

King County Stormwater Services

Bear-Evans Creek FC TMDL Program 2018

Executive Summary

This document answers Question 71 of the questionnaire from the Washington State Department of Ecology regarding King County's Phase I NPDES Municipal Stormwater Permit implementation activities for 2018.

In 2018, King County Stormwater Services (SWS) staff conducted bacterial source screening in the County's municipal separate storm sewer (MS4) in the Bear and Evans Creek basins, as required by the 2013-2018 municipal NPDES permit. Work and findings specific to year 2018 are summarized in this document.

The following is a brief list of highlights from SWS' work in 2018; details of each are included later in this document:

- A property near Cottage Lake Creek was discovered to be contributing human fecal waste to a small watercourse which crosses through the property;
- Follow-up sampling was carried out to confirm the elimination of one illicit sewage discharge originally discovered in 2015 and finally eliminated in 2017;
- Follow-up investigation took place at another location suspected to be a possible source of human fecal waste to the MS4;
- Investigations of other possible sources of fecal indicator bacteria to Bear and Evans Creek were conducted as appropriate; and
- SWS continued to perform dry-season screening of its MS4, as well as wet-season sampling of select MS4 and stream sites.

In 2019, King County SWS will continue both dry-season and wet-season reconnaissance and sampling work in its MS4 in order to comply with its TMDL requirements. However, due to the initiation of a new NPDES permit cycle, SWS plans to transfer most of its efforts to other geographic areas of the Bear/Evans basin (i.e. the 50% of MS4 subbasins not prioritized in the 2013-2018 permit cycle).

Regulatory Requirements:

Under the Washington State Department of Ecology Phase I NPDES Municipal Stormwater Permit effective August 1, 2013, in Appendix 2, Bear/Evans Fecal Coliform Total Maximum Daily Load (FC TMDL), King County is required to perform the following:

- "Designate areas discharging via the MS4 to the TMDL area as high priority areas for illicit discharge detection and elimination. Complete IDDE field screening for bacteria sources in 50 percent of MS4 subbasins, including rural MS4 subbasins, by February 2, 2017 and implement

the schedules and activities identified in S5.C.8 of the Phase I permit for response to any illicit discharges found.”

- “Install and maintain animal waste education and/or collection stations at municipal parks and other Permittee owned and operated lands reasonably expected to have substantial animal (dog and horse) use and the potential for pollution of stormwater.”

Previous reports

The Annual Reports for this project for years 2015 through 2017, already submitted to Ecology, may be consulted for descriptions of work previously conducted for the Bear/Evans FC TMDL. Additional copies can be provided upon request. These reports included SWS’ Sampling and Analysis Plan (SAP) for wet-season sampling work in the Bear/Evans Creek basin. The work discussed in this report has complied with the approach described in the updated version of the SAP provided with the 2016 Annual Report.

Work conducted in the Bear/Evans Creek basin, year 2018

In 2018, the following work was performed in the Bear/Evans Creek basin:

- Investigation of suspected sources of fecal bacteria to Bear and Evans Creeks, and follow-up on known or eliminated sources;
- Dry-season and wet-season reconnaissance and analysis of water quality in the County's MS4, as well as in Bear/Evans Creeks and their tributaries;
- Mapping of the County’s MS4 and drainage patterns in the Bear and Evans Creek basins;
- Acquisition of additional animal biomarker data for samples collected in 2017;
- Public outreach; and
- Business inspection program.

Investigation/follow-up on suspected/known sources of fecal bacteria. In December 2017, SWS began taking samples from a watercourse leaving a private property and entering the County’s MS4 before flowing a short distance to Cottage Lake Creek. The small watercourse is fed by hillside seeps above the property. In April 2018, SWS began to submit samples for qPCR analysis due to elevated *E. coli* readings at this location. The human biomarkers *Hu-2-Bacteroidales* and *Hu-3-Bacteroidales* were detected at high levels in two separate samples, and a third sample was also positive at lower levels, while no ruminant or dog waste were detected in the same samples. This information was passed on to King County Code Enforcement, which has an open case against the property owners for several violations of County code. Subsequent visits to the property by other County and State personnel, including Department of Public Health-Seattle & King County (DPHSC) staff, determined that there is an illegal RV on the property and that individuals may be defecating in the hillside forest due to inadequate sanitary facilities on the site. The County is using all legal means to bring this property owner into compliance.

Additionally, and as described in last year’s annual report, a major illicit discharge of wastewater from a private property within the City of Redmond to the County’s MS4 (and thence to Bear Creek) was detected by SWS in 2015 and eliminated in June 2017. Three follow-up samples were taken in 2018 in order to determine whether sewage is still entering the MS4 from the property. The samples were taken January 11, April 16 and November 26, 2018 -- water from the site typically only enters the MS4 during storms. While low to moderate levels of *E. coli* and the human biomarker *Hu-2-Bacteroidales* were found

King County Stormwater Services, Water Quality Compliance Unit clc/jed January 11, 2019

in the first two samples, the November 26 sample was low in *E. coli*, and the human biomarker was not detected. It was expected that some residual contamination might exist even after correction of the illicit discharge, due to the nature of the problem (which has not been elucidated here in the interest of brevity). More samples are planned to be taken in 2019. If another moderate or high result for the human biomarker is acquired, SWS will contact its colleagues in the DPHSKC and at the City of Redmond to reinitiate investigation of the property.

Also as reported in the 2017 annual report, another possible illicit discharge was detected by SWS in the Cottage Lake Creek basin in unincorporated King County in summer 2016, and confirmed as human sewage (using qPCR analysis) in late 2016. It is suspected that perforated private pipes associated with local French drains or downspouts are intercepting partially treated sewage from a nearby on-site septic system (OSS) and conveying it to the MS4. Dye testing carried out by DPHSKC at a suspect property was delayed due to the property owner being out of the country for many months; however, dye testing in late 2017 found no evidence that the suspect property was responsible for the illicit flows. Other potentially responsible properties nearby are still being investigated by DPHSKC.

Other suspected sources of fecal bacteria in the Bear and Evans basins are still being investigated, and it is planned that work outcomes will be described in future annual reports, as appropriate.

Dry-season reconnaissance and sampling. During the dry season of 2018, SWS visited and screened for bacteria sources at 130 locations in the Bear/Evans basin where stormwater leaves the County's MS4. SWS has now visited all of the 958 locations in these basins where stormwater leaves the County's MS4. Since 2015, *E. coli* measurements have been made at all locations (about 135 of the 958 just mentioned) where flowing water was found in the dry season. At most of these locations, pH, temperature, specific conductivity and ammonium were also measured. These measurements have also been made at some locations without flowing water, where poor pool quality in a nearby catch basin gave reason for concern. In year 2018, dry-season measurements rarely triggered follow-up sampling, as screening thresholds were seldom exceeded. Investigations are ongoing at a small number of sites, but no specific, mitigable sources of fecal bacteria were identified during dry season investigations in 2018.

Dry-season inspection observations and collected analytical data are stored in SWS' stormwater geodatabase. For a map of locations where dry-season inspections were conducted in 2018, please see Figure 1 at the end of this document.

Wet-season reconnaissance and sampling. In late 2015, SWS initiated storm sampling in its MS4 to attempt to identify possible sources of excessive levels of fecal bacteria. Although wet-season bacteria screening in the Bear/Evans basin is not required by the County's NPDES permit, SWS believes that certain problems cannot be detected in the dry season that may be detected in the wet season. Wet-season work continued throughout 2018 in numerous events, and is planned to continue in 2019. This work consists mainly of in-house *E. coli* measurements using Coliscan Easygels. Where justified by high *E. coli* results, samples are analyzed for animal biomarkers in attempts to determine the sources.

One shift in SWS' work in 2018 relative to earlier years' investigations has been with regard to storm targeting during the wet season. More wet-season sampling occurred on dry days, as opposed to wet days, in 2018 relative to previous years. This is in part because water running off road surfaces is often found to be high in FIB prior to entering the MS4, creating a significant source of "noise" during storms -- making

difficult the detection of failing OSS with basic FIB-screening methods. Briefly, the type of reconnaissance or sampling event to target (storm vs. non-storm, wet season vs. dry season) depends on the type of fecal bacteria source in question. SWS is in the process of reviewing and reformulating its bacterial screening approaches for its TMDL work in various stream basins; this is in part driven by the new upcoming permit cycle. Any significant changes to SWS' FC TMDL work will be detailed in the 2019 annual report.

Altogether, water quality measurements were taken by SWS at 200 distinct locations in the Bear/Evans basin in year 2018. About 150 of these were locations in the County's MS4, and the rest were natural watercourses. All collected water quality data are stored in SWS' stormwater geodatabase. For a map of the locations where fecal bacteria measurements were made in 2018, please see Figure 2 at the end of this document.

Mapping work. King County's MS4 in the Bear and Evans basins consists of over 250 miles of conveyance, and roughly 7000 catch basins or manholes. At the beginning of this TMDL program, mapping data in many locations in these basins were either outdated or incomplete. In 2018, SWS finished its mapping of the Bear and Evans basins, with the exception of some minor anomalies (buried structures, etc.). Further mapping analysis in 2018 of the conveyance system has turned up dozens of additional locations where water leaves the County's MS4 (that had not been identified at the end of 2017). SWS has also been mapping the locations of ephemeral watercourses that are not included in available databases (e.g. the National Hydrography Dataset or the King County GIS watercourse dataset). Improvement of the County's mapping data is an important aspect of the TMDL program described here.

