2015 Stream Health Assessment for City of Bothell Streams

Version 2015-01

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City of Bothell™

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Introduction

The City of Bothell's Comprehensive Plan, *Imagine Bothell*…, calls for actions to "protect, preserve, and enhance those features of the natural environment which are most sensitive to human activities." Collection of data and observations (i.e., monitoring) is one means to determine attainment of that goal.

The City of Bothell has adopted ordinances to protect, maintain, and restore its waters through knowledge of past, current, and future trends and conditions. The City of Bothell Municipal code 18.01.010 (18) defines Storm and Surface Water Management Services in part as "…water quality and environmental monitoring…." Ordinance 1968 (2006), effective in 2007, stipulates the expenditure of Surface Water Management fees be used to conduct Storm and Surface Water Management Services.

The monitoring effort will facilitate the City's commitment to wise management of land and water for the benefit of current and future generations. One measure of success will be attainment of state water quality standards and beneficial uses as designated by city, state, and federal water quality standards.

Goal

A means by which the City of Bothell can measure and describe our progress to protect and restore the chemical, physical, and biological integrity of the City's surface waters.

Objective

To monthly monitor surface water quality to develop baseline data to identify trends. Data is assessed for occurrences of degraded conditions and to quantify levels observed, and document instream water quality and other opportunistic observations. Use information to facilitate City policy and land use rules, prioritize restorative actions, and direct future program monitoring efforts. Use the assessment to measure effectiveness with the Federal National Pollutant Discharge Elimination System (NPDES) Phase II permit, Endangered Species Act, and Clean Water Act.

Methods

Methods have been extensively described in previous annual monitoring reports (Loch 2009 and 2010). The following is a brief summary of methods.

Sample Station Selection

City staff selected sites through in-office review of maps and follow-up field surveys. Sites were selected based on the representativeness of the stream and upstream land use patterns. Sites were located as far downstream as was practical.

Chemical

At each site, monthly water quality measures were taken of dissolved oxygen, temperature, turbidity, conductivity, specific conductivity, and salinity.

Temperature

Stream temperatures were taken using two methods. One method was an instantaneous measure collected at the time of general water quality sample with YSI 85 meter. The second method involved use of a continuous instream temperature data logger. The data loggers were installed in a stream and were set to record continuous temperature reading every 15 minutes.

Physical

Hydrology Flows

Visual estimates of flow were made during monthly water quality sampling events. Flows were estimated and recorded in cubic feet per second (CFS) or, if flows were slight, estimates were made in gallons per minute (gpm).

QA/QC

To ensure accurate and precise data, all meters are calibrated at a minimum of once per month or per manufacturer's recommendations. Calibration records were kept of water quality meters. Meters were checked for accuracy prior to each monthly sampling event.

Field data collection was supervised by a practicing aquatic ecologist. Field data was entered into digital tables and checked for accuracy. Anomalies were investigated for possible errors in transferring data and compared to accompanying field comments.

Data Analysis

The data presentation for the annual summary report is limited to simple graphs of data. Graphs are assessed for general characteristic purposes and as early indicators of trends. Future efforts should include stronger statistical review to provide insight to problematic or poorly understood observations.

