City of Kenmore, WA

Quality Assurance Project Plan

Swamp Creek Fecal Coliform Bacteria Total Maximum Daily Load

February 2, 2015

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Quality Assurance Project Plan

Swamp Creek Fecal Coliform Bacteria Total Maximum Daily Load

Approvals

Richard Sawyer, Surface Water Program Manager, City of Kenmore	2/2/2015 Date
See Attachment (next page) Washington State Department of Ecology	3/26/2015 Date
	Date

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STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
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711 for Washington Relay Service • Persons with a speech disability can call 877-833-6341

March 26, 2015

Richard Sawyer
City of Kenmore
PO Box 82607
Kenmore, WA 98028

Re: Swamp Creek Monitoring Quality Assurance Project Plan Review
Western Washington Phase II Municipal Stormwater Permit No. WAR04-5519

Dear Mr. Sawyer:

Ecology has reviewed the following Quality Assurance Project Plan (QAPP) in accordance with Special Condition S7 and Appendix 2 of the City of Kenmore's Western Washington Phase II Municipal Stormwater Permit.

- QAPP Swamp Creek Fecal Coliform Bacteria TMDL, February 2, 2015

This letter documents Ecology's conditional approval of the above-listed QAPP. The QAPP is approvable with the minor revisions as noted below. No further Ecology review is necessary.

Please include additional text, or equivalent, as noted in the electronic QAPP file provided concurrently with this letter. In particular, please be aware of new protocols for all Lake Washington watersheds to address control of Aquatic Invasive Species.

If you have questions regarding the QAPP and Ecology's comments, please contact Ralph Svrjcek at 425-649-7165, or at rsvr461@ecy.wa.gov, or myself at 425-649-7223.

Sincerely,

Rachel McCrea

Rachel McCrea
Municipal Stormwater Specialist

cc: Permit file

encl: QAPP comments/redlines (electronic only)

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Table of Contents

Background

Swamp Creek Basin

The 24 square mile Swamp Creek basin extends from its terminus at Sammamish River in the City of Kenmore to its northern headwaters in the City of Everett. The watershed includes the Cities of Bothell, Brier, Everett, Lynnwood and Mountlake Terrace and unincorporated Snohomish County. Figure 1 shows the Swamp Creek Basin with Kenmore's portion hatched in yellow.

Swamp Creek is typical of Puget Sound lowland watersheds. In the gently sloping upper basin, Swamp Creek flows through a narrow valley which gradually broadens to a floodplain almost ¾ of a mile wide in the lower basin. The middle basin contains a narrow valley with steep slopes in excess of 15 percent just south of the I-405 and I-5 crossing. Elevation in the headwaters is approximately 520 feet, while the elevation at the mouth is about 20 feet above sea level. The stream gradient is flat, decreasing from about 50 feet per mile in the upper basin to less than 20 feet per mile near the mouth. Scriber Creek, Little Swamp Creek, and Martha Creek are the largest of the 19 streams tributary to Swamp Creek. Major lakes in the Swamp Creek watershed are Scriber Lake, Martha Lake, and Stickney Lake (Snohomish County SWM 1994, 2000).

Most of Swamp Creek and its tributaries are shallow and unsuitable for full-immersion swimming activities. However, several noteworthy exceptions are Lake Martha, and Lake Stickney. Wallace Swamp Creek Park in Kenmore and Scriber Lake in Lynnwood is large enough and deep enough for swimming but this activity is not encouraged by the city. Although public access to the creek is largely limited to road crossings and a few parks, Swamp Creek is fully accessible to adjacent landowners, their children, and in some cases their neighbors. Limited boating opportunities exist where Swamp Creek meets the Sammamish River. The watershed is located within the US Census Defined Urbanized Area; therefore, it is expected that population growth and urban development will be concentrated in this area. Road density is highest in the Scriber Creek subbasin (Svrjcek 2006).

Kenmore has a population of about 20,000 and is primarily a residential community, with small commercial area along State Highway 522. The City is located in King County, just upstream of the confluence of the Sammamish River and Lake Washington. Swamp Creek flows through the middle of the City and joins the Sammamish River at the southernmost boundary of the city. The City comprises about eight percent of the Swamp Creek watershed. It is located at the terminus of the Swamp Creek watershed and, consequently, all pollution generated upstream flows through the City of Kenmore.

Study Area – Swamp Creek in Kenmore

The study area for this QAPP covers the Swamp Creek basin within the boundaries of Kenmore. In addition to the main channel of Swamp Creek, three tributaries have been studied, including; Little Swamp Creek, Little Swamp Creek Tributary 01 and Muck Creek. Figure 2 shows the Kenmore study area and sample sites from previous Kenmore's previous study.

Figure 1: Swamp Creek Basin Map

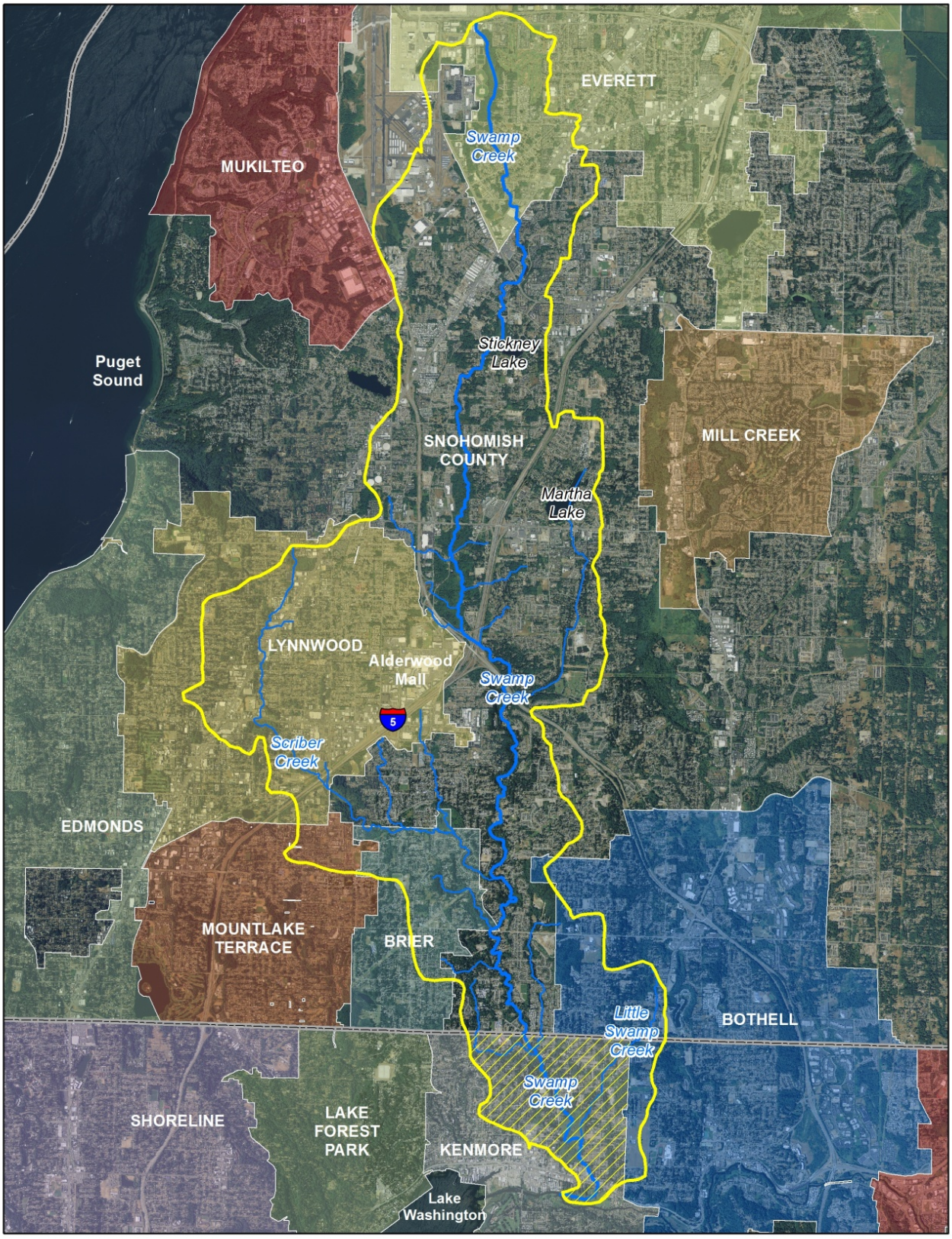
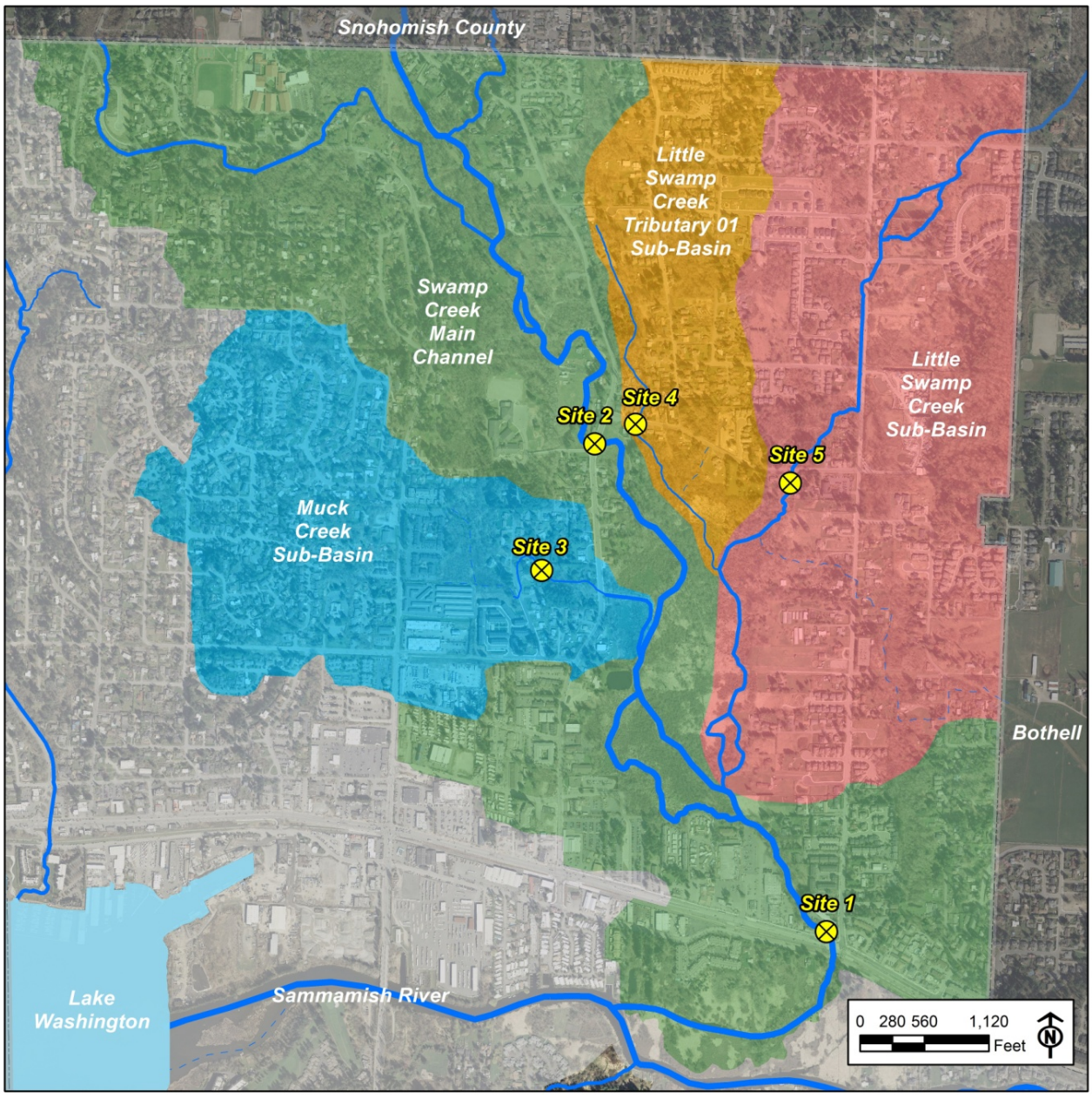


