Pierce County

2016 Report Card
Surface Water Health

Swan Creek

A report on the health of surface water in Pierce County

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www.piercecountywa.org/swm

Surface Water Health Report Card

The Puget Sound region is a unique network of mountain peaks, plateaus, rivers, lakes, and marine waters. These natural wonders make Pierce County a beautiful place to live, work and play. Maintaining healthy water quality in the streams, rivers and lakes that connect the Cascade Mountains to Puget Sound is essential to the quality of life and prosperity of Pierce County residents, businesses and wildlife.

The Pierce County Surface Water Health Report Card is updated annually. The report card assigns a letter grade to streams, lakes and watersheds and includes information about local water quality issues.

Pierce County uses several scoring systems to determine grades:

- The Water Quality Index (WQI) score is calculated using monthly stream water quality sampling for fecal coliform bacteria, pH, dissolved oxygen, temperature, turbidity, total suspended solids, total nitrogen and total phosphorus. Streams with scores of 80-100 are of the lowest concern, 40-79 are of marginal concern and less than 40 are of highest concern.
- The Lake Quality Index (LQI) score is generated based on summer sampling results of total phosphorus, algae, fecal coliform bacteria and water clarity. A penalty is assessed for closures due to unsafe water quality at public swimming beaches. Lakes with scores greater than 10 received an A; between 10 and 8 received a B; between 7 and 5 received a C; between 4 and 2 a D; and less than 2 an F.
- The Benthic Index of Biotic Integrity (BIBI) scores are calculated using benthic macroinvertebrate (bugs living on the bottom of streams) samples collected at least once every five years. Scores between 80-100 are considered excellent; 60-79 are good; 40-59 are fair; 20-39 are poor and 0-19 are very poor.

Pierce County Planning and Public Works staff monitor water quality monthly at 54 Pierce County streams. Benthic samples from a subset of 43 streams are collected every summer. The Pierce Conservation District samples water quality in a number of lakes each summer. This report card summarizes the results of the streams and lakes sampled between Oct. 1, 2015 and Sept. 30, 2016.

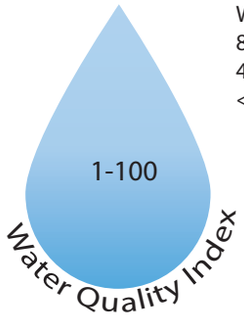
Pierce County's Stream Water Quality and Biological Health

Watershed health grades for 29 of the 54 streams increased compared to 2015, while watershed health grades for 14 streams decreased compared to last year. Additionally, three lakes and one stream received an A in 2016. No waters received an F, an improvement from 2015. Trends in surface water health scores are in Appendix E – Watershed Health Trends.

Of the 43 streams assessed, 11 were tested for both water quality and macroinvertebrate community composition. Four streams had better water quality and macroinvertebrate scores (Kapowsin, Key Peninsula's Schoolhouse, Dutchers and 25 Mile creeks). Herron and Purdy creeks improved in water quality, but decreased in macroinvertebrate scores. Fennel Creek declined in water quality, but improved in macroinvertebrate scores. Voight Creek declined in both areas. Twenty-four streams had improved water quality scores and macroinvertebrates were not sampled, while eight streams had decreased water quality scores and macroinvertebrates were not sampled compared to 2015.

What's The Score?

Stream grades are based on two scores: a Water Quality Index (WQI) and Benthic Index of Biotic Integrity (BIBI).



WQI Scoring Criteria:
80-100 Lowest Concern
40-79 Marginal Concern
<40 of Highest Concern

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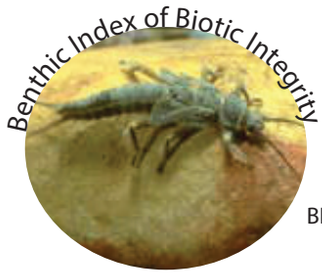

BIBI Scoring Criteria:
0 Very Poor
to
100 Excellent

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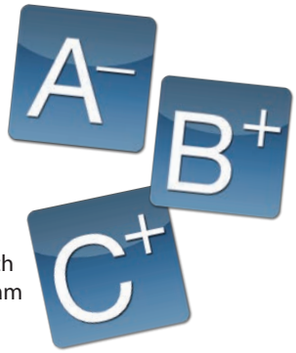


Grades are recalculated annually for each monitored stream

2016 Report Card

Key Peninsula, Gig Harbor and Islands Watershed				
Creek	BIBI	WQI	Final	Grade
Artondale	46	63	55	C
Crescent	92	78	85	B+
Dutchers	42	81	62	C+
Goodnough	36	55	46	D+
Herron	35	89	62	C+
Huge	58	77	67	C+
Little Minter	83	79	81	B+
Mark Dickson	57	49	53	C-
McCormick	41	79	60	C
Minter	29	72	50	C-
Nelyaly	58	61	59	C
Purdy	64	84	74	B
Ray Nash	49	65	57	C
Rocky	63	89	76	B
Rosedale	39	78	58	C
Schoolhouse - Anderson Island	51	63	57	C
Schoolhouse - Key Peninsula	66	68	67	C+
Vaughn Creek	57	72	65	C+

Nisqually River Watershed				
Creek Name	BIBI	WQI	Final	Grade
Copper	69	54	61	C+
Goat	73	62	67	C+
Horn	82	56	69	B-
Lacamas	56	45	50	C-
Lynch	63	23	43	D+
Midway	81	13	47	D+
Ohop	61	31	46	C-
Ohop Lake Outlet	77	34	56	D
Twenty-five Mile	82	80	81	C

Puyallup River Watershed				
Creek Name	BIBI	WQI	Final	Grade
Canyon	42	59	51	C-
Canyon Falls	5	78	42	D+
Clarks	47	52	49	C-
Clear	18	65	41	D+
Diru	33	73	53	C-
Lower Fennel	82	69	76	B
Fiske	80	92	86	A-
Kapowsin	69	69	69	B-
Rody	27	58	42	D+
Spiketon	60	72	66	C+
Squally	44	63	54	C-
Swan	34	61	47	D+
Voights	70	61	66	C+
Wilkeson	71	60	65	C+

Chambers-Clover Watershed				
Creek Name	BIBI	WQI	Final	Grade
Clover	13	49	31	D-
Spanaway	15	57	36	D

Chambers-Clover Watershed Lakes		
Lake Name	Final	Grade
American	88	A-
Carp	56	C
Gravelly	93	A
Louise	93	A
Spanaway	45	C-
Steilacoom	64	B-
Waughop	47	C-

Grades from 2009 to 2014 were retroactively recalculated based on changes to the scoring system. For more detailed information, see Appendix B.

