QUALITY ASSURANCE PROJECT PLAN
LUMMI NATION FIRST FLUSH MONITORING PROJECT

Version 1.1a

Water Resources Division
Natural Resources Department
Lummi Indian Business Council

Prepared for EPA Region 10

July 2021

Lummi Nation First Flush Monitoring Quality Assurance Project Plan Approval (A1):

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REVISION RECORD

Approval	Date	Responsible Person	Description of Change	Location of Change
1	October 2018	Kara Kuhlman	Initial Approval and Release of Version 1.0	N/A
1.1	December 2019	Kara Kuhlman	Staffing updates (new staff)	Distribution List, Section 1.2
			Remove completed studies	Section 1.1
			Update water quality concerns	Sections 2.2, 13.1
			Added two sites to Program, update run timing of one site	Sections 3.1, 6.2, Tables 6.1, 6.2, Figure 3.1
			Reporting frequency increased from annual to every two years	Sections 3.1, 5.2, 11.2
			Replace sign-out board with informing supervisor	Section 7.3
1.1a	July 2021	Kara Kuhlman	Change EPA Tribal Coordinator to Michael Ortiz	Signature page, Distribution List
			Remove ZAPS Technologies LiquID Station Continuous Water Quality Monitoring Study. The study has been completed.	Section 1.1
			Correct frequency of Water Quality Assessment Report from annual to every two years	Section 4.0
			Change STORET to WQX	Sections 3.1, 5.2, 10.0, 11.1

SIGNATURE PAGE

Document: Lummi Nation First Flush Monitoring Project

Version 1.1a

The following technical staff have read this manual. A copy of this page will be distributed to the employee training record file.

Signature	**Date**
Name (printed)	**Title**

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1. DOCUMENT AND PROJECT ORGANIZATION

1.1 Document Organization

This document is organized following Environmental Protection Agency (EPA) Requirements for Quality Assurance Project Plans (EPA 2001, reissued 2006a) with the companion document Guidance for Quality Assurance Project Plans (EPA 2002). Where a letter and number follow a section title (*e.g.,* Distribution List [A3]), they indicate the corresponding section in the EPA Requirements for Quality Assurance Project Plans.

This Quality Assurance Project Plan (QAPP) Version 1.1a for the Lummi Nation First Flush Monitoring Project supersedes the Lummi Nation Water Quality Monitoring Program QAPP Version 4.0 (2010 QAPP; LWRD 2010).

The 2010 QAPP (LWRD 2010) has been reviewed, revised, and reorganized into a new framework. Whereas the 2010 QAPP included quality procedures for all Lummi Nation Water Quality Monitoring Program (WQM Program) projects (*e.g.,* surface and ground water) and equipment under one QAPP, the new framework includes a Quality Management Plan (QMP) as the umbrella document outlining the overall quality system for the WQM Program and several QAPPs for each individual project. The individual projects include the following:

- Ambient Surface Water Quality Monitoring Project
- Ambient Groundwater Quality and Quantity Monitoring Project
- Continuous Water Temperature Monitoring Project
- First Flush Monitoring Project (this document)
- Department of Health Support (National Shellfish Sanitation Program) Project
- Nutrient, Metal, and Hydrocarbon Monitoring Project
- Continuous Water Level Monitoring Project
- Lummi Peninsula Groundwater Settlement Agreement Compliance Monitoring Project

In addition, Standard Operating Procedures (SOPs) have been developed for each instrument used or parameter measured.

1.2 Project Organization (A4)

The Lummi Nation First Flush Monitoring Project (First Flush Project) is administered and implemented through the Lummi Water Resources Division (LWRD), a division within the Lummi Natural Resources Department (LNR), contained under the Lummi Indian Business Council (LIBC). An organizational chart of the individuals participating in the First Flush Project and laboratories providing analytical services is provided in the QMP. A complete and detailed discussion of the structure of the WQM Program, including organization charts identifying the components of all WQM Program and individuals participating in the WQM Program are provided in the QMP (LWRD 2021c).

The Water Resources Specialist II is the primary staff person responsible for First Flush Project coordination, including maintaining the official, approved QAPP. The Water Resources Specialist II, Water Resources Technician II, and Natural Resources Technician II are responsible for implementing the First Flush Project. The Water Resources Specialist II supervises the Water Resources Technician II and Natural Resources Technician II and provides approval and oversight of the First Flush Project, including coordinating with the independent contracted laboratory. The Water Resources Manager evaluates compliance with project goals and makes recommendations to the LNR Director and Deputy Director, who make decisions based upon data collected as part of this project. The Database Manager created and maintains the Water Database and is the primary staff member responsible for database training and documentation.