Figure 2: Kenmore Study Area and Sample Sites



History of Swamp Creek Basin and Study Area

Swamp Creek is polluted by bacterial pollution from a variety of sources throughout the watershed. Although the specific sources have not been identified, many of the potential sources are believed to come from humans and/or human activities, including pet wastes, failing septic tanks and illegal discharges. As a result of the bacterial pollution problem, the Department of Ecology (Ecology) developed the Swamp Creek Fecal Coliform Total Maximum Daily Load Detailed Implementation Plan,

(Svrjcek 2006). In this plan, Ecology established water quality monitoring requirements for local municipalities that collect, treat, and convey stormwater.

This Quality Assurance Project Plan (QAPP) is designed to meet Ecology requirements for water quality monitoring related to the Swamp Creek TMDL. The City of Kenmore understands the need to identify the local bacterial pollution problems and reduce coliform concentrations within Swamp Creek. The City also understands the importance of working together with other local municipalities including Everett, Lynnwood, Mountlake Terrace, Brier, and Bothell to achieve water quality objectives within the watershed. The water quality monitoring activities for the City of Kenmore to support those efforts are detailed in this document. Existing Snohomish County monitoring programs are presumed to satisfy the TMDL-related permit requirements of identifying baseline concentrations. The City of Kenmore has proposed an assessment program to track fecal coliform levels and monitor major drainage areas (for elevated concentrations) within the City.

The City of Kenmore's surface and stormwater management program began in 1998 when the City was formed from within unincorporated King County. Kenmore has a stormwater utility and a citywide comprehensive stormwater management plan.

Contaminants of Concern

Fecal coliform pollution usually comes from a combination of both point and non-point sources. Nationally, one of the major non-point source contributions is urban stormwater runoff, which includes municipal stormwater discharges currently covered by National Pollutant Discharge Elimination System (NPDES) stormwater permits.

Non-point water pollution most commonly results from land use related activities, such as inadequate agricultural practices, failing onsite septic systems, and untreated stormwater runoff that does not come from municipal separate storm sewer systems (MS4s). Where stormwater comes from rural areas it may carry wastes from domesticated animals. Stormwater from the more urban areas is likely to carry pet wastes directly into nearby streams. Hobby farms are common on larger parcels within the Swamp Creek watershed. Urban and suburban development is continuing in the Swamp Creek watershed, increasing the water quality impacts from stormwater runoff.

Current non-point source pollution controls within the City of Kenmore, as currently practiced by the City, include:

- Public Education and involvement
- Management and maintenance of the City's storm sewer system
- Legal authorities and ordinances (i.e., pet wastes, illegal discharges, etc.)
- Pet waste management
- Proposed assessment monitoring (as proposed in this QAPP)
- Interagency coordination

Previous Studies & Programs

Snohomish County performed water quality studies in Swamp Creek in the early 1990s. One study was conducted above station SCLU and the other was done as part of a larger one-year urban monitoring program. The purpose of the study was to examine the quality of water coming from residential, mixed, or small farmland uses. Although it turned out to be difficult to clearly show the effect of each type of land use, none of the five locations monitored met state bacteria standards. Fourteen Swamp Creek sites were tested as part of the urban monitoring study - 11 out of the 14 sites exceeded state bacteria thresholds. Swamp Creek was included on Washington's 1996 303(d) list because of numerous exceedances of fecal coliform bacteria standards, as monitored and documented by Ecology (Svrjcek, 2006).

From 2000 to 2006, a consistent pattern of bacterial pollution was observed in Swamp Creek at each of the three long-term stations being monitored. All areas exceeded state criteria for bacteria at all times of the year. During the dry summer months when stream flows were low, bacteria levels rose far beyond both the geometric mean criterion of 50 cfu/100 mL and the 90th percentile criterion 100 cfu/100 mL. During the wetter months of the year, bacteria concentrations improved at each site (possibly due to dilution from increased runoff conditions), but not enough to meet state standards. For these reasons, Ecology established a TMDL for Swamp Creek (Svrjcek, 2006).

The 2007 Western Washington Phase I and Phase II Municipal Stormwater Permit (Permit) required monitoring of fecal coliform bacteria concentrations in Swamp Creek. During this Permit period, sampling results in Swamp Creek continued to exceed State water quality standards for Permit holders, including Kenmore (Loch 2013, Lynnwood 2011, Kibbey 2013, Gaudette 2014, Shaw 2013). Kenmore's sampling results from 2009 through 2013 are summarized in Table 1.

Table 1: Kenmore Study Area Fecal Coliform Concentrations during 2009-2013

		Site 1	Site 2	Site 3	Site 4	Site 5
Wet Season (May-September)	Geometric Mean	148	51	77	22	53
	Upper 10th Percentile	580	296	552	198	222
Dry Season October - April	Geometric Mean	200	120	239	59	184
	Upper 10th Percentile	978	378	1296	422	984

Fecal Coliform Criteria and Standards

State Water Quality Standards (Washington Administrative Code 173-201A) establish the use of primary recreational contact for both Swamp Creek and Lake Washington. The Standard requires that water quality in these receiving waters meet a geometric mean of 50 cfu/100mL, and a10 percent not-to-exceed value of 100 cfu/100mL.

Project Description

Project Goal

The goal of this QAPP is to comply with the requirements of the Swamp Creek TMDL as outlined in Appendix 2 of the 2013 Western Washington Phase II Municipal Stormwater Permit (Permit). This goal will be met by measuring fecal coliform concentrations in the QAPP study area at sites 1 – 5 (identified in Figure 2) in order to continue characterization and long term trends evaluation of fecal coliform. Fecal coliform concentrations are being measured at Site 3, in particular, to evaluate conditions in the City's high priority area of Muck Creek (which was identified February 2, 2014 per Permit requirements). During 2009 – 2013 sampling, Much Creek had the highest dry season fecal coliform concentrations and the second highest during the wet season (see Table 1). The City's goal within this high priority area is to identify and eliminate targeted sources of bacterial pollution.

