year 2017 (October 2016-September 2017) as well as an overview of noteworthy observations and trends from the data collected since the first edition.

The City of Bainbridge Island (City) collects information on water quality, water quantity, and biologic activity which help us understand the state of our surface waters. In addition to data collection, the City shares data with external sources such as The Bainbridge Island Watershed Council, Washington State Department of Health, Kitsap Public Health District, Washington State Department of Ecology and others. This data collection and compilation lets us perform a more complete analysis of the data and informs the need to address specific stressors and prioritize watersheds for improvement projects as well as provide educational reports, such as this one, to the public.

New to this edition is the use of indices to help compare sites' water quality relative to one another and other streams in the region. Notable is the addition of an index developed by the Washington State Department of Ecology (Ecology) simply named the Water Quality Index (WQI). [2] The index is used to help compare fresh water data from one stream to another and from year to year. Due to the large amount of data available only a small subset could be displayed in this report. To review all the data gathered by the City and manipulate interactive graphs please visit: Water Quality Data Web Portal

## Key Findings

Since the last State of the Island's Waters report, we have observed some improvements in water quality parameters whiles others have been on the decline. Previously, over 90% of the sampled streams failed the standard for bacteria, and now only 87% fail the standard. Also, the overall average level of bacteria in the streams has been decreasing from high of 479 (CFU) in 2014 to 118 (CFU) in 2017. Using bacteria as a surrogate for other pollutants, we can be hopeful that efforts to correct failing septic systems and reduce mismanagement of livestock manure and pet waste in the environment has been somewhat successful.

Since 2012 water temperatures in the streams have increased slightly, resulting in more annual maximum temperatures exceedances, measurements above the standard of 16 degrees Celsius [8]. The combination of increased development and the conversion of streamside vegetation into landscaping and garden areas has led to more sunlight reaching the surface of fresh water bodies and increased warm stormwater runoff from hard surfaces and roofs flowing to the streams. Freshwater above 16 degrees begins to impair fish and other organisms adapted to cooler water.

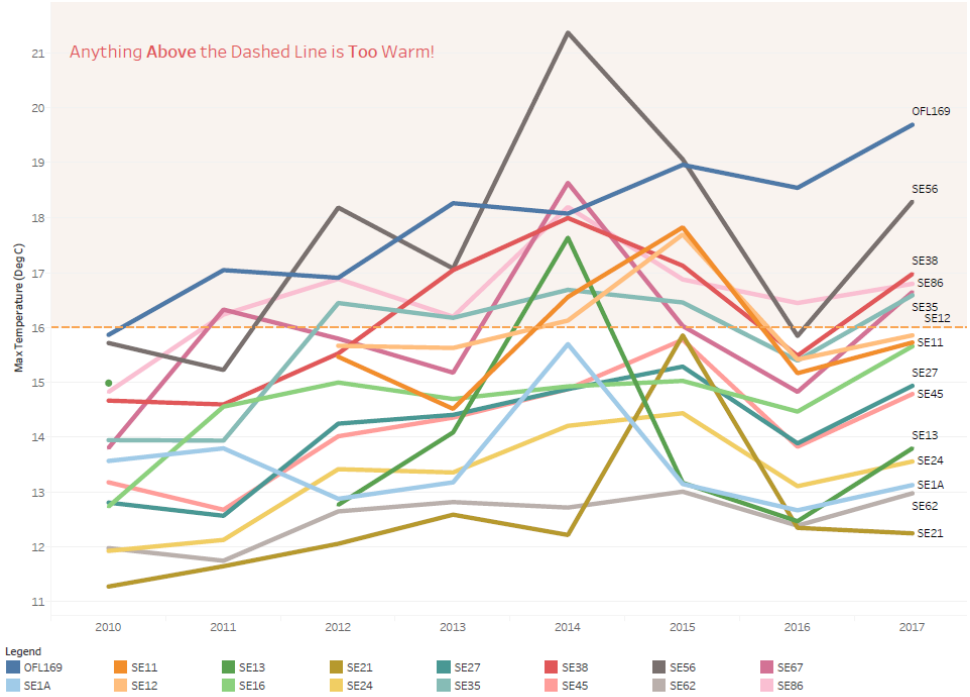



Figure 1. In-Stream Water Temperature, maximum annual, all sites 2010-2017

Another important finding is that streams with higher temperatures experience faster increases in bacteria growth and less dissolved oxygen. Just as we need adequate oxygen to breath, fish and other in-stream animals require dissolved oxygen to survive. As temperature increases there is a direct correlation with decreased dissolved oxygen levels. We know that the shading provided by stream-side trees is paramount to preserving cool, oxygenated stream water. In addition to shading, keeping stream flows higher (more volume) helps to retain cool temperatures in stream water and higher turbulence adding to dissolved oxygen content.

The City is working toward retaining adequate flow by monitoring stream level and furthering the understanding of the groundwater-surface water connection. These actions will become more necessary as local climate change impacts stress groundwater resources and more wells draw more groundwater to the surface. Some simple things that any community member can do to help mitigate this is to conserve water where possible and considering how our water use, mainly irrigation, can affect the health of our in-stream habitat. One simple takeaway from this report is, if you want to do your part to improve the state of our Island's waters:

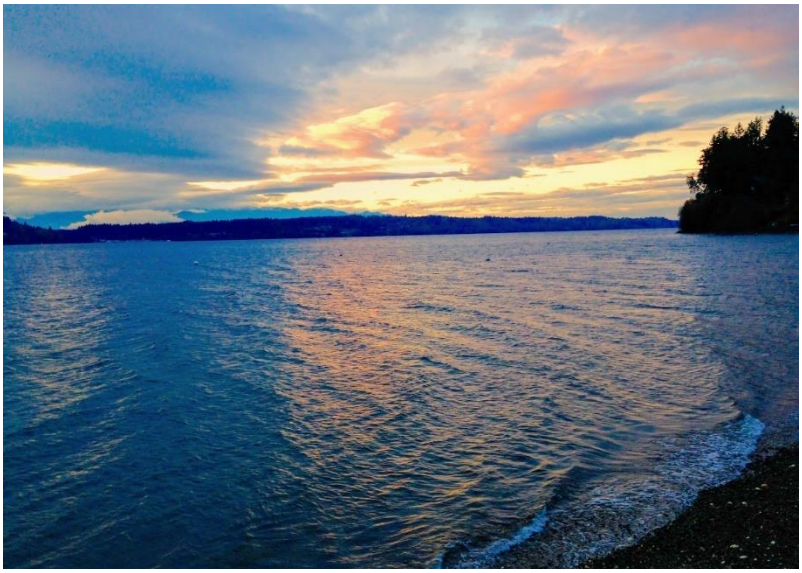
**Plant Trees Near Streams and Irrigate Less**

By focusing on healthy streamside vegetation and water conservation we will help our small streams retain the ability to buffer against stress and remain places for aquatic organisms to live during our challenging environmental future.

# 2 THE WATER RESOURCE

The fresh and marine waters on and around Bainbridge Island provide a place for children to play, for people to collect drinking water, and gather food. This is why we monitor the quality and quantity of water that moves through the water cycle and interacts with our Island.

As an Island, we are familiar with the forces of water all around us and we must be cognizant of how our actions constitute a force as well. We ride the ferry or use the bridge to cross salt water, we don a rain jacket on many days of the year to stay dry, and we turn on the kitchen faucet to fill a glass of water. Yet infrequently we don't stop to think about how each of these actions are connected. How the rainwater that falls is the same water that has travelled through the soil, descended the aquifers and has been pumped back up to surface, ultimately pushed to your faucet.



Marine Waters of Fletcher Bay Watershed

As resources managers charged with keeping the water cycle healthy and balanced, the City of Bainbridge Island works to understand how the elements of the three-dimensional watershed are affected by the actions that humans take while living within our island landscape. One way we do this is by collecting data on water resources such as streams, aquifers and marine waters.

In order to help simplify the vast amounts of data collected and present the relative health of each watershed, this report presents findings from the Washington State Water Quality Index (WQI) [2] as well as the Benthic Index of Biological Integrity (B-IBI), where available. An index helps us combine sets of varying data types into one number that is easily understandable and comparable. Note that in both scales, higher numbers represent healthier ecosystems.

The WQI has been identified as a way to judge whether we are making progress towards the goals of improving the health of Puget Sound. The regional goal is to have half of all monitored sites to score on the higher end of the Index (>80) by 2020 [25].

# 3 MONITORING SITES

Surface water monitoring sites are spread evenly throughout the island, targeting larger stream systems with perennial flow. They are visited monthly by volunteers or city staff to collect water samples and measure water chemistry. For more information on how and why these sites were selected, see the 2008 Water Quality and Flow Monitoring Program Plan on the City's website: https://www.bainbridgewa.gov/555/Water-Quality-Flow-Monitoring-Program-Pl

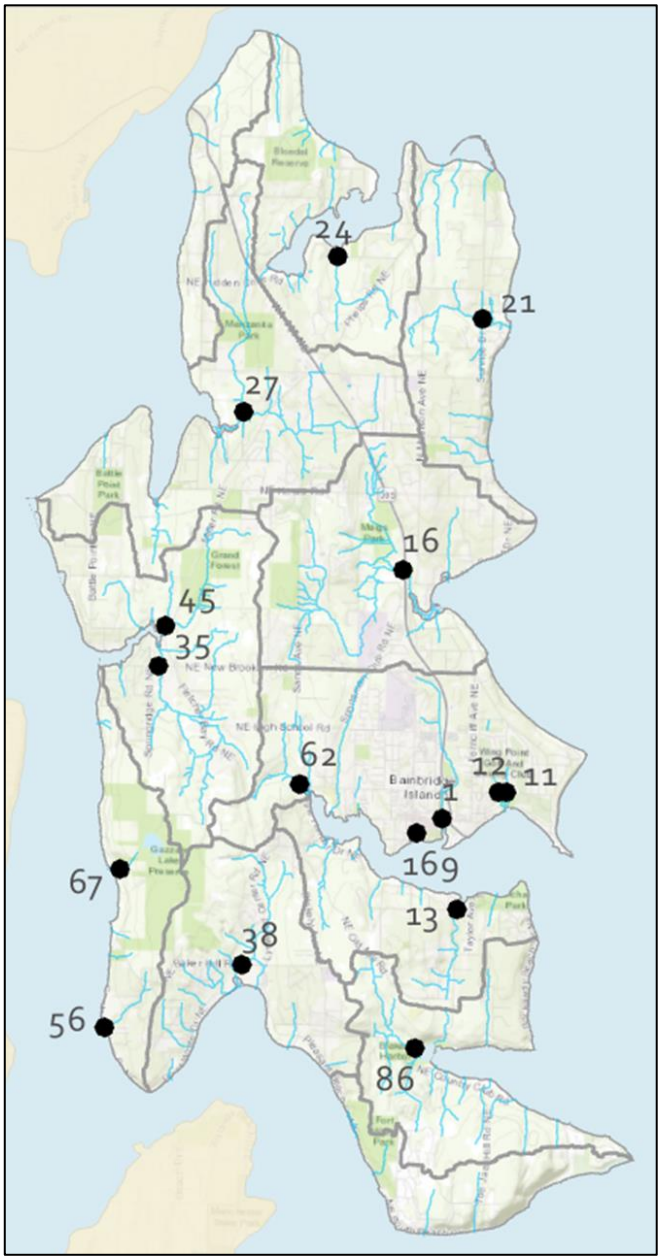



*Figure 2. City of Bainbridge Island Surface Water Monitoring Sites (Site ID minus SE or OFL prefix)*

# 4 GETTING INTO THE DATA

To highlight some of the key findings this section will present only index scores, grades and bacteria averages and trends. For more information on what the index scores say about the condition of the stream or for a deeper dive in the bacteria data please visit the following watershed sections or Appendix I and Appendix III.

Table 1 summarizes the WQI and B-IBI for water year 2017 and is sorted by compound grade from high to low. The compound grade is based on the compound index , an average from the Water Quality Index and Biologic Index (B-IBI), where available. For visual reference, the location of the stream is identified by Site ID on the map in Figure 2, above.

| Site ID | Stream | Water Quality Index | Biologic Index | Compound Index | Compound Grade |
|---|---|---|---|---|---|
| 21 | Dripping Water | 69 | NA | 69 | **B-** |
| 24 | Coho | 66 | NA | 66 | **C+** |
| 67 | Gazzam | 63 | NA | 63 | **C+** |
| 11 | Hawley East | 61 | NA | 61 | **C+** |
| 35 | Springbrook | 55 | 63.5 | 59.25 | **C** |
| 62 | Cooper | 73 | 42.8 | 57.9 | **C** |
| 12 | Hawley West | 56 | NA | 56 | **C** |
| 45 | Issei | 55 | 55.5 | 55.25 | **C** |
| 27 | Manzanita | 50 | 54 | 52 | **C-** |
| 13 | Whiskey | 65 | 25.9 | 45.45 | **D+** |
| 86 | Mac's Dam | 42 | NA | 42 | **D+** |
| 16 | Murden | 44 | 30.8 | 37.4 | **D** |
| 1 | Ravine | 63 | 10.9 | 36.95 | **D** |
| 56 | Lindquist | 25 | NA | 25 | **F** |
| 38 | Schel Chelb | 9 | NA | 9 | **F** |
| 169 | Madrone | 1 | NA | 1 | **F** |

*Table 1. Index Summary and Grades, Water Year 2017 (Oct 2016-Sept 2017) Sorted by Compound Grade. Yellow indicates moderate conditions, red indicates poor conditions.*

Another common measure of water quality is based on the amount of Fecal Coliform bacteria present in the water. Table 2 shows the average (geometric mean) bacteria levels for 2017, whether the stream met part one or two of the Washington State standard for bacteria [Appendix II] and the long-term trend of bacteria in the stream. We can see that Cooper, Coho and Dripping water scored relatively well on both tables 1 and 2, showing overall intact watershed conditions and good water quality while Lindquist and Mac's Dam fell on the lower end of both tables indicating continued stress on watershed and poor water quality in both stream systems. It should be noted that Madrone stream (169) is a former stream, currently utilized as a stormwater conveyance system made up of pipes and catch basins in downtown Winslow.

| Site ID | Stream Name | Bacteria geomean | Meets part One | Meets part Two | Bacteria Trend |
|---|---|---|---|---|---|
| 62 | Cooper | 16 | Y | Y | Steady |
| 38 | Schel Chelb | 18 | Y | Y | Improving |
| 24 | Coho | 22 | Y | N | Improving |
| 11 | Hawley, East | 31 | Y | N | Improving |
| 21 | Dripping Water | 40 | Y | N | Improving |
| 67 | Gazzam | 44 | Y | N | Steady |
| 16 | Murden | 54 | N | N | Improving |
| 1 | Ravine | 56 | N | N | Improving |
| 13 | Whiskey | 61 | N | N | Improving |
| 12 | Hawley, West | 67 | N | N | Improving |
| 35 | Springbrook | 96 | N | N | Steady |
| 27 | Manzanita | 112 | N | N | Improving |
| 45 | Issei | 121 | N | N | Improving |
| 86 | Mac's Dam | 123 | N | N | Worsening |
| 56 | Lindquist | 199 | N | N | Worsening |
| 169 | Madrone | 2036 | N | N | Steady |

*Table 2. Bacteria Geomean based on data from Water Year 2017 (Oct 2016-Sept 2017)*
*Bacteria Trend based on all available data, table sorted by Bacteria Geomean*

# 5 WATERSHEDS

Bainbridge Island's topography divides the island into 12 watersheds, often named after a special feature in the watershed or the water body that is the receiving water for the watershed.