Challenges in an Urban Watershed

Water quality has declined in most areas of Pierce County as the population and development have grown over the past century. Heavier recreational use of lakes, more hard surfaces such as roofs, roads, parking lots, clearing of streamside plants and trees, increased pet waste, auto leaks and emissions, spills, greater pesticide and fertilizer use, and leaks from underground storage tanks are all products of increased development and are sources of water pollution. These pollutants are picked up by rainwater and carried to local streams, rivers, lakes and Puget Sound.

In many areas, sewage is treated in septic tanks and drainfields because sewer service expansion has not kept pace with development or has been restricted to prevent urban sprawl. In areas like the Chambers-Clover Watershed, the sandy and gravelly soils may not sufficiently treat septic waste before it potentially contaminates groundwater with excess nutrients and bacteria. Groundwater is much more difficult to treat and can impact drinking water wells.

Hard surfaces prevent rain from filtering through soil and can increase the flow of pollution into local streams and rivers. Slowing the flow of runoff to local streams and filtering some pollutants is achievable by removing unneeded hard surfaces and replacing it with plants, permeable paving materials and stormwater infiltration systems.

The most common water quality concerns in Pierce County streams are fecal coliform bacteria, high levels of nitrogen and phosphorus, high temperature and low dissolved oxygen concentrations. These issues are typical, but difficult to treat in communities with a combination of urban and rural land uses.

How Can You Help?

Working together we can make a huge difference protecting local rivers, lakes, streams and, ultimately, Puget Sound with a few easy tips.

For more information, go to www.PugetSoundStartsHere.org

Simple Tips:

Only Rain Down the Drain: Never dump anything down the storm drain. Call (253) 798-4274 to report spills.

Your Yard: Use compost and mulch instead of chemical fertilizers. Tips: naturalyardcare.info

Your Dog: Always scoop the poop and put it in the trash. Tips: scooppoop.org

Your Car: Take your car to a commercial car wash or wash it on your lawn. Fix leaks right away or soak them up with cardboard and throw it in the trash. Tips: fixcarleaks.org

Your Home: Use less hazardous cleaning supplies and always dispose of household chemicals properly. Tips: piercecountywa.org/hhw

Your Septic System: Have your septic system pumped regularly and use a sink strainer to keep pollution out of your drainfield that could end up in local streams. Tips: tpchd.org/septic

Your Medications: Turn in unused medications so they don't end up in our waterways. To find a local take-back location, go to takebackyourmeds.org

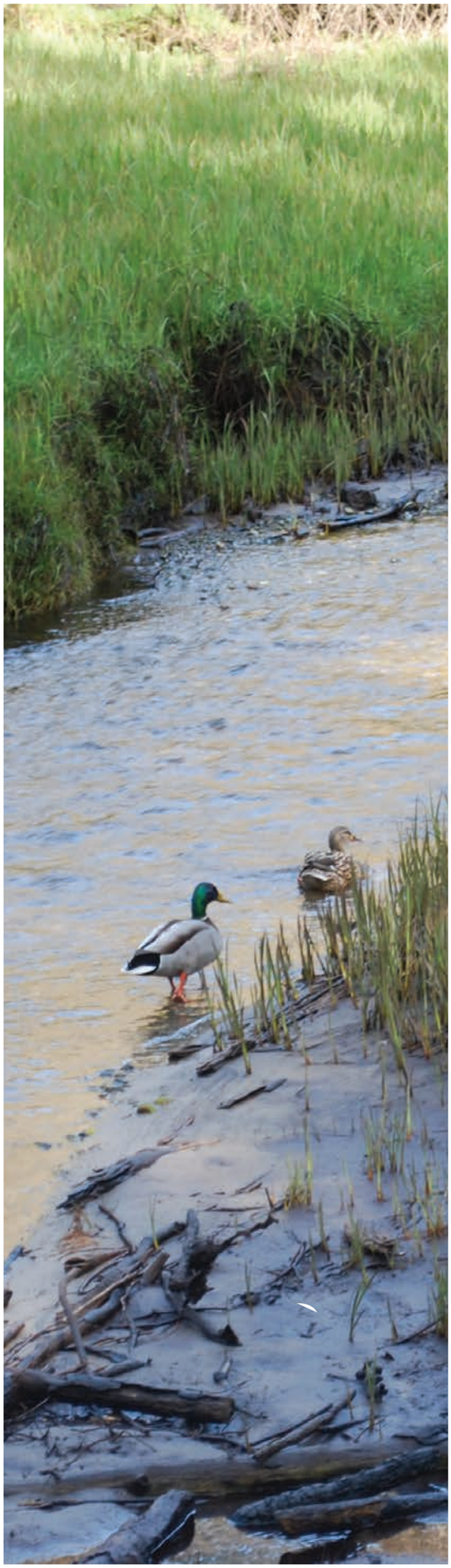
Your Livestock: Fence livestock away from water, plant between pastures and water sources, prevent overgrazing and manage manure. Tips: piercecountycd.org

Get Involved:

Know Where Your Runoff Goes: Go to piercecountywa.org/waterflow to find out!

Know Your Local Stream: Volunteer to work on a water quality data collection team or mark storm drains in your neighborhood. For opportunities, go to piercecountycd.org

Participate in Your Watershed Council: Each of the watersheds in Pierce County has a watershed council that works together on problems facing the watershed. Go to piercecountywa.org/watersheds



Key Peninsula, Gig Harbor and Islands Watershed

The watershed is about 101,000 acres (158 square miles) with a population of approximately 64,200. Much of the watershed is rural, with more development in community centers at Purdy, Key Center and Gig Harbor. Most residents live along the watershed's 144 miles of saltwater shoreline. Most streams run a short distance before draining directly into Puget Sound.

The average of all stream grades in the watershed was a C+, the same grade as in 2015.