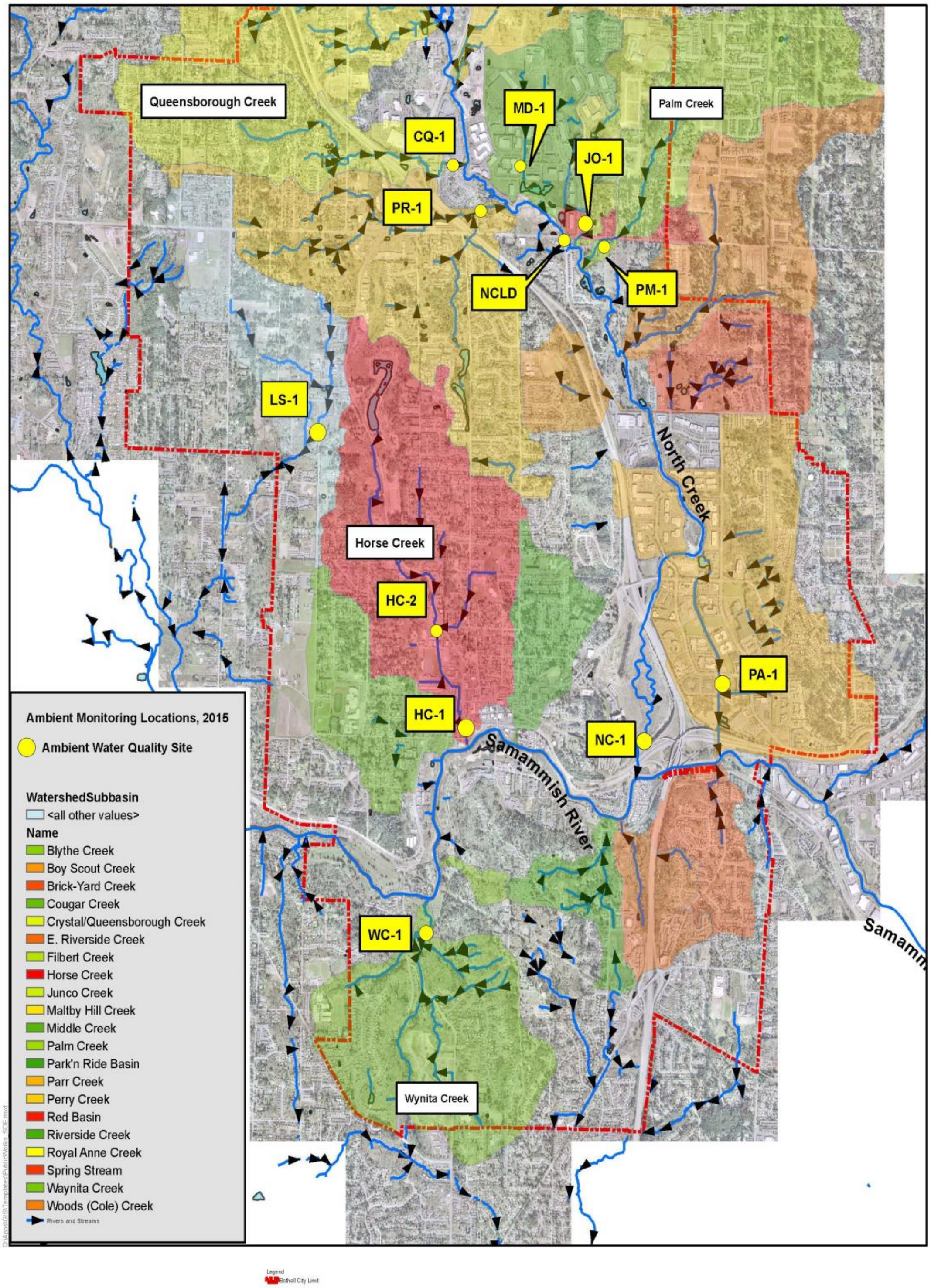

Figure 1. Water quality sample locations for 2015.

Results

Sample Station Selection

A total of 12 sites (Figure 1) were selected for sampling in 2015. Of the 12 sites sampled, 9 have been sampled since 2010. The sites were sampled for water quality parameters and six sites received deployment of temperature loggers. Four of the sites are part of the City's long-term fecal coliform bacteria sampling efforts. Fecal coliform test results are presented in a separate annual report (Loch 2015).

Ten watersheds were sampled among the 12 sample sites (Figure 1). Their basins' general characteristics are summarized in previous reports (Loch 2014). Horse Creek and North Creek had two sample sites each. The complete ambient monitoring data set for all sample locations may be found in Appendix A.

Chemical

Monthly measurements included dissolved oxygen, specific conductivity, salinity, pH and NTUs (nephelometric turbidity units). No upsets in sampling protocol occurred in 2015. Equipment was calibrated prior to sampling and was maintained per manufacturer's specifications.