Project Objectives

To successfully achieve the goal of this QAPP, the City has identified several objectives, including:

- This QAPP follows Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies, July 2004, Ecology Publication No. 04-03-030.
- Collect 12 fecal coliform samples at each site per calendar year (beginning by August 1, 2015).
- Targeted source identification and elimination activities will be conducted in the identified high priority area (Muck Creek).
- Inspect commercial animal handling areas and commercial composting facilities to ensure implementation of source control BMPs for bacteria.
- Conduct public education and outreach activities to increase awareness of bacterial pollution problems and promote proper pet waste management behavior.
- Install and maintain animal waste collection and/or educational stations at municipal parks and other Kenmore owned and operated lands reasonably expected to have substantial domestic animal (dog or horse) use and the potential for pollution of stormwater.
- IDDE-related field screening conducted under S5.C.3 of the Permit, which will include screening for bacteria sources in MS4 subbasins that discharge to Swamp Creek.
- Submit sample data to the Environmental Information Management System (EIM) database by May 31 of each year (beginning in 2016).
- Provide data summaries and narrative evaluation of the data in each annual report's TMDL summary.

Organization, Schedule and Budget

Table 2 describes the roles and responsibilities of staff involved in this project.

Table 2: Roles and Responsibilities	
Title/Organization	**Responsibilities**
City Manager (City of Kenmore)	Authorized signatory for Western Washington Phase II Municipal Stormwater Permit (Permit) Annual Report
Surface Water Program Manager (City of Kenmore)	QAPP preparation, develop reports (Annual Permit Report, Stormwater Management Plan, Bacterial Pollution Prevention Plan), sample collection, data analysis
Surface Water Technician (City of Kenmore)	Sample collection
AmTest Laboratories (Ecology Accredited Laboratory)	Sample analysis

Table 3 describes the QAPP schedule involved in this project

Table 3: Schedule	
Activity	**Schedule**
QAPP Submittal	February 2, 2015
QAPP Approval	March 26, 2015
Begin Monitoring (3rd Wednesday Each Month)	August 1, 2015
Annual Permit Report and SWMPP Submittal	March 31, 2016
Submit Data to EIM Database (1st Submittal)	May 31, 2016
Annual Permit Report and SWMPP Submittal	March 31, 2017
Submit Data to EIM Database (2nd Submittal)	May 31, 2017
Annual Permit Report and SWMPP Submittal	March 31, 2018
Submit Data to EIM Database (3rd Submittal)	May 31, 2018
Permit Expires (End Monitoring)	July 31, 2018
Annual Permit Report and SWMPP Submittal	March 31, 2019
Submit Data to EIM Database (4th Submittal)	May 31, 2019

Limitations: There are no known limitations imposed on the QAPP schedule by factors such as weather, seasonal conditions, and equipment availability. However, such limitations will be addressed accordingly if they occur. Flows in Swamp Creek are known to get very high at times and very high flow conditions may have an effect on the sampling program if it is unsafe for City staff to collect samples. Should problems develop they will be reported through annual SWMP reporting.

Table 4 Describes the QAPP budget involved in this project

Table 4: Budget Summary					
Expenditure Type	**2015**	**2016**	**2017**	**2018**	**2019**
Staff Time (Field)	$4,000	$10,400	$10,400	$6,400	$800
Laboratory Costs	$750	$1,800	$1,800	$1,050	$0

Quality Objectives

Data quality objectives are qualitative and quantitative statements of the precision, bias, representativeness, completeness, and comparability necessary in order for the data to address project objectives. The primary indicators of data quality are precision and bias, which, together, express the data's accuracy.

Precision, expressed as the standard deviation of replicate sample analyses, is a measure of data scatter due to random error, while bias is a measure of the difference between the result for a parameter and the true value due to systematic errors. Potential sources of errors include sample collection, physical and chemical instability of samples, interference effects, instrument calibration, and contamination. Random error affects the determination of bias; thus bias estimation may be problematic. Consequently, dedication to established protocols is one method used to reduce concern over sources of bias (Lombard and Kirchmer, 2001).

Fecal coliform bacteria levels are highly influenced by the biological component in the aquatic environment and can be subject to sample contamination problems. Table 5 below summarizes the laboratory accuracy and analytical reporting limits for parameters that can reliably be used for decision-making. Seasonal sampling and other sampling design features will be used to better evaluate critical conditions on which to determine water quality compliance with state bacteria standards.

The goals for evaluating the impacts to water quality require the ability to detect "differences." These differences can be based on: (1) a simple comparison of upstream and downstream locations (e.g., "bracketing" and BMP effectiveness evaluations), or (2) determining a trend over time at points on a stream in the absence of changes to upstream land-use activities.

Table 5: Quantitative Data Quality Objectives

Analysis	Accuracy % Deviation From True Value	Precision Relative Standard Deviation	Bias % Deviation From True Value	Required Reporting Limits (Concentration)
Laboratory Analysis				
Fecal Coliform (MF) Method 9222D	N/A	RSD ±30%	N/A	1 colony forming unit per 100 mL

Upstream/Downstream Differences

Sources of very high fecal coliform concentrations, such as failing septic systems or leaking sewer lines, can have severe effects on overall stream concentrations even when the volume discharged is low. However, when the concentration upstream of a source is high the change due to the source can be difficult to separate and quantify.

Trends Over Time

The ability to detect changes in water quality (trends) is the objective of a long-term sampling design. A historical perspective, which only long-term records can provide, is necessary in order to make informed decisions regarding water quality assessments. These long-term needs are currently satisfied by the stations maintained by King and Snohomish Counties, as Swamp Creek passes through the City of Kenmore.

Comparability

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared to another. This goal is achieved through use of standard techniques to collect and analyze representative samples, along with standardized data verification and reporting procedures to Ecology's EIM system. Data may be compared with other bacteria data sampled by local municipalities within the watershed.

Bias

Bias is defined as the difference between the sample population mean and the true value of the parameter being measured (Lombard and Kirchmer, 2004). Bias is also a component of data accuracy. However, bias from the true value is very difficult to determine for fecal coliform bacteria. Calibration standards for microbiological analyses are not available. Bias in field measurements will be minimized by strictly following sampling and handling protocols.

Sampling Process Design

Sampling related to the TMDL is limited to bacterial pollution measured using fecal coliform testing procedures described in this QAPP.

Fecal coliform samples will be collected from Sites 1 – 5 as identified in Figure 2. Fecal coliform concentrations sampled between 2009 – 2013 typically exceeded state water quality standards at all five sites, therefore, sampling will continue at each site during this QAPP.

The frequency of sampling will be 12 grab samples collected per year per site (presumably for years that the QAPP is in effect for the entire year, otherwise proportional to the amount of the year that the QAPP is in effect). Kenmore will attempt to collect samples on the third Wednesday of each month. This sampling day was determined and agreed upon through regional consensus between all of the Swamp Creek Basin TMDL partners (Cities of Bothell, Brier, Everett, Lynnwood and Mountlake Terrace and unincorporated Snohomish County) in an effort to produce regionally useful datasets.

Sampling Procedures

Overview

Ambient level of fecal coliform bacteria is the preferred indicator of disease-causing microorganisms in Washington State. There are two standard methods for the detection of coliform bacteria, the Membrane Filter (MF) technique and the Most Probable Number (MPN) index. The MF and MPN methods are frequently not comparable. The US Environmental Protection Agency (EPA) currently recommends the MF procedure because it is faster and more precise than the MPN technique (EPA, 2001). However, MPN is better for use in chlorinated effluents, highly turbid waters, and salt or brackish waters. Ecology requires all partners in this program to have samples analyzed by state-accredited laboratories using the Membrane Filter technique SM9222D. Samples collected for this project will be analyzed by AmTest Laboratories in Redmond, Washington http://www.amtestlab.com.

Planning

Bacteria samples must be collected in sterilized bottles. Because there is a relatively short holding time and culture medium must be prepared ahead of time, it is important to prearrange sampling with the laboratory.

Ecology recommends that data be collected in a format consistent with the Ecology Environmental Information Management (EIM) database. To accomplish this, each station will need a user location ID that is unique within EIM. Ecology will assist Kenmore in developing these. Guidance on the use of EIM is found on Ecology's website at http://www.ecy.wa.gov/eim/submitdata.htm.

Field Procedures

Ambient water quality samples collected as part of this QAPP will generally use the "dipping method." The dipping method is intended to collect the most representative sample taken at a single point in time (also called a grab sample). Field personnel will avoid collecting water from near the surface and will collect samples from the center of flow (thalweg) when possible.

Field measurements and comments are recorded on either a form prepared prior to sampling, ideally in a notebook of water resistant paper, or loose-leaf water resistant paper. All notes should be photocopied and stored in a safe location after a sampling run. Project name, station location, date and time of sample collection, and sample number should be recorded, at a minimum. Other useful information may include staff gauge or tape down measurements, estimates of discharge, field quality control information, field meter measurements if applicable, weather conditions, and comments about turbidity, color and odor.