C+

B+
Crescent Creek
Little Minter Creek

B
Purdy Creek
Rocky Creek

C+
Dutchers Creek
Herron Creek
Huge Creek
Schoolhouse Creek - KP
Vaughn Creek

C
Artondale Creek
McCormick Creek Nelyaly Creek
Ray Nash
Rosedale Creek
Schoolhouse Creek - AI

C-
Mark Dickson Creek
Minter Creek

D+
Goodnough Creek

Puyallup River Watershed

This watershed is the largest in Pierce County at about 670,000 acres (1,053 square miles) with a population of approximately 419,660. More than 728 miles of streams and rivers in the watershed drain 60 percent of Mount Rainier. Water quality in rural areas is impacted by agriculture, forestry and mining. The industrial and urban areas are impacted by runoff and clearing of native vegetation. Fiske Creek was the only stream to recieve an A in 2016.

The average stream grade in the watershed in 2016 was a C, the same as in 2015.

C

A⁻ Fiske Creek

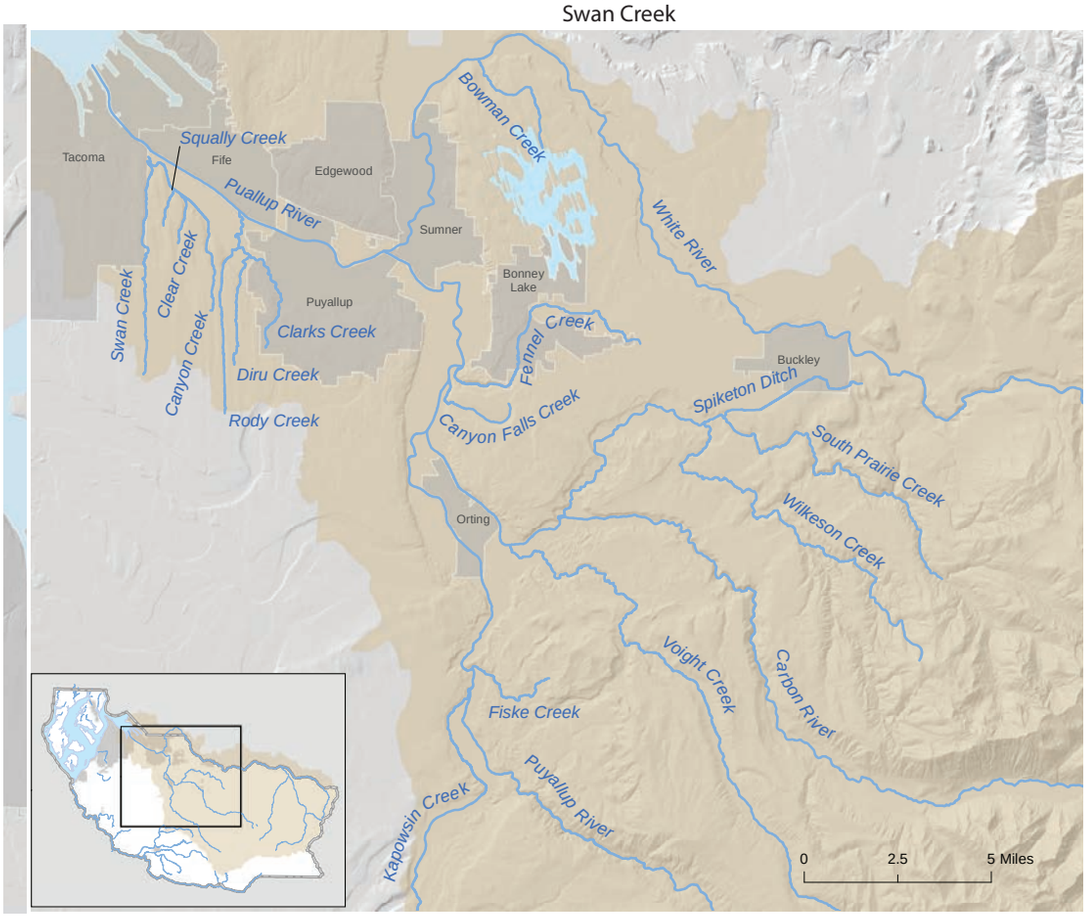
B Fennel Creek

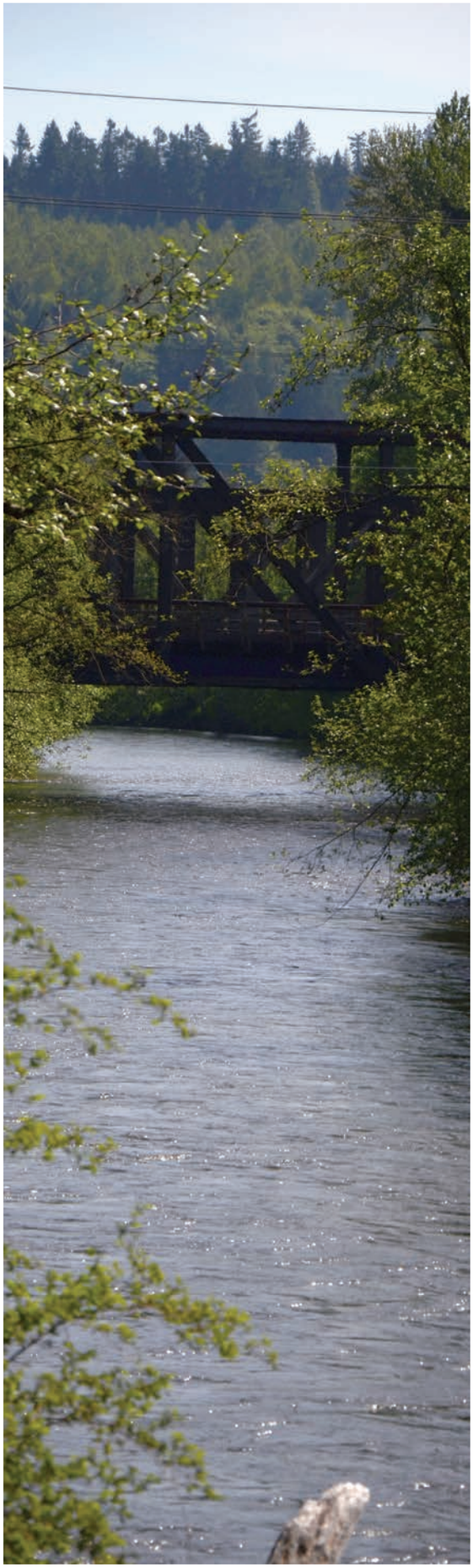
B⁻ Kapowsin Creek

C⁺ Spiketon Ditch
Voight Creek
Wilkeson Creek

C⁻ Canyon Creek
Clarks Creek
Diru Creek
Squally Creek

D⁺ Canyon Falls Creek
Clear Creek
Rody Creek
Swan Creek





Nisqually River Watershed