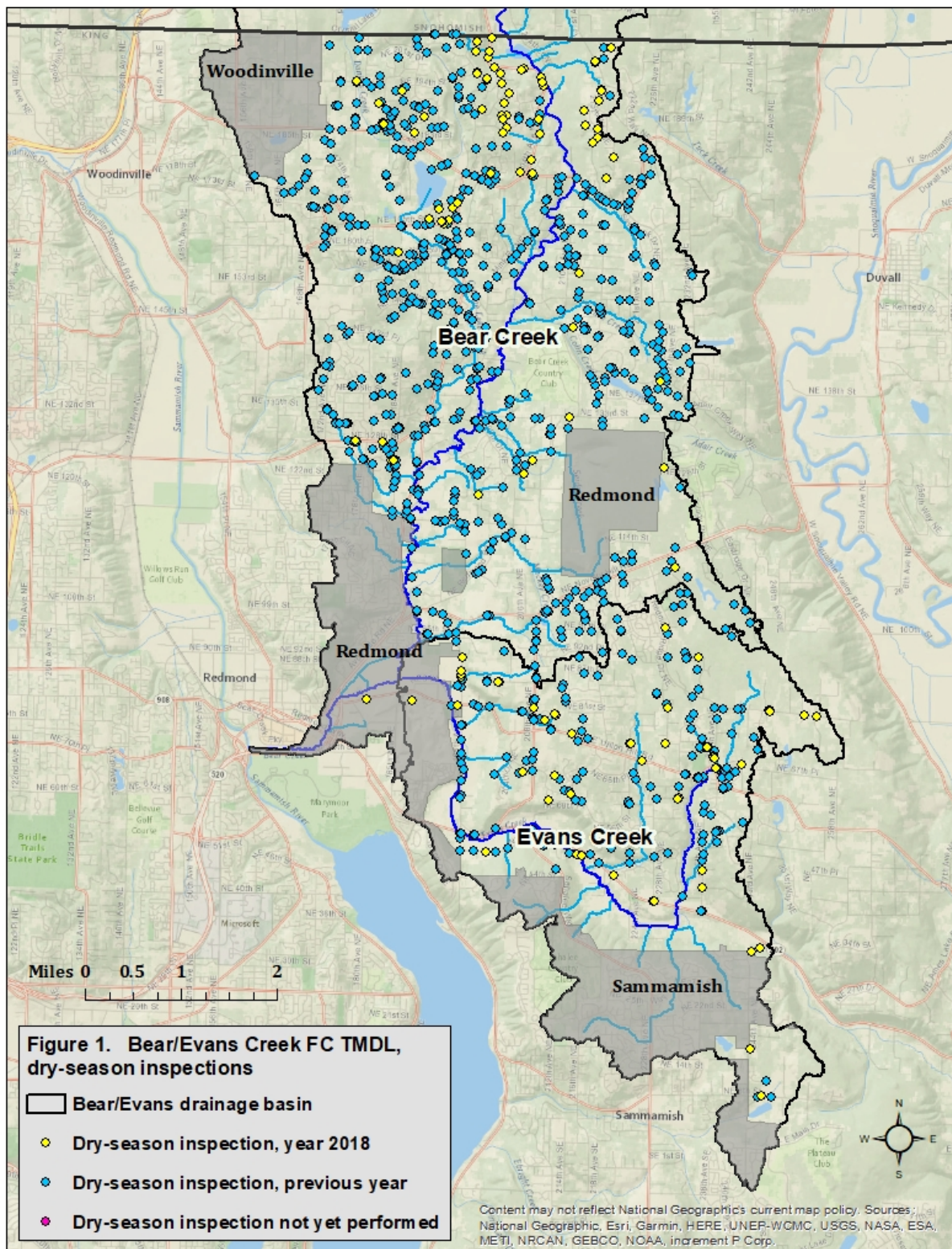
Acquisition of qPCR data. As described in the SAP, laboratory samples submitted to King County Environmental Laboratory (KCEL) are initially analyzed for only *E. coli* and, using quantitative polymerase chain reaction (qPCR) DNA amplification techniques, the human-specific biomarker *Hu-2-Bacteroidales*. Sample extract is also frozen and stored for possible additional future qPCR analyses. This approach is used because of the high expense of qPCR analysis and the ability of processed sample material to be archived (stored frozen) long-term. At some locations, repeated high *E.coli* results were not accompanied by significant measurements of *Hu-2-Bacteroidales*. Therefore, as budget allowed and as appropriate, select archived samples were submitted in 2018 for additional qPCR analyses – mostly ruminant, cow or dog. These techniques have identified one property as a possible source of cattle waste, although more data are needed. The most abundant large domestic animal in the Bear/Evans basin is the horse. Unfortunately, as reported in the last annual report, SWS does not have confidence in the genetic marker available for horse waste bacterial DNA analysis. SWS and KCEL are looking for another way of analyzing water samples for horse fecal waste, but so far to no avail.

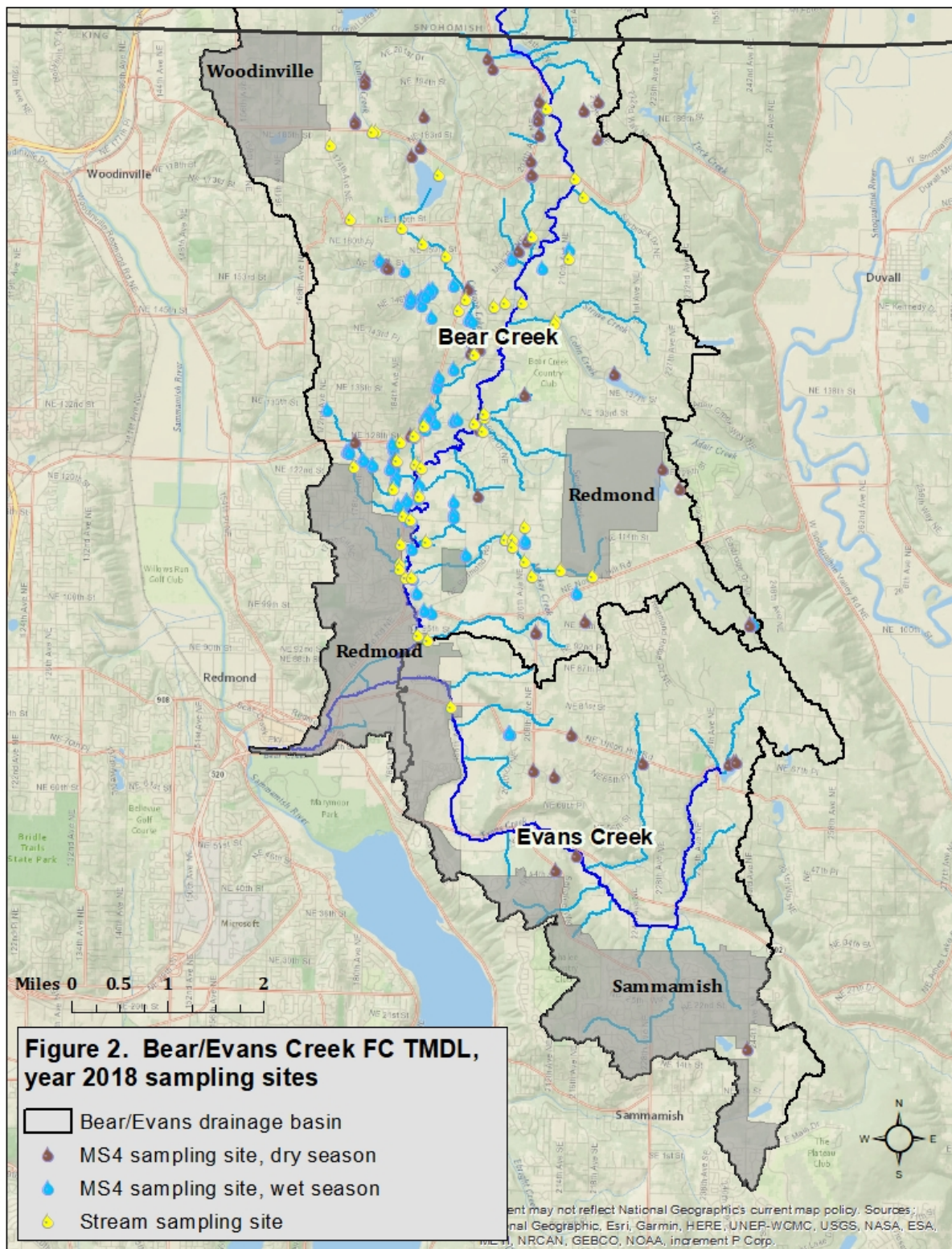
Public outreach. The FC TMDL program manager attended the Bear Creek Watershed-Scale Stormwater Plan Public Meeting #3, hosted by King County Water & Land Resources Division at Brightwater Visitor Center the evening of March 7, 2018. The program manager displayed posters describing SWS' FC TMDL efforts in the basins, as well as examples of Coliscan Easygels, answered questions, and listened one-on-one to citizen concerns regarding water quality.

Business inspections. SWS' existing business inspection program was leveraged to support this TMDL work. A total of 74 business properties in the Bear and Evans basins were identified as needing their

once-per-five-year inspections in 2018. Of the 74 properties visited by staff, none were identified as having business practices that were contributing to the fecal bacteria problem in the creeks.

-----end of write-up. Figures on following pages---





King County Science & Stormwater Services Sections

Issaquah Creek FC TMDL Program 2018

Introduction

The Issaquah Creek basin is located in the Cedar/Sammamish basin in Water Resources Inventory Area 8 (WRIA 8) in King County in western Washington State. The middle and upper Issaquah Creek subbasins are considered Regionally Significant Resource Areas because of their exceptional fisheries habitat and forested land cover. However, there are several factors contributing to the decline of fish habitat within the basin, including the exceedance of nutrient loadings and State water quality standards during storm events.