A word about safety: Safety is a primary concern whenever working in or near waterbodies. In addition, many sampling locations are sited close to roadway crossings to facilitate access in right-of-ways and to reduce travel times to the actual sample site. The need for life vests, reflective clothing, orange marking

cones, and flashing lights should be considered to protect field personnel in the event of a fall into the water, and to alert drivers to workers' presence on the roadside.

The sampling run will be planned to collect upstream samples first. Any downstream samples will be collected after upstream samples to minimize the possibility of transporting New Zealand mud snails. Wherever possible, a sampling pole will be used to collect fecal coliform samples and avoid disturbing sediments, which typically have much higher bacteria levels than surface waters. Aquatic Invasive Species Protocols are included in Appendix A and will be followed.

The general procedures for taking a proper fecal coliform sample are discussed below.

Sampling Procedure

1. A sterilized sample container provided by the accredited laboratory will be used. The minimum sample size is 250 mL. Both polypropylene and glass bottles are considered acceptable.

2. Sampling of sites will be from upstream to downstream where applicable in accordance with Aquatic Invasive Species Protocols detailed in Appendix B. Where staff travel from watershed to watershed, appropriate decontamination procedures will be used on boots and other equipment as needed.
3. A sample pole will be used whenever possible for reaching the thalweg quickly and conveniently (such as a boat hook fashioned with a burette clamp or two hose clamps fastened to the end of the pole). Caution will be taken not to contaminate the pole with sediments or other substances that increase the likelihood of contaminating the sampling process. Staff will attempt to avoid walking within the wetted perimeter of the stream to avoid New Zealand Mud Snail contamination of their boots.
4. For sites that may require entering the stream, care will be taken to not stir up sediment. Approaching sites from downstream at the individual sampling site will be done in all possible cases. Where this is not possible, allow the flow to dissipate any stirred up sediment before proceeding to sample. Face upstream, preferably in the portion of the channel with predominant flow.
5. Uncap the sample bottle, leaving the aluminum foil on the cap. Be careful not to contaminate the inside of the bottle, cap, or aluminum foil with your fingers, dirt, water dripping from bridges or other sources.
6. Invert the bottle and plunge it mouth down through the surface to a depth of 15 to 30 cm (6 to 12 inches, mid-depth of stream where feasible). While under water, rotate the mouth of the bottle into the current. Bring the upright sample bottle back through the surface. Pour off enough water until the water level is at the shoulder of the bottle. This allows room for mixing the sample before analysis at the lab.
7. If the samples need to be collected in slow moving waters with stratified velocity, then collect a depth-integrated bacteria sample. To collect a depth-integrated sample, first submerge the bottle (mouth facing down) to roughly 25 percent of the water's depth. Next, invert the bottle slightly until it begins to fill and then slowly move the bottle up through the

water column as it fills. Quickly remove the bottle from beneath the water when the bottle reaches roughly 75 percent of the water's depth and the water level inside the bottle is at or near the shoulder. *Note: Depth integrated bacteria sampling is performed in TMDL or other special studies*

8. Avoid sample collection in stagnant waters. If unsure whether or not water is stagnant (generally less than 0.1 ft/s), then use a flow meter to measure velocity. *Note: TMDL or other special studies may require sample collection in stagnant water under certain conditions (e.g. sampling behind a pump station or tide gate).*
9. Recap the bottle. Attach the appropriate label and place the bottle on ice upon reaching shore or your vehicle.
10. Other notes:
    - Do not rinse the bottle.
    - Do not pour water into the fecal bottle from another container.

Field Quality Control

Field Replicates

Total variability (precision) for field sampling and laboratory analysis will be assessed by collecting field replicates. In some cases field duplicates, field blanks, and field splits may also be appropriate. *(Note that 10% field blanks are proposed to be used in this QAPP.)*

Field replicates are two samples collected from the same location at the same time. A second bottle is plunged side-by-side with the regular sample. Field replicates will be collected at the rate of ten percent, with a minimum of one field replicate per sampling run. If using a pole to collect samples it may not be possible to collect the samples side-by-side. In this case the field replicate should be collected as soon as possible after the regular sample. Make a comment in the field notes if the samples are not collected side-by-side.

Replicate results that are "non-detects" cannot be used to estimate precision. Similarly, the variability found at low concentrations cannot be used to estimate the variability at higher concentrations, and vice versa. Variability, or precision, is estimated as the standard deviation of a number of results. The standard deviation varies with the magnitude of the results. Separate estimates of standard deviation will be determined for each range of concentration. By collecting field replicates often over a long time period we should be able to calculate standard deviations for a wide range of concentrations.

There is no advantage to randomly selecting samples for replication, so field personnel should use all available information and professional judgment to select samples likely to yield positive results representing a range of concentrations. To simplify matters, replicates could be collected randomly at the beginning of the program and then adjust to collecting replicates at stations with anticipated concentration ranges.

Field replicates may be marked as such before they are sent to the laboratory or they can be labeled in such a way as to give the impression that they are completely separate samples. The latter are referred to as "blind" field replicates, since the laboratory analysts are not made aware of the fact that they are field replicates.

Other Field QC Samples
At this time, field replicates are required but field duplicates, field splits, and field blanks are not. The need for additional quality control samples will be determined as the project develops. Quality control sample types are described below:

1. Field duplicates are useful for estimating variability due to laboratory analysis. Field duplicates are collected by obtaining a sample in a sterilized container large enough for two regular samples. The sample is shaken and then partitioned into two regular sterilized bottles, which are assigned different sample numbers and analyzed as two distinct samples.
2. Field splits are like field duplicates but the two samples are sent to different laboratories. Laboratories may require different amounts of water for analysis so the size of the common bottle will need to be adjusted accordingly.
3. Field blanks are used to measure the presence of contamination due to sample collection and handling procedures. Two types of field blanks exist. Both types require bottles filled with sterile, non-chlorinated water prior to a sampling run. Transport blanks are left unopened but otherwise handled and transported in the same way as other samples. Transfer blanks are sterile water transferred to another sterile empty container during the sampling run, but otherwise handled and transported normally.

An impromptu field blank may become necessary if a field person suspects that the bottles have become contaminated. A bottle should be filled with clean, non-chlorinated water and analyzed as a regular sample. Obtaining such water can be difficult however, as bottled water may have some fecal coliform present. City tap water would be a better choice if the chlorination level were sufficiently low. Field personnel may also elect to stop sampling until new bottles are obtained.

Sample Container

A sterile glass or polypropylene bottle will be used for all samples collected. When working with laboratories associated with wastewater treatment plants, it should be specified that the bottle be empty, with no sodium thiosulfate or other dechlorinating agents. Sample bottles should be autoclaved with caps covered in aluminum foil or otherwise sterilized supplied by an accredited laboratory.

Select a bottle according to the following criteria:

- Use the 500 ml bottle when sampling for enterococci in addition to fecal coliform.
- Use bottles with EDTA added if high metal concentrations are suspected.

At Ecology, empty bottles have a holding time; three months for bottles without thiosulfate or EDTA, and one month for bottles with thiosulfate or EDTA. Your laboratory may have different recommendations.

Field processing
No field processing is required.

Sample storage
All samples will be placed in an ice chest with crushed or cube ice immediately. The temperature should be between 0°C and 4°C. Samples will be stored in the dark. For chain-of-custody procedures, the vehicle must be locked whenever it is not in view of sampling personnel.

Holding Time Before Testing

The culturing of samples will take place as soon as possible. Standard Methods (APHA, AWWA, and WEF, 1998) recommends a maximum holding time of eight hours for microbiological samples (six hours transit and two hours laboratory processing) for water tested for compliance purposes. When compliance is not an issue, a maximum of 24 hours is allowed for refrigerated samples. Samples under this program will be subject to the 24-hour maximum hold time.

Chain-of-Custody and Labels

Chain-of-custody is a series of procedures designed to document a sample or set of samples from the moment of collection, through transport, analysis and reporting. Chain-of-custody requires that each sample be properly identified, and that a record be kept of the names of all persons who handle the sample. The person with custody must have full and verifiable control of the samples at all times.

A sample is considered to be under a person's custody if it is:

- · In the individual's physical possession
- · In the individual's sight
- · Secured in a tamper-proof way by that person, or
- · Secured by the person in an area that is restricted to authorized personnel

Elements of chain-of-custody include:

- · Sample identification
- · Security seals and locks
- · Security procedures
- · Chain-of-custody record
- · Field log book

Proper labeling requires using waterproof paper and waterproof inks. Some laboratories used gummed labels and others use tags, both of which can come off. One way to help prevent this is to place samples in plastic bags that are then submerged in the ice. The plastic bags prevent direct contact between the ice and labels and make it more likely to be able to reassign a label if it does come off.

Labels should include the time of collection since the holding time for fecal coliform analyses are limited.

Sample seals and custody tape are usually not necessary if the samples are transported to the laboratory immediately after collection by the personnel who collected the sample. If samples are transferred or stored in an unsecured area then custody seals or tape should be used.