- Agate Passage
- Blakely Harbor
- Fletcher Bay
- Gazzam Lake
- Manzanita Bay
- Murden Cove
- North Eagle Harbor
- Pleasant Beach
- Port Madison
- South Beach
- South Eagle Harbor (Eagledale)
- Sunrise

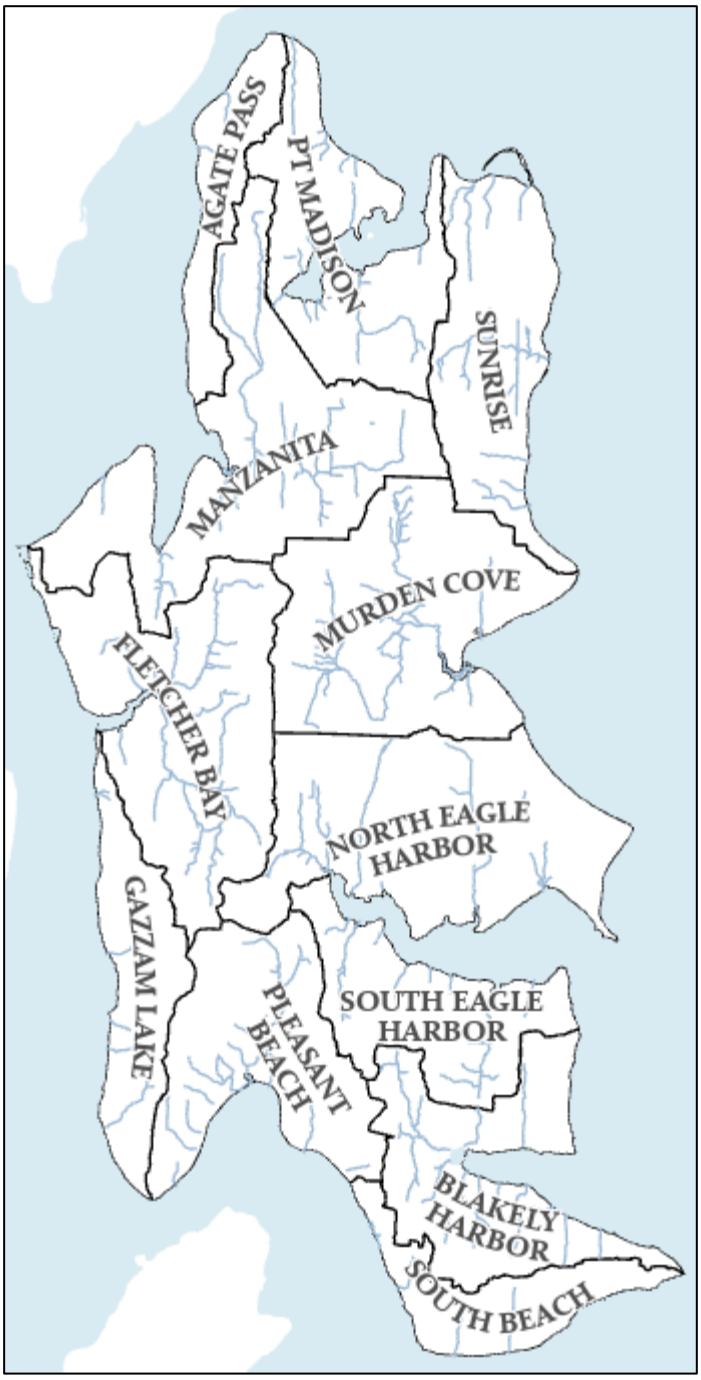


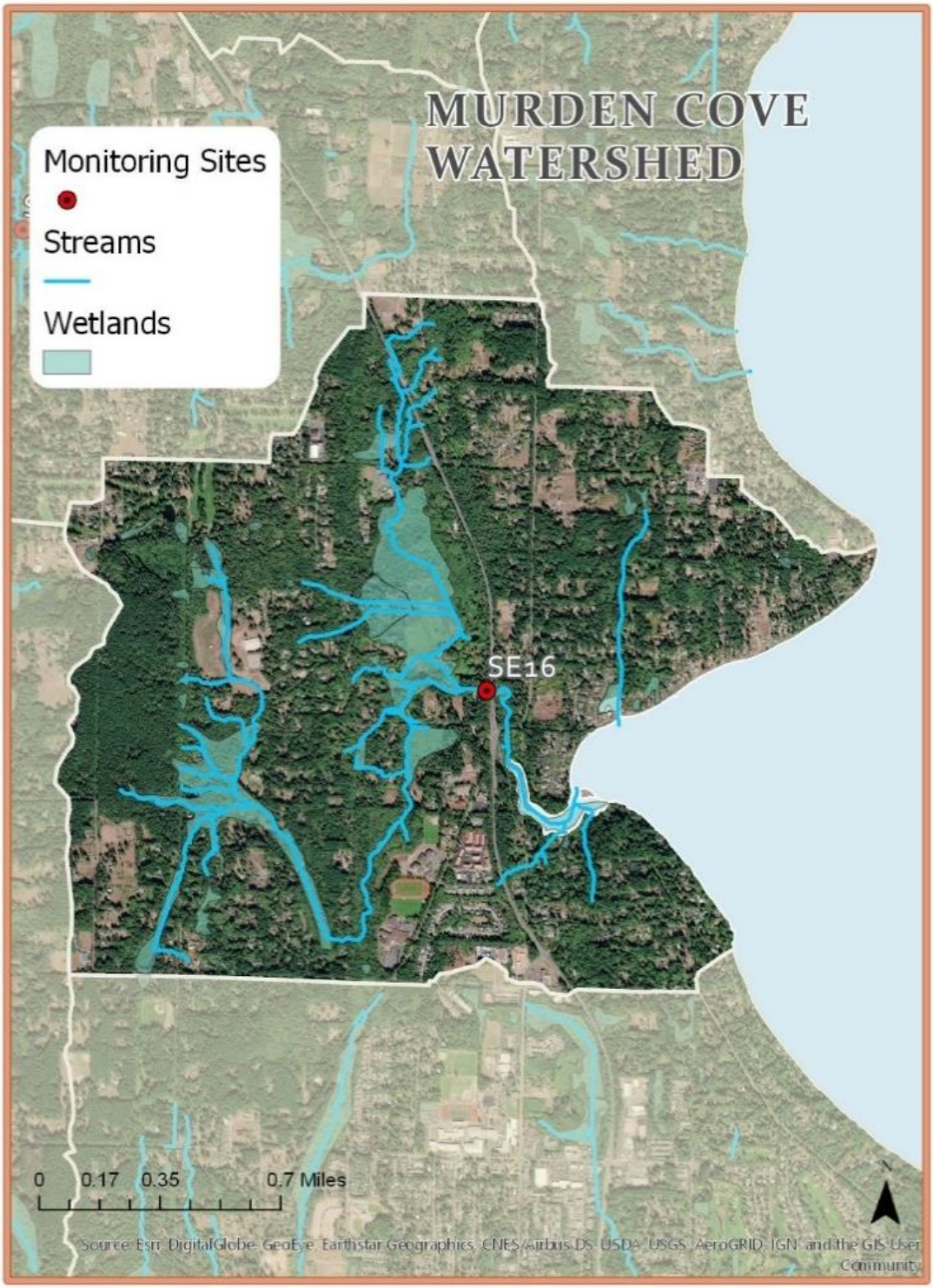

*Figure 1. The 12 Watersheds of Bainbridge Island*

Watersheds help us plan and analyze on a smaller scale than the entire island, and to better examine how changes in the landscape affect the quality of water in a stream and adjacent marine water.

By understanding changes in the landscape, we can better explain trends in the data we collect and relationships to trends in development. One recent study by DeGasperi [6] shows us how forest removal contributes to the increase in detrimental, high pulse-like flows in streams and a lower abundance of some insect communities important to fish diet. Our watersheds are also the designated areas that the City will use to plan and prioritize for water quality improvement projects, based on the level of potential for successful ecosystem recovery [21].

Next, sites will be presented by watershed (clockwise around the island beginning with Murden Cove) with introductory information for watersheds containing more than one monitoring site.

# 6 MURDEN COVE WATERSHED



## 6.1 Murden Creek (SE16)

WQ Index **44 Moderate**

B-IBI Index **31 Poor**

Compound Index **37 D**

One of the top three salmon streams on the island, Murden Creek (*Doe-qud-sake-qub*) dominates the Murden Cove watershed.

The City monitors water quality monthly at this site (SE16) on the west side of higway SR 305.

Even though a focused water quality improvement project was undertaken in the Murden Cove watershed from 2013-2015 that corrected pollution sources and reduced bacteria loads [4], the area still struggles with many stresssors including a history of cleared wetlands, mismanged livestock manure, aging septic systems, and an expanding commercial district. These stressors combine to create increased water temperatures, high bacteria counts (Figure 2), and low dissolved oxygen levels.

*Figure 1. WADOH Growing Area Report 2017*

These poor water quality parameters translate to low biological index scores. With a negative trend over the course of all available data (Figure 3) Murden Creek continues to present a poor habitat for insects living in the stream. Fortunately this fact is not true for the upper reaches of Murden Creek. A limited set of B-IBI samples in Woodward Creek, a major tributrary to Murden Creek, indicated relatively intact insect habitat and better condidions for fish to live.