Segments of Issaquah Creek and its tributaries have regularly exceeded State fecal coliform standards. In 2004 the Washington State Department of Ecology implemented a Total Maximum Daily Load (TMDL) plan to reduce fecal coliform concentrations in impaired segments and maintain the health of unimpaired reaches. The plan identified likely sources of contamination to include fecal material from failing septic systems, domestic animals, and wildlife, with transport mechanisms including urban and rural stormwater conveyance systems.

Under Appendix 2 of the 2013 – 2018 Phase I National Pollution Discharge Elimination System (NPDES) Municipal Stormwater Permit, the jurisdiction of King County is required to perform certain tasks to attempt to reduce bacterial loadings to Issaquah Creek and its tributaries. One requirement is to perform bacteria source screening in at least 50 percent of the Issaquah Creek municipal separate storm sewer system (MS4) subbasins. A second requirement is for the County to inventory its properties to ascertain if any can benefit from installing pet waste collection stations or waste pick-up reminder signs. The following document describes King County's efforts in 2018 to fulfill these requirements.

Task Description Narrative

Updates on the major task descriptions in 2018 (see Figure 1 in Appendix A):

Mapping: Updates and corrections to the King County ArcGIS MS4 map occurred throughout 2018. Work focused on verifying MS4 outfalls and documenting natural drainage through the MS4 system.

Selection of Subbasins: No updates to this work were done; subbasins had been previously selected in 2016. Herein these subbasins are referred to as the “targeted subbasins”.

Field reconnaissance: Enhanced Conveyance Screening Program (CSP) inspections occurred throughout summer of 2018. When flowing water was observed, King County staff obtained *E. coli* concentrations.

Establish sampling sites: Sampling sites were established in 2016.

Sampling & analysis plan (SAP) development: No updates to the SAP were made in 2018; the draft of the SAP was completed in November 2016.

View the SAP here: <http://your.kingcounty.gov/dnrp/library/2016/kcr2823/kcr2823-rpt.pdf>

SAP implementation: SAP implementation began on November 15, 2016. SAP implementation occurred in 2017 and 2018.

Animal waste collection stations and waste pick-up reminder signs: The permit requirement for King County regarding pet waste collection and pet waste pick-up reminder signs was addressed in the Issaquah Creek basin in 2017; the 2017 annual report may be consulted for details.

Field Reconnaissance, Sampling and Analysis Findings

Enhanced CSP in summer 2018

From May 31, 2018 to August 30, 2018, King County inspected the MS4 at locations where water enters and exits the system (herein referred to as “links”) as part of its Conveyance Screening Program (CSP). When flowing water was observed, King County staff performed “enhanced” CSP inspections which entailed sampling *Escherichia coli* (*E. coli*) concentrations using Coliscan® Easygel® (EZgel) media¹. One hundred and four (104) CSP inspections were completed in the targeted subbasins of Issaquah Creek (see Figure 2 in Appendix A for a map of all enhanced CSP inspection locations). Of the 104 inspections, flowing water was observed on six instances (see Table 1 in the Appendix for a results tabulation).

E. coli concentrations at enhanced CSP locations were generally low. Two samples exceeded 100 colony forming units per 100 milliliters (CFU/100mL) and only one was >500 CFU/100mL. This sample, collected at locator “Issaquah_20043” (see site highlighted by red circle in Figure 2 in Appendix A) on August 28, 2018, had an *E. coli* concentration of 720 CFU/100mL. The sample was collected at a 4” PVC pipe that discharges into a roadside ditch in the King County MS4. The origin of the pipe is unknown but likely collects subsurface drainage between a forested hillside and residence as it flows continuously throughout the year. *E. coli* concentrations during follow-up were only 10 CFU/100mL. The high results from the first sample may have been due to some one-time or intermittent fecal contamination event or to contamination or misidentification of colonies during culture counting

Wet weather Mirrormont “microbasin” reconnaissance

Mirrormont is a 1.64 square mile census designated place (CDP) located in the Middle Issaquah Creek basin. Most of the Mirrormont area is classified as higher density rural subbasin (HDRS) and contains the highest density of King County stormwater assets within the target subbasins of Issaquah Creek. A number of intermittent and first-order perennial streams drain the Mirrormont area and flow directly into Issaquah Creek. In order to better understand possible contributions of fecal pollution from this community to Issaquah Creek, the area was subdivided into nine “microbasins” where the small streams crossed Issaquah-Hobart Road (see Figure 3 in Appendix A). During winter and spring months when soils were moist but there was not significant precipitation, thorough reconnaissance was performed in five of the nine microbasins (reconnaissance was prioritized by the number of links within the microbasin). During reconnaissance:

- All links were physically visited and conditions documented
- EZgels were taken at links with flowing water
- EZgels were taken at the microbasin outlet

¹ From Micrology Laboratories. <https://www.micrologylabs.com/page/93/Coliscan-Easygel>

- The source of water within the microbasin was traced to understand where flow was originating
- Windshield survey of properties was performed within the microbasin to see if there could be obvious sources of contamination such as failing septic systems

Based on sampling results, there does not appear to be widespread fecal contamination in the King County MS4 during wet season base flow; 29 of the 31 samples taken had *E. coli* concentrations less than 300 CFU/100mL. Further, windshield surveys of properties did not reveal any obvious sources of contamination, though surveys were limited to portions of properties visible from the public right-of-way. Most water flowing in the King County MS4 in the Mirrormont area during wet weather baseflow originated from seeps/springs and ephemeral streams discharging from forested hillsides, with a smaller amount coming from private property yard and roof drains.

The two locations that exceeded 300 CFU/100mL were at the outlets of roadside ditches along SE Tiger Mountain Rd (Issaquah_19420) and along SE 157th St (Issaquah_88183). The latter had a count of 7,360 CFU/100mL. Field reconnaissance did not reveal any obvious sources of contamination in the ditches, and *E. coli* concentrations were less than 100 CFU/100mL during follow-up sampling. It is possible that the high concentrations observed during initial sampling were results of intermittent or one-time fecal contamination events (e.g. canine fecal material getting tossed or washed into a roadside ditch) or the result of misidentification of bacterial colonies during sample counting.

The remaining four microbasins of the Mirrormont area (R, U, V, and W in Figure 3) will be investigated in Q1 of 2019.

Baseflow/Storm sampling of a Mirrormont subbasin: “Basin X”

A water quality sample during a 2017 summer CSP inspection at the mouth of an unnamed perennial stream in the Mirrormont area had an *E. coli* concentration in excess of 1,000 CFU/mL. Though follow-up water quality samples had much lower *E. coli* concentrations, this drainage area (herein referred to as “Basin X”) was selected for intensive baseflow/storm event sampling in 2018. Basin X made an ideal case study for how the King County MS4 might serve as a conduit that connects contaminated runoff to first order streams that drain into Issaquah Creek; it has the highest density of outfalls in the Mirrormont area and the drainage area had a gradient of increasing home and road density from the forested upper basin to the developed lower basin.

Sampling occurred on 1/11/2018 and 3/5/2018. Approximately 1.5” of rain fell in the Mirrormont area on the first day of sampling (4-day antecedent rainfall totaled 1.44”). There was significant flow through the King County MS4 and most of the outfalls in the Basin X were actively flowing. In contrast, during baseflow sampling on 3/5/2018, no precipitation occurred during sampling or in the preceding 24 hour period (the 4-day antecedent precipitation totaled about 0.9”). Consequently, there was no surface runoff into the King County MS4 on the March sampling day; however, soils were moist and there was some seasonal natural flow through the MS4.

All samples were analyzed for *E. coli* and the human fecal waste bacterial qPCR marker “Hu-2”. qPCR is an analytical technique that uses DNA segments from bacteria unique to the digestive systems – and hence, the fecal waste – of respective animal species (e.g. humans, dogs, cows). Additional qPCR markers (Hu-3, Rum-2, Bird, and Dog1) were run on two samples taken on 1/11/2018 due to high *E. coli* concentrations. See Figure 4 in Appendix A for a plot of storm vs. baseflow *E. coli* results and Figure 5 for

a map of Basin X sampling locations. Table 2 contains a tabular display of *E. coli* and qPCR results. Findings for each sampling event are briefly summarized below.

Storm Event

At 31 of the 35 sample sites, *E. coli* concentrations were generally low, averaging 86 CFU/100mL and not exceeding 400 CFU/100mL. Of the four remaining higher concentration sites, two had values of 2,500 and 18,000 CFU/100mL. These sites (Issaquah_4608 and Issaquah_23136) were both outfalls to an unnamed perennial stream from roadside ditches.

The Hu-2 qPCR marker was detected at 14 of the 35 sites, but only at trace amounts as no sample exceeded 10 copies/mL. Additional qPCR markers were run on the two outfalls mentioned above; Hu-3, bird, and ruminant (Rum-2) markers all came back negative for both sites but the canine marker (Dog1) was detected at both sites.

Baseflow

During baseflow sampling on 3/5/2018, 14 of the 35 sites had no flow and could not be sampled. Of the remaining 21 sites, *E. coli* was not detected at eight; and, where *E. coli* was detected, no concentration exceeded 100 CFU/100mL. Hu-2 was detected at five of 21 sites, but only at trace levels. While these results only represent a single snapshot in time, they suggest that this subbasin does not contribute significant fecal pollution to Issaquah Creek under inter-storm baseflow conditions during the wet season.

Follow-up work

The outfalls at Issaquah_4608 and Issaquah_23136 and the drainage areas contributing flow to them were inspected during wet and dry conditions. Flow was never observed at the outfalls or in contributing ditches so no additional samples could be collected. There were no obvious signs of sources such as failing septic systems, large domestic animal grazing fields, or wildlife trails that could explain the high *E. coli* results on 1/11/2018. Given the detection of the canine qPCR marker at these locations, a possible explanation is that surface runoff from the intense rainfall on 1/11/2018 mobilized canine fecal waste left along roadsides by people walking dogs. While not a King County property, this area might benefit from the addition of pet waste stations or signs reminding pet owners to dispose of pet waste properly.