Measurement Procedures

Field

Station Information
After the network of long term monitoring stations has been determined it will be necessary to obtain location information for each station. A Geographic Positioning System (GPS) receiver is the recommended method for obtaining coordinates. Coordinates can also be estimated by computer programs with aerial photos and topographic maps but this method is less accurate and some of these are based on an outdated coordinate referencing system. GPS measurements are not required for source identification monitoring projects.

Station location information:

- Coordinate Reference System: NAD83
- Latitude: 47° 47’ 57”
- Longitude: 122° 15’ 21”
- Altitude: 200 feet

Coordinates should be obtained whenever stations are added to the long term monitoring program. Even if there is no intention to include the data in EIM coordinate information is useful for data archival and presentations.

Discharge Measurements
Discharge will be determined using Price Type current meters. The Price Type current meter is the primary version used by the USGS for stream gaging, and will be used for all measurements of flow velocity. The Price Type meter has six conical shaped cups that rotate on a vertical axis. When the meter is in use, the cups trap air in them and keep water and silt away from the bearing surfaces, reducing friction so that the wheel can spin freely in very low velocity currents. Inside the chamber, a wire makes contact with the bucket wheel shaft once during every revolution to record velocities in slow currents, and a second makes contact once during every five revolutions to record velocities in faster currents.

The pygmy model is supported by a top-setting wading rod for work in shallow and moderate-depth streams. The top-setting wading rod permits all settings to be made in-the-dry, and has a main column of 1/2-inch hexagonal stock and a meter positioning rod of 3/8- inch-diameter stock. When the setting rod is adjusted to read the depth of water, the meter is positioned automatically for the six-tenths-depth method (described below). The main rod attaches to a base plate and allows the rod to rest on the streambed of the flow channel. The main rod is graduated in 0.1-foot intervals so depths of flow can be measured accurately. (U.S. Bureau of Reclamation, 1984).

Velocity and depth measurements are made along a cross section of the stream at vertical intervals (or stations). Typically, a tag line is stretched across the stream, perpendicular to the direction of stream flow. The tag line is used to determine the width of the stream and the distance of each measurement interval from a cross-section boundary (edge of water). Ideally, five percent of the discharge is measured at each of twenty vertical intervals, with no more than ten percent measured at any one interval. In the case of very small streams, a smaller number of verticals intervals may be used (U.S. Bureau of Reclamation, 1984).

One of two methods is typically used to determine mean velocities in a vertical line with a current meter; they include the six-tenths-depth method and the two-point method. The sixteenths method consists of measuring the velocity at 0.6 of the depth from the water surface when the depth of flow is less than 2.5 feet. Here, the measured velocity is taken as the mean velocity for the vertical. When the depth of flow is greater than 2.5 feet, the two-point method is used. It consists of measuring the velocity at 0.2 and then at 0.8 of the depth from the water surface with the mean velocity taken as the average of the two measurements (Rantz et al., 1982).

Before leaving the site, the magnitude of the widths, depths, and velocities for each vertical interval or station will be reviewed for gross errors. The Aqua-Calc Open Channel Flow Computer automatically determines the total stream discharge for the cross section measured. Using a local reference point or staff gage, the stream stage will be noted and later used to construct a rating curve. The stage may be used to estimate discharge when a sufficient number of discharge measurements have been made.

Office

Stream Discharge Data

Bacteria concentration data collected as part of this QAPP may be evaluated using flow duration or similar analyses in the future. To accomplish that, high quality flow data collected on a daily, or more frequent, basis is needed at representative locations in the watershed. Currently, stream gauging networks provided by Snohomish County and King County are well suited for this purpose. At present, three stream gauges are functioning on Swamp Creek.

A new stage-discharge relationship is currently being assembled for a gage that was installed upstream from the new 73rd Avenue bridge near Wallace Park (King County Flow Site 56b). This gage was installed to replace the Flow Site 56b that had been maintained by King County (See Figure 1.). The automated sensor within the gage housing records stream stage and water temperature in 15 minute intervals. During monthly visits, this information will be downloaded, and flow velocity measurements will be made so that the stream stage data can be converted to stream discharge data.

Note: Discharge measurements will be performed at the 73rd Avenue Bridge following USGS approved techniques. Discharge measurements will initially be made over a range of hydrologic conditions (including peak flow events) to define the relation between stage and discharge. Subsequent measurements will be made at periodic intervals to verify the stagedischarge relation established. A continuous record of stage will be obtained by installing instruments that sense and record the water-surface elevation in Swamp Creek. The discharge rating established at the site and the gage-height record will be reduced to mean values for selected time periods. The mean discharge for each day (average daily discharge) and extremes of discharge (peak flow events) for the year will be computed. The computation of continuous records of streamflow will follow approved USGS guidelines.

Snohomish County maintains two stream gauges on Swamp Creek. One station is Swamp Creek near 228th and the other is Swamp Creek at I-405. Discharge and water temperature data is available at both stations in numerous formats. This data is available at http://web5.co.snohomish.wa.us/spw_swhydro/hydrology-find-site.asp.

Lab

Fecal Coliform - Membrane Filtration Method

Laboratory analyses for fecal coliform bacteria will be performed by laboratories accredited by the Washington State Department of Ecology. The analytical method to be used is described by Standard Methods for the Examination of Water and Wastewater, No: 9222 D, 24 hour Membrane Filter (MF) procedure. This method will be used for this study with the following exceptions:

Holding temperature is to be between zero and four degrees Celsius (Standard Methods allows up to ten degrees Celsius). Holding time is not to exceed 24 hours (Standard Methods recommends no more than eight hours but allows up to 24 hours).

The detection limit and the precision for this method are both 1 colony per 100 mL. Densities are to be reported as fecal coliform bacteria per 100 mL.

In this method, samples are filtered using varying volumes to establish fecal coliform plate densities in the range of 20 and 60 colonies. The filtered samples are incubated for 24 ± 2 hours at 44.5 ± 0.2°C. The colonies produced by fecal coliform bacteria are various shades of blue. The colonies are counted with a low power microscope or other optical device.

Quality Control

Quality control procedures used during field sampling and laboratory analysis will provide estimates of the precision of the monitoring data. Bacteria samples will be analyzed using Standard Method SM 9222D, membrane filtration method. Field replicates will help to determine compliance with measurement quality objectives. Total variation for field sampling and analytical variation will be assessed by collecting replicate samples and performing lab replicates as discussed below.

Table 5 – Summary of Field and Laboratory Quality Control Procedures

Analysis	Field Blanks	Field Replicates	Lab Check Standard	Lab Method Blank	Lab Replicates	Matrix Spikes
Fecal Coliform (MF)	N/A	1/10 samples	N/A	1/run	1/10 samples	N/A

Field

Station Information

Station coordinates obtained by GPS, or descriptions will be accurately recorded. If GIS resources are available they will be plotted on a Geographic Information System (GIS) map and compared to the expected location and features. The need for adjustments or new coordinates will be made on a case-by-case basis.

Field Notes

The notes from each field run will be tabulated and compared to chain-of-custody forms and laboratory results for completeness and accuracy. Any problems and associated corrective actions will be recorded. Any unresolved problems should be flagged and discussed in the data report.

Fecal Coliform Bacteria

Total variability for field sampling and laboratory analysis will be assessed by collecting replicate samples at the rate of ten percent of regular samples collected, and a minimum of one replicate per sampling run. Bacteria samples tend to have a high relative standard deviation between replicates compared to other water quality analyses. The standard deviation also varies based on the order of magnitude of the results.

Laboratory

Fecal Coliform

Routine laboratory quality control procedures will be followed. Laboratories should perform at least one analytical duplicate per sampling run. Duplicate laboratory analysis refers to analyzing duplicate aliquots from a single sample container. Each sample is carried through all steps of sample preparation and analysis. The results for laboratory duplicates provide an estimate of analytical precision, including the homogeneity of the sample matrix.

Field personnel may want to request that the analytical duplicate be performed on the same sample that accompanies the field replicate, as this allows an estimate total and analytical variability from results for the same sample. There is no advantage to randomly selecting samples for duplicate analysis.

If the samples selected for duplicate analyses do not contain measurable amounts of fecal coliform, the results provide no information on precision. Similarly, if the laboratory selects samples from another study with significantly different levels of fecal coliform or different matrices, the estimate of precision may not be applicable to these samples.

The laboratory must report the results of their analytical duplicates.

The laboratory may have additional quality control procedures and they may report those results. For example, Ecology's Manchester Environmental Laboratory (MEL) reports whether procedural blanks and laboratory control samples are within acceptable limits. Procedural blanks and laboratory control samples ensure that the media, buffers, reagents, glassware, filters and other laboratory apparatus are sterile.

The laboratory will be instructed to contact the city's Surface Water Program Manager if values over 500 cfu/100 mL are observed.

Data Qualifiers

Each laboratory will have its own list of data qualifiers. Table 6 lists the data qualifiers used by Ecology's MEL. At some time during the study each laboratory will be expected to provide a list of relevant qualifiers and supporting documentation so that a cross-reference list can be developed.