Dissolved Oxygen (DO)

Dissolved oxygen levels for all but one stream (Palm Creek) recorded readings below Washington State Department of Ecology's water quality standard of ≥ 9.5 mg/l (Figure 2). The annual 12-month average was below state standards at most streams. The trend for all streams since 2011 is lower dissolved oxygen. One stream of particular note for its low dissolved oxygen levels is Parr Creek at station PA-1. It routinely has recorded DO lethal levels to salmonids from July through October (critical times for juvenile rearing and adult spawner migration). Lethal level to salmonids is: < 3.3 mg/l, Spence et. al. 1996.

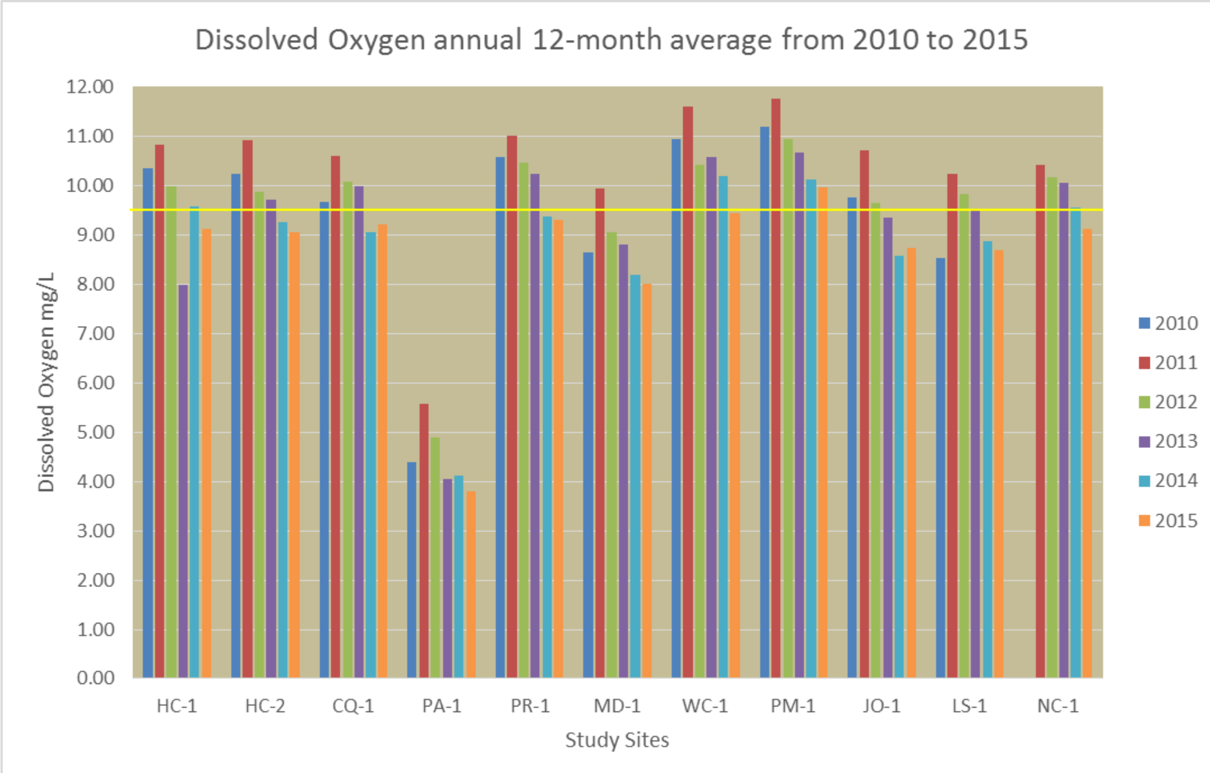

Figure 2 – Dissolved oxygen annual 12-month average from 2010 to 2015. The yellow line demarcates state standard of 9.5 mg/l level to meet standards.