1.3 Special Training Requirements and Certification (A8)

Details on the roles, contact information, position requirements, and qualifications held by the individuals responsible for managing and implementing the First Flush Project are listed in detail in the QMP. The QMP also includes details on the required and recommended training and certification for all staff involved in the WQM Program. Supervisors and the Water Resources Manager are responsible for ensuring staff are qualified and trained.

2. PROBLEM DEFINITION AND BACKGROUND (A5)

2.1 Project Summary

The First Flush Project is focused on monitoring the water quality of freshwater drainages on and flowing onto and through the Lummi Indian Reservation (Reservation) during storm events. Bacteria (fecal coliform, *Escherichia coli*, and enterococcus) samples and *in situ* water quality parameters are measured at 22 sample sites during the first storm event at the onset of the wet season to characterize bacterial loading of Reservation surface waters.

The First Flush Project supplements the Ambient Surface Water Quality Monitoring Project (Surface Water Project), providing data on the first significant surface water flows of the season. The First Flush Project captures information on the water quality of runoff originating from off- and on-Reservation sources in forested, developed, and agricultural areas within the Lummi Bay and Portage Bay watersheds. Summaries of other Lummi Nation water quality monitoring projects within the WQM Program are provided in the QMP.

Water quality data collected as part of the First Flush Project are compared to Surface Water Project data as well as with water quality criteria to determine whether these waters meet the *Water Quality Standards for Surface Waters of the Lummi Indian Reservation* (Lummi Nation Water Quality Standards; 17 Lummi Administrative Regulation [LAR] 07). The results of this project will advise regulatory actions, restoration efforts, and Total Maximum Daily Load development for the Nooksack River and Lummi River watersheds, as determined by the Water Resources Manager, LNR Director, and LNR Deputy Director.

2.2 Water Quality

As summarized in the QMP, there are numerous threats to Lummi Nation Waters.[1] The QMP provides a detailed description of Lummi Nation Waters and the geographical location of the Lummi Indian Reservation. Threats to Lummi Nation Waters include bacterial contamination of surface waters from both on- and off-Reservation sources which have the potential to damage resource-rich Reservation tidelands and adversely impact fisheries (*e.g.,* closure of shellfish beds harvested for cultural, subsistence, and commercial purposes). Commercial shellfish beds located on the Portage Bay tidelands of the Reservation were downgraded from "approved" to "restricted" status in various areas from 1996 to 2006. The cause of the downgrades was attributed to contaminated Nooksack River water entering Portage Bay (Ecology 2000). The presence of Nooksack River water in Portage Bay occurs frequently and is evidenced by lowered salinities, salinity-based stratification, and/or color. In general, elevated fecal coliform bacteria levels in Portage Bay are associated with lower surface salinities. Since water quality improvements led to the reopening of Portage Bay shellfish beds in 2006, water quality has

[1] Pursuant to 17.09.010 of the Lummi Code of Laws, Lummi Nation Water includes all fresh and marine waters that originate or flow in, into, or through the Reservation, or that are stored on the Reservation, whether found on the surface of the earth or underground, and all Lummi Nation tribal reserved water rights.

again declined. In September 2014, a 335-acre portion of the Portage Bay shellfish growing area was voluntarily closed to harvest by the Lummi Nation. In March 2015, the Washington State Department of Health (DOH) changed the classification of nearly 500 acres of Portage Bay, including the portions already under the voluntary closure, from "approved" to "conditionally approved," which closes harvesting from April through June and October through December (DOH 2015). In April 2016, an additional 325 acres of the Portage Bay growing area were voluntarily closed by the Lummi Nation to protect public health; these areas were reclassified from "approved" to "conditionally approved" with the areas failing to meet National Shellfish Sanitation Program (NSSP) standards closed to harvest from April through June and October through December (DOH 2016).

Following improvements in water quality during the spring season, all of Portage Bay was reopened to commercial, ceremonial, and subsistence shellfish harvest from April 1 through June 30 beginning in 2019 (DOH 2018). Poor water quality persists during the fall season, and commercial, ceremonial, and subsistence shellfish harvest remains closed in 820 acres of Portage Bay from October 1 through December 31 annually.

2.3 Project Context

The First Flush Project is implemented by the LWRD, which has the overall goal of protecting treaty rights to water of sufficient quantity and quality to (a) support the purposes of the Reservation as a permanent economically viable homeland for the Lummi People, and (b) to support a sustainable harvestable surplus of salmon and shellfish sufficient to maintain a moderate living standard.

The First Flush Project is a component of the Lummi Nation Water Quality Monitoring Program (WQM Program). The goals of the WQM Program are threefold:

1. To establish the baseline conditions of surface and ground waters on and flowing onto the Reservation;
2. To use this information to evaluate regulatory compliance of waters flowing onto the Reservation; and
3. To support the development and implementation of a water quality regulatory program (*e.g.,* Lummi Code of Laws Title 17, Water Quality Standards) on the Reservation.