Table 6: Data Qualifiers Used by Ecology's MEL

Code	Definition
E	Reported result is an estimate because it exceeds the calibration range.
G	Value is likely greater than result reported; result is an estimated minimum value.
J	The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
N	The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification".
NJ	The analysis indicates the presence of an analyte that has been "tentatively identified" and the associated numerical value represents its approximate concentration.
NAF	Not analyzed for.
NC	Not calculated.
R {REJ}	The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.
U	The analyte was not detected at or above the reported sample quantitation limit.
UJ	The analyte was not detected at or above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately measure the analyte in the sample.

The same qualifier may used for several unrelated problems. For example, the "J" qualifier is used when samples exceed the 24-hour holding time, when there are too many colonies on a plate to make a precise determination, and when non-fecal colonies that may interfere with fecal colonies are observed on the plates. For this reason, laboratory reports should include a narrative that describes why data qualifiers are assigned. The project manager will review the data qualifiers promptly to ensure that

proper modifications are made as needed to field or lab procedures. Laboratory quality control will be regularly assessed by the project manager.

Data Management Procedures

Recording Field Measurements
Time, location, weather conditions, and other observations and environmental factors will be recorded at the time of sampling and maintained for public record purposes. Data will be transferred no less than quarterly to a computer spreadsheet to provide a backup copy of hard data and to facilitate information sharing with Ecology and other agencies. At that time, the hard data will be checked for errors. Laboratory reports, worksheets, and chain-of-custody records will be filed together and stored in a binder or other organized form.

Staff will be responsible for internal quality control validation and for properly transferring and reporting data to the project manager throughout the project. The project manager may approve data that does not meet data quality objectives above for use with appropriate qualification and consultation.

Data will be summarized annually and reported as part of the Stormwater Management Plan. Data qualifiers will be explained in all reports as needed. Data will be explained in tabular and graphical format. Tables will track seasonal compliance with water quality standards using a dry season period of May through September.

Audits and Reports

The accredited laboratory will submit data reports to the project lead. Any problems with the analyses, corrective actions taken, or changes to the referenced method will be reported to the project manager for correction or action as needed. Reports will also be prepared no less than annually for permit reporting purposes as noted above.

Specific Quality Assurance information that will be noted in the reports includes the following:

- Changes in monitoring, i.e., divergence from the QA project plan
- Results of performance and/or system audits
- Significant QA problems and recommended solutions
- Data quality assessment in terms of precision, accuracy, representativeness, completeness, comparability, and reporting limits
- Sample estimates and rejections
- Discussion of whether the QA objectives were met, and the resulting impact on decision making
- Limitation on use of the measurement data

Data Verification and Validation

Verification
Data verification involves examining the data for errors, omissions, and compliance with quality control (QC) acceptance criteria. Once measurement results have been recorded, they are verified to ensure that:

- Data are consistent, correct, and complete, with no errors or omissions
- Results for QC samples accompany the sample results
- Established criteria for QC results were met
- Data qualifiers are properly assigned where necessary
- Data specified in Sampling Process Design were obtained
- Methods and protocols specified in the QA Project Plan were followed

Qualified and experienced laboratory staff will examine lab results for errors, omissions, and compliance with QC acceptance criteria. Findings will be documented in each case narrative.

Note on additional field measurements taken in addition to TMDL-required samples:
When field measurements are taken, field results should also be verified, whenever possible before leaving the site where the measurements are made. The field lead is responsible for checking to be sure that field data entries are complete, and to check for errors if field measurements are taken. The field lead should be on the lookout for any entries that do not seem consistent with expected values; verification measurements may need to be made. Field duplicate measurements that can be easily repeated (e.g. gauge) should be checked against each other.

Measurements that differ by more than the acceptable error limit should be repeated and the new value(s) recorded and evaluated. If the difference is not a result of reading error, but is a result of rapidly changing conditions; e.g. a rapidly rising or falling stream, or a great deal of turbulence, a note should be made to that effect, and both values should be recorded for potential averaging.

Validation
Data validation will follow verification. Validation is parameter-specific, and involves a detailed examination of the data package, using professional judgment to determine whether the method quality objectives (MQOs) (Table 5) have been met. The project lead will examine the complete data package in detail to determine whether the procedures in the methods and procedures specified in this QA Project Plan were followed.

Validation will entail evaluation of relative percent differences between field duplicates and lab splits. Acceptable precision is outlined in Table 5. Bias is unknown, and will be addressed in the context of the sampling regimen. Laboratory duplicates will yield estimates of laboratory precision. Field duplicates will indicate overall variability (environmental + sampling + laboratory) in the case of bacteria or (environment + instrumentation + sampling) in the case of flow and stream gauge.

Review
It is vital that results be transferred accurately at each stage of this project. The individual tasked with that data entry is responsible for reviewing the data to be sure it is complete, consistent and correct.

Data Quality (Usability) Assessment

This QAPP follows Ecology's requirements to collect at least 12 samples annually per site to ensure data usability at long-term monitoring sites. If values of zero are obtained during the study, a value of 1 should be used for computations because geometric means cannot be calculated using zero values.

Typical calculations derived from fecal coliform data include the geometric mean and upper 10th percentile (90th percentile). When fecal coliform values appear to be approaching compliance with state standards, the not-to-exceed 10% secondary criteria will be used to determine compliance.

The geometric mean, unlike an arithmetic mean, dampens the effect of very high or low values, which might bias the mean if a straight average were calculated. To calculate the geometric mean, the GEOMEAN function is used in Microsoft Excel, which from a group of values y_1, y_2, …, y_n, calculates the geomean using the formula:

$$GM_{\bar{y}} = \sqrt[n]{y_1 * y_2 * \ldots * y_n}$$

The percentile is a statistical measure that describes a dataset's distribution. The 90th percentile tells you the value for which 90% of the data is smaller and 10% is larger. To calculate the 90th percentile, the PERCENTILE function is used in Microsoft Excel, which first calculates the rank (n) in a dataset containing N elements with values $v_1 \leq v_2 \leq \ldots \leq v_N$ by using the formula: n = 0.9(N-1)+1. Then the rank is split into its integer component k and decimal component d, such that n = k + d. Then V_p (pth percentile value) is calculated as:

$$v_P = \begin{cases} v_1, & \text{for } k = 0 \\ v_N, & \text{for } k = N \\ v_k + d(v_{k+1} - v_k), & \text{for } 0 < k < N \end{cases}$$

Geometric mean and 90th percentile values will be calculated by season (dry or wet) and summarized in tables. These values will be compared to state water quality standards to demonstrate whether standards are being met or exceeded.

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Appendix A—Invasive Aquatic Species Protocols.

Special care must be taken to prevent the spread of aquatic invasive species (AIS). Two problem species have been tentatively or definitively identified in western Washington watersheds. These include *Didymopsphenia geminate* (Didymo) and New Zealand Mud Snail (*Potamopyrgus sp.*).

Ecology currently defines problem invasive species areas into two categories: Areas of Extreme Concern and Areas of Moderate Concern. Watersheds with NZ Mud Snails are Extreme Concern Areas while those with Didymo (see brochure below) are Moderate Concern Areas. Staff must follow Ecology's standard operating procedures (Parsons et al., 2012).

Staff designing studies in the greater Puget Sound watershed will evaluate two potential sampling sites for the likely presence of mud snails (see Ecology's Invasive Species webpage at www.ecy.wa.gov/programs/eap/InvasiveSpecies/AIS-PublicVersion.html and the USGS Nonindigenous Aquatic Species webpage at http://nas2.er.usgs.gov/viewer/omap.aspx?SpeciesID=1008) and contact Jesse Shultz (Washington Department of Fish and Wildlife Invasive Aquatic Species Unit) or Jenifer Parsons (EAP Central Regional Office) with questions that arise.

Any sampling done in a watershed contributing to Lake Washington should be followed by decontamination procedures for Areas of Extreme Concern (Parsons et al., 2012, Appendix D).

- Sampling will be done in these watersheds using a pole, if feasible, and avoiding contact with wet streamside soils.
- Sampling will proceed from upstream to downstream.
- Between sampling sites, boots that have contacted stream water or wet streamside soils during sample collection will undergo decontamination procedures using chemicals or heat, especially when cold treatment (4hrs at -4^{0}C) or drying (48 hrs to fully dry) cannot be completed in time.
- Wearing short rubber boots will simplify decontamination, while wearing felt-soled boots will make decontamination more difficult.

New Zealand Mud Snails

New Zealand Mud Snails have been found in numerous areas of Washington State, where they can potentially cause tremendous environmental and economic impacts. These areas are now considered to be of Extreme Concern. In western Washington they include Marathon Park, Capital Lake (Olympia), and Kelsey and Thornton Creeks in the Seattle area (Figure 2).