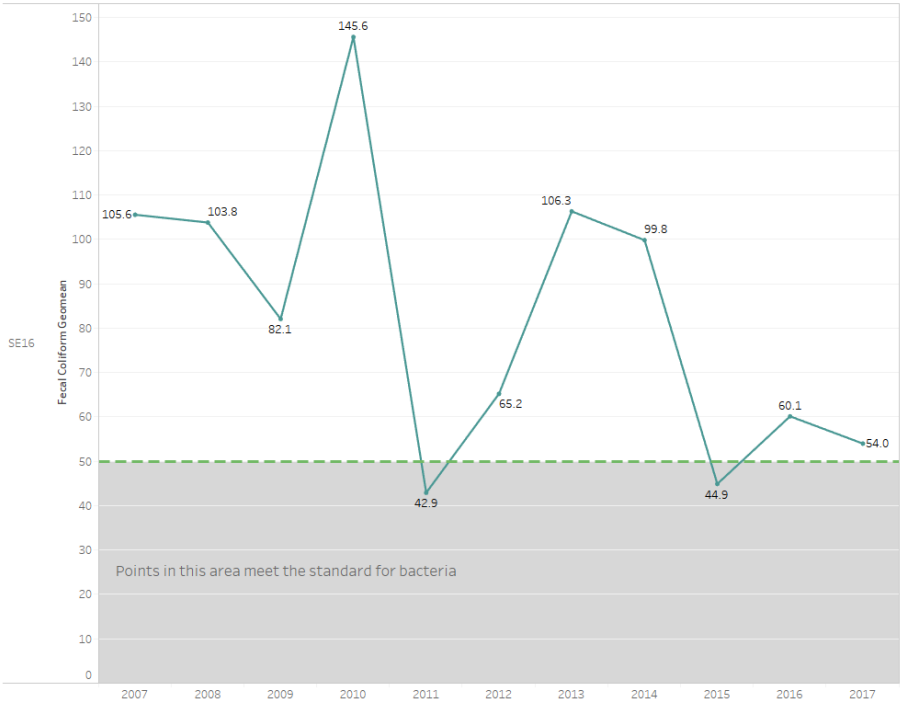



*Figure 2. Bacteria averages compared to part 1 of the standard*

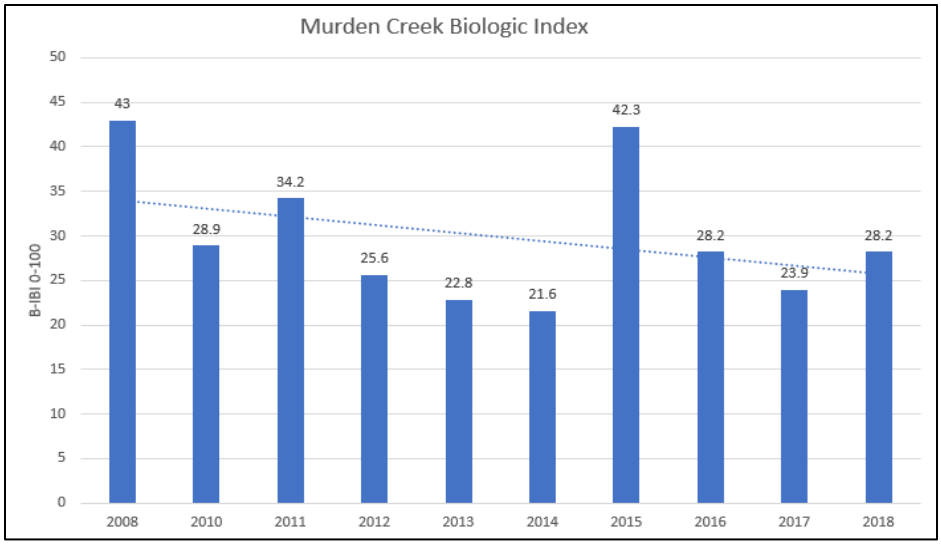



*Figure 3. Murden Creek B-IBI trend 2008-2018*

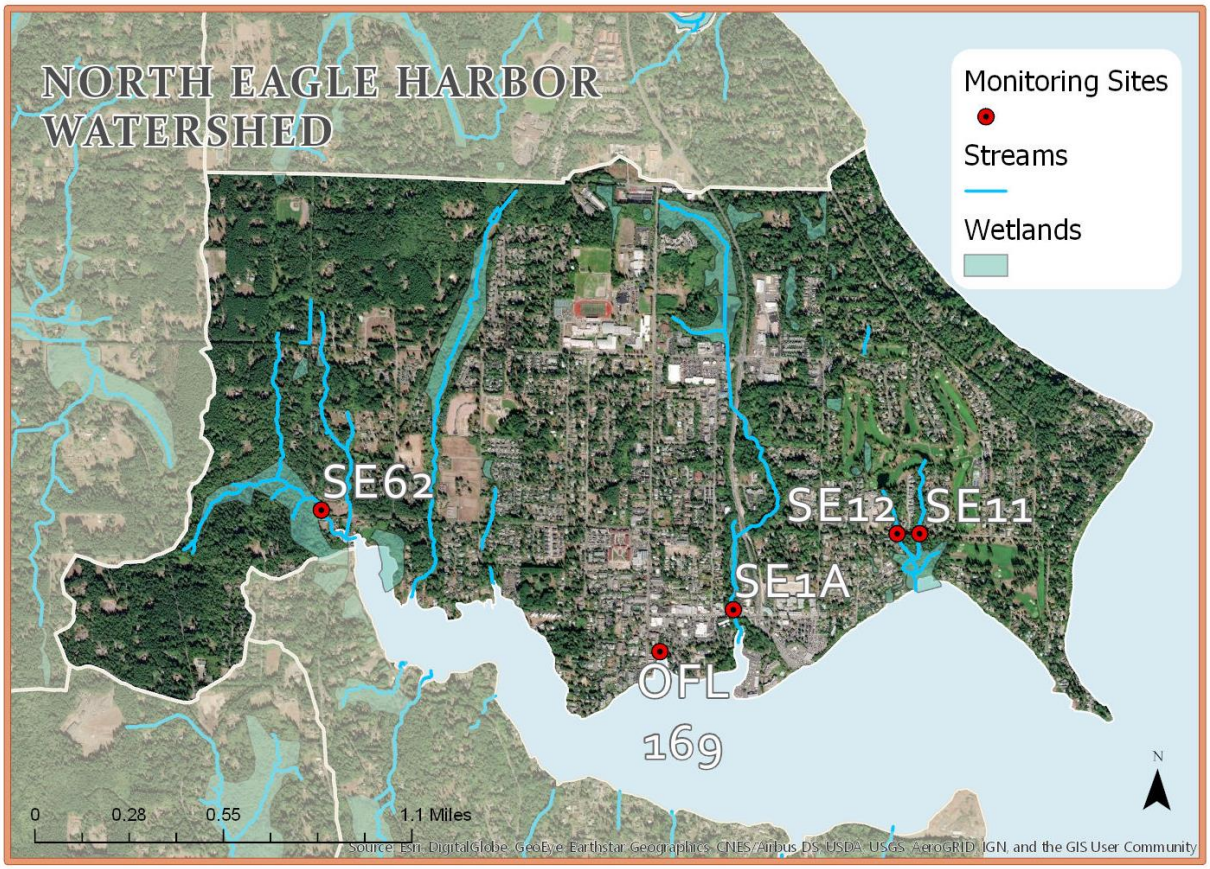
To help fish get to those healthy upper reaches and improve water quality the City recently replaced an undersized culvert with a small bridge (Figure 4) and added bioswales along Wardwell Road to mitigate pollution generated by automobiles. Fish may still have a hard time reaching the upper watershed due to a partial barrier culvert under highway SR 305, downstream of this location. Currently the Washington State Department of Transportation (WADOT) is working on a design is to correct this barrier.

Murden Creek and Murden Cove are both identified by the State Department of Ecology's Water Quality Assessment Program as impaired due to high bacteria levels as well as periods of excess algae, this identification by the State puts the water bodies on a list known as the 303(d) list for impaired waters. The Kitsap Public Health District (KPHD) has identified and corrected multiple failing septic systems, helping to alleviate some of the sources.

*Figure 4. Fish passage culvert under Wardwell Road, upgraded 2017*

Despite high bacteria levels in the stream, shellfish harvesting is currently approved on beaches in most of the watershed except near the northern extent where the Messenger House sewer system outfalls to Puget Sound (currently inactive due to a closure of the facility) (Figure 1).

# 7 NORTH EAGLE HARBOR WATERSHED




With the greatest concentration of development, North Eagle Harbor watershed also has the greatest number of monitoring sites; four surface water sites and one stream/stormwater outfall. This watershed is unique because it hosts streams with both the lowest and highest water quality on the island.

Cooper Creek (SE62), on the west side of the watershed, is fed by an intact forested wetland complex and produces cold, clean water year-round. Former Madrone Creek (OFL169), was a seasonal drainage that once naturally ran through Winslow but is now contained in a below ground pipe. Stormwater from the downtown Winslow core and Madison Avenue is directed into this pipe which discharges water into Eagle Harbor with very high bacteria counts. Other streams in this watershed have been heavily altered as well. The east and west forks of Hawley Creek (SE11, SE12 respectively) both run through the Wing Point Golf Course and surrounding neighborhoods. A series of pipe and ponds lacking vegetated buffers contribute to poor water quality in these systems.

Along with current pollution contributions, legacy pollution from historic industrial uses has closed Eagle Harbor to shellfish harvesting. Eagle Harbor is included on the State's 303(d) list of impaired waters.

## 7.1 Ravine Creek (SE1A)

WQ Index **63 Moderate**

B-IBI Index **10.9 Poor**

Compound Index **36.95 D**

The water of Ravine Creek spends much of its time in closed pipes and culverts (Figure 5). It flows through a long pipe under High School Road and then under highway SR 305 twice before reaching a final culvert under Winslow Way.

As the Island's most urbanized stream system, Ravine Creek suffers from sudden high-flows causing erosion and inputs of polluted stormwater known as the "Urban Stream Syndrome" [20]

*Figure 5. Culvert under Winslow Way and flow sensor*

Temperature and oxygen levels in Ravine Creek are relatively good despite the urban nature of this watershed. Insect health does not share the same outcome, showing the negative effects of stormwater discharges entering the stream untreated. The stream is currently on the State's 303(d) list for impaired waters due to high bacteria levels. Since 2009, bacteria levels have decreased some but continue to fail state water quality standards (part 1 and 2).

Many changes have occurred in the Ravine Creek watershed since the last State of the Island's Waters report. At the headwaters, development has converted historic tree farms into light industrial buildings. Closer to the mouth of the system, the Sound to Olympics non-motorized transportation trail has been constructed parallel to highway SR 305, crossing the stream twice, increasing impervious area in the watershed. A large business complex including a bank, drug store and medical clinic have been built on the east side of the creek, adding large, private stormwater management systems.

Sediment sampling in Ravine Creek and nearby Eagle Harbor reveals increased levels of pollutants such as motor oil, diesel, zinc, and some plastic additives. Sampling of shellfish tissue in Eagle Harbor shows similarly high levels of pollution even compared to many sites in the greater Puget Sound (Figure 6). Some of this pollution is most likely legacy from the Wyckoff Superfund Site (see the Eagledale watershed section for more information).

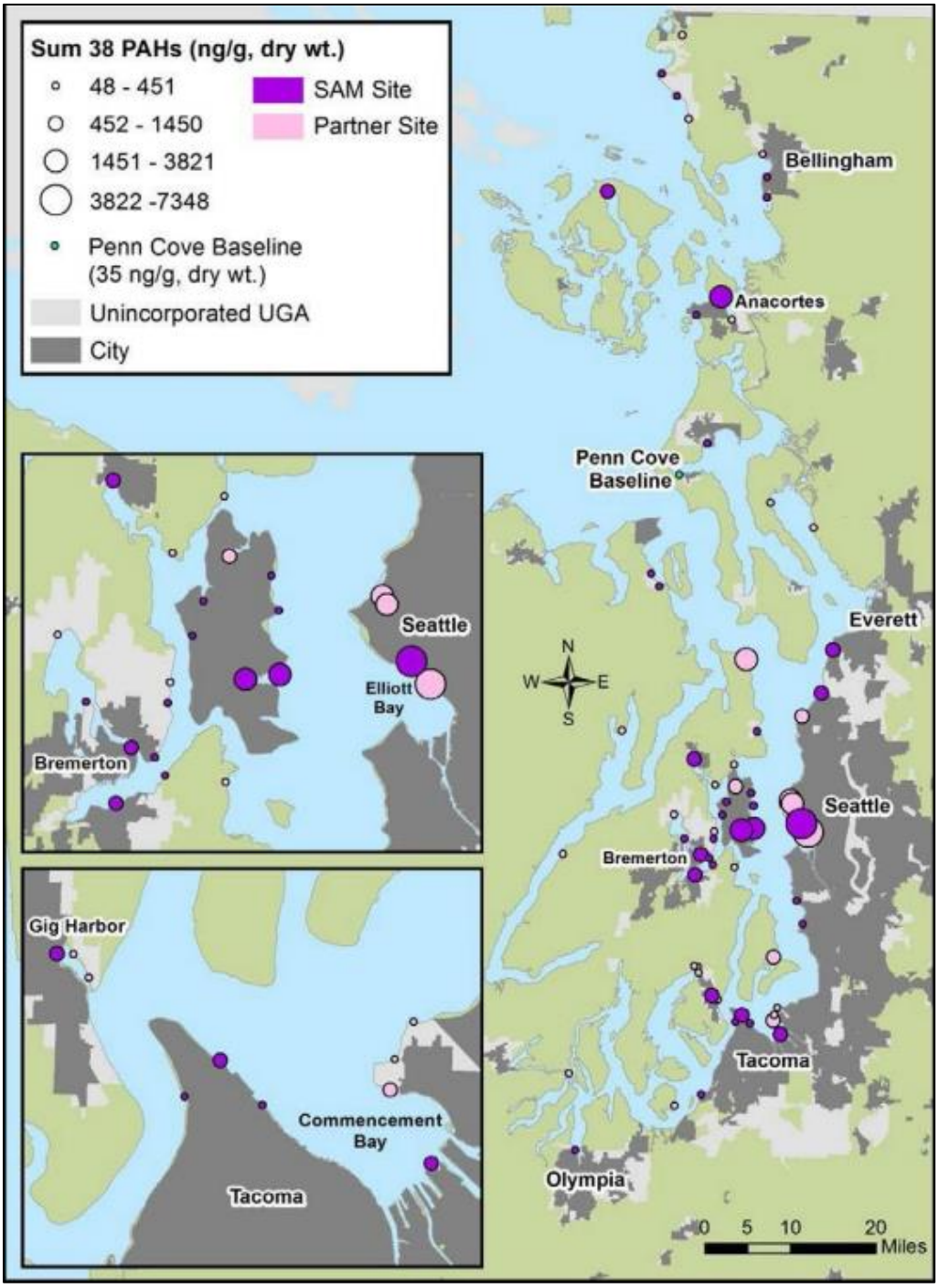



*Figure 6. Mussel (shellfish) Tissue Pollutant Levels 2016, Larger circles represent higher concentration of PAH's, a family of chemicals found tar, creosote, and soot [8]*

## 7.2 Cooper Creek (SE62)

WQ Index **73 Moderate**

B-IBI Index **42.8 Poor**

Compound Index **57.9 C**

The watershed draining to Cooper Creek is one of the least developed basins on the island. Therefore, we would expect water quality to be very good, and it is.

We use this site as a benchmark for water quality when assessing other streams' data. The B-IBI score was not as high as usual this year, its 10-year average score is 50.6, a single point behind our highest scoring creek Manzanita. The WQI did agree with our expectations this year, scoring the highest out of all the sites.

*Figure 7. Cooper Creek's natural riparian conditions*

Stormwater pollutants were found at relatively low levels compared to other streams except for certain pollutants such as chromium and a plasticizer (bis2phalate) that were present during water year 2014 targeted storm sampling.

Water level in the stream is monitored at this location by telemetry, an automated sensor that relays information wirelessly to City Hall. This information is crucial because it helps the City know if it is pulling too much water out of the ground at its nearby drinking water well field, lowering the stream level.

Recently the City participated in a test to find out if the wells near Cooper creek could extract more water during the winter, when water is plentiful and less in the summer by transferring production to deeper wells. The results were promising [18].

A salmon supplementation project was undertaken in 2009 and returns of Chum salmon were observed in 2012 but have tapered off since then [17] (Figure 8).

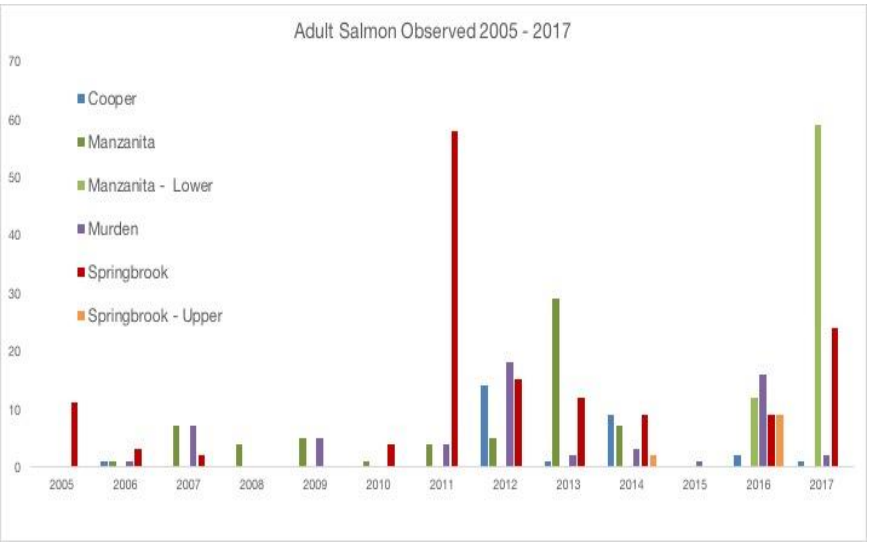



*Figure 8. Bainbridge Island Watershed Council Salmon Data*

## 7.3 HAWLEY, EAST (SE11)

WQ Index **61 Moderate**

B-IBI Index NA

Compound Index **61 C+**

With headwaters near the intersection of High School Road and Ferncliff Avenue, this east fork of Hawley Creek spends much of its course navigating culverts, pipe systems and constructed ponds. Finally running under Wing Point Way and out though Hawley Cove Park, the east fork of Hawley Creek supports relatively average physical water quality parameters such as temperature, dissolved oxygen and pH.