The watershed spans both Pierce and Thurston counties and is about 460,000 acres (720 square miles) in size. Approximately 54,500 people live in the Pierce County portion of the watershed. Forests and pasture land make up a significant portion of the watershed. In rural areas, manure from livestock can be washed into streams. Septic drainfields can leach into surface and groundwater. Too much waste in streams can harm fish and threaten habitat. In addition, the possibility of bacterial contamination in water can threaten human health.

The average of all stream grades in the watershed was a C, the same grade as 2015.

C

- B+ 25 Mile Creek
- B- Horn Creek
- C+ Goat Creek, Copper Creek
- C Ohop Lake Outlet
- C- Lacamas Creek, Ohop Creek
- D+ Lynch Creek, Midway Creek

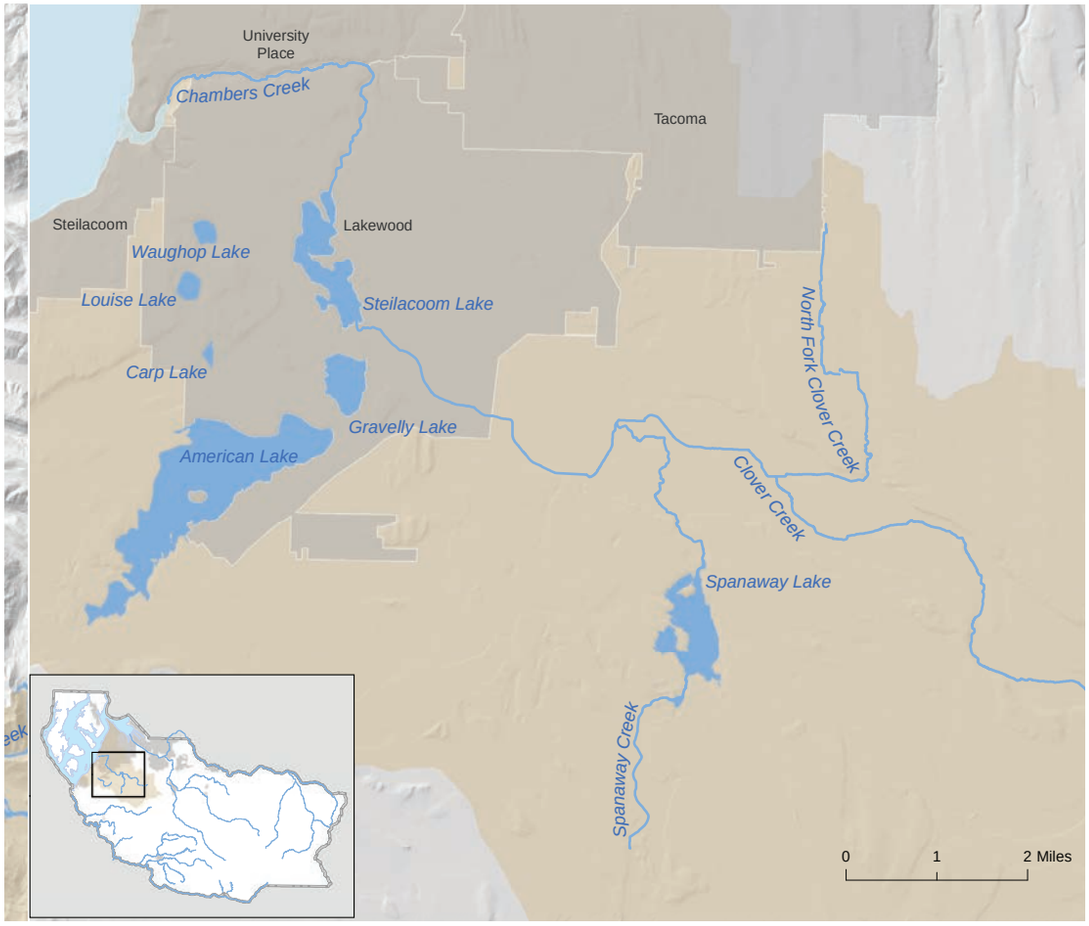
Chambers - Clover Watershed

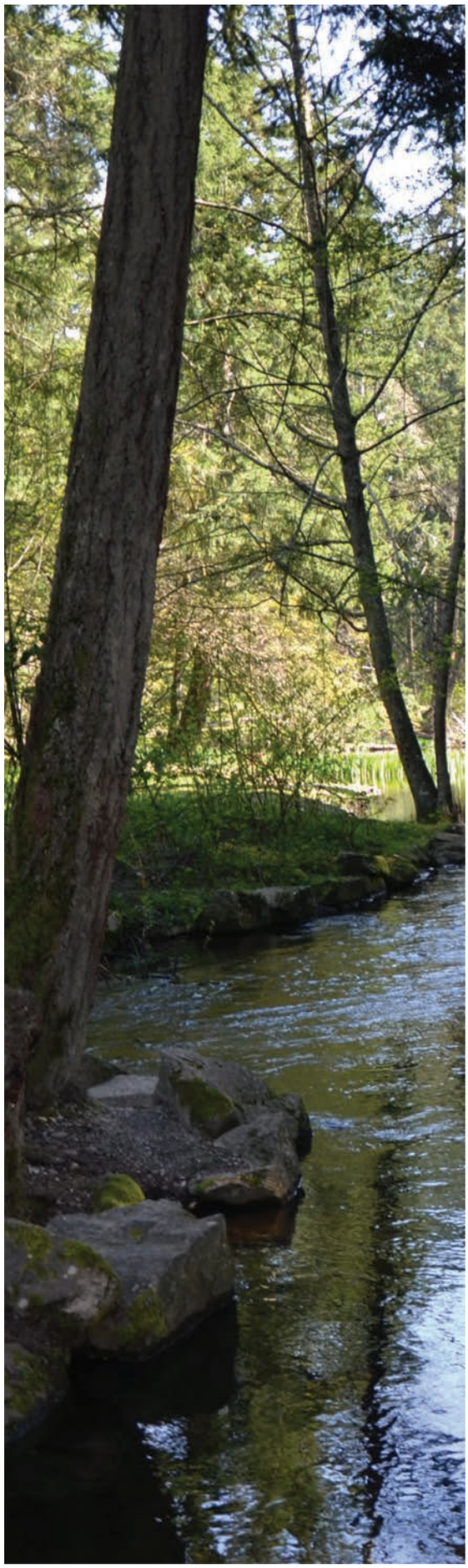
The smallers watershed in Pierce County at about 95,360 acres (149 square miles), but the most urban with a population of about 345,000. Water quality has deteriorated rapidly over the past century as the area developed. Development has resulted in heavy recreational use of lakes, more hard surfaces like pavement and roofs, clearing of streamside plants and trees and decreased salmon runs. Clear Creek showed some improvement from 2015 when it received an F.