Baseflow/Storm sampling on the Hobart Plateau Subbasin: “Basin H”

EZgel sampling in 2017 identified the SE 200th St area of the Hobart Plateau as an area of concern for further investigation due to high *E. coli* values. This area, called “Basin H” in this report, consists of natural drainage flowing through King County MS4 adjacent to SE 200th St. with several inputs from adjacent agricultural properties. Similar to Basin “X”, sampling occurred during two different hydrologic conditions: wet season baseflow conditions in the spring and during a storm event in autumn. Samples were analyzed for *E. coli* and human (Hu-2) and cow (CowM3) qPCR markers. Wet weather samples were analyzed for a bird qPCR marker by a private laboratory. See Table 3 in Appendix A for sampling results and Figure 6 for a map of sampling locations. Findings for each sampling event are briefly summarized below.

Baseflow

On May 7, 2018 conditions were generally dry; the 4-day antecedent rainfall was 0.04" but all seasonal streams were flowing due to heavy rains in April (9.32"). *E. coli* concentrations were low at all samples sites; no sample exceeded 50 CFU/100mL. Hu-2 markers were detected at two sites, but at relatively low concentrations. No cow markers were detected at any site.

Storm Event

Sampling occurred on October 29, 2018 after a 4-day period of heavy rain (3.75") between October 25 and October 28. Light rain was falling on the day of sampling. *E. coli* concentrations were considerably higher than dry weather sampling in May; the minimum concentration was 270 CFU/100mL and five samples exceeded 1,000 CFU/100mL. The highest concentration samples occurred at in-flows to the natural drainage in the roadside ditch (see Table 3 and Figure 6), two of which drain cattle grazing fields. The CowM3 marker was detected at the outlets of these two fields and further downstream where the natural drainage turns north away from SE 200th St. towards its confluences with Carey Creek. The CowM3 marker was not detected at any other site. The bird marker was detected at four of the six samples where it was analyzed, but only in trace amounts.

The human qPCR marker was detected at seven of the nine sites with the highest number of DNA copies occurring at the site "Issaquah_87544", where a natural drainage channel meets the King County roadside MS4 after flowing through a cattle grazing field. The natural drainage channel also flows in close proximity to a residence on 276th Ave SE. It is possible that their septic system could be seeping into this drainage channel but closer sampling is needed to determine the possible impacts from this parcel.

Upcoming Work in 2019

Work in 2019 will focus in three key areas:

1. Briefing King County Agricultural staff on Hobart area findings (Basin H)

Results from water quality sampling in 2018 showed that storm runoff from agricultural fields to a seasonal, unnamed tributary may be contaminated with fecal contamination from cattle, though failing septic systems may also be a factor. King County Stormwater Staff will meet with King County Agriculture staff to discuss possible courses of action to address the situation. This will be completed in Q1 of 2019.

2. Complete wet season recon/sampling for remaining Mirrormont microbasins

Wet weather reconnaissance is still needed in four small microbasins (R, U, V, and W in Figure 3) in the Mirrormont area. This will be completed in Q1 of 2019.

3. Begin source tracking work in the other 50% subbasins of Issaquah Creek

After the above tasks are completed, all screening work will shift to the remaining subbasins of Issaquah Creek. See Figure 7 in Appendix A. These subbasins include Macdonald Creek and the North and East Forks of Issaquah Creek. These areas generally more developed and have a higher density of MS4 per area than largely forested Upper and Middle Issaquah Creek subbasins. A microbasin approach similar to the one utilized in the Mirrormont area is planned to be used.

APPENDIX A: TABLES AND FIGURES

Scope of Work, Issaquah Creek FC TMDL 2016-2018, Science & Stormwater Services

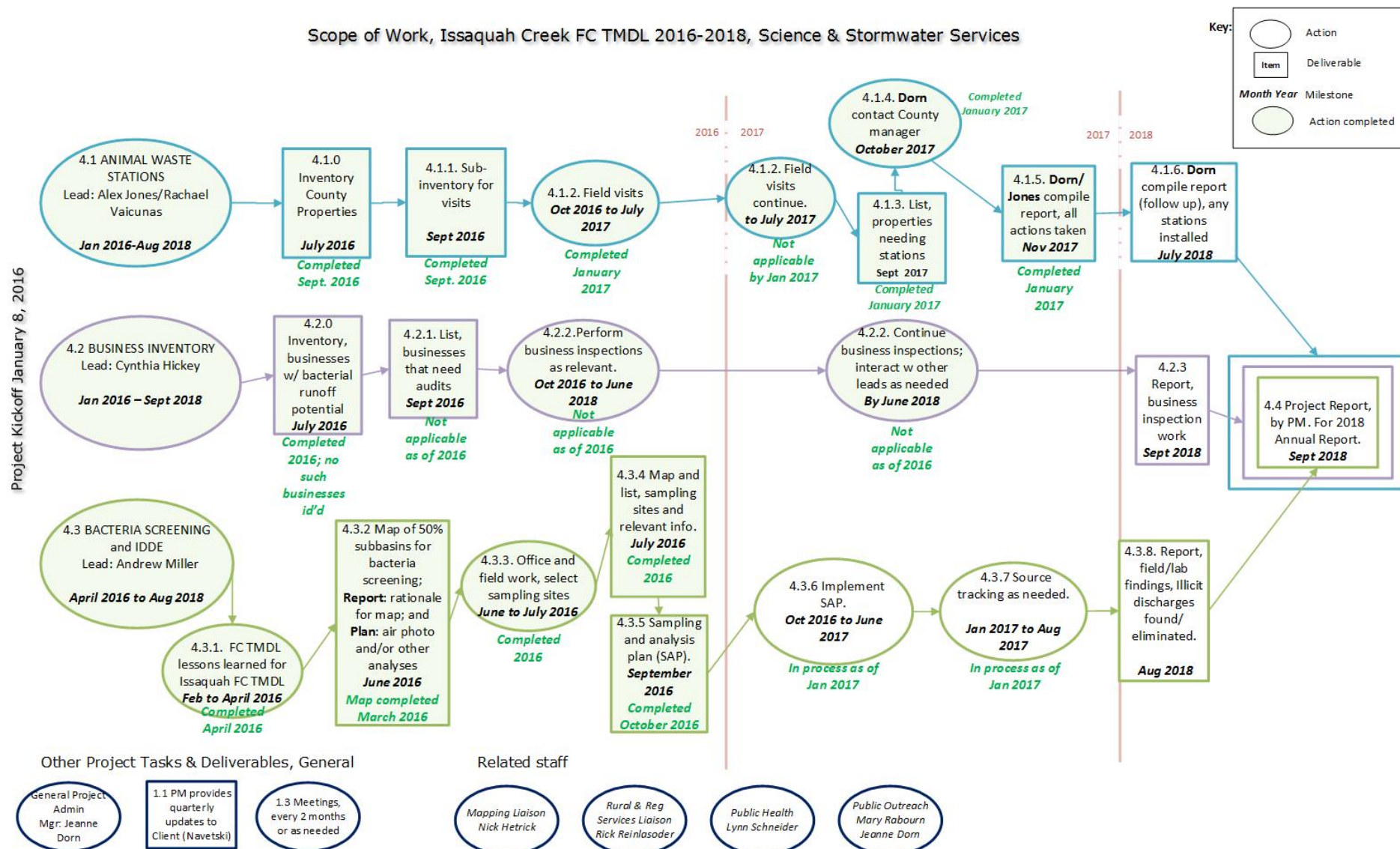


Figure 1 | Project scope of work and timeline.