Dissolved oxygen levels fall below standards during some of the summer months while the west fork fails to meet standards during most of the summer months. This is most likely due to the small size of these creeks. Nutrients and bacteria also have some impact on the overall water quality.

## 7.4 HAWLEY, WEST (SE12)

WQ Index **56 Moderate**

B-IBI Index NA

Compound Index **56 C**

The west fork of Hawley Creek also flows through a golf course and residential neighborhoods, spending time in pipes and ponds. As the smaller of the two tributaries, this site tends to have higher temperatures and lower oxygen levels in the summer. Combine this with higher than average bacteria counts and spikes in nutrient levels, results in the West fork scoring slightly lower on the Water Quality Index than the east fork.

Increasing development and infill has continued to add stressors to these small creeks. The only improvements to water quality has come from a recent upgrade of the stormwater sewer system in Wing Point Way. In 2017, the City installed stormwater teatment filters to help remove pollutants that accumulate on the roadway (Figure 9).

*Figure 9. Example of the stormwater filters installed at Wing Point Way*

## 7.5 MADRONE OUTFALL (OFL169)

WQ Index **1 Poor**

B-IBI Index NA

Compound Index **1 F**

As the only stormwater outfall monitored on the island on a monthly basis, OFL169, also known as the Lower Madison Brien Bjune Outfall or former Madrone Creek, has the poorest water quality in the monitoring network.

Very high bacteria levels are consistently observed at this monitoring point as well as very high water temperatures in the summer. While other streams reflect the ups and downs of the ambient air temperature on a seasonal timeframe, water temperature at OFL169 has been steadily trending upwards, likely due to the increased levels of asphalt (Figure 11).

*Figure 10. Largest Outfall Pipe in Winslow*

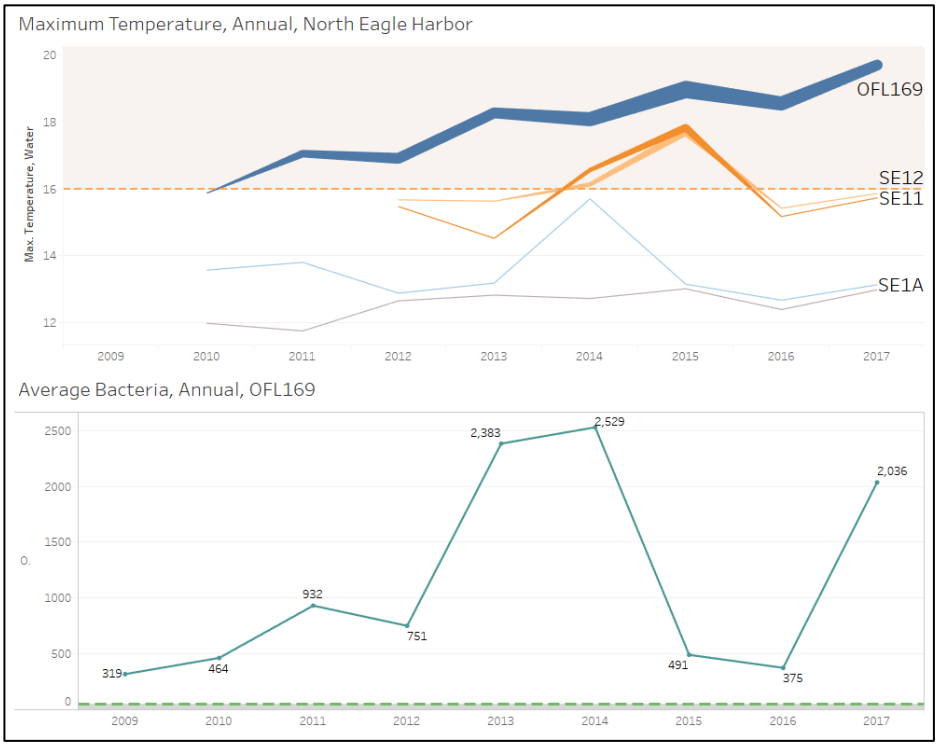
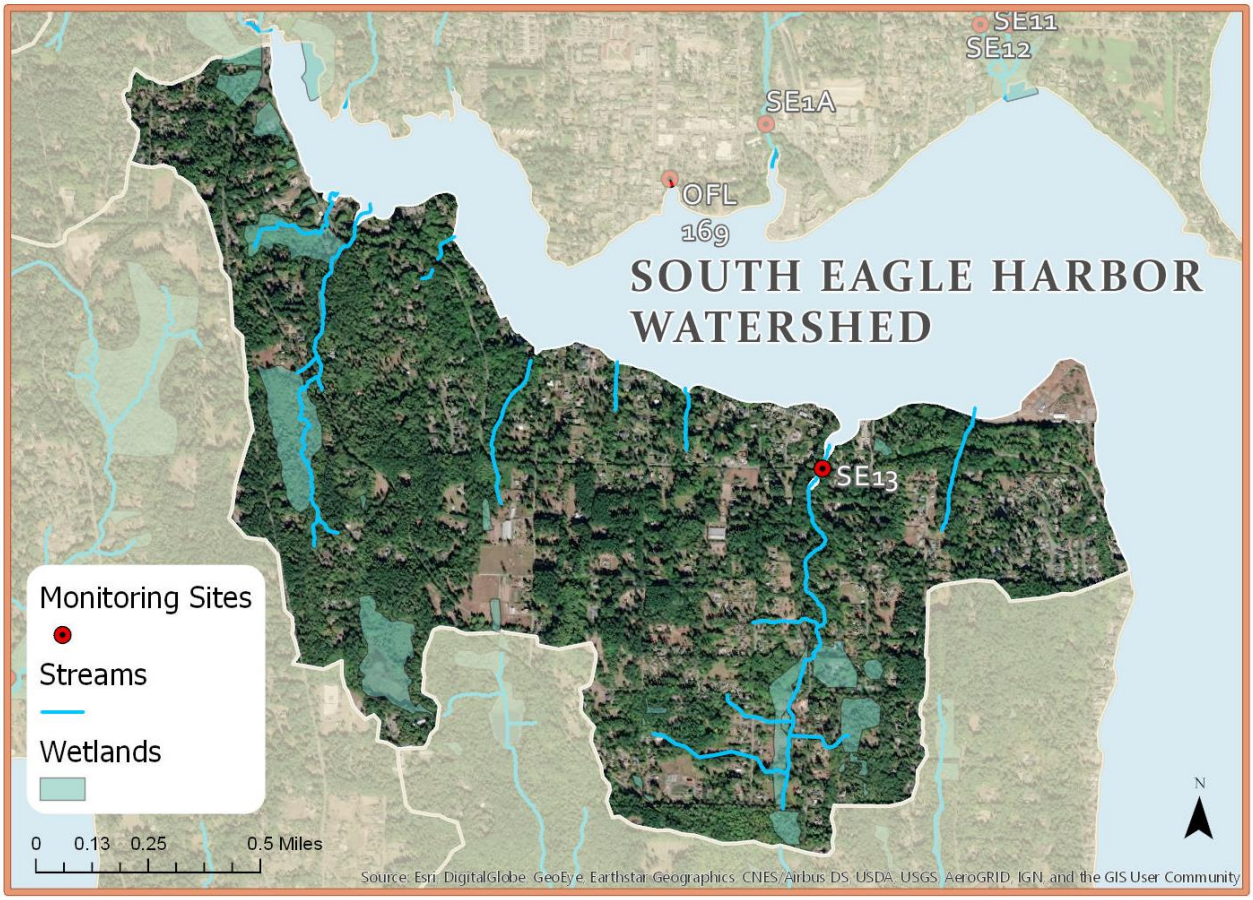



*Figure 11. North Eagle Harbor Stream temperatures (top) OFL169 Bacteria (bottom) 2009-2017*

# 8 South Eagle Harbor (Eagledale) Watershed




## 8.1 Whiskey Creek (SE13)

WQ Index **65 Moderate**

B-IBI Index **25.9 Poor**

Compound Index **45.45 D+**

The waters of Whiskey Creek flow through the historic neighborhood of Eagledale before entering Eagle Harbor from the south. Like many streams, bacteria levels are high but otherwise water quality is relatively good, only exceeding temperature and oxygen standards breifly during the dry season. Though water quality is above average, the Biological Index (B-IBI) shows significant impact from pollution over the years. Aging septic systems are a potential source of pollution due to the age of many of the houses in the area.

Ocean-going fish use is limited due to the culverts under Eagle Harbor Drive near the mouth of the creek. The Washington State Department of Fish and Wildlife has calculated a Priority Index Score of over 20 for this culvert system, making it a high priority for an upgrade to a more fish-friendly design. [10]

Another notable water quality stressor in the South Eagle Harbor Watershed is the ongoing cleanup of Wycoff Superfund Site located Bill Point. Cleanup efforts have been underway at the former Wyckoff Wood Treatment Plant for 28 years [11]. Though much work has been done to remove and contain the contaminated soils, a failing sheet-pile perimeter wall and underground seepage has led to a need for new solutions (Figures 12 and 13). The next phase of the cleanup is planned to start in 2019.

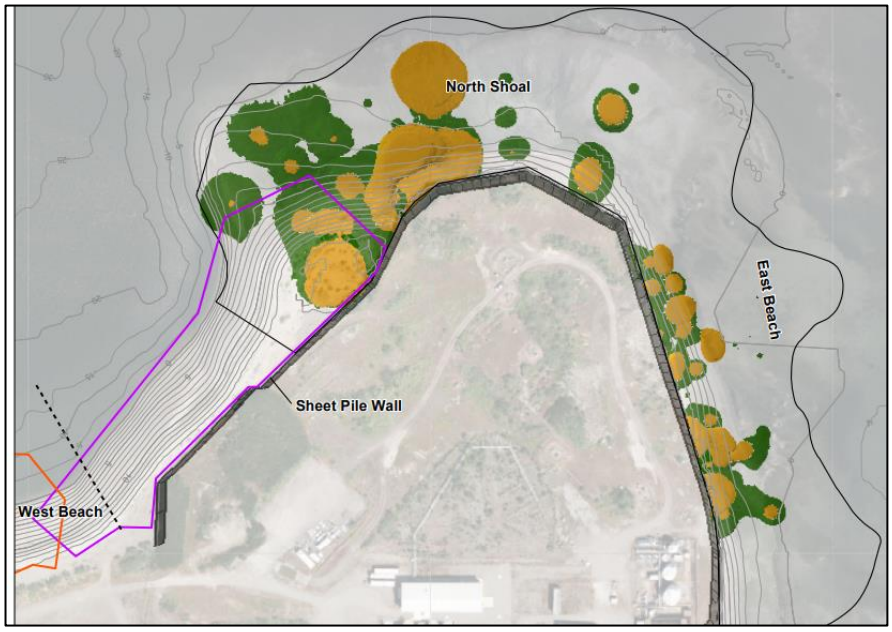



*Figure 12. Wyckoff Superfund Site, estimated subsurface pollution outside of the containment wall*