Conductivity

Specific conductivity is a measure of dissolved metal ions. The higher the conductivity, the more dissolved metals, such as copper, lead, zinc, cadmium and others. Specific conductivity throughout the city was seasonally influenced. Highest readings occurred in the summer, and lowest readings in late spring. The highest readings for specific conductivity occurred on Parr Creek (PA-1) and at Waynita Creek (WC-1). The trend since 2010 was variable between streams. Four trends were observed. The first trend seen at Queensborough and Middle Creeks was a decrease in conductivity since 2010. The second trend observed at Junco and North Creek was little to no change over time. The third trend, most common, was observed at Perry, Palm, Horse (lower and upper sites), Waynita, and Little Swamp Creeks. In general, the third trend saw conductivity levels increase from 2012 through 2015. The fourth trend observed at lower Parr Creek was an up and down between years of conductivity. One trend observed at all sites was an increase in conductivity levels from 2014 to 2015. The common trend indicates that sources of dissolved metals in surface waters is increasing over time.

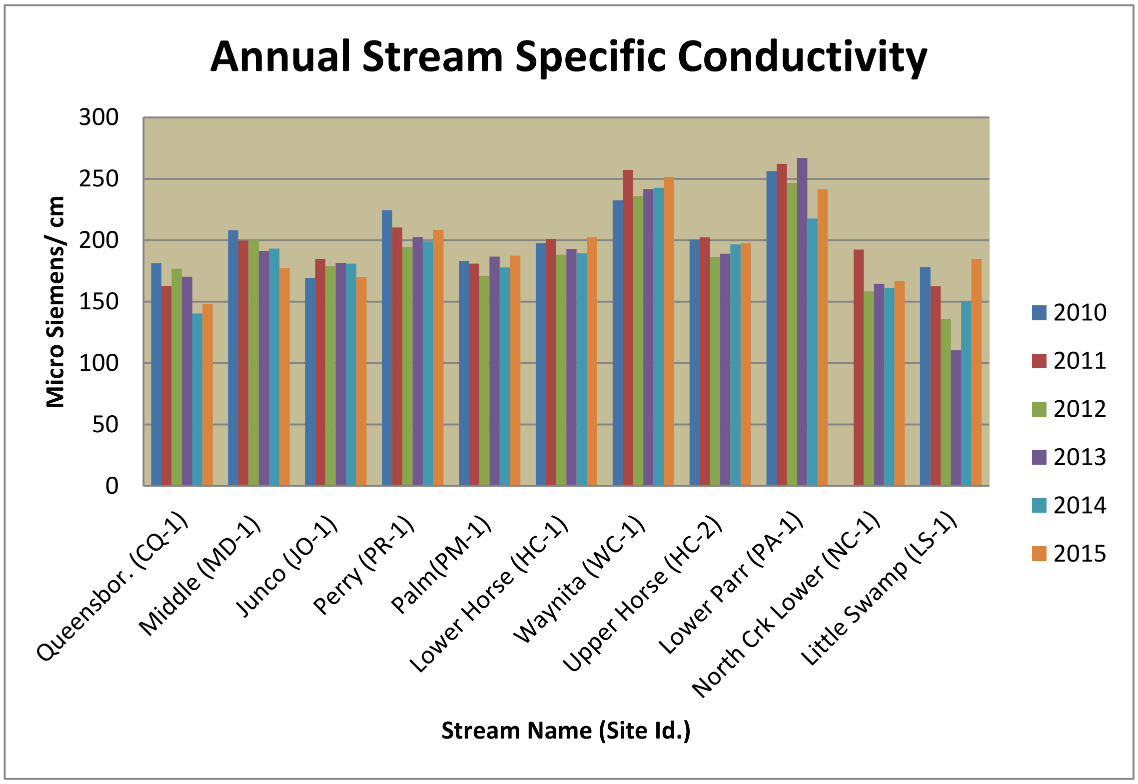

Figure 3 – Annual stream-specific conductivity levels from 2010 through 2015.

pH

Values of pH followed the same seasonal trend as conductivity. No site had recorded measures below or above state water quality standards. The overall trend in pH has been for a slight decrease at most streams beginning since 2010, Figure 4.