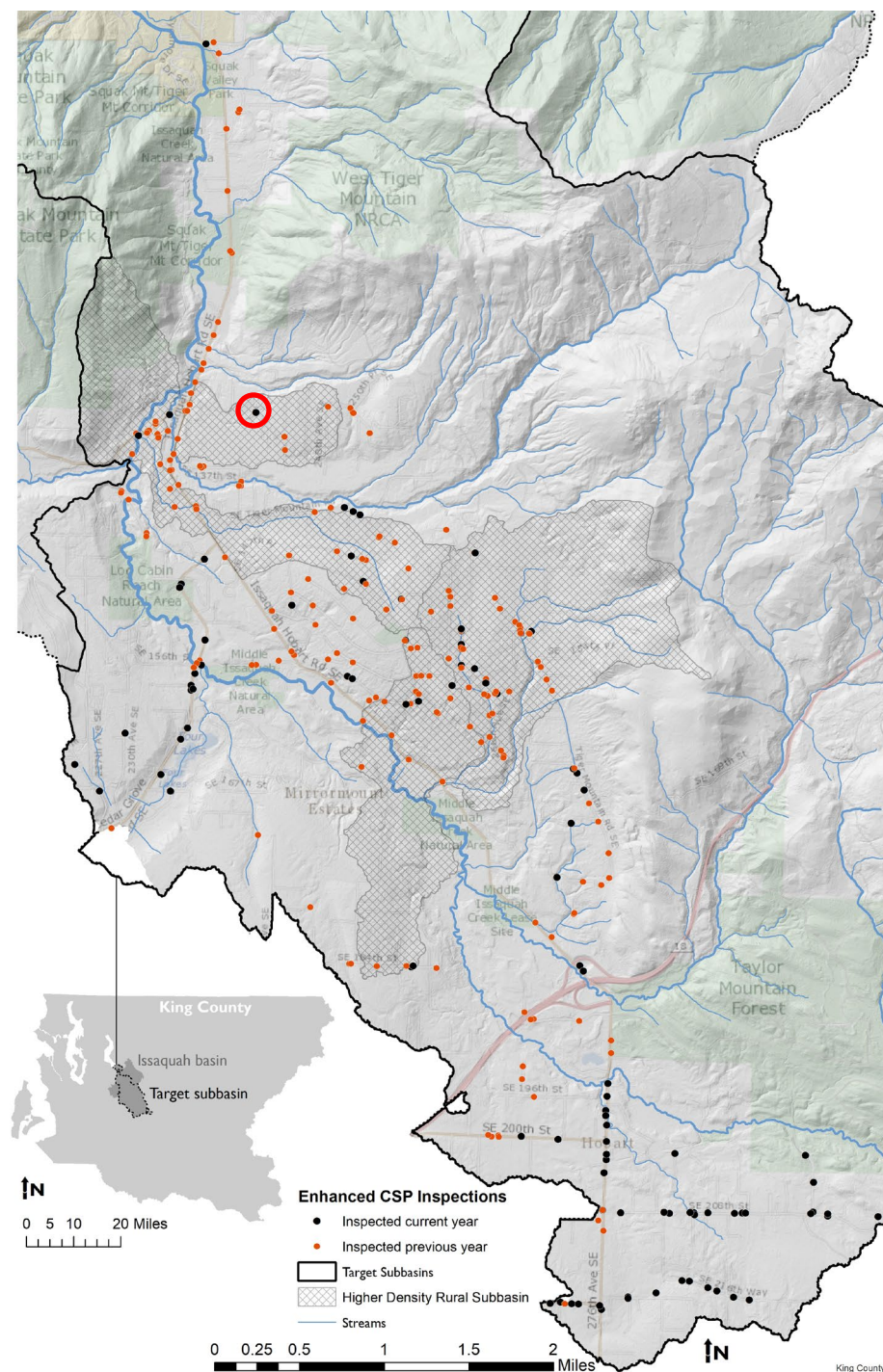


Figure 2 | Map of enhanced CSP inspections of King County stormwater system in the Issaquah Creek basin during summer of 2018 (black circles) and 2017 (orange circles). *E. coli* concentrations were measured anywhere flowing water was observed. The site located with the red circle had flow present with a concentration of 720 CFU/100mL.

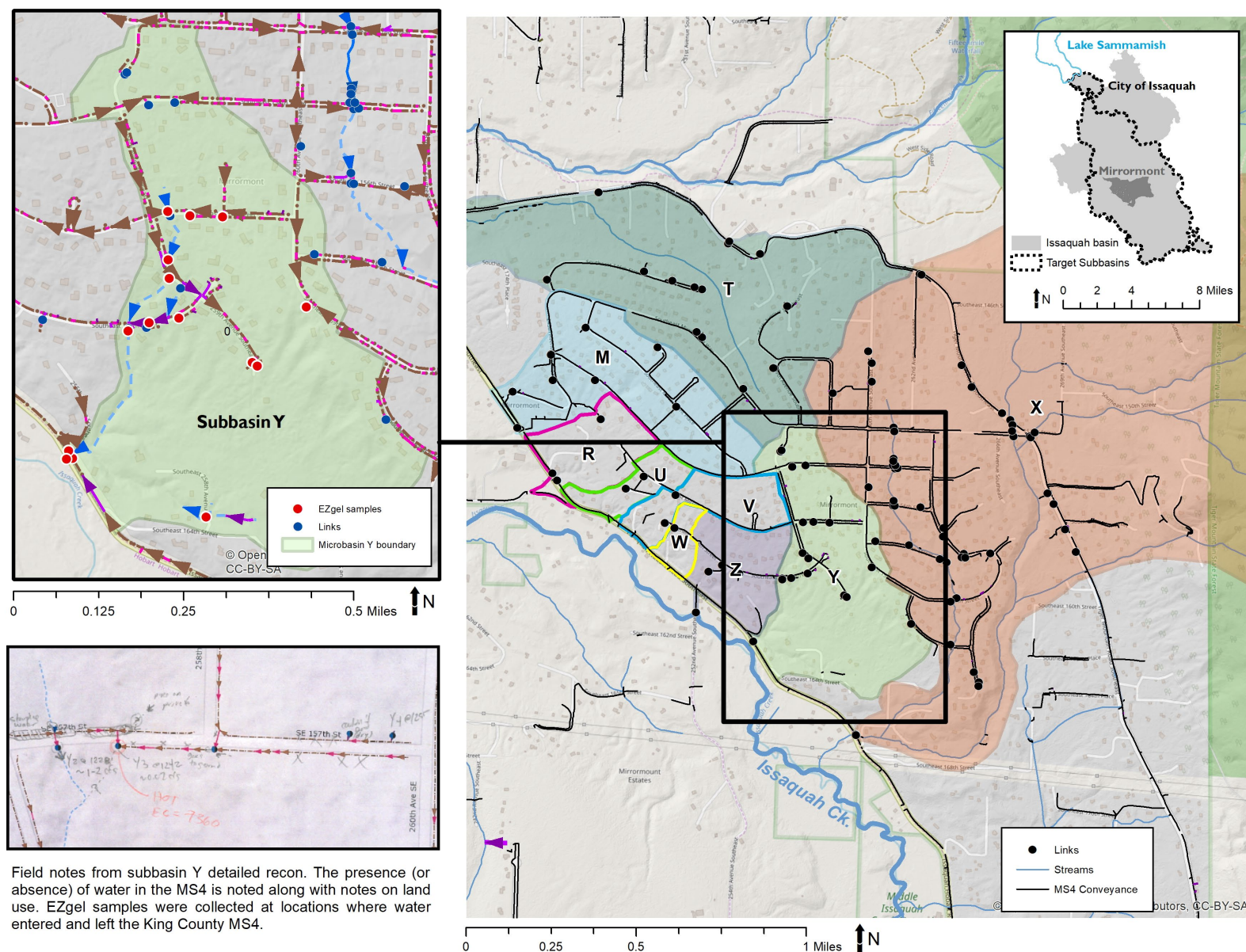


Figure 3 | Map of the Mirrmont area with "microbasins" highlighted. These microbasins were thoroughly investigated in 2018 – all links were inspected and EZgel samples were collected where water flowed into and out of the King County outlet as well as the subbasin outlet. Sample collection sites and field notes are shown for subbasin Y on the left. Microbasins with just an outline (R, U, V, W) will be investigated in 2019.

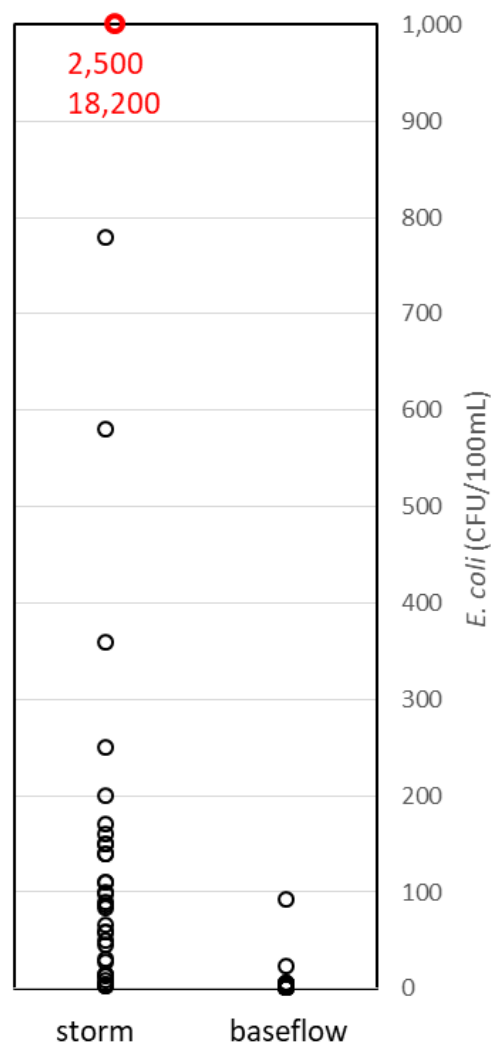


Figure 4 | Plot of *E. coli* concentrations in water quality samples from Basin X during storm and wet season baseflow conditions. No sites exceeded 100 CFU/100mL during wet season baseflow (with many sites being dry) but *E. coli* concentrations were significantly higher during storm sampling.