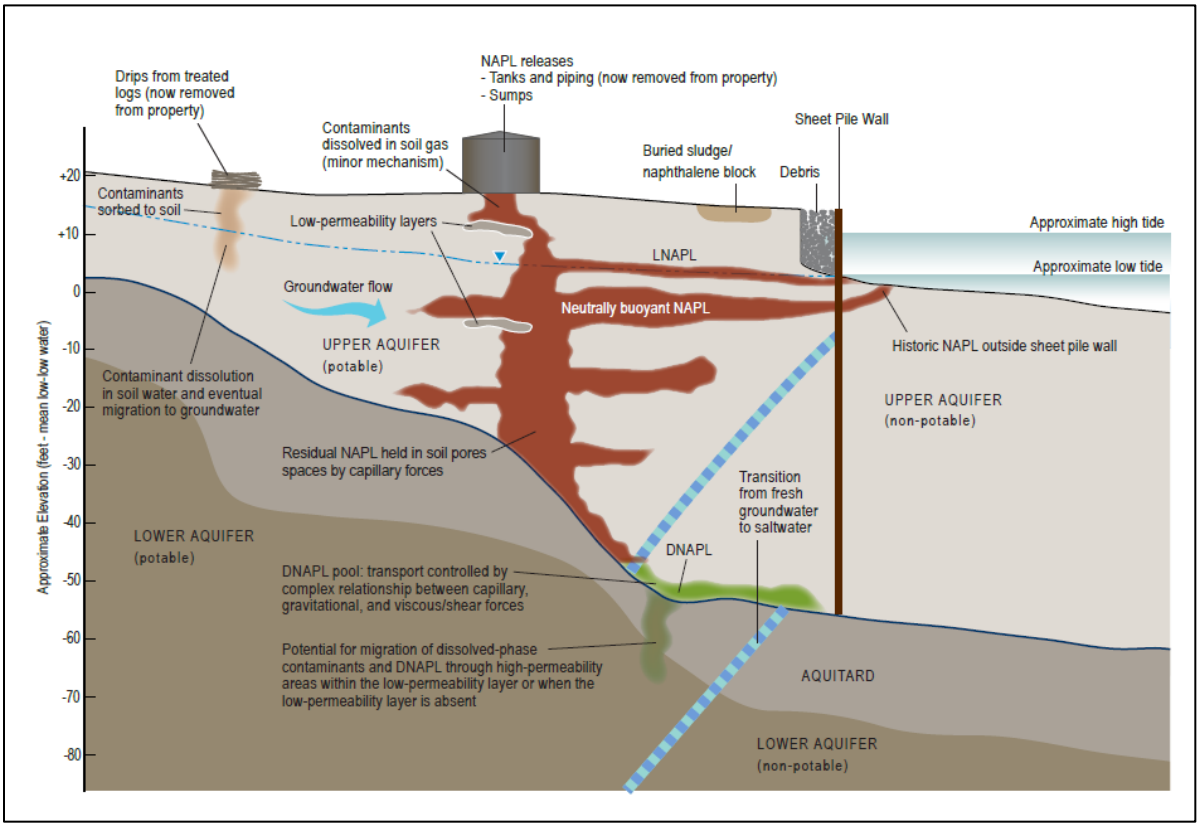
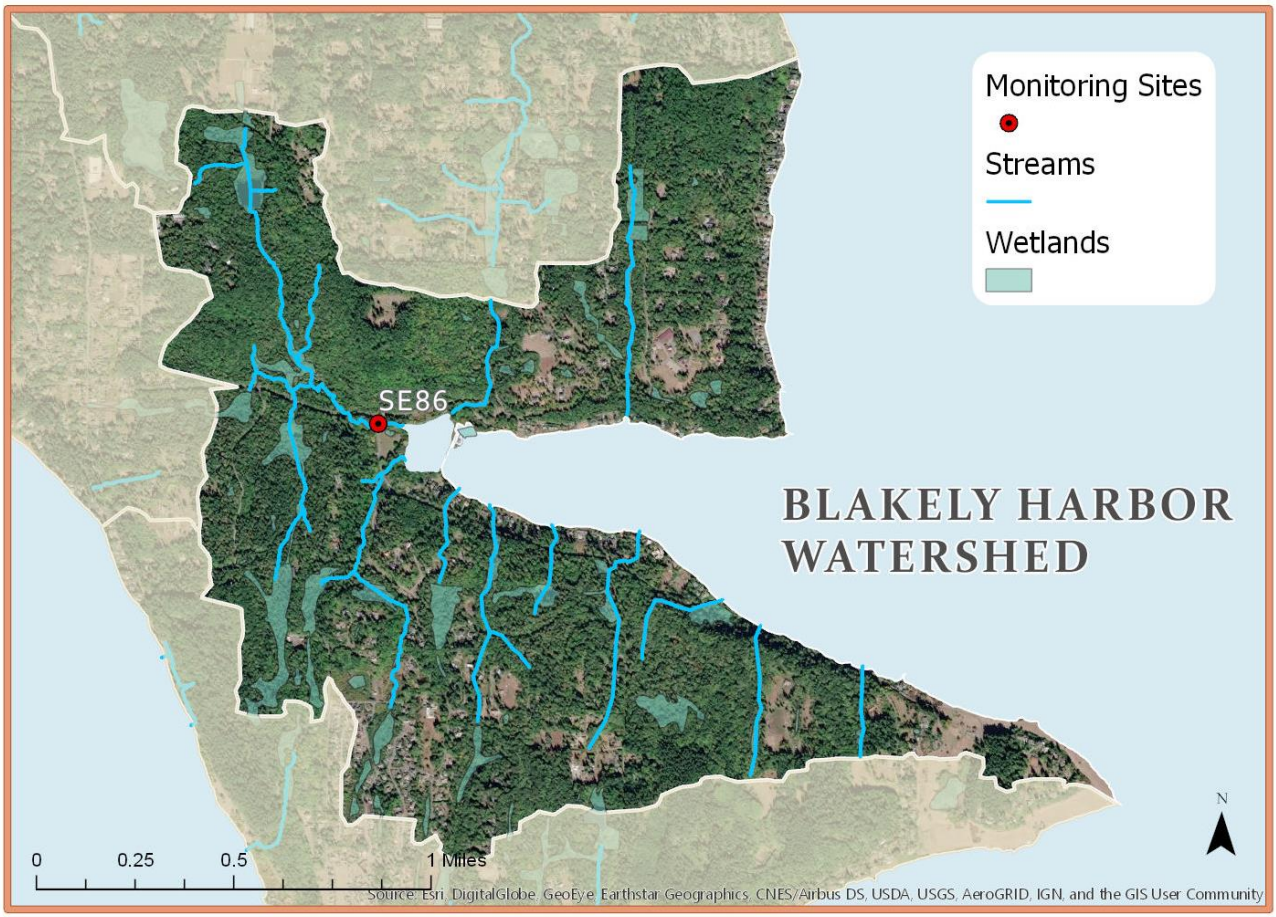



*Figure 13. Wyckoff Superfund Site, cross section of subterranean pollution.*

# 9 BLAKELY HARBOR WATERSHED




## 9.1 MAC'S DAM CREEK (SE86)

WQ Index **42 Moderate**

B-IBI Index **NA**

Compound Index **42 D+**

The City monitors one stream system in the Blakely Harbor Watershed. Site SE86 on Mac's Dam Creek is directly below the last culvert, under Country Club Road.

Bacteria levels at this site are generally low meeting part 1 of the state standard (50 CFU/100ml) five out of the

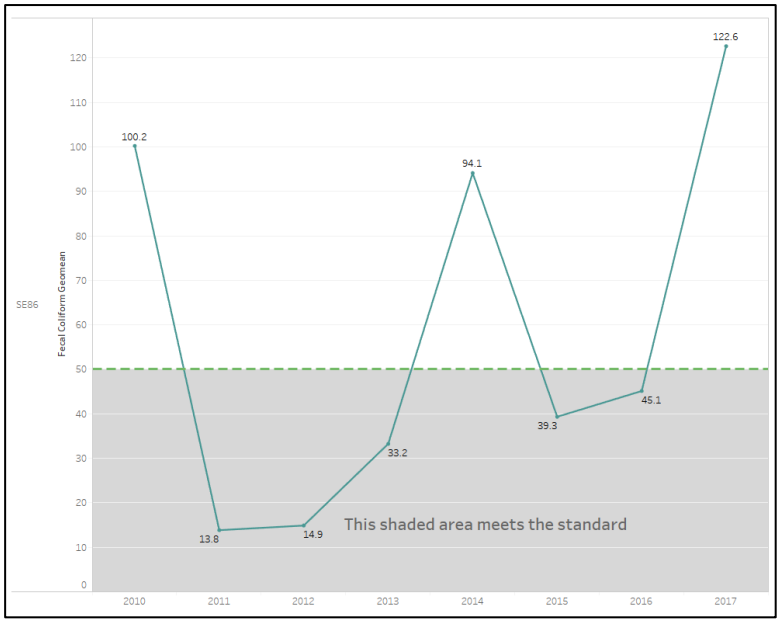



*Figure 14. Bacteria levels and part 1 of the State standard*

last eight years (Figure 14). Bacteria level spikes in 2010 and 2014 follow trends in other streams while a spike in 2017 is somewhat unique.

Seven out of the eight Washington State Department of Health's (WADOH) marine monitoring sites show acceptable levels of bacteria while one station on the inner south side of Blakely Harbor (site 418) is showing above average bacteria levels and has been downgraded from approved to concerned by WADOH (Figure 16) [12].

Though shellfish harvesting is approved based on bacteria levels other legacy contaminents are present in the sediment that may impact the marine water quality and shellfish tissue. Sediment sampling in 2013 reveals that Blakely Harbor has the highest levels of lead, copper and aluminum found during the study.

Currently the stormwater input to the Harbor is minimal, but historically the Harbor housed a large sawmill and associated industrial processes. Pollution in the Habor's marine floor sediment is most likely left behind by activities of the past. Shellfish harvesters should be aware of these facts.

*Figure 15. Monitoring Site Mac's Dam Creek (SE86)*

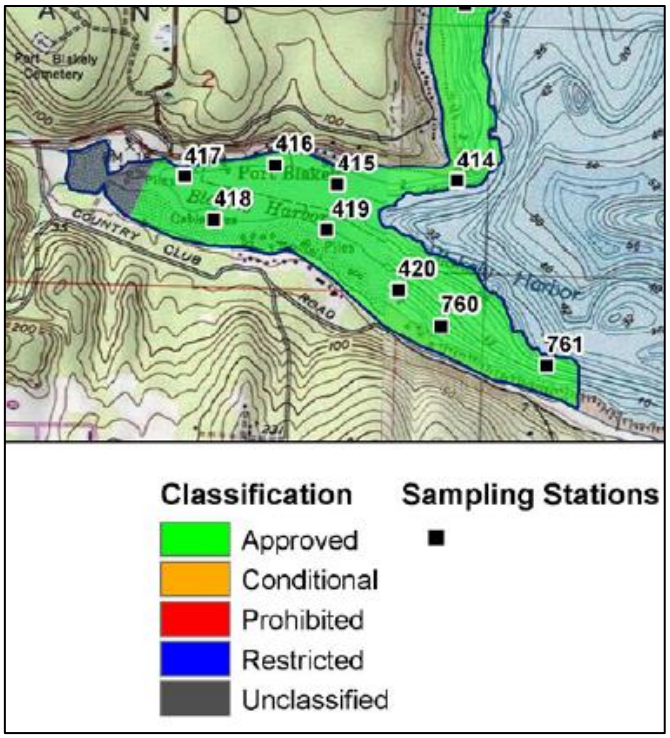
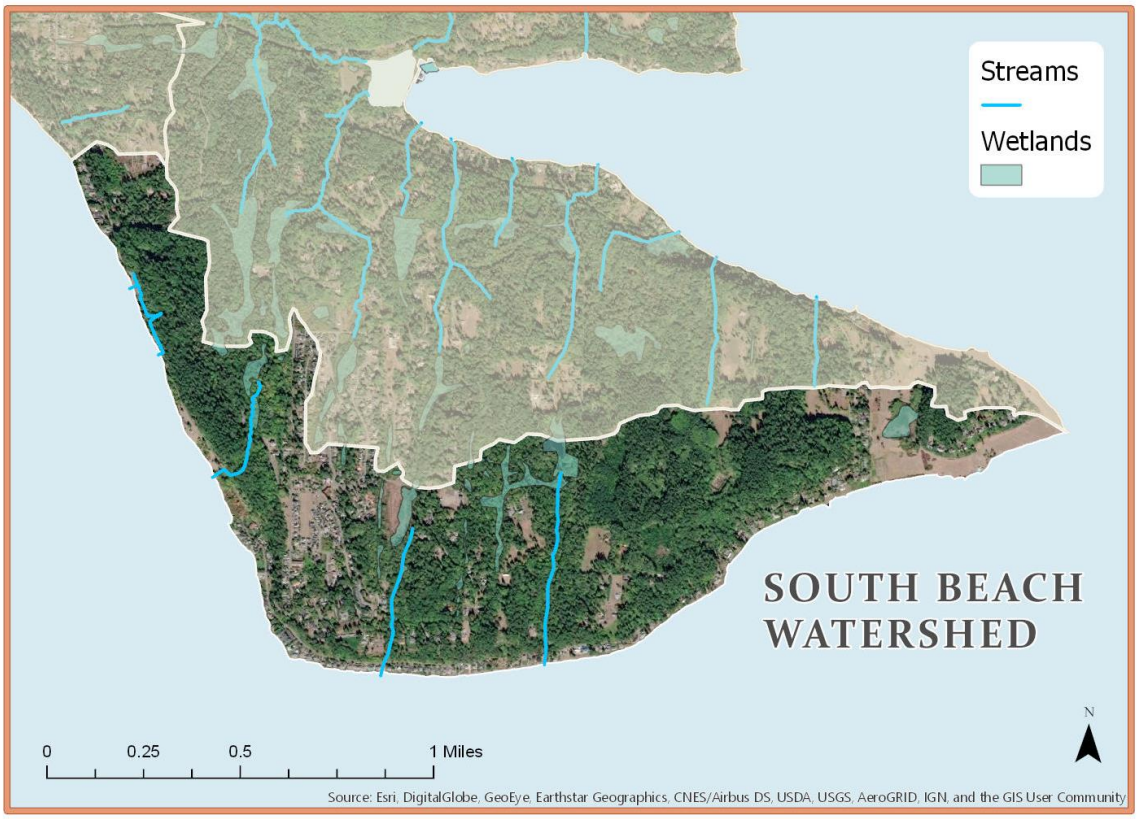



*Figure 16. WADOH Blakely Harbor growing area report 2017*

# 10 SOUTH BEACH WATERSHED

One of the four minor watersheds on the island, South Beach Watershed does not support a year-round stream.




Apart from being a small narrow watershed, the geology of the watershed does not tend to store enough water in the wet season to sustain perennial streams. Thus, the City does not have a monitoring site in this watershed.

The Washington State Department of Health (WADOH) does collect data at six sites in the near-shore marine water associated with the watershed. Generally, water quality is good and meets the state standards. The small area colored in red in Figure 17 identifies 'prohibited' shellfish harvest area due to the location of a permanent sewer outfall from Kitsap County Sewer District 7.