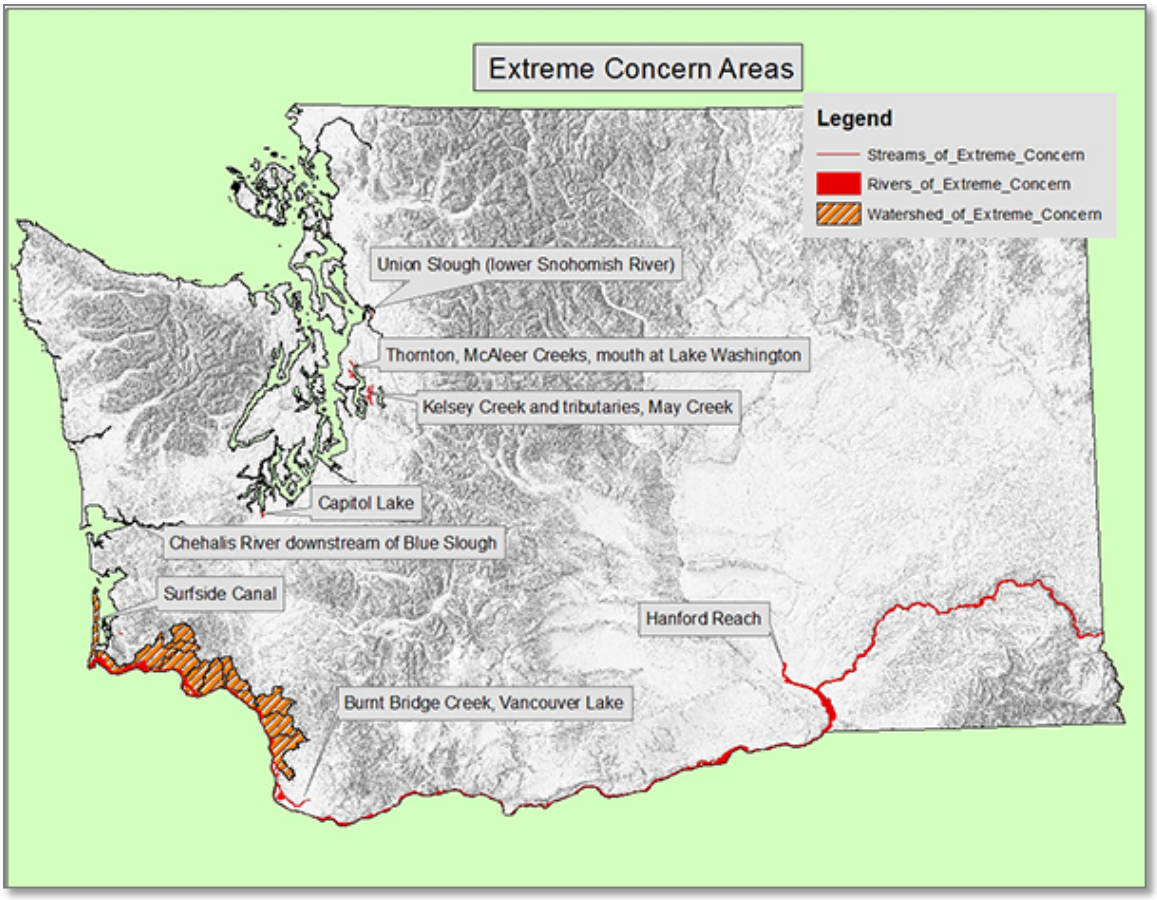

Figure A1. Aquatic Invasive Species Distribution in Washington State.

Consult Ecology's Invasive Species webpage when designing sampling studies in the Puget Sound area.

Parsons, et al, 2012. Standard Operating Procedures to Minimize the Spread of Invasive Species. EAP SOP 070, Version 2.0, Washington State Department of Ecology, Olympia, WA. www.ecy.wa.gov/programs/eap/InvasiveSpecies/AIS-PublicVersion.html

Specialized sampling devices to reduce contamination risk

A sampling extension pole such as the one shown in Figure 1 may be used to collect stream samples where feasible. Use of the sampling pole can reduce overall disturbance of the stream and riparian zone, help prevent the spread of New Zealand mud snails, and help ensure a representative sample is collected where wading would be dangerous. The use of a sampling pole can also speed up sample collection times and increase overall staff safety. When using a sampling pole, caution should be taken to prevent the pole from collecting water internally and spilling into the sample bottle. Similarly, if the previous sampling site is suspected to have very high bacteria levels, the end of the pole should be rinsed prior to taking a sample at the next location to avoid contamination.

If sample collection using the sampling pole is not feasible, samples may be collected using a Specialized Bridge Sampler such as shown in Figure 1. In sampling with the Specialized Bridge Sampler, the stopper/lid is removed just before lowering the sampler-with-bottle down on the rope. Hold the

stopper/lid via the aluminum foil, or set it somewhere free of dirt or other sources of contamination and out of the wind so it is not disturbed. Lower the sampler so as not to contaminate the open bottle with dirt or dripping water. Lower the base on the sampler to the water surface and raise it up to clean the bottom of the sampler. Lower the sampler about 15 cm and allow sampler to orient into the current. After the sampler is oriented with the bottle upstream of the fin, continue lowering. When approaching the water surface, drop the sampler quickly through the surface to a depth of 25 cm to 50 cm to avoid oversampling the micro-layer. Keep the bottle submerged just long enough for the bottle to fill (or 1-2 inches below the top).

Pull up the sampler and bottle, careful not to contaminate the sample with dirt or water from either the rope or bridge, or other sources of contamination. Pour out sample to allow for the air space needed for proper mixing at the lab. Securely replace the aluminum covered stopper/lid. Rinse any large amount of dirt or debris from the outside of the container.

Where water bodies or discharges to surface water are very shallow, a 50 mL sterile syringe can be used to prevent the introduction of sediments into the sample. The syringe should be filled and emptied into the sample bottle four times to ensure an adequate volume of water/wastewater is sampled. It is preferable to use a new syringe at each location. If an adequate number of syringes is not available then the reused syringe should be flushed at least 3 times at each site and annotations on the use of a reused syringe should be logged in the field notes.

Sampling and Decontamination Procedures

The following is an excerpt from Ecology Approved Standard Operating Procedure 070 that addresses decontamination procedures in Areas of Moderate Concern and Areas of Extreme Concern.

6.0 Procedures

6.1 Planning - Prior to Conducting Field Work and During Field Work

6.11 Determine if the field activity is located within an Area of Extreme Concern by checking the current maps at this link: www.ecy.wa.gov/programs/eap/InvasiveSpecies/AIS-PublicVersion.html If so, the extra decontamination step (section 6.2.1.2) will need to be followed for all equipment that contacted aquatic sediment, aquatic vegetation or fish. (Note: felt sole wading boots must be decontaminated no matter where they are used).

6.1.2 Use equipment which can be easily inspected and cleaned to both avoid spreading invasive species and reduce impacts to planned field schedules. If possible, bring extra sets of “back up” field equipment in case cleaning and decontamination (if required) can’t be done in the field prior to arrival at a new sampling site. Where feasible, especially when working in areas of extreme concern, dedicate gear to be used only in that water body.

6.1.3 Note: wading gear has been implicated in the spread of New Zealand mudsnails as well as other AIS such as didymo (the diatom Didymosphenia geminata) and fish and amphibian diseases. Felt soles can be particularly problematic because of their tendency to stay moist for long periods. The laces and eyelets of lace-up wading boots can also be problem spots because they are difficult to clean. To the extent possible, consider using non-felt soles and boot-foot waders. Information about new boots is available at http://aww.ecology.ecy.wa.gov/programs/eap/InvasiveSpecies/AlternativesToFeltBoots.html Because of these risks from felt sole waders, they must go through the decontamination step (section 6.2.1.2) in all parts of the state.

6.1.4 Conduct field activities to minimize contact between equipment and potential sources of invasive species, particularly aquatic plants, sediment and fish. This can include the following:

6.1.4.1 Sample from least to most contaminated areas, for example, sample upstream to downstream or from areas of less weed growth to dense weed growth.

6.1.4.2 Minimize wading and avoid running boats onto sediment.

6.1.4.3 Avoid getting plants, sediment and fish inside boats or other sampling gear.

6.1.4.4 Use a catch pan underneath dredges, etc., to keep potential AIS off boat decks and out of bilges.

6.1.4.5 Avoid driving or walking through areas of mud and high weed growth

6.2 After Field Work

6.2.1 Inspect, clean and if working in an area of extreme concern, decontaminate equipment – this step is divided into two parts:

6.2.1.1 First – inspect, clean and drain all equipment

6.2.1.1.1 Inspect and clean all equipment that contacted (terrestrial or aquatic) soil, vegetation, or water. Remove any visible vertebrates, invertebrates, plants, algae or sediment. If necessary, use a scrub brush and rinse with clean water either from the site or brought for that purpose. Continue this process until the equipment is clean. Drain all water in bilges, samplers or other equipment that could hold water from the site. Flush areas that can't be seen with clean water until the rinse water is clean. Information on cleaning boats and motors is in Attachment B.