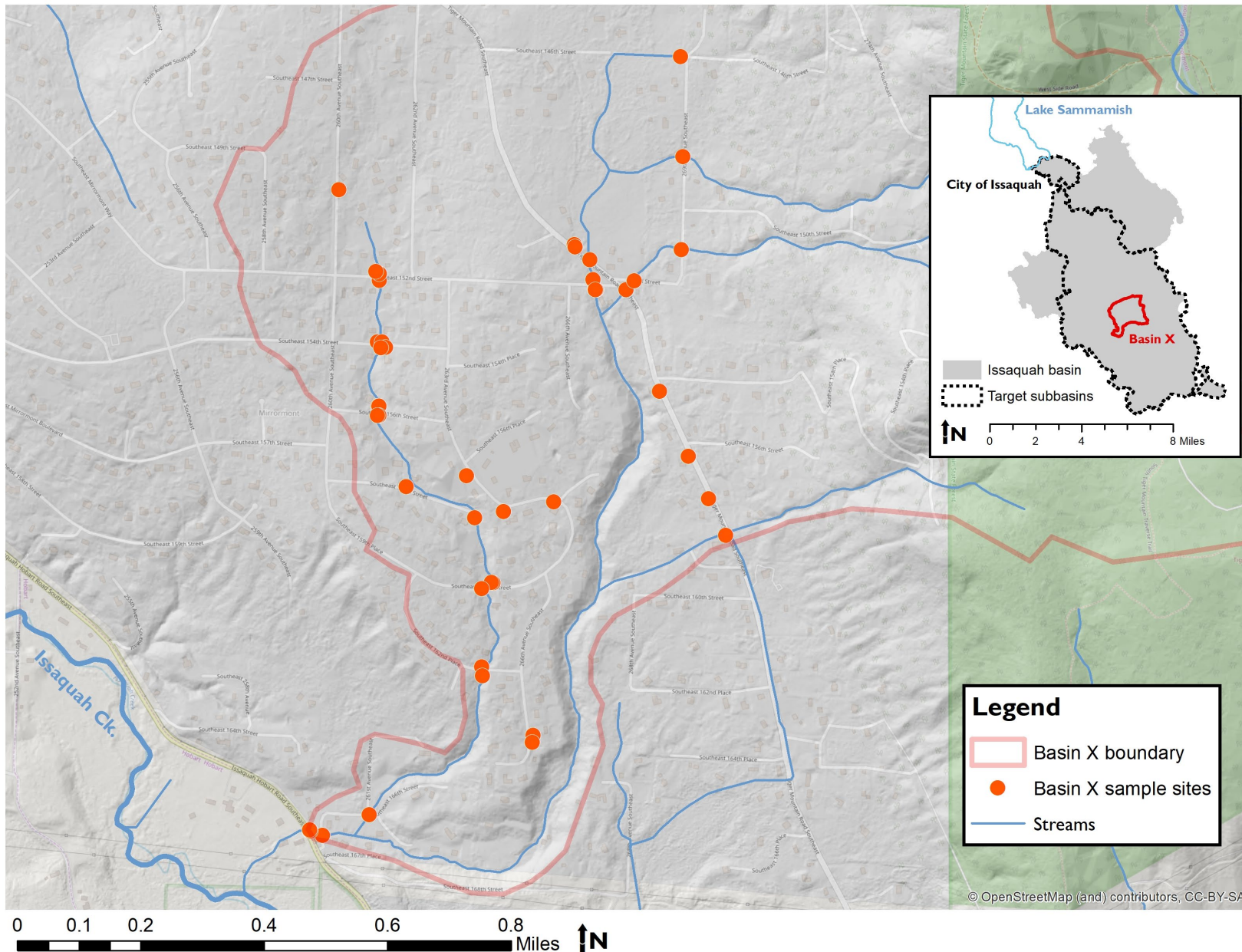


Figure 5 | Map of sampling sites in Basin X during wet season baseflow and storm event sampling in 2018.

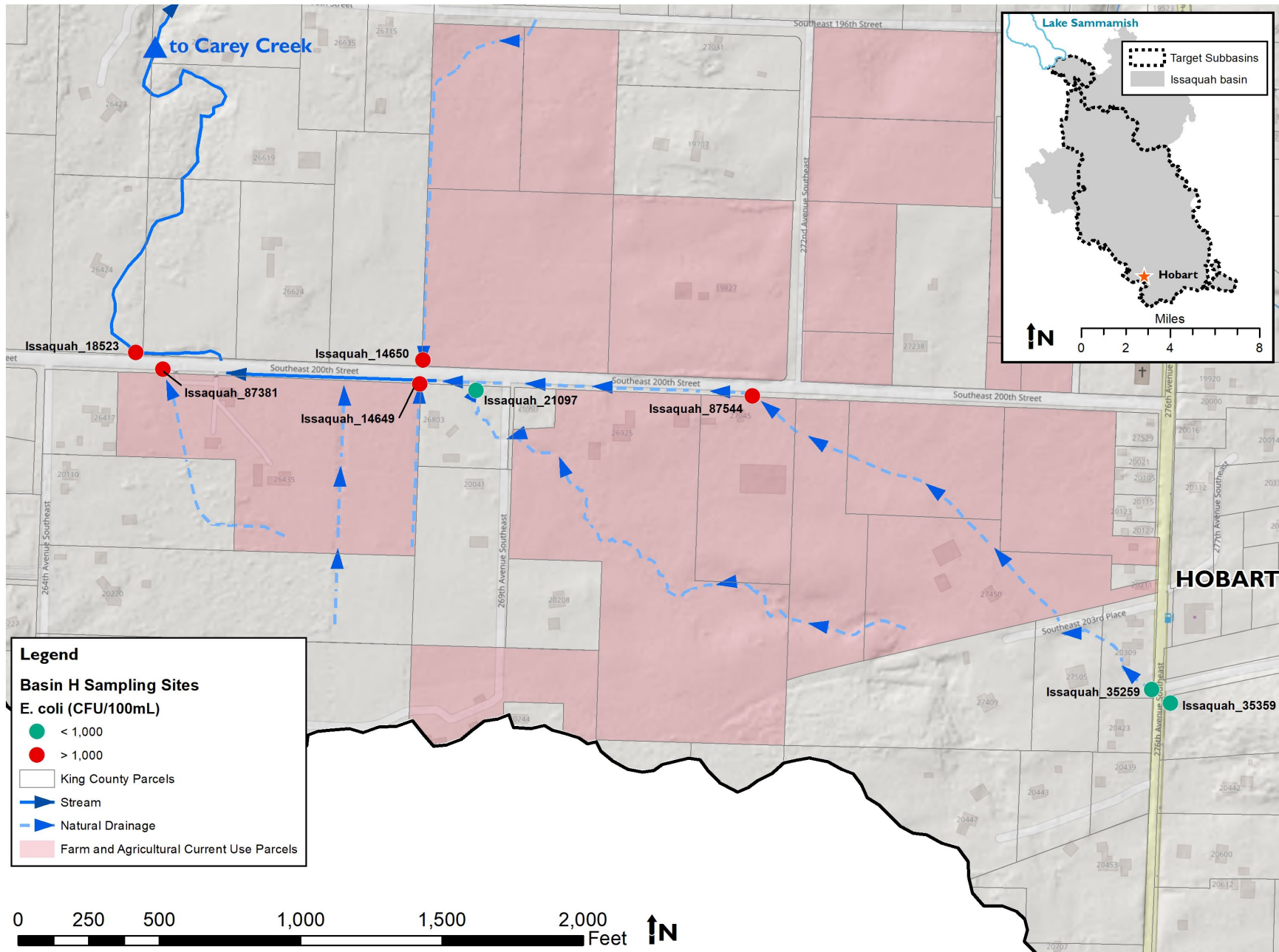


Figure 6 | Map of water quality sampling sites in Basin H. *E. coli* results during wet weather sampling are shown.

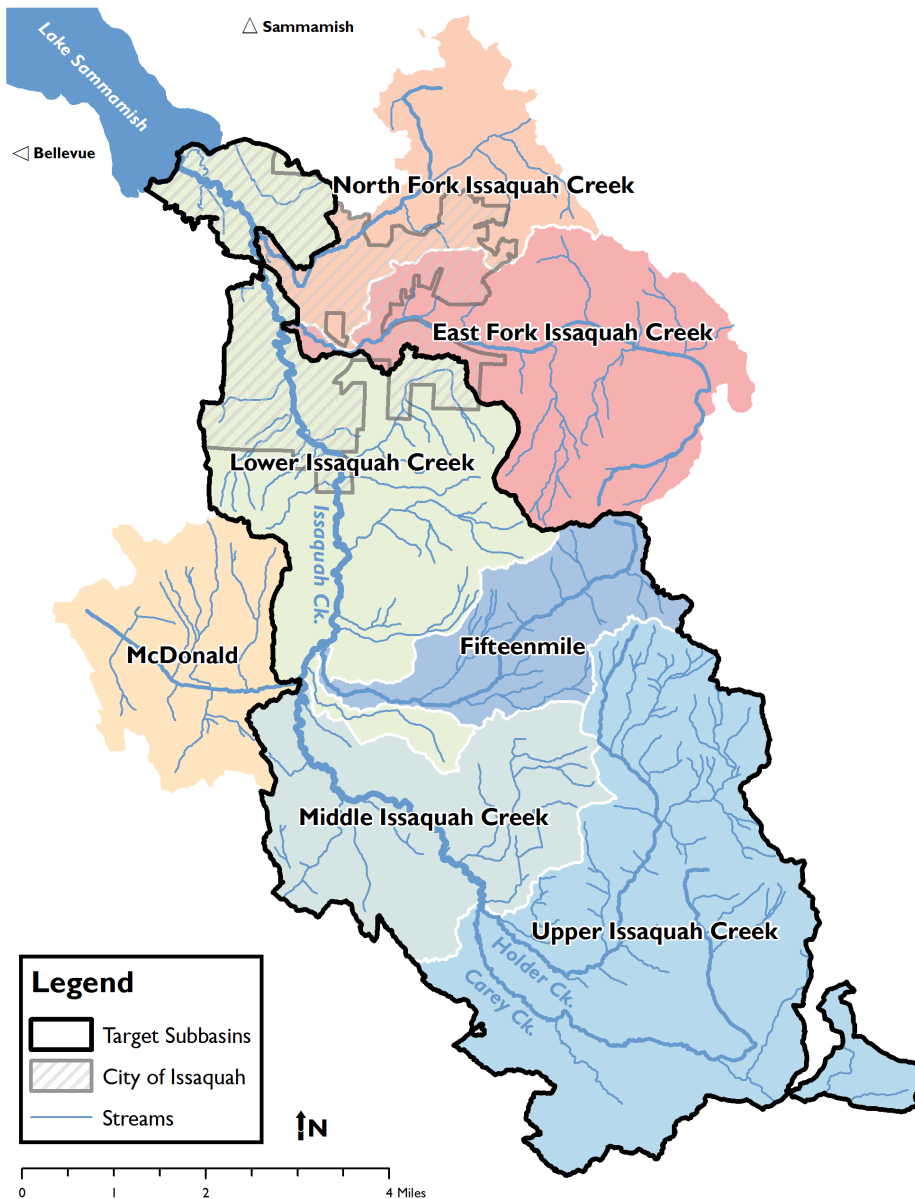


Figure 7 | Map of subbasins of Issaquah Creek. Subbasins bounded in black were the focus of work from 2016 – 2019. The other subbasins (McDonald, East Fork of Issaquah, and the North Fork of Issaquah) will be the focus of work in 2019 and beyond.