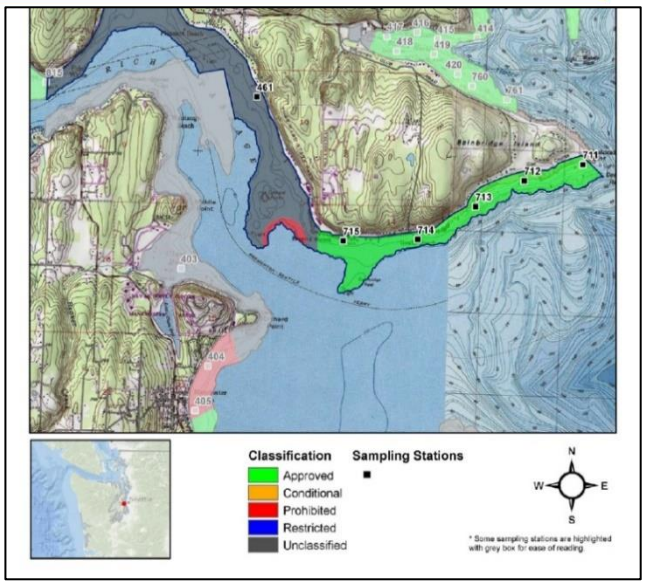
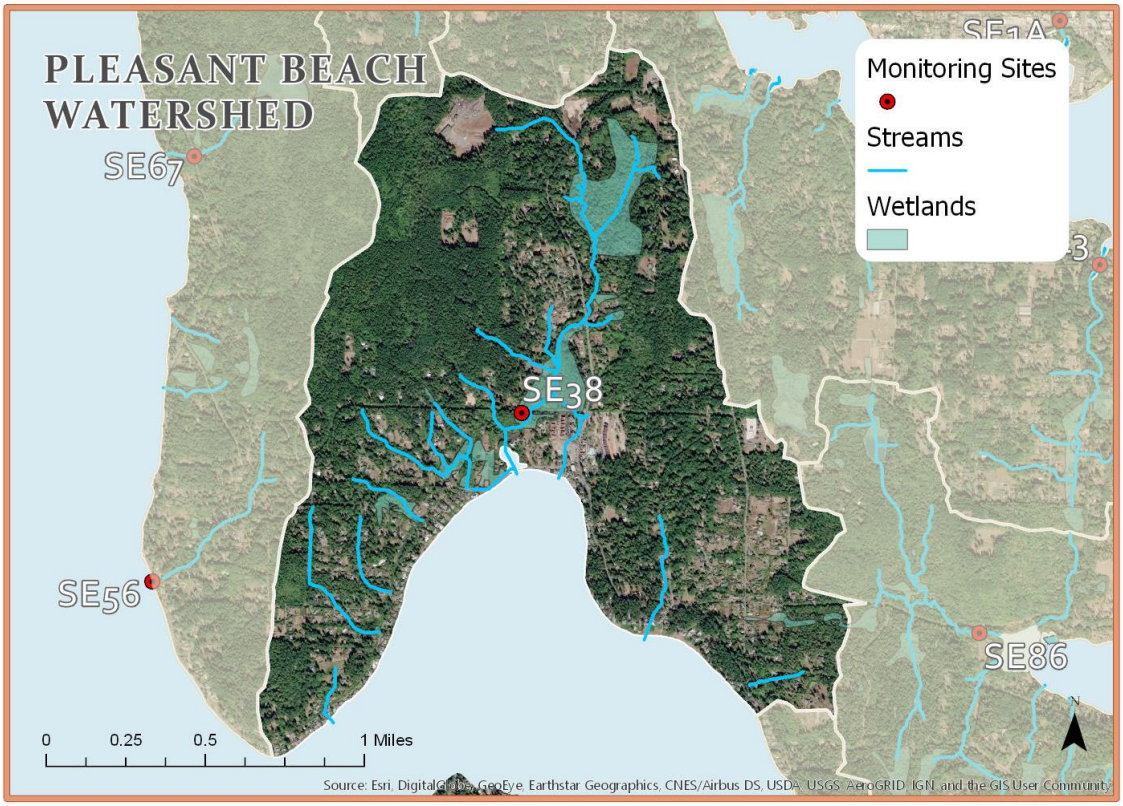



*Figure 17. WADOH Annual Growing Report 2017 Bainbridge South*

# 11 PLEASANT BEACH WATERSHED




## 11.1 SCHEL CHELB CREEK (SE38)

WQ Index **9 Poor**

B-IBI Index **NA**

Compound Index **9 F**

Pleasant Beach Watershed has seen many changes since 2012 including the ongoing expansion of dense residential centers in Lynwood Center, a complete rebuilding of the Blakely Elementary School, a replacement of Fire Station 22 and steady building of single-family residential dwellings throughout the watershed.

The City's monitoring station is located on the downhill side of Baker Hill Road and indicates very low water quality mainly due to extremely low oxygen levels. This is partially explained by the fact that Schel Chelb Creek travels through a large wetland and has been split in two, starting north of Baker Hill Road (Figure 18). The main stem now flows west through the constructed estuary and a minor flow is directed through the old pipe system under Lynwood center. Dividing this small stream in two has led to less water in each channel and the circumstances are exacerbated by multiple expanding well fields in the area. Anecdotal

observations by longtime residents indicate that the streams are lower now than they have been in the past.

Though stream flow is not routinely monitored at this site, data on groundwater drinking wells is reported to WADOH. This data can be used to estimate the increased use of groundwater in the area, drawn from multiple wellfields, and its potential effects on surface waters. The three largest group A water systems reported approximately 110 million gallons of water use over the last 8 years (2009-2017), with large portion of it being diverted to a sewer treatment plant and bypassing the local water cycle completely. This translates to about 0.5 cubic feet per second of equivalent flow being diverted each year to the marine waters of Rich passage, flow that could have ended up in the streams and wetlands of the Schel Chelb sub-watershed. [14]

*Figure 18. Flow control under Baker Hill Road, old Schel Chelb Creek & Location of bisected stream flow (red circle) and flow control device (red arrow) on historic main stem, near Lynwood Center*

# 12 GAZZAM LAKE WATERSHED

Even though Gazzam Lake represents one of the minor watersheds, without salmon-bearing streams, it supports many small perennial, spring-fed streams, two of which are monitored by the City on a monthly basis.

This watershed flows into Puget Sound's Port Orchard and Rich Passages, contributing to the Sinclair and Dyes Inlets, 303(d) listed waterbodies, impaired for bacteria. As a result of the State's Sinclair and Dyes Inlets Water Quality Implementation Plan, the City's stormwater permit requires the City to monitor and help address bacteria sources in Gazzam Lake Watershed.

One or the many tactics being used by the City to try to help reduce bacteria sources in this watershed and throughout the island, is by promoting proper pet waste management by providing Mutt Mitt stations, a pet waste bag dispenser. Some stations are maintained by the City and some are maintained by private neighbor groups and volunteers.

A small area of shoreline is still prohibited from shellfish harvest due to intermittent, high levels of bacteria called "hot spots" and shaded red (Figure 19).

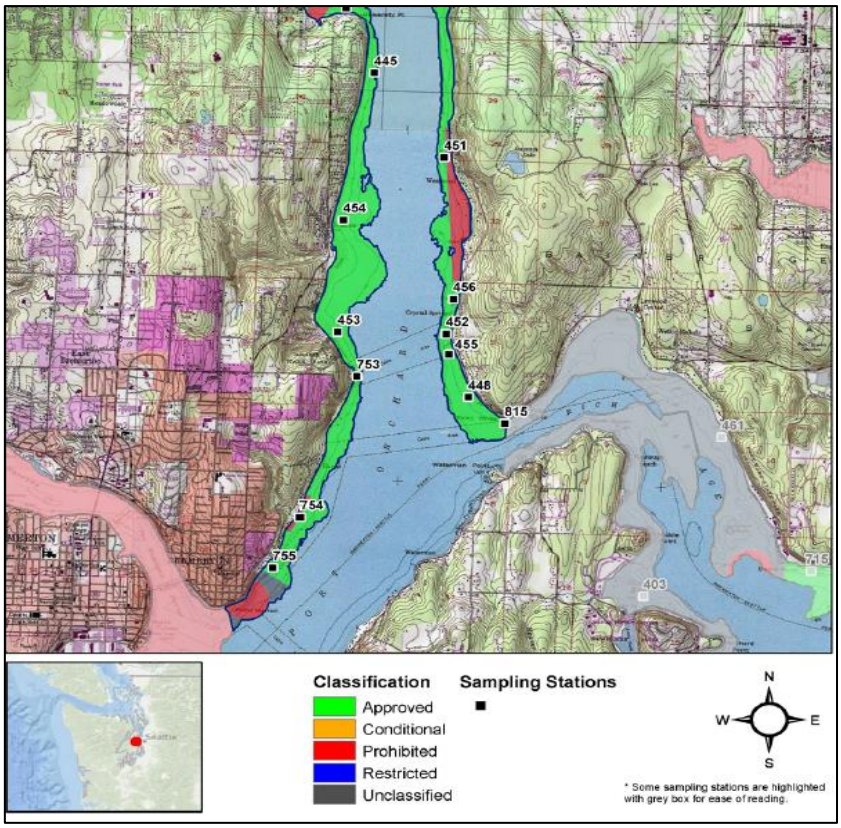



*Figure 19. WADOH Growing Area Report 2017, Port Orchard Passage*

## 12.1 Lindquist Creek (SE 56)

WQ Index **25 Poor**

B-IBI Index NA

Compound Index **25 F**

Flowing through relatively steep gradient terrain, Lindquist Creek flows under many small private roads as well as through rural backyards where it has been altered to create multiple landscape ponds. Water in this creek shows a worsening trend in bacteria levels and some unique spikes in water temperature.

## 12.2 Gazzam Creek (SE 67)

WQ Index **63 Moderate**

B-IBI Index NA

Compound Index **63 C+**

With the least developed sub-watershed, Gazzam Creek still has moderate levels of bacteria (Figure 20) and is tied for 5th overall based on the WQ index. This is somewhat surprising due to of the absence of septic systems and the lack of surfaces that generate stormwater in the drainage basin. The only substantial sources of bacteria in the area are pet waste and wildlife contributions.

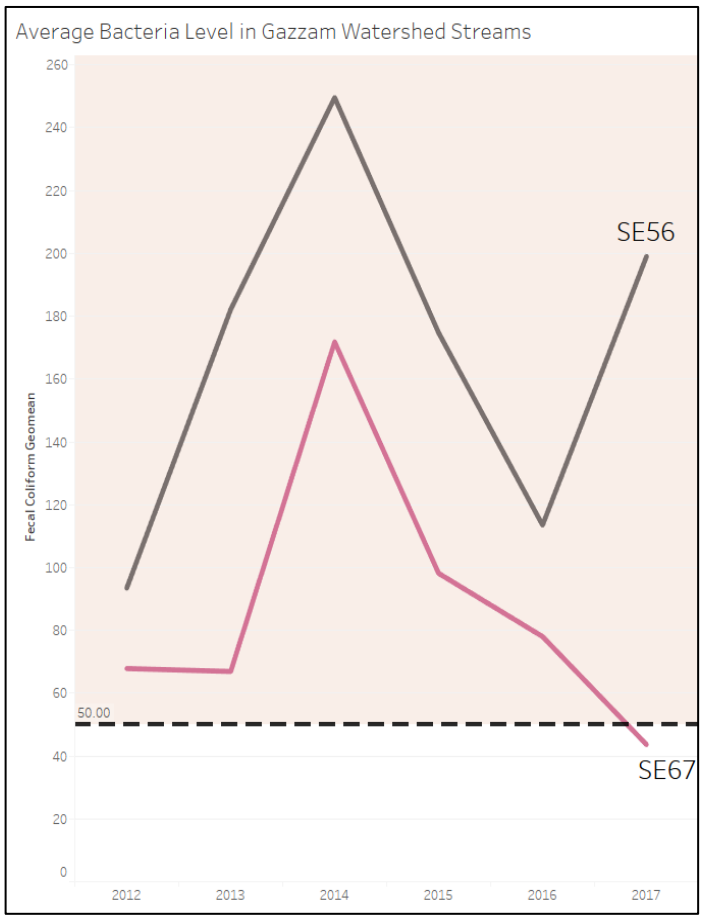



*Figure 20. Average Bacteria Levels vs Part 1 of the standard (red shaded area does not meet the standard)*

# 13 FLETCHER BAY WATERSHED

Fletcher Bay is fed by the two salmon-bearing streams, Issei and Springbrook, as well as other smaller streams. Like in most large streams on the Island the Fletcher bay streams fail to meet part one of the bacteria standard in all but one year, Issei in 2012 (Figure 21). Conversely, bacteria levels in the marine water, near the mouth of Fletcher Bay, have been on the decline, meeting standards in the last few years [15].

Both Issei and Springbrook have shown relatively elevated levels of impact from stormwater as compared to other streams on the island. Levels of copper and zinc have been above other streams yet seem to be trending somewhat lower recently.

For more information on the watershed please visit the Current Conditions section of the Island Center Subarea plan https://www.bainbridgewa.gov/950/Island-Center-Subarea-Planning-Process

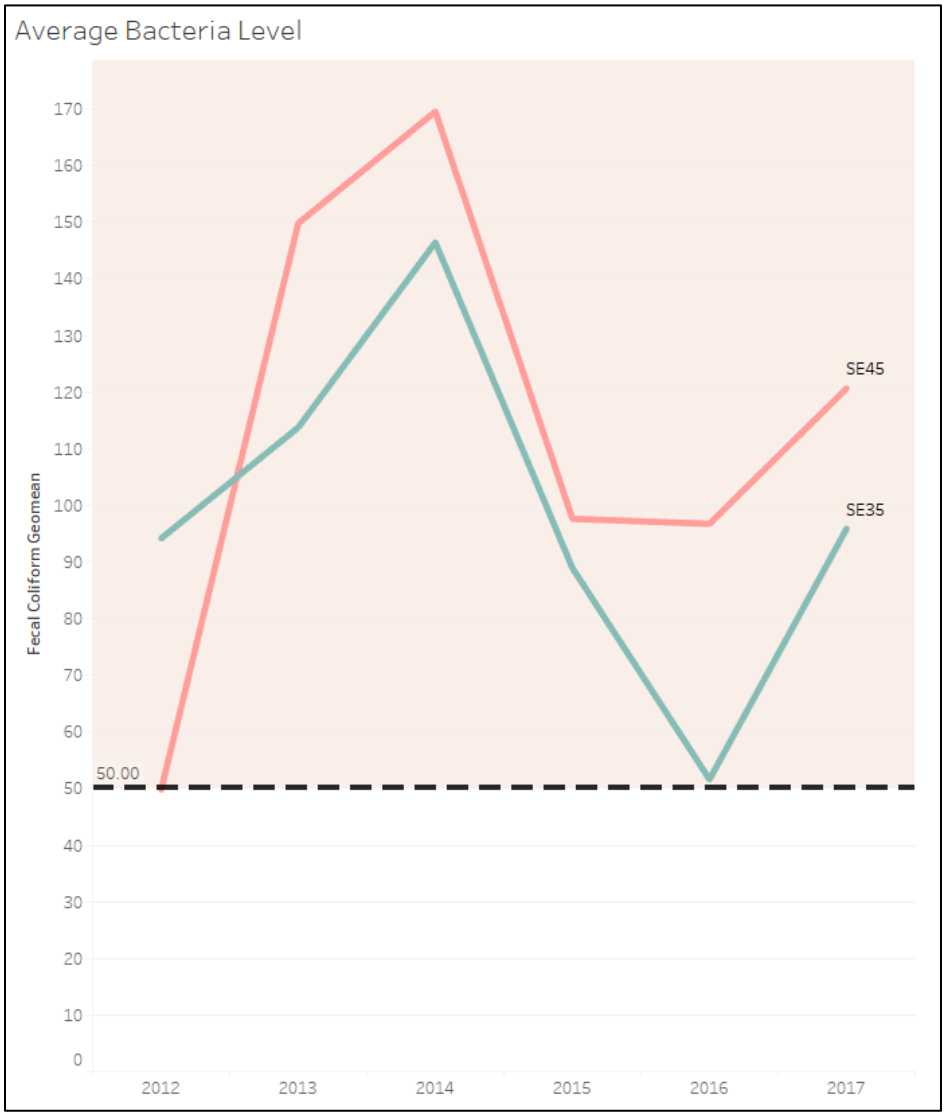



*Figure 21. Annual Bacteria levels vs part 1 of the Standard, Fletcher Bay streams*
*(red shaded area does not meet the standard)*