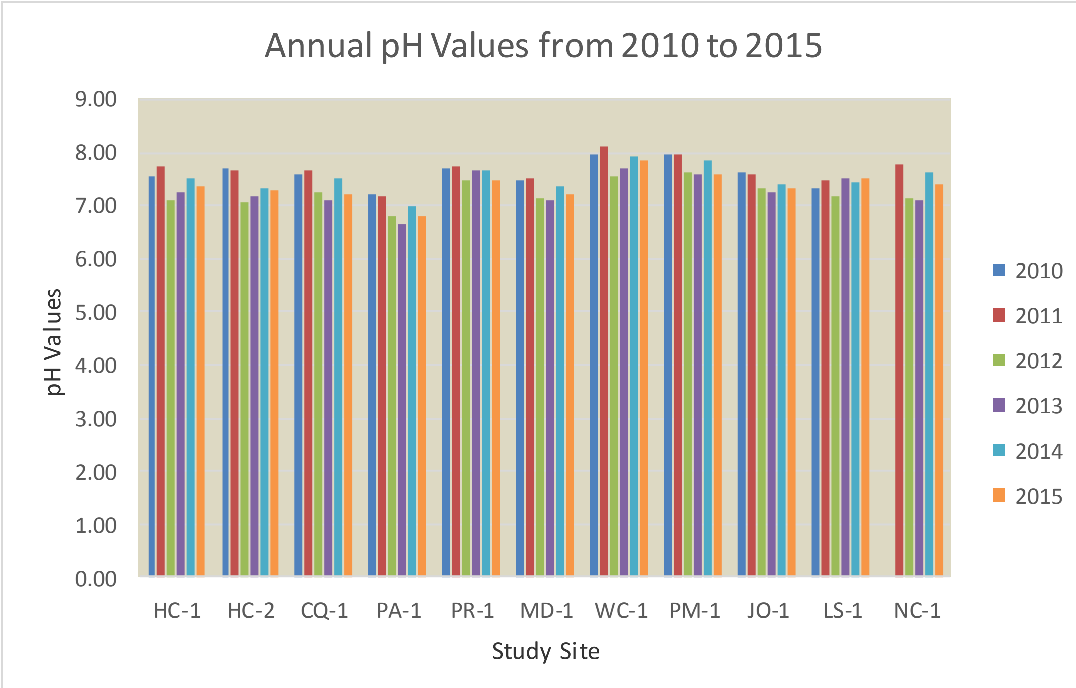

Figure 4 – Annual pH values from 2010 through 2015.

NTUs (Nephelometric Turbidity Units)

Turbidity levels were visually positively correlated to rain events. Parr Creek tended to have highest turbidity readings throughout the year due to algae diatom blooms from an upstream wetland pond. Two streams, Horse Creek and Waynita Creek, with active construction or demolition work upstream of the sample locations, at times had elevated levels of turbidity that were unrelated to rain events.

Temperature

Temperature loggers were deployed at eight sites between 2014 and 2015. The loggers measured stream temperature at 15-minute intervals. Data was cropped pre-retrieval and post-deployment to allow for near same start and finish time for comparison between streams. The long term climate change predictions suggest continuation of increasing stream temperatures for the foreseeable future.

The data from 2015 is not available as the loggers will not be retrieved until later in 2016. The weather during 2015 set records throughout the region for number of days above normal. It is expected that the effect of a warming climate will result in an increase number of occurrences of stream temperatures not meeting state standards.