Table 1 | Table of water quality samples collected as part of enhanced CSP screening of the King County stormwater system during summer of 2018. *E. coli* concentration (via EZgel) were collected anywhere flowing water was observed.

Locator	Date	Time	Flow Estimate	<i>E. coli</i> (EZgel)	Notes
			Gallons/min	CFU/100mL	
ISSAQUAH_130679	5/31/2018	11:15	< 1	30	Summer CSP: Trickle flow, dark staining on leaves in ditch. Flow coming from seep flow upditch.
ISSAQUAH_20043	8/28/2018	12:00	2-3	720	Summer CSP: flow goes to ground in roadside ditch. Steady flow. No OCD
ISSAQUAH_21273	8/28/2018	12:15	< 1	120	Summer CSP. Barely flowing. No OCD. Flow appears to come from wetlands adjacent to ditch
ISSAQUAH_UNT_SVP_US	8/28/2018	12:18	4	50	Summer CSP. Taken US of ditch flow. No OCD.
ISSAQUAH_23038	8/28/2018	14:50	1-2	90	Summer CSP. No OCD. Probably GW flow into CB
ISSAQUAH_35770	8/28/2018	15:08	10-12	40	Summer CSP. No OCD. Fed in part by nutrient rich hillside flow.

Table 2 | Table showing water quality samples collected from Basin X during wet weather (1/11/2018) and dry weather (3/5/2018) sampling.

Locator	Date	<i>E. coli</i>	Hu-2	Hu-3	Dog1	Rum-2	Bird	Date	<i>E. coli</i>	Hu-2
		CFU/100mL	copies/mL						CFU/100mL	copies/mL
STORM EVENT								BASEFLOW		
ISSAQUAH_88483	1/11/2018	98	0.45					3/5/2018	5	<MDL
ISSAQUAH_166st	1/11/2018	100	0.45					3/5/2018	no flow	
ISSAQUAH_87936	1/11/2018	8	<MDL					3/5/2018	93	0.6
ISSAQUAH_4616	1/11/2018	580	<MDL					3/5/2018	5	<MDL
ISSAQUAH_34660	1/11/2018	150	<MDL					3/5/2018	<MDL	<MDL
ISSAQUAH_1927	1/11/2018	110	0.72					3/5/2018	<MDL	<MDL
ISSAQUAH_152ND_US	1/11/2018	14	<MDL					3/5/2018	<MDL	<MDL
ISSAQUAH_4613	1/11/2018	86	<MDL					3/5/2018	1	0.49
ISSAQUAH_87709	1/11/2018	14	<MDL					3/5/2018	<MDL	<MDL
ISSAQUAH_5435	1/11/2018	2	<MDL					3/5/2018	no flow	
ISSAQUAH_24681	1/11/2018	27	<MDL					3/5/2018	1	<MDL
ISSAQUAH_4666	1/11/2018	4	1					3/5/2018	no flow	
ISSAQUAH_4668	1/11/2018	59	<MDL					3/5/2018	no flow	
ISSAQUAH_88199	1/11/2018	59	1.3					3/5/2018	<MDL	<MDL
ISSAQUAH_4662	1/11/2018	30	<MDL					3/5/2018	no flow	
ISSAQUAH_4663	1/11/2018	140	<MDL					3/5/2018	no flow	
ISSAQUAH_4608	1/11/2018	2,500	<MDL	<MDL	9.4	<MDL	<MDL	3/5/2018	no flow	
ISSAQUAH_UNT_US4609	1/11/2018	89	1.4					3/5/2018	6	0.49
ISSAQUAH_23136	1/11/2018	18,000	<MDL	<MDL	1,000	<MDL	<MDL	3/5/2018	no flow	
ISSAQUAH_4614	1/11/2018	170	<MDL					3/5/2018	no flow	
ISSAQUAH_87932	1/11/2018	66	1.4					3/5/2018	1	<MDL
ISSAQUAH_5433	1/11/2018	780	1					3/5/2018	3	3
ISSAQUAH_5432	1/11/2018	250	0.25					3/5/2018	no flow	
ISSAQUAH_14955	1/11/2018	13	<MDL					3/5/2018	<MDL	<MDL
ISSAQUAH_21572	1/11/2018	150	9.1					3/5/2018	23	<MDL
ISSAQUAH_88605	1/11/2018	200	0.37					3/5/2018	2	<MDL
ISSAQUAH_4667	1/11/2018	3	<MDL					3/5/2018	no flow	
ISSAQUAH_20283	1/11/2018	50	1.4					3/5/2018	no flow	
ISSAQUAH_4673	1/11/2018	46	0.44					3/5/2018	4	<MDL
ISSAQUAH_18733	1/11/2018	110	<MDL					3/5/2018	3	<MDL
ISSAQUAH_5434	1/11/2018	360	2.7					3/5/2018	no flow	
ISSAQUAH_24459	1/11/2018	84	<MDL					3/5/2018	<MDL	<MDL
ISSAQUAH_4609	1/11/2018	4	<MDL					3/5/2018	no flow	
ISSAQUAH_87666	1/11/2018	4	<MDL					3/5/2018	<MDL	<MDL
ISSAQUAH_88629	1/11/2018	160	<MDL					3/5/2018	5	0.57

<MDL = below method detection limit

Table 3 | Table of water quality samples collected from Basin H and adjacent areas during dry weather (5/7/2018) and wet weather (10/29/2018) sampling.

Locator	Date	<i>E. coli</i>	Hu-2	CowM3	Bird
		CFU/100mL	copies / mL		
BASEFLOW					
ISSAQUAH_85113	5/7/2018	28	<MDL	<MDL	NS
ISSAQUAH_35259	5/7/2018	2	<MDL	<MDL	NS
ISSAQUAH_35359	5/7/2018	2	<MDL	<MDL	NS
ISSAQUAH_87544	5/7/2018	48	<MDL	<MDL	NS
ISSAQUAH_21097	5/7/2018	35	22	<MDL	NS
ISSAQUAH_14650	5/7/2018	11	<MDL	<MDL	NS
ISSAQUAH_18523	5/7/2018	50	12	<MDL	NS
ISSAQUAH_87381	5/7/2018	50	<MDL	<MDL	NS
STORM EVENT					
ISSAQUAH_85113	10/29/2018	840	6.7	<MDL	Low
ISSAQUAH_35259	10/29/2018	330	2.8	<MDL	NS
ISSAQUAH_35359	10/29/2018	270	<MDL	<MDL	Low
ISSAQUAH_87544	10/29/2018	2,400	230	8.4	Low
ISSAQUAH_21097	10/29/2018	330	24	<MDL	NS
ISSAQUAH_14649	10/29/2018	13,000	39	<MDL	<MDL
ISSAQUAH_14650	10/29/2018	35,000	<MDL	750	<MDL
ISSAQUAH_87381	10/29/2018	1,400	13	<MDL	NS
ISSAQUAH_18523	10/29/2018	3,400	34	59	Low

<MDL = below method detection limit

NS = parameter not selected for analysis

Low = trace amount of marker detected but below quantification limit

King County Stormwater Services

Puyallup-White River FC TMDL Program 2018

Executive Summary

This document responds to Question 71 of the questionnaire from the Washington State Department of Ecology (Ecology) regarding King County's 2013-2018 Phase I NPDES Municipal Stormwater Permit, specifically the Appendix 2 Puyallup-White Fecal Coliform Total Maximum Daily Load (FC TMDL) implementation activities for 2018.

In 2018, King County Stormwater Services (SWS) staff conducted bacterial source screening in both the Boise and Jovita Creek municipal separate storm sewer (MS4) basins as required by its municipal NPDES permit. Work and findings specific to each basin in 2018 are described in this document. For work performed prior to 2018, previous documentation submitted to Ecology for years 2014 through 2017 can be reviewed. Copies of these previous reports can be provided upon request.

The following is a brief list of highlights from SWS' work in 2018; details of each are included later in this document:

- One illicitly connected on-site sewage system (OSS), which was discovered by SWS in late 2017 to be plumbed to the County's MS4, was replaced, thanks to enforcement by the Department of Public Health-Seattle & King County (DPHSC).
- A second OSS was found to be discharging partially-treated septage to the County's MS4. SWS began working with DPHSC to identify the source (one of two houses).
- Monthly *E. coli* measurements were taken at over a dozen sites in Boise Creek and its tributaries.

Regulatory Requirements

Under Ecology's Phase I NPDES Municipal Stormwater Permit effective August 1, 2013, in Appendix 2, Puyallup-White Watershed Fecal Coliform TMDL, King County is required to perform the following:

- Designate areas discharging via the MS4 to Boise Creek as high priority areas for illicit discharge detection and elimination. Complete IDDE field screening for bacteria sources in 100 percent of the MS4 subbasins, including rural subbasins, by February 2, 2016 and implement the schedules and activities identified in S5.C.8 of the Phase I permit for response to any illicit discharges found. Field screening must include activities for both the dry season (May through September) and the wet season (October through April).
- Inventory commercial animal handling areas (associated with Standard Industrial Code 074 and 075) in areas discharging via the MS4 to Boise Creek and conduct inspections of

these areas as part of the Source Control program required in S5.C.7 of the Phase I permit. All qualifying facilities must be inspected by August 1, 2016. The Permitted shall implement an ongoing inspection program to re-inspect facilities or areas with bacteria source control problems every three years. (County note: no such areas were found in the Boise Creek basin.)

- Designate areas discharging via the MS4 to Jovita Creek as high priority areas for illicit discharge detection and elimination field screening, and implement the schedules and activities identified in S5.C.8 of the Phase I permit.