## 13.1 Springbrook Creek (SE35)

WQ Index **55** **Moderate**

B-IBI Index **63.5** **Moderate**

Compound Index **59.25** **C**

Springbrook Creek is also known as Springridge Brook, Fletcher Creek, Island Center Creek and others. It has a long history of bacteria and temperature exceedances. The last few years tell a different story with bacteria levels on a slight decline and B-IBI scores higher (Appendix II). Along with this improvement comes added interest in upgrading culverts in the lower watershed to improve fish migration. A recent study led by the Bainbridge Island Land Trust and supported by the City, has provided an in depth understanding of water quality and habitat stressors in the Watershed. For more information on this stream please visit the project's webpage at: https://www.bainbridgewa.gov/868/Springbrook-Creek-Watershed-Study

## 13.2 Issei Creek (SE45)

WQ Index **55** **Moderate**

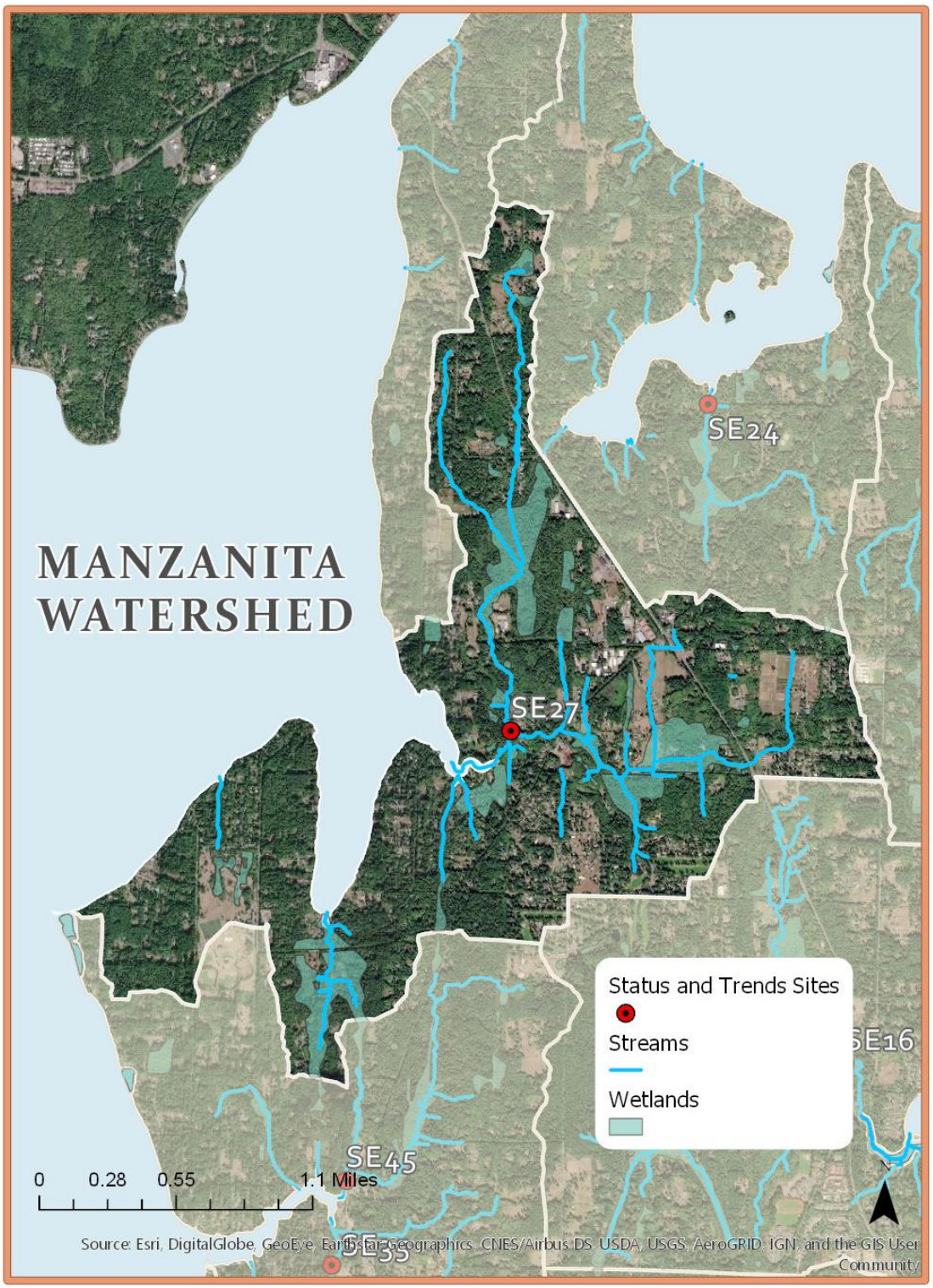
B-IBI Index **55.5** **Moderate**

Compound Index **55** **C**

With headwaters starting in the mature forest of the Grand Forest, we would expect Issei Creek to have relatively high-quality water, but data suggests otherwise. Data from targeted storm sampling in 2013 shows impacts from stormwater runoff in concentrations of lube oil, plastic additives and aluminum in the stream. On the other hand, insect populations have rebounded some since 2012 with B-IBI scores climbing from a low of 14 in 2012 to 55.5 in 2017.

Sampling in May of 2013 indicates that the west fork of Issei Creek contributes a greater concentration of bacteria than the larger east fork [16]. In a 2014 study, water from Issei was found to contain chemicals found in tobacco, pharmaceuticals and herbicides, though at low levels, this is still an indication of human impacts, such as failing septic systems or runoff from landscaping areas [24].

# 14 MANZANITA WATERSHED



## 14.1 MANZANITA (SE27)

WQ Index **50 Moderate**

B-IBI Index **54 Poor**

Compound Index **52 C-**

The relatively large salmon-bearing stream, Manzanita has been plagued with bacteria and turbidity issues over the years but fortunately has also shown a relatively steep decline in bacteria levels in the past few years (Figure 22). Manzanita also has the good fortune of staying cool year-round and is generally the coldest salmon-bearing stream on the Island. Further, B-IBI scores have been on the rise indicating generally better conditions for insects to live and consequently more food for fish to eat (Figure 23). However, some of this change may be due to a change in location sampling, from higher in the watershed to a lower location in 2015.

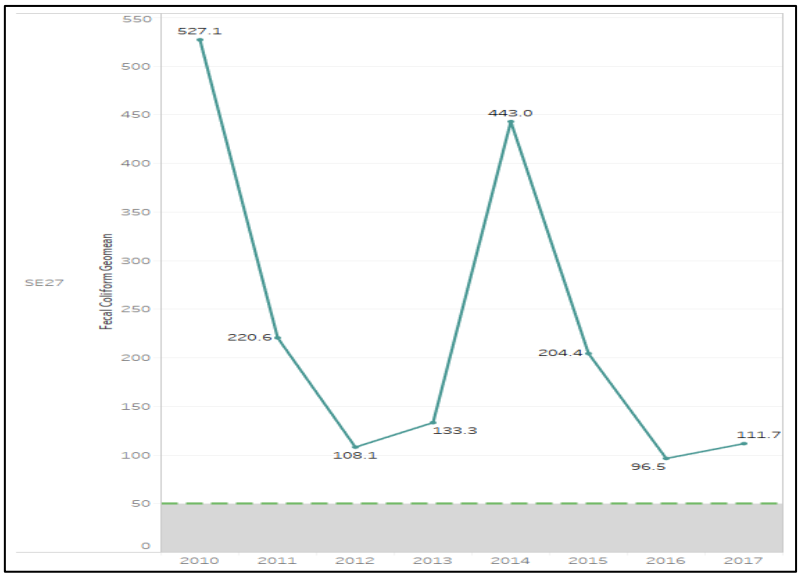



*Figure 22. Average Annual Bacteria Manzanita Creek*

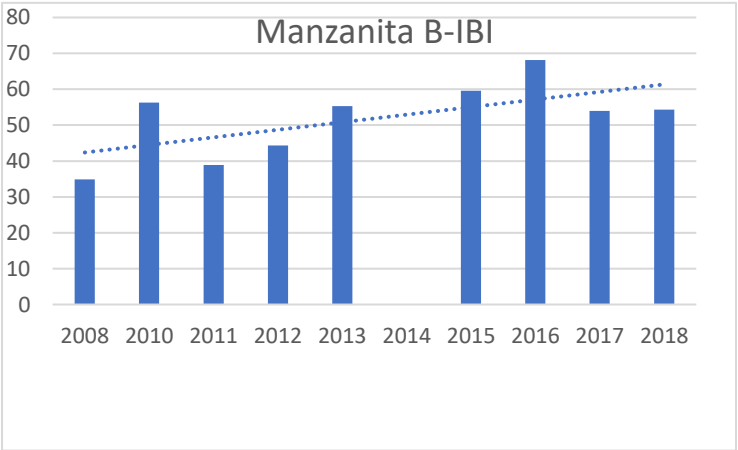



*Figure 23. Annual B-IBI (0-100) Scores and Trend, Manzanita Creek.*

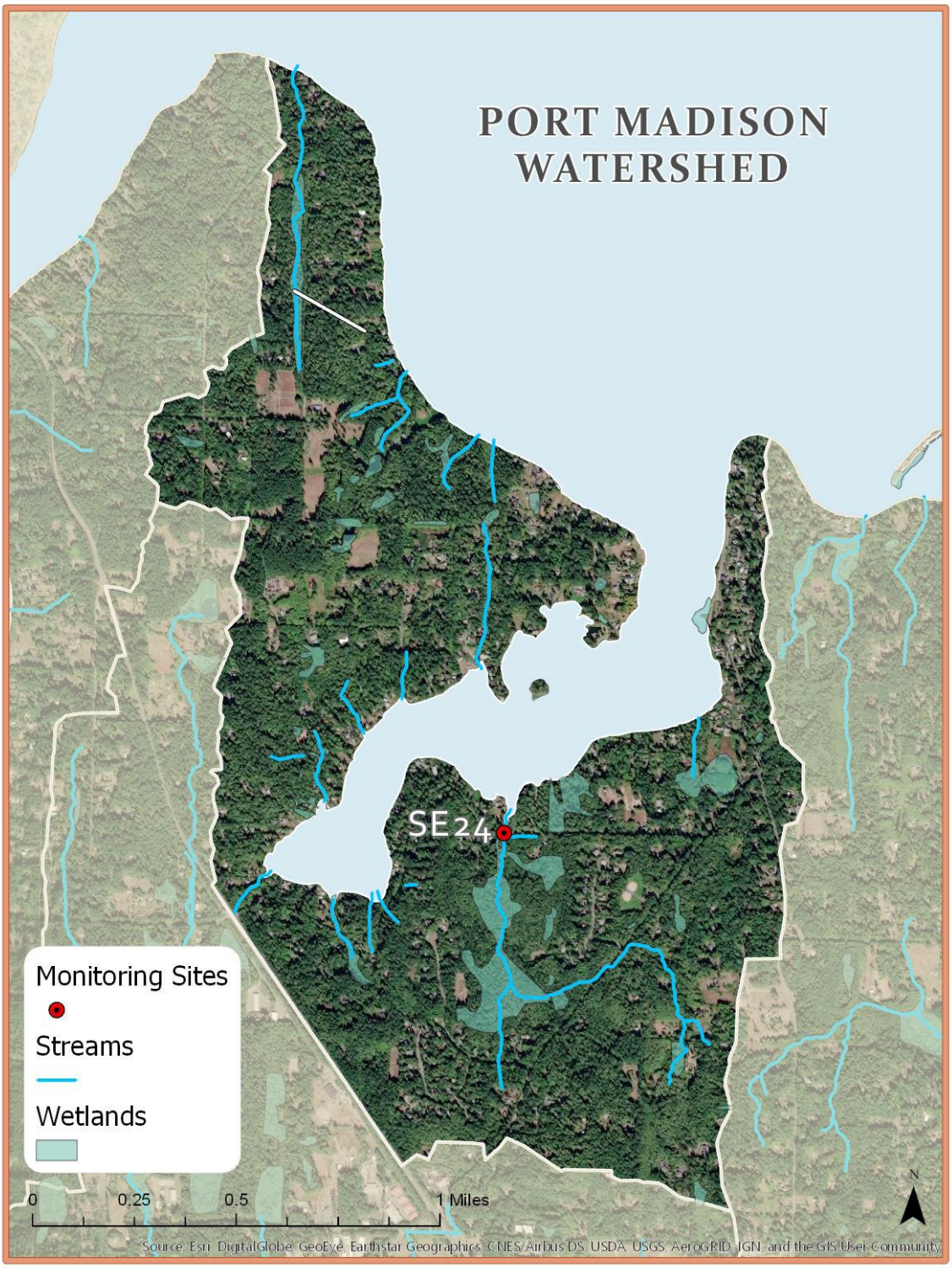
# 15 AGATE PASSAGE WATERSHED

Agate Passage is minor watershed next to Manzanita and Port Madison watersheds. The City does not monitor surface water in this watershed.

*Figure 24. WADOH Port Orchard Passage Growing area report 2017*

Current water quality monitoring is being performed in the marine waters by the Washington State Department of Health (WADOH) to protect shellfish beds and recreation. If and when WADOH find elevated levels of bacteria, the Kitsap Public Health District (KPHD) steps in and looks for upland sources, like failing septic systems, that may be contributing to the problem. From 2010-2016 KPHD identified six outfalls with high bacteria levels and was able to work with property owners to repair eight septic systems. Additional monitoring by WADOH is scheduled for 2019, after which the area could be reclassified [22]. Figure 24 shows impacted area of 'hot spots' with high bacteria.

# 16 PORT MADISON WATERSHED



## 16.1 Coho Creek (SE24)

WQ Index **66 Moderate**

B-IBI Index NA

Compound Index **66 C+**

The watershed draining to the City's monitoring site on Coho Creek is dominated by a mature forest and healthy wetlands, much like those found on Cooper Creek (SE62), our reference site. Though Dripping Water Creek scored slightly higher on the WQI at 69, Coho Creek generally has lower levels of bacteria. Historic monitoring data gathered by the Hidden Cove Estates housing development shows no apparent impact to the water quality from the addition of the houses. Additionally, the protected wetland seems to improve water quality, seen by comparing the bacteria levels up stream of the wetland (blue) and downstream (orange) (Figure 25).