The average of all grades in the watershed was a D-, the same as in 2015.

D-

- A — Gravelly Lake, Lake Louise
- A- — American Lake
- B- — Lake Steilacoom
- C — Carp Lake
- C- — Spanaway Lake, Waughop Lake
- D — Spanaway Creek
- D- — Clover Creek





Appendix A - **WQI and BIBI**

Water Quality Index (WQI)

The WQI is a measure of eight common parameters that are known to impact the health of freshwater streams. By observing the chemical and physical properties of the stream, we can better understand the stream health and the impacts it may have on humans, fish and wildlife.

The WQI is a unitless number ranging from 1 to 100, with a higher number indicating better water quality.

Field and laboratory data is collected each month at a number of streams. Results are compared to statistical curves available for each parameter measured: dissolved oxygen, total phosphorus, total nitrogen, turbidity, temperature, total suspended solids, fecal coliform bacteria and pH. The curves are based in part on state standards developed to maintain beneficial uses of water, such as recreation, drinking water and aquatic habitat. For each parameter, the numerical value is multiplied by a "weighting factor." Some parameters like temperature and dissolved oxygen are given more "weight" than others because they are more influential in determining watershed health than others. The resulting individual values are then combined to arrive at an overall WQI score.

For more information on the WQI, go to ecy.wa.gov/programs/eap/fw_riv/wqioverview.html.

Benthic Index of Biotic Integrity (BIBI)

The BIBI is based on samples of macroinvertebrates (animals without backbones) that live on or near the stream bottom. Some examples include insects (mayflies, stoneflies and beetles), worms, crustaceans (crayfish) and mollusks (snails and clams). Macroinvertebrates play an important role in the stream food web as a link between plants, microscopic organisms and fish. Macroinvertebrates are useful indicators of stream quality because they generally spend their life cycles in a small area, have a short life span and are sensitive to subtle changes in water quality or habitat. Different macroinvertebrate species have various levels of tolerance to pollution. Some species that are important food sources for salmon, such as mayflies, stoneflies, and caddis flies, are very intolerant to pollution. In an unhealthy stream the amount of these species may decline while the numbers of more pollution-tolerant species like leeches and black fly larvae, which salmon do not eat, may increase. Monitoring macroinvertebrate populations over many years allows for the establishment of "usual" stream health conditions and can indicate fundamental changes in those conditions.

BIBI is a watershed health monitoring tool based on the types and numbers of organisms living in the stream instead of chemical or physical stream properties. A healthy stream contains a high diversity of macroinvertebrate species, supports a greater numbers of these species, and allows for their successful reproduction and resistance to disease.

Pierce County collects macroinvertebrate samples from the bottoms of selected streams throughout the county at least once every five years. A number of biological attributes, called metrics, are analyzed and summarized into an overall BIBI score for the stream. This scoring system enables us to compare streams with natural differences in physical or chemical characteristics.

BIBI data is in the regional Puget Sound Stream Benthos (PSSB) database. For more information, visit pugetsoundstreambenthos.org.

BIBI Scoring System	
0 - 19	Very poor
20 -39	Poor
40 - 59	Fair
60 - 79	Good
80 - 100	Excellent

Determining Stream Grades

The letter grades are based on a normalized and averaged score using WQI and BIBI.

Grading is based on a compound index of WQI and BIBI, which is a more representative and useful description of stream health than each factor viewed individually. Stream grades are calculated using the following steps:

1. Select the most recent BIBI score from those calculated within the last five years.
2. Average the BIBI from Step 1 and WQI by adding them together and dividing by two.
3. Determine the letter grade based on the grade index.

Appendix B - **Determining Stream Grades**

Stream Grading System				
Score is greater than or equal to:	Score is less than:	Grade	Status	Description
0	28	F	Very poor	Very few or no water quality and biological indicators meet expectations. Conditions are very poor.
28	35	D-		
35	41	D	Poor	Some or few indicators meet expectations. Conditions are poor.
41	48	D+		
48	55	C-		
55	61	C	Fair	Mix of good and poor indicators. Water quality and habitat conditions are fair.
61	68	C+		
68	74	B-		
74	80	B	Good	Most indicators meet expectations. Conditions are good.
80	86	B+		
86	93	A-		
93	100	A	Excellent	All indicators meet expectations. Conditions are excellent.

Improvements to The Grading System

Pierce County first began to grade streams in 2008 using its "compound index system." Grades were assigned based on the procedure described in Appendix A, and a stream would receive a "penalty" if it was on the Washington State Department of Ecology's List of Polluted Waters (2008 303(d) List). State 303(d) Lists are available at: ecy.wa.gov/programs/wq/303d/index.html

In 2013, Pierce County stopped assigning penalties to waterbodies on the 303(d) Lists.

This change was made for several reasons. The 303(d) List is based on water quality data that is not indexed and, thus, not comparable with WQI scores. The 303(d) List contains historic data, in some cases 10 or 15 years old, whereas Pierce County's WQI and BIBI data are collected within the Report Card's reporting year and reflect current or recent stream conditions. The penalties to waterbodies from the 303(d) List "double counted" against stream health grades. Finally, the state's reasons for putting waterbodies on the 303(d) List change over time, and can involve policy or legal issues regardless of water quality conditions.