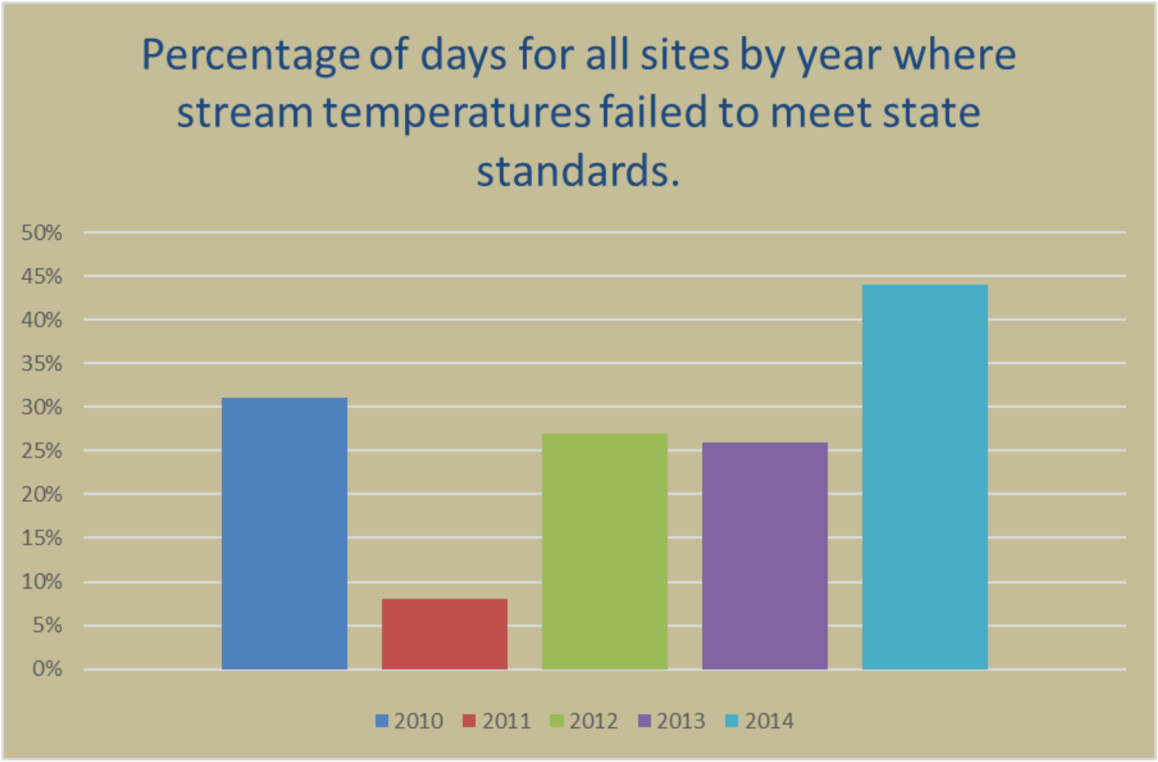

Figure 5. Percentage of days measured for all sites by year where stream temperatures exceeded state standards.

Summary

Results for ambient water quality monitoring for 2015 found degraded stream conditions throughout the city. In 2015 the most common condition not meeting state standards were dissolved oxygen and stream temperature. Conductivity levels were elevated, but there are no established state standards for conductivity. The common trend for conductivity indicates that sources of dissolved metals in surface waters is increasing over time. [1]

[1] Best available science has frequently found urban stream degradation to be related to common and pervasive urban development. Urban development is often characterized as having a dense road network, high levels of impervious surfaces, loss of riparian corridor (treed stream sides), increases in peak storm flows, inadequate stormwater treatment controls, reduced wetland acreage, and modified stream channel networks. It often is accompanied by an increase in heavy metals concentrations, nutrients, pesticides and herbicides, and a loss of instream and terrestrial habitat, as well as a decrease (and in some cases extirpation) of native species.

Future

To address the impairments noted in this and previous studies, the following are potential actions:

- ✓ Reduce peak flows, discharge of fine sediment, and polluted stormwater to streams.
- ✓ Identify means to retrofit direct discharge of stormwater that has been inadequately treated for pollutants and flow volumes.
- ✓ Encourage landowners to enhance and increase riparian zones along streams and wetlands, while limiting future encroachment.
- ✓ Develop and prioritize watershed-based restoration schedule to address instream deficiencies.
- ✓ Allow for and protect stream channel migration zones within floodplains.
- ✓ Educate landowners on improved vegetation management techniques that reduce applications of fertilizers, herbicides, and pesticides.
- ✓ Develop City plans to reduce road-generated pollutants from reaching streams.
- ✓ Continue to monitor the condition of streams for future trend and effectiveness analysis.
- ✓ Increase forested canopy throughout the city that promotes hydrologic maturity runoff conditions.
- ✓ The City's National Pollution Discharge Elimination System Phase II permit should be closely structured around the identified sources of degradation identified in this report.