Previous reports

The Annual Reports for 2014 through 2017, previously submitted to Ecology, may be consulted for descriptions of work previously conducted for the Puyallup-White Fecal Coliform TMDL. Copies of these earlier Annual Reports can be provided upon request. These previously submitted documents include: maps of sites where bacteria screening was performed; sampling data collected; and descriptions of field and laboratory methods used in this work.

Work conducted in the Boise Creek basin, year 2018

In 2018, the following work was performed in the Boise Creek basin:

- Follow-up on previously identified/eliminated illicit connections;
- Source tracking for suspected illicit connections;
- Dry weather reconnaissance and sampling;
- Monthly Coliscan measurements in Boise Creek and its tributaries; and
- Acquisition of additional qPCR data for samples collected prior to year 2018.

As reported in previous Annual Reports submitted by SWS to Ecology, the illicit connections (ICs) to a County ditch found in late 2014 at the Bettine property on 248th Ave SE were ostensibly removed in mid-2015. However, elevated levels of bacteria were detected in the MS4 below the ICs in 2015 and 2016, so limited monitoring continued in 2017, before the monitoring was discontinued due to delays in installation of a new OSS at the property. The installation of a new OSS was officially approved by DPHSKC in late September 2017. In 2018, two samples were taken at the former location of the illicit pipes, on April 10 and November 28. The human biomarker Hu-2-Bacteroidales was not detected in either sample.

Also in 2018, SWS carried out follow-up sampling at the locations of two other previously eliminated ICs. At the Ritter Dairy (IC eliminated in year 2013), the human biomarker Hu-2-Bacteroidales was not detected in a sample taken April 10 (a similar result was obtained in two samples taken at the end of 2015). At the Dover property (IC eliminated in year 2014), the human biomarker Hu-2-Bacteroidales was not detected in samples acquired April 10 and November 28, 2018.

Dry-season reconnaissance and sampling continued in 2018. As of the time of this writing, all locations in the Boise Creek basin where water leaves the County's MS4 have been visited in the dry season, in most cases multiple times, and these visits have been documented with photos and inspection data saved in SWSS' stormwater geodatabase. There are roughly 60 such locations in the Boise Creek basin. SWSS has also walked most of the MS4 open conveyance in the basin in dry weather in order to locate possible illicit sources of water. Water found flowing in the MS4 in the dry season has been analyzed for *E. coli*. No illicit discharges to the MS4 were found in this manner in year 2018.

In May 2017, SWS instituted monthly *E. coli* measurements at locations in the natural drainage network, using a proprietary, commercially available method called Coliscan© Easygel© ('Coliscans'). This is a low-cost, in-house, rapid substitute for laboratory analysis that allows SWS to continue to analyze fecal indicator bacteria in the Boise Creek basin. SWS has high confidence in the validity of *E. coli* data acquired with Coliscans. This work continued throughout year 2018. These monthly measurements will not continue indefinitely – they are meant to (1) identify which portions of the basin, if any, are contributing most to the bacteria problem in Boise Creek and (2) compare with past and (potentially) future sampling results in order to identify, as possible, temporal trends in the creek.

With specific regard to SWS' current source tracking efforts in the Boise Creek basin, in September 2017 SWS identified a house on SE 469th St which had plumbed its sewage to the County's MS4. The property owner eliminated the illicit connection and has just completed installation of a new OSS as of December 2018, as required by DPHSKC. Follow-up sampling is planned to take place in 2019 to confirm the elimination of the human waste signal. Elsewhere, in spring 2018 a private drainage pipe along 244th Ave SE was found to be discharging water with high fecal indicator bacteria (*E. coli*) and high levels of the human biomarker Hu-2-Bacteroidales to the County's MS4. The flow dried up in summer 2018 before a specific source could be identified, though the origin is almost certainly one of two nearby residential properties. It is likely that the private pipe is picking up partially-treated septage from the drainfield of a local OSS and conveying it to the MS4. Further source tracking, including possible dye testing, is planned for wet season 2018-2019. Finally, another source of human fecal waste was suspected along SE 464th St, based on analytical results from late 2015 to early 2017. Additional samples taken after early 2017 have not allowed additional tracking or identification of the source, as levels of the human biomarker Hu-2-Bacteroidales have been consistently low. This location will continue to be monitored as resources allow.

A map of sites sampled in 2018 is included with this report in Figure 1.

Work conducted in the Jovita Creek basin, year 2018

Dry weather reconnaissance and sampling continued in a limited manner in the unincorporated portion of the Jovita Creek basin in 2018. As of time of writing, all locations in the Jovita Creek

basin where water leaves the County's MS4 have been visited in dry weather, in many cases multiple times, and these visits have been documented with photos and inspection data saved in SWS' stormwater geodatabase. There are roughly 100 such locations in the Jovita Creek basin. (SWS has also walked much of the MS4 conveyance in the basin in dry weather, in order to locate possible illicit discharges.) No strong indicators were encountered to indicate possible failing septic systems, livestock waste runoff or other illicit discharges to the MS4.

To summarize previous FC TMDL work in Jovita, in year 2014 some field sampling in the MS4 was conducted. Locations with relatively elevated bacterial results from year 2014's sampling and analysis were revisited in years 2015 and 2016, with the goal of finding possible bacteria sources such as failing septic systems or domestic animal waste mismanagement. No such sources were ever identified.

No map of the Jovita Creek stormwater drainage system and the associated County MS4 sampling sites is provided in this report. Summaries of SWS's FC TMDL work in Jovita have been provided to Ecology in previous Annual Report submissions. These previous reports can be supplied again on request.

No FC TMDL-specific work activities are planned by SWS in the Jovita Creek basin during year 2019. However, as the Phase I NPDES Municipal Stormwater Permit for 2019-2024 has expanded the geographic coverage of the Puyallup Watershed FC TMDL to include any MS4 subbasins which discharge to surface waters in the TMDL area in unincorporated King County, as resources allow, some work in Jovita may be conducted sometime in the new permit's cycle.

-----end of write-up. Figure 1 follows-----

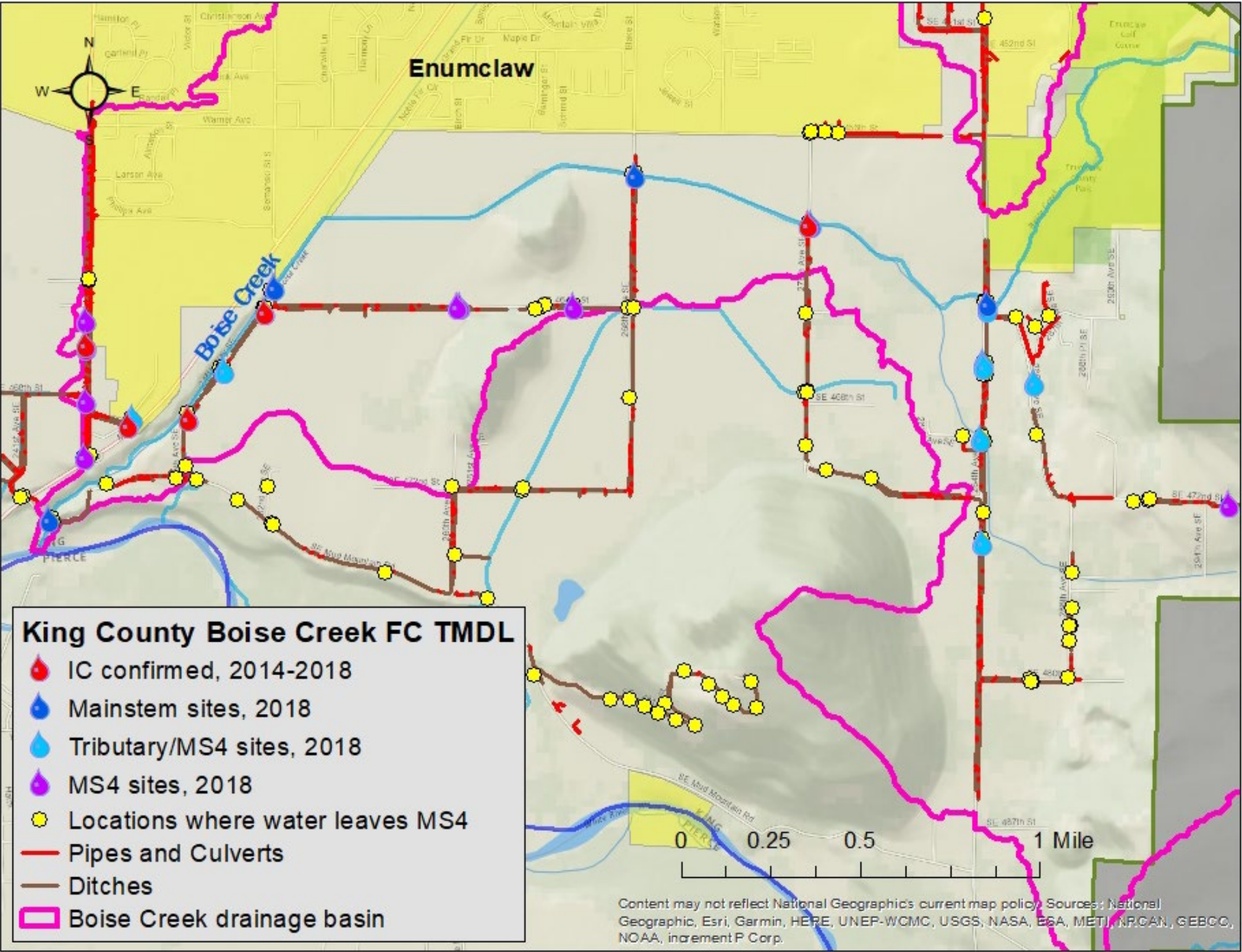


Figure 1. Locations sampled in year 2018 for the Boise Creek (Puyallup-White) FC TMDL