Starting with the 2013 Report Card, Pierce County changed from a Benthic Index scale of 0-50 to 0-100 to correspond to the Puget Sound regional BIBI procedures. For more information, go to: pugetsoundbenthos.org/bibi-scoring-types.aspx.

Past Pierce County grades shown in Appendix D of this report have been recalculated using the most current system, which allows better comparisons of water quality trends in Pierce County streams and watersheds. Therefore, historic grades in this report card may look slightly different than grades in previous report cards.

Appendix C - Determining Lake Grades

How the process works

Lake grades are the average score of several water quality parameters. Each summer, the Tacoma-Pierce County Health Department (TPCHD) and the Pierce Conservation District Stream Team collect water quality samples from a number of lakes to monitor water quality and to protect the health of people and pets. Each lake is graded based on three to five of these measurements:

- Clarity is measured by how far a Secchi disk is lowered into the water before it cannot be seen from a boat. Clarity indicates the amount of algae and sediment in the water.
- Total phosphorus is measured in the lab from a water sample. A nutrient is a substance that provides nourishment essential for growth and life. An excess of nutrients, called nutrient pollution, can cause imbalances and be harmful to natural systems. Total phosphorus is a type of nutrient pollution that encourages the overgrowth of plants and algae.
- Chlorophyll a, a pigment from plants and algae is measured in the lab from a water sample. The amount of chlorophyll a indicates the amount of plants and algae in the lake.
- Toxic algae advisories are issued by TPCHD when large blooms of blue-green algae (cyanobacteria) are observed on the lake, which may make people or pets sick.
- A combination of bacteria (E. coli) counts, and whether TPCHD issued a public advisory against swimming in the lake that year may affect lake scores. If the lake does not have a monitored swimming beach, the score is not affected.

How are grades assigned?

Factor	A (Grade)	B	C	D	F
Clarity (m): Deep Lakes Shallow Lakes	>5 >3	5.0 - 3.8 3.0 - 2.3	3.7 - 2.4 2.2 - 1.6	2.3 - 1.0 1.5 - 1.0	<1.0 <1.0
Total Phosphorous (µg/L)	<12	12 - 20	21 - 30	31 - 45	>45
Chlorophyll a (µg/L)	<4	4 - 10	>10 - 18	>18 - 30	>30
Toxic Algae Advisory			Caution	Warning	Closed
Average: Swimming Beach Advisory & E. coli counts (GMV)*	<10	>10-20	>25-50	Advisory Issued >50-126	>126
Overall Score	11-12	10-8	7-5	4-2	<2

*(GMV) = Geometric Mean Value of coliform-forming units (cfu), expressed as cfu/100 ml

Each of these factors receives a grade of A-F. Each grade is then assigned a number value: A = 12, A- = 11, B+ = 10, etc.
Next, the numbers are added together and divided by the total number of grades.

The report does not provide an exact comparison between lakes, because the same types of data are not being collected for all lakes. For example, a lake without a swimming beach will not receive a grade for that factor.

More information about the lake grading system:

The amounts of E. coli, as well as other bacteria, varies greatly in the environment. To help reduce the influence of one or two very high counts or very low counts in calculating the average number of E. coli present over time, the geometric mean value (GMV) is used rather than the arithmetic mean. The GMV is calculated by multiplying all the results together and taking the nth root of the product, where n is the number of results entered into the calculation. This is different than the arithmetic mean, which is calculated by adding all the results together and then dividing the sum by the number of results.

Total phosphorus, chlorophyll a, and clarity values are the arithmetic mean concentration of all samples collected or measurements taken at or near the surface over the deepest part of the lake from May through September (June through August on Spanaway Lake and June through September on Wapato Lake). The clarity grade varies depending on if it is a deep lake (greater or equal to five meters at its deepest spot) or a shallow lake (less than five meters in depth).

Swimming beach advisories are generally issued when two consecutive samples have high E. coli counts. The swimming beach advisories and E. coli geometric mean values (GMVs) will be averaged together such that there is one grade for swimming beaches. For example, if a lake has an E. coli GMV of 32 and no advisories against swimming, the grade will be a C. If a lake has an E. coli GMV of 32 and has a "no swimming" advisory, the grade will be a C- ([C + D]/2). American Lake and Spanaway Lake have two swimming beaches, so the arithmetic mean of the two beaches' E. coli GMVs is used.

Toxic algae advisories are issued when potentially toxic blooms of blue-green cyanobacteria are observed on the lake. A caution advisory means the lake may be unsafe for people and pets. A warning advisory means the lake is unsafe for people and pets. Excessive blooms may result in the lake being closed.

The intervals between grades for each parameter were not uniform. The intervals were selected based upon criteria used in other regions of the United States and Canada:

- minnehahacreek.advantagelabs.com/data-center/understanding-lake-water-quality-grades
- metrocouncil.org/Wastewater-Water/Services/Water-Quality-Management.aspx

Action levels and criteria in existing state guidelines and regulations. For example, Washington Administrative Code 173-201A-230 specifies that if Total Phosphorus is greater than 20 µg/L, a lake specific study may be initiated;
Literature values for trophic status index: Carlson, R.E. 1977. A Trophic State Index for Lakes. Limnol. Oceanogr. 22: 361-369; Welch, E. B. and T. Lindell. 1992. Ecological Effects of Wastewater – Applied Limnology and Pollutant Effects; and
Personal knowledge and professional judgment about lakes in this area.