6.2.1.1.2 Do the initial treatment (scrubbing and rinsing) before leaving the sampling site (if possible). If cleaning after leaving the field site, ensure that no debris will leave the equipment and potentially spread invasive species during transit or cleaning. Acceptable interim sites for cleaning include: Ecology OC or Regional Offices, commercial car wash businesses, or other facilities (e.g. WADOT shops), provided drains do not lead to surface waters. A table with commercial car wash locations is available to Ecology employees http://aww.ecology.ecy.wa.gov/programs/eap/InvasiveSpecies/AIS-EAPPage.html

6.2.1.2 Second – decontaminate felt sole waders and, in areas of extreme concern, equipment that contacted aquatic sediment, aquatic vegetation, or fish.

6.2.1.2.1 Wipe smooth surfaced sampling equipment that can be easily and fully wiped down until dry. The equipment must be smooth enough so there are no cracks or crevices that could harbor a sand-grain-sized juvenile New Zealand mudsnail while being wiped dry.

6.2.1.2.2 Use one of the decontamination treatments from Attachment A for all other equipment. For additional information on cleaning boats and motors, see Attachment B.

6.2.1.2.3 Decontamination treatments should take place where the procedure can be carried out effectively and safely. Keep in mind that wash and rinse water must not drain to surface water, and all chemicals must be disposed of to a sanitary sewer.

6.3 Relaxing Requirements

6.3.1 Equipment should be cleaned whenever leaving a field site, however, decontamination procedures as described in this SOP need not be followed under the following circumstances.

6.3.2 Documented exceptions:

6.3.2.1 If procedures in this SOP are not workable for a particular project, exceptions may be documented and approved following QAPP guidance.

6.3.3 Moving short distances:

6.3.3.1 If moving by foot within the same watershed, equipment may be used without following procedures in this SOP. Keep in mind to work from upstream to down whenever possible. Procedures laid out in this SOP must be followed when leaving the area.

6.3.4 Sampling by boat:

6.3.4.1 When transiting by boat to different sites within a water body, procedures detailed in this SOP may not be necessary. However, when boating from site to site, don't move water, sediment, organisms or vegetation on sampling gear, boat props, etc. Leaving the water body requires implementing this SOP.

Summary of Field Gear Cleaning and Decontamination Procedure

Prior to field work:

- Check if the sampling will take place in an area of extreme concern – maps at this link: www.ecy.wa.gov/programs/eap/InvasiveSpecies/AIS-PublicVersion.html

- Plan field activities to minimize contact between equipment and potential sources of invasive species, particularly aquatic plants and sediment.

After conducting field work:

- **Inspect and clean** all equipment. Remove any visible soil, vegetation, vertebrates, invertebrates, aquatic plants, algae or sediment. If necessary, use a scrub brush and rinse with clean water either from the site or brought for that purpose. Continue this process until the equipment is clean. **Drain** all water in bilges, samplers or other equipment that could harbor water from the site. This step should take place before leaving the sampling site or at an interim site. If cleaning after leaving the sampling site, ensure that no debris will leave the equipment and potentially spread invasive species during transit or cleaning.
- **Additional Requirements for felt sole waders used anywhere in the state and equipment that contacted sediment, aquatic vegetation or fish in areas of extreme concern**:
    - **Smooth surfaced sampling equipment that can be easily and fully wiped down – wipe until dry**. The equipment must be smooth enough so there are no cracks or crevices that could harbor a sand-grain-sized juvenile New Zealand mud snail while being wiped dry.
    - **For all other equipment, use one of the decontamination treatments found in the table below**. Conduct decontamination where the procedure can be carried out effectively and safely. Wash and rinse water must not drain to surface water, and all chemicals must be disposed of to a sanitary sewer.

Equipment Storage:

- **Dry** – Between field sites and upon returning from the field, when cleaning and decontamination requirements are complete store gear to facilitate drying.

Table A1. Decontamination Options

Treatment	Concentration or temperature	Exposure Time	Comments
hot water wash or soak	60° C (140° F)	5 min for felt-soled boots and nets; 10 sec for all other equipment	Ensure all parts of the equipment reach temperature for the full exposure time
	49° C (120° F)	10 min for felt-sole boots and nets; 5 min for other equipment	Ensure all parts of the equipment reach temperature for the full exposure time
cold	-4° C	4 hours minimum	Time starts after the equipment reaches -4 °C
drying	low humidity, in sunlight is best	48 hours	Time starts after the equipment is thoroughly dry

Treatment	Concentration or temperature	Exposure Time	Comments
Formula 409 All-Purpose Cleaner[1]	100% (full strength)	10 min	Follow proper procedures for storage and handling.
sparquat 256[2]	3.1% or higher	10 min	Follow proper procedures for storage and handling.
Quat 128	4.60%	10 min	Follow proper procedures for storage and handling.
Hydrogen peroxide[3]	30,000 ppm (3%)	15 min	Spray on until soaked, then keep damp for contact time (cover or place gear in a dry bag)
Virkon Aquatic®	2%	20 min	Must soak (not spray on) Follow proper procedures for storage and handling[4]

[1] Must be antibacterial (make sure it has quaternary ammonia, otherwise it is ineffective)

[2] Sparquat is corrosive; read the MSDS and use with caution.

[3] May be corrosive; read the MSDS and follow safety precautions

[4] Rinse gear after soak to prolong life. Solution degrades, lasts up to 7 days, best if mixed fresh

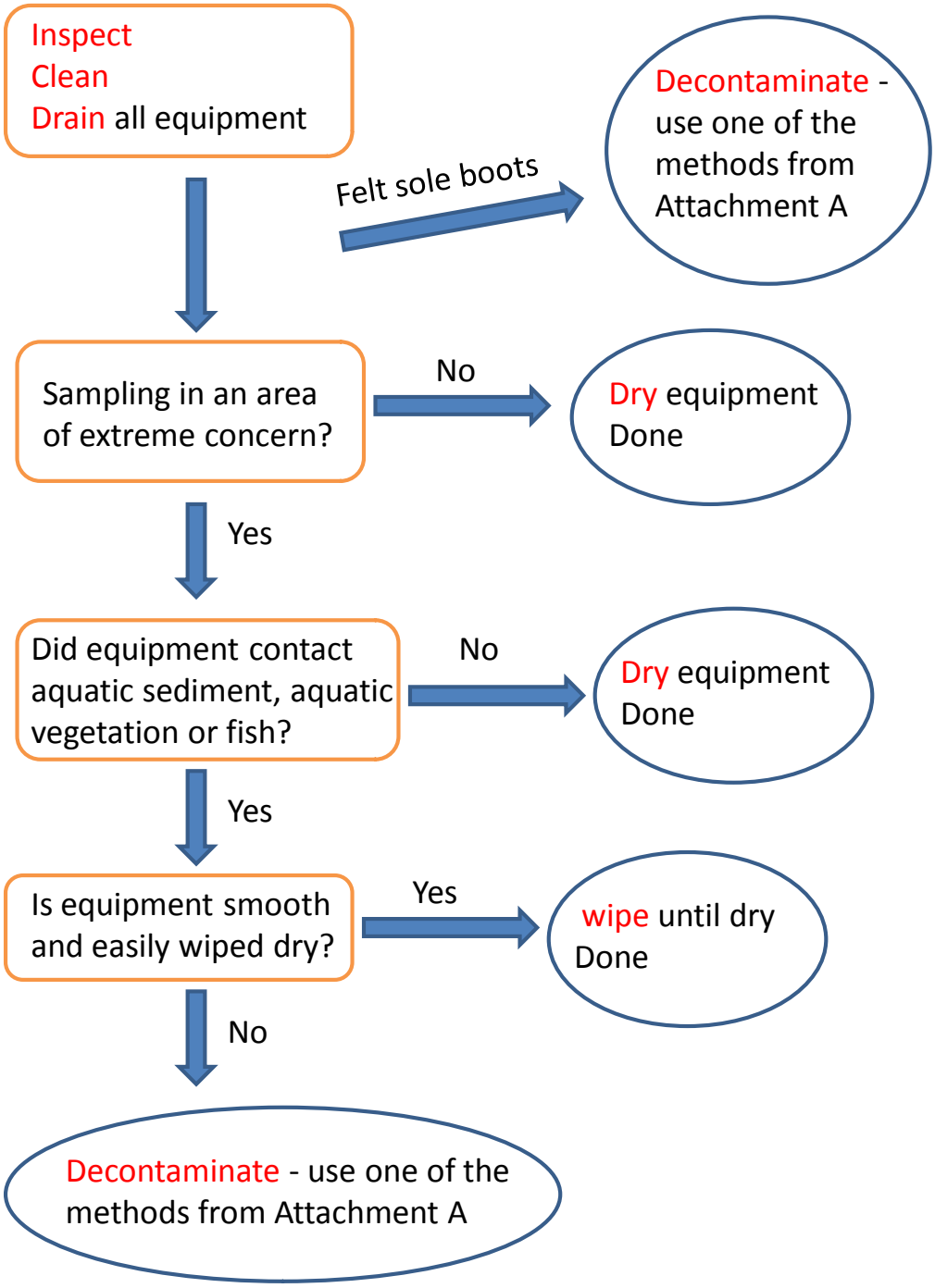

Figure A2. Summary Flow Chart