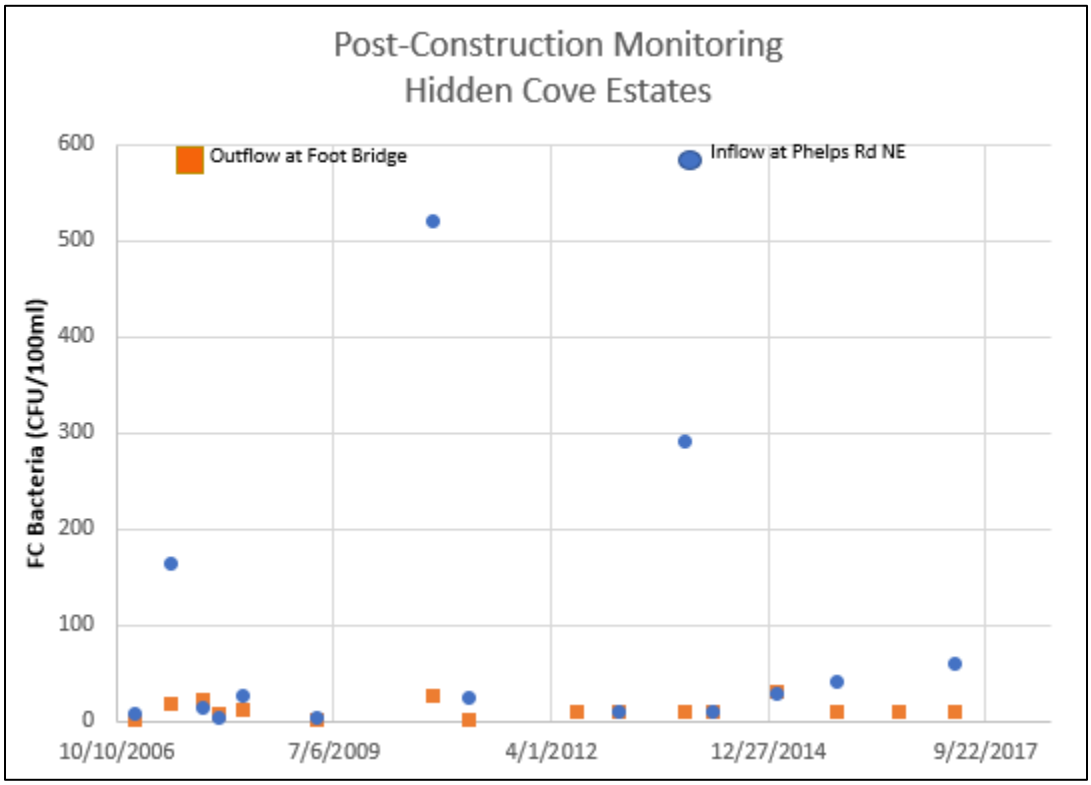
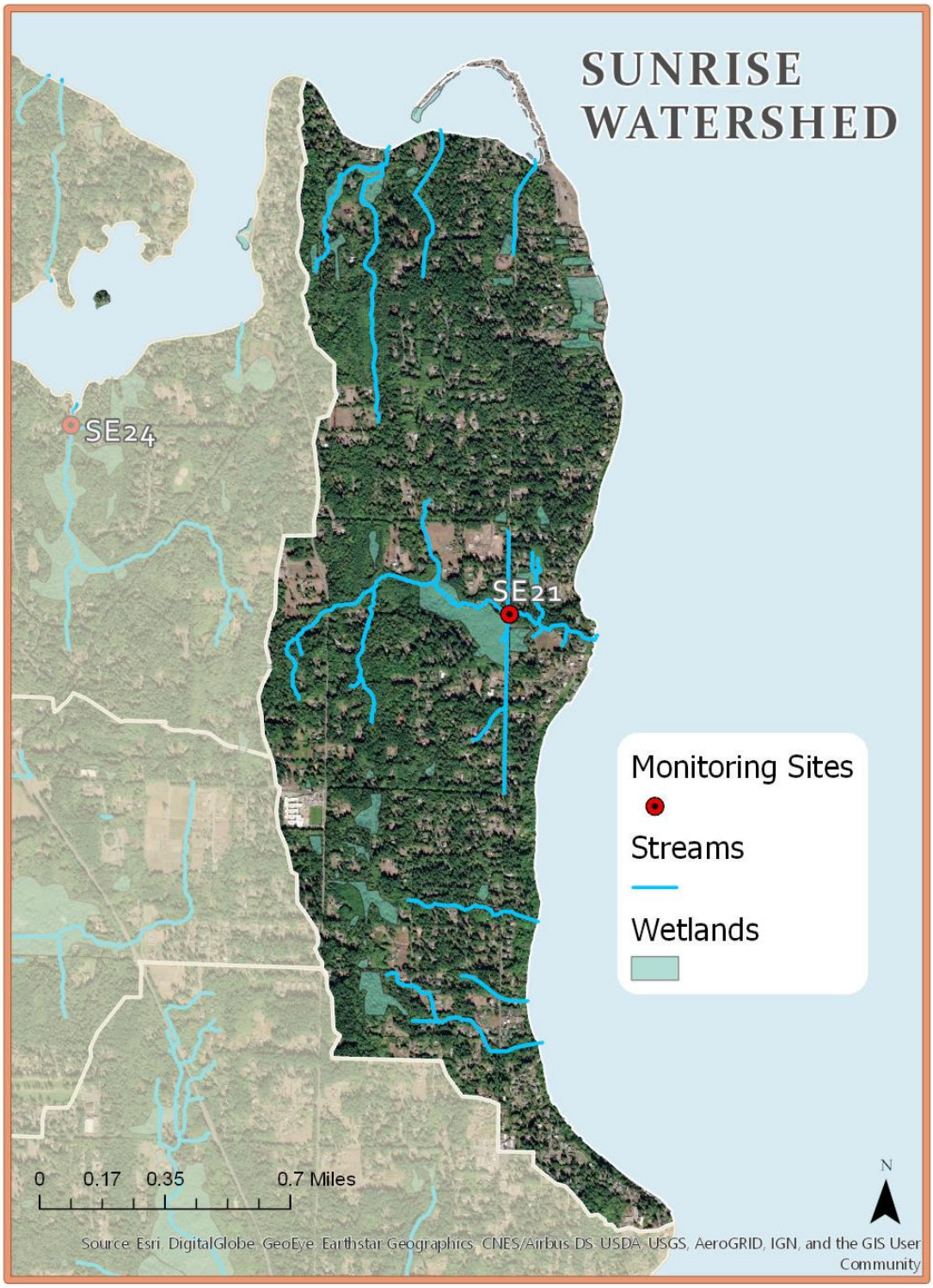



*Figure 25. Bacteria Data 2006-2017, Hidden Cove Estate's Monitoring*

# 17 SUNRISE WATERSHED



## 17.1 Dripping Water Creek (SE21)

WQ Index **69 Moderate**

B-IBI Index NA

Compound Index **69 B-**

Also know as C'txa by native peoples, Dripping Water Creek had the second highest WQI in water year 2017 consistently providing cool clean water to resident and migratory fish alike. This is most likely caused by the large forested wetland complex that feeds this small system and the relative low density residential development that dots the watershed's headwaters.

Thanks to a 2014 culvert replacement project at SE21, migratory ocean-going fish (anadromous) and smaller resident fish alike can now migrate above Sunrise drive (see photos and map).

Culvert Before

Culvert During Construction

Culvert After

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# 19 ACKNOWLEDGEMENTS

The majority of the information that make this report possible was collected in the field by a group of volunteers that brave the rain, sleet and snow to steward our freshwater resources. The City could not have a water quality and flow monitoring program without you. Thank you. Additional editing support was provided by Sarah Pearl, Christy Carr, Michael Michael and Stella Collier. Thank you for spending your time and energy to help produce this document.

# 20 APPENDIX I

## 20.1 METHODS

The WQI was calculated using a tool from the Washington State Department of Ecology (Ecology) and the B-IBI scores were downloaded from the Puget Sound Regional Benthos Database, where available. To further simplify the data, the two indices were averaged to find the compound index (or simply the WQI score when a B-IBI score was not available for averaging). Next the compound scores were converted to a letter grade based on the rubric in Table 3. This method has been adapted from a method used by the Pierce County Planning & Public Works – Surface Water Management Annual Water Quality Report Card [5].Bacteria data was compiled from the City's database and averaged for WY2017 using the geometric mean in Tableau software and trend analysis was performed using a linear trendline.

## 20.2 INDEX DESCRIPTION

The State's Water Quality Index combines temperature, dissolved oxygen, bacteria, turbidity, nurient, and pH data (collected monthly) into one number between 0 and 100 and subsequest status.

The biologic index is based on insect data (collected annually) in the larger streams. Also based on a range from 0-100, the Benthic Index of Biotic Integrity ($B\text{-}IBI_{0\text{-}100}$) uses the ratios between and levels of, insect communities to inform levels of pollution in the waterbody. Appendix I-20.4 shows the relationship between B-IBI score and relative biologic condition.

## 20.3 STANDARDS

In addition to using indices and letter grades to show the State of the Island's Waters, 'standards' are also used to help show when certain qualities are not ideal. Standards are limits of certain measurable parameters, created to help understand when a water quality parameter is outside of the desired range. For example: if a water temperature measurement is above the standard of 16 degrees C, the water is too warm for fish and therefore not meeting the standard.

A basic standard considered when assessing water quality is fecal coliform (FC) bacteria counts, a bacterium found in warm blooded animals. Ecology has set standards to know if there is too much bacteria in fresh water [23].

**Ecology's Standard for Bacteria:**

To meet Part 1 the annual average (geometric mean) bacteria levels need to be less than 50 colony forming units cfu/100ml

To meet Part 2 less than 10 percent of all samples can be over 100 cfu/100ml

| | |
|---|---|
| Fecal Coliform Bacteria (FC) | **Part 1**: **≤50 FC**/100 ml (geometric mean)<br>**Part 2:** Not more than 10% of all samples obtained for calculating a geomean **>100 FC**/100 ml |

For a complete list of water quality standards view Ecology's Water Quality Standards Document [23]

## 20.4 Index Scales and Grading Rubric

| Compound Index | Letter Grade |
|---|---|
| 93-100 | A |
| 86-93 | A- |
| 74-80 | B |
| 68-74 | B- |
| 80-86 | B+ |
| 55-61 | C |
| 48-55 | C- |
| 61-68 | C+ |
| 35-41 | D |
| 28-35 | D- |
| 41-48 | D+ |
| 0-28 | F |

*Table 3. Compound Grade Rubric for Summary Index [5]*

| WQI score | Status | Color code on station page |
|---|---|---|
| 80 and above | Good — meets expectations —lowest concern | lavender |
| 40 to 80 | Moderate concern | light yellow |
| 40 and below | Poor - does not meet expectations - highest concern | red |

*Table 4. Washington State Water Quality Index (WQI) Summary [2]*

| Biological Condition | Description | $B\text{-}IBI_{10\text{-}50}$ | $B\text{-}IBI_{0\text{-}100}$ |
|---|---|---|---|
| **Excellent** | Comparable to least disturbed reference condition; overall high taxa diversity, particularly of Ephemeroptera (mayfly), Plecoptera (stonefly), Trichoptera (caddisfly), long-lived, clinger, and intolerant taxa. Relative abundance of predators high. | [46, 50] | [80, 100] |
| **Good** | Slightly divergent from least disturbed condition; absence of some long-lived and intolerant taxa; slight decline in richness of Ephemeroptera, Plecoptera, and Trichoptera; proportion of tolerant individuals increases. | [38, 44] | [60, 80) |
| **Fair** | Total taxa richness reduced – particularly intolerant, long-lived, Plecoptera, and clinger taxa; relative abundance of predators declines; proportion of tolerant individuals continues to increase. | [28, 36] | [40, 60) |
| **Poor** | Overall taxa diversity depressed; proportion of predators greatly reduced as is long-lived taxa richness; few Plecoptera or intolerant taxa present; dominance by three most abundant taxa often very high. | [18, 26] | [20, 40) |
| **Very Poor** | Overall taxa diversity very low and dominated by a few highly tolerant taxa; Ephemeroptera, Plecoptera, caddisfly, clinger, long-lived, and intolerant taxa largely absent; relative abundance of predators very low. | [10, 16] | [0, 20) |

*Table 5. Benthic-Index of Biological Integrity (B-IBI) Summary [3]*

# 21 APPENDIX II

## 21.1 B-IBI TREND DATA SUMMARY TABLE

| | 2008 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Springbrook | 55 | 75.1 | 59.9 | 52.6 | 51.5 | | 48.4 | 52.7 | 63.5 | 66.9 | 58.4 |
| Manzanita | 34.9 | 56.3 | 38.9 | 44.3 | 55.3 | | 59.6 | 68.1 | 54 | 54.3 | 51.7 |
| Cooper | 41.6 | 59.7 | 40.4 | 65.9 | 62.1 | 36.5 | 54.3 | 54.8 | 42.8 | 48.2 | 50.6 |
| Issei | 38.8 | 58 | 20.9 | 14.2 | 20.8 | | 51.3 | 53.4 | 55.5 | 41.7 | 39.4 |
| Murden | 43 | 28.9 | 34.2 | 25.6 | 22.8 | 21.6 | 42.3 | 28.2 | 23.9 | 28.2 | 29.9 |
| Whiskey | | | | 21.9 | 22.2 | | 35.6 | 27.6 | 25.9 | 33.7 | 27.8 |
| Ravine | 8.7 | 23.7 | 6.5 | 15.3 | 10 | | 4.3 | 6.4 | 10.9 | 11 | 10.8 |

*Table 6. Benthic Index of Biotic Integrity (B-IBI) Summary 2008-Present, sorted by Average, high to low*

# 22 APPENDIX III

## 22.1 BACTERIA STATUS AND TRENDS GRAPHS

https://www.bainbridgewa.gov/DocumentCenter/View/11708/Appendix-III-222-All-Detected-Analytes

## 22.2 ALL DETECTED ANALYTES

https://www.bainbridgewa.gov/DocumentCenter/View/11707/Appendix-III-221-Bacteria-Status-and-Trends