Tacoma-Pierce County Health Department swimming beach advisory information: www.tpchd.org/swimmingbeaches

Pierce Conservation District: piercecountycd.org

Appendix D - Annual Stream and Lake Health Grades & Trends*

Puyallup River Watershed								
Creek	2009	2010	2011	2012	2013	2014	2015	2016
Canyon	C+	B	D	D	D+	C+	B -	C-
Canyon Falls	D-	D-	D	D+	D	D	D	D+
Clarks		C+	C+	B-	C+	C	C-	C-
Clear	D	D	D+	D	D+	D	D	D+
Diru	D+	C-	C	C-	D+	D	C-	C-
Fennel	C+	B-	B	C+	B	B-	B	B
Fiske				B+	B+	B	C+	A-
Kapowsin	C+	C+	B-	C+	C+	D+	C+	B-
Rody				C	D+	C-	C-	D+
Spiketon		C-	C+	C-	C+	C-	B-	C+
Squally	C+	B-	C+	B	B	B-	C	C-
Swan	C-	C	C+	C	C	C-	C	D+
Voights	C-	C-	C+	C+	C	C-	B	C+
Wilkeson	C-	D	C+	C	C-	D+	B	C+

Chambers-Clover Watershed								
Creek	2009	2010	2011	2012	2013	2014	2015	2016
Clover		D	D+	D-	D-	F	F	D-
Spanaway		D	D+	D+	D	D	D	D

Nisqually River Watershed								
Creek	2009	2010	2011	2012	2013	2014	2015	2016
Copper			B-	B-	B-	B	C+	C+
Goat			C+	B	B+	B	B-	C+
Horn	C+	C	B-	C-	C+	C	C+	B-
Lacamas	C-	C	C-	C-	D+	D+	D+	C-
Lynch	C-	C	C-	C-	D	D+	D	D+
Midway					D+	D+	D	D+
Ohop	C-	C	B-	C	C-	D+	D	C-
Ohop Lake Outlet	D	D	D+	D+	D-	D	D	D
Tanwax	C+	C+	C	C+	C-			
25 Mile		C-	B-	C+	C-	D+	C-	C

* Missing grades indicate that a grade was not calculated for that year.

Appendix D continued

Key Peninsula, Gig Harbor and Islands Watershed								
Creek	2009	2010	2011	2012	2013	2014	2015	2016
Artondale	C	C-	C+	C	C	C-	C-	C
Crescent	D+	C-	C+	B-	B-	B-	B	B+
Dutchers	D+	C	C	C	D+	C+	C	C+
Goodnough	D-	D+	C	C	D-	C-	D+	D+
Herron		C+	B-	B	D+	C-	C+	C+
Huge			C+	B	C-	C+	C-	C+
Little Minter				B+	C+	B	C+	B+
Mark Dickson			C-	D	D+	C-	C-	C-
McCormick	D	C-	C-	C-	C-	C	C-	C
Minter	C+	B-	C+	B	C-	C-	C-	C-
Nelyaly	D-	C	C	C	C-	C-	C	C
Purdy	C	C	C+	C	C+	C+	B-	B
Ray Nash	C-	C	C	C-	C-	D+	C	C
Rocky		C+	B+	B-	C-	B-	B-	B
Rosedale	D+	B-	C-	D+	C-	C	C	C
Schoolhouse - Anderson Island			C+	C	C-	C-	C-	C
Schoolhouse - Key Peninsula		C-	C+	C	C	C	D+	C+
Vaughn		C+	B-	C-	C	C	C	C+

Lakes Scores								
Lakes	2009	2010	2011	2012	2013	2014	2015	2016
American	C+	B+	B-	B+	B+	B+	B+	A-
Carp			C+	C+	D+	C	B	C
Gravelly	A-	B+	A	A	A	B+	A	A
Lake Louise	A-	B+	B+	A-	A	A	B+	A
Spanaway				B	n/a	n/a	n/a	C-
Steilacoom	C+	C-	C+	C+	C+	C-	C	B-
Waughop			D-	D+	D	C-	D-	C-

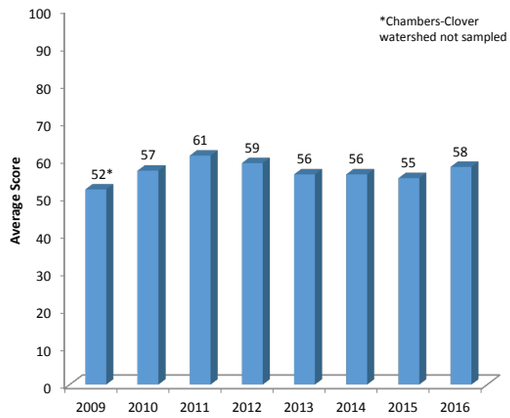
Appendix E - Watershed Health Trends

The figures below display overall scores in each of the four watersheds in Pierce County and the average score for all of Pierce County since 2009. Overall health scores in the Puyallup watershed are relatively stable around an average score of 57. Health scores in the Nisqually and Key Peninsula/Gig Harbor/Islands watersheds appear to be more cyclical, with scores for both watersheds peaking in 2011. The reasons for these patterns are not readily apparent given the data available. Health scores in the Chambers-Clover watershed dipped in 2015, with many stream miles in the watershed going dry during the hottest months of the summer of 2015. However, health scores returned closer to the long-term average of 53 in 2016.

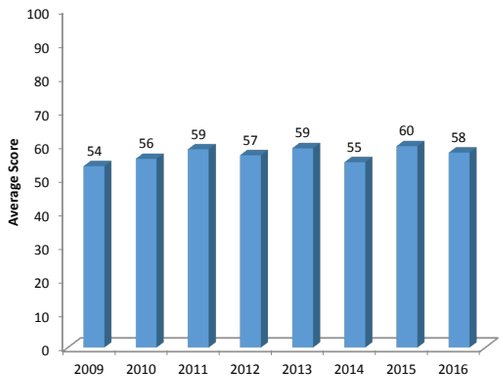
Change in Grades By Watershed

	Lower	No Change	Higher
Puyallup	4	5	9
Chambers-Clover	1	1	0
Nisqually	1	6	2
Key Pen	1	7	10
Lakes	0	3	4
Total	7	22	25

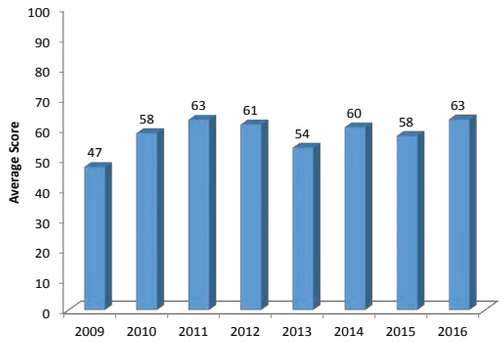
Overall Surface Water Health Scores



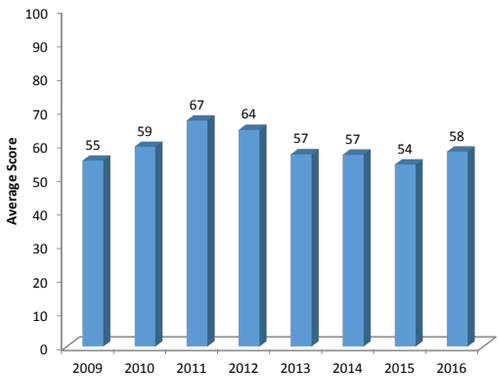
Surface Water Health Scores
Puyallup Watershed