The City is currently carrying out actions to address the problem of degraded stream conditions. Some of these actions have been ongoing for years, such as the Shoreline Management Plan, Critical Areas Ordinance, and the stormwater design controls. In 2007, the National Pollution Discharge Elimination System (NPDES) permit issued by Washington State Department of Ecology mandated that the City begin implementation of measures and programs to address stormwater impacts on streams. The results here provide a means to measure over time whether the new stormwater programs are effective towards meeting the goal to protect and restore the chemical, physical, and biological integrity of the city's surface waters.

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APPENDIX A

2015 Stream Ambient Monitoring Data

Annual Summary of ambient water quality monitoring for 2015													
		Site											
	HC-1	HC-2	CQ-1	PA-1	PR-1	MD-1	WC-1	PM-1	JO-1	LS-1	NC-1	NCLD	HCBP
Dissolved Oxygen (mg/l)													
Average	9.12	9.06	9.21	3.81	9.32	8.01	9.44	9.97	8.74	8.70	9.13	9.95	8.27
Standard Deviation	0.98	1.04	0.81	1.62	0.95	1.57	0.98	0.73	0.92	1.40	1.26	1.16	0.89
Min	7.84	7.60	8.17	1.07	7.93	5.81	8.32	8.58	7.37	6.41	7.50	8.12	6.92
Max	10.5	10.45	10.26	6.15	10.67	10.59	11.09	11.11	10.32	10.75	10.73	11.90	9.38
Count	12	12	12	12	12	12	12	12	12	12	12	12.00	12.00
Specific Conductivity (*us/* cm)													
Average	202.24	197.58	148.14	241.26	208.19	177.23	251.37	187.42	169.92	184.74	166.80	168.96	264.5
Standard Deviation	34.55	32.44	19.60	56.16	21.64	29.68	49.53	26.55	42.72	52.80	31.65	32.35	105.1
Min	142.8	143.70	98.20	122.30	158.90	122.30	140.90	123.40	54.70	103.90	111.10	112.30	24.7
Max	236.5	229.70	165.00	289.30	229.90	207.10	303.9	204.20	200.60	295.70	197.60	196.80	430.3
Count	12	12	12	12	12	12	12	12	12	12	12	12.00	12.0
pH													
Average	7.36	7.27	7.21	6.80	7.47	7.20	7.84	7.58	7.34	7.52	7.41	7.47	7.21
Standard Deviation	0.26	0.31	0.22	0.27	0.23	0.31	0.35	0.32	0.21	0.26	0.29	0.42	0.25
Min	6.65	6.40	6.81	6.40	6.92	6.72	7.20	6.82	6.86	7.14	6.86	6.64	6.77
Max	7.62	7.56	7.53	7.18	7.74	7.63	8.39	7.94	7.72	7.91	7.80	7.90	7.54
Count	12	12	12	12	12	12	12	12	12	12	12	12.00	12.00
NTUs													
Average	1.48	7.27	1.52	4.05	3.16	1.87	14.34	2.28	1.41	2.23	1.58	1.16	2.65
Standard Deviation	1.43	0.31	1.16	2.03	3.67	1.86	40.31	4.71	2.02	1.78	0.88	0.92	3.78
Min	0.10	6.40	0.21	0.37	0.05	0.15	0.28	0.05	0.13	0.10	0.30	0.15	0.11
Max	5.45	7.56	3.90	6.58	11.10	6.91	142.00	17.10	7.38	6.30	3.29	3.28	13.50
Count	12	12	12	12	12	12	12	12	11	12	12	12.00	12.00
Flow (cfs)													
Average	1.46	1.17	1.12	3.73	1.69	0.78	1.82	2.90	1.46	0.43	69.25	37.58	0.11
Standard Deviation	0.98	0.84	0.69	3.34	0.85	0.68	2.19	0.63	0.66	0.62	42.18	19.92	0.15
Min	0.25	0.25	0.20	1.00	0.50	0.07	0.03	1.75	0.75	0.01	25.00	18.00	0.01
Max	3.50	2.50	2.00	10.00	3.00	2.00	8.00	4.00	3.00	2.00	175.00	80.00	0.50
Count	12	12	12	12	12	12	12	12	12	12	12	12.00	11.00