The WQM Program is an important element of the Comprehensive Water Resources Management Program (CWRMP). Additional details on project context and related projects are provided in the QMP. Two important milestones in the CWRMP development were the January 2004 adoption of the Lummi Nation Water Resources Protection Code (Title 17 of the Lummi Code of Laws) and the August 2007 adoption of the *Water Quality Standards for Surface Waters of the Reservation* (Lummi Nation Water Quality Standards; 17 LAR 07), which the EPA approved in September 2008. The Lummi Nation Water Quality Standards detail four surface water classes and their characteristic uses, and provide numeric water quality criteria for, among others, fecal coliform, enterococcus, dissolved oxygen, temperature, pH, and turbidity.

Additional details on the Lummi Nation Water Quality Standards are provided in the QMP. Applicable criteria and action limits are also provided in the QMP.

2.4 Project Justification

Rain event monitoring as part of the First Flush Project is required to supplement ambient monitoring as part of the Surface Water Project because the random sampling of ambient conditions may or may not capture non-point source runoff from storm related events. The First Flush Project provides the targeted, non-random sampling of water quality monitoring sites when sites are flowing following the first significant rains at the onset of the wet season. Since fecal coliform concentrations in surface waters typically peak after major rain events, the First Flush Project aims to capture the first pulse of runoff after soils and wetlands have become saturated.

The First Flush Project provides storm-related bacteria and water quality information that can be compared to ambient conditions and for compliance with Lummi Nation Water Quality Standards. Sample runs are established to monitor water quality conditions in different geographical regions of the Reservation, and can serve to provide representative and targeted information for both the Lummi Bay and Portage Bay watersheds. Details on the justification of the experimental design for this project are provided in Section 6.1.

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3. PROJECT DESCRIPTION (A6)

The overall objective of the First Flush Project is to achieve the LWRD mission and WQM Program goals (Section 0). Specifically, the First Flush Project objectives are:

1. To evaluate water quality during first flush conditions;
2. To evaluate compliance with water quality criteria;
3. To evaluate fecal coliform contributions from on- and off-Reservation sources; and
4. To support the development of a water quality regulatory program.

3.1 Project Description

The Lummi Nation First Flush Project is focused on monitoring the water quality of freshwater drainages on and flowing onto and through the Reservation during storm events. As previously described, the First Flush Project supplements the Surface Water Project, providing data on the first significant surface water flows of the season. The First Flush Project captures information on the water quality of runoff from forested, developed, and agricultural areas originating from off- and on-Reservation sources within the Lummi Bay and Portage Bay watersheds.

Surface water quality on the Reservation is characterized at the onset of the rainy season at 24 sites, which can be divided into one or two sample runs, depending on time constraints. One site is occasionally sampled more frequently; SW118 (Nooksack River at Marine Drive Bridge) is sampled twice, once during each sample run, when the runs are sampled on different days. All sample sites are accessible from land. Figure 3.1 provides a map of the sample site locations.

Water quality is generally measured *in situ* for salinity, specific conductivity, water temperature, dissolved oxygen, and pH using a multi-parameter water quality sonde. A bacteria sample for analysis at an independent contracted laboratory is collected at all sites. In addition, air temperature, water depth, flow direction, and other site observations are recorded.

Summary statistics are calculated for each parameter, as needed, and compared to ambient conditions monitored as part of the Surface Water Project as well as Lummi Nation Water Quality Standards for each designated class. A summary of water quality data for the two-year reporting period, comparison to Lummi Nation Water Quality Standards, and comparison with ambient conditions from the period of record is included in the Water Quality Assessment Report provided to the EPA every-other year to fulfill Clean Water Act Section 106 grant funding requirements (EPA 2006b) by March 31 of the year following the two-year reporting period. Surface water quality data are transmitted to EPA via the Water Quality Exchange (WQX) framework annually by March 31 after the year of record.

Field visits and sample collection occurs at the onset of the rainy season, typically October or November. Occasionally, second flush monitoring is conducted in addition to first flush monitoring when a significant dry period occurs between storm events or periods of precipitation typical of the wet season. Data analysis and report preparation is conducted

every-other year in January-March of the year following data collection for the two-year reporting period. As described above, the data transfer to EPA via WQX is completed annually by March 31 of the year following data collection. It is anticipated that all sites will be sampled as scheduled (once per year during or immediately following storm events). First flush conditions occurring outside of working hours are not sampled; if possible, second flush monitoring is conducted if first flush sampling is incomplete. Equipment failure, staffing limitations, and budget restraints may also restrict planned site visit frequency.

Quality Assurance/Quality Control (QA/QC) procedures include duplicate field measurements as well as equipment calibration, accuracy checks, and maintenance as specified in equipment SOPs. Details of the QA/QC procedures are provided in Section 8 of this QAPP.