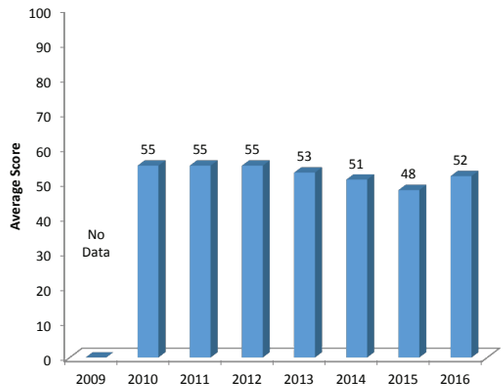
Surface Water Health Scores
Key Peninsula/Gig Harbor/Islands Watershed



Surface Water Health Scores
Nisqually Watershed



Surface Water Health Scores
Chambers-Clover Watershed



Appendix F - Glossary of Terms

Benthic Macroinvertebrates
Organisms that live on the bottom of a water body or in the sediment, and have no backbone.

Chlorophyll a
Chlorophyll is the green pigment found in all plants and algae and is necessary for photosynthesis. Chlorophyll a is the most abundant form in algae. Measurement of chlorophyll a concentrations in lakes provides an indication of the amount of algae present.

Conductivity
Conductivity refers to the ability of a substance to conduct an electric current. Conductivity measurements indicate the number of dissolved ions (positive or negative charged molecules) in the water. Conductivity data can help characterize overall stream chemistry and its effects on plants and animals. Changes in conductivity can indicate pollutants from sources like agriculture or wastewater are entering a stream.

Dissolved Oxygen
Dissolved Oxygen (DO) is oxygen dissolved in water. Certain concentrations are necessary for aquatic plants and animals to survive. Low levels of DO are primarily caused by high water temperature and decomposing algae and plants in the water. Excess algae and plant growth is often caused by phosphorus and nitrogen pollution. In general, the state minimum acceptable level of DO ranges from 6.5 to 9.5 milligrams of DO per liter of water. Higher levels of DO indicate healthy streams.

E. coli Bacteria
Escherichia coli (E. coli) bacteria are commonly found in the intestines of warm-blooded animals. Most E. coli are not harmful. High E. coli counts indicate high amounts of fecal material, which may in turn increase the risk of harmful bacteria.

Fecal Coliform Bacteria
Fecal coliform bacteria are bacteria from the intestines of warm blooded animals, including humans, dogs, birds and livestock. The measure of fecal matter in the water indicates the potential for other disease-causing organisms. It is a health risk for humans to be exposed to water with high concentrations of fecal coliform bacteria. Environmental Protection Agency defines maximum contaminant level based on an average of the samples taken each month. To be in compliance, no more than five percent of the samples can include coliform bacteria (fecal or E. coli).

pH
pH is a measure of how acid or alkaline the water is on a scale of 0 to 14. A pH below 7 indicates acidic and a pH above 7 indicates alkaline. Most aquatic organisms are sensitive to pH. The level can be affected by polluted runoff, polluted precipitation and decaying vegetation.

Secchi Depth
Secchi depth is a measure of water clarity. It is measured by lowering a secchi disk (an 8-inch disk with alternating black and white quadrants) into a lake until it can no longer be seen. Higher secchi depth readings indicate clearer water. Because water clarity is most often affected by algae, secchi depth is used as a measure of algae abundance.

Swimming Beaches
All rivers, streams, lakes and ponds can naturally contain bacteria, viruses, parasites and algae. Most of these organisms are not harmful to people, but some can cause illness. The Tacoma-Pierce County Health Department collects water samples for E. coli bacteria counts every other week during the summer from seven swimming beaches. If the water samples have high bacteria counts, an advisory is issued against swimming at the beach.

Temperature
Salmon and trout need water temperatures of 9-12 degrees Celsius (48-64 degrees Fahrenheit) to survive and reproduce. Warm temperatures reduce the amount of dissolved oxygen in the water and threatens native fish species. Water temperature can increase due to removal of streamside vegetation, eroding stream banks and polluted runoff.

Total Nitrogen and Phosphorus
High levels of nitrogen and phosphorus cause excessive algae and plant growth. When these plants die and decompose, they consume large amounts of dissolved oxygen. Common sources of nitrogen and phosphorus are fertilizers and human and animal waste. The Environmental Protection Agency has determined a healthy level of phosphorus to be less than one milligram per liter of water. The acceptable level of nitrogen is less than 10 milligrams per liter.

Total Suspended Solids (TSS)
These are particles, both mineral and organic, that are suspended in the water. High concentrations can harm aquatic life by blocking sunlight and reducing plant photosynthesis, clogging fish gills and increasing water temperature. TSS will vary by stream, but clear water is 20 milligrams or less of TSS per liter of water.

Toxic Algae
Toxic algae, also known as cyanobacteria or blue-green algae, are naturally occurring, but may produce toxins. These toxins can kill pets, waterfowl and other animals. They can also cause serious illness or even death in people. The Tacoma-Pierce County Health Department monitors toxic algae and issues advisories when conditions pose a health concern. There are three advisory levels: Caution (lower level of concern), Warning and Closed (highest level of concern).

Turbidity
Turbidity is a measure of water clarity. Algae and suspended solids can increase turbidity, making the water cloudy. Particles suspended in the water absorb heat from sunlight, increase water temperature and reduce dissolved oxygen. Heavy metals and other toxics can attach to the suspended materials. High turbidity blocks sunlight, decreasing plant and algae photosynthesis which affects the food chain for fish. Like TSS, turbidity varies by stream.

Water Year
A water year is the 12-month period from October 1 through September 30. The water year is a useful way to look at water data, because it starts at the beginning of the "wet season" and extends to the end of the "dry season." The water year is designated by the year in which it ends. This report card for the 2016 water year includes water data from October 1, 2015 through September 30, 2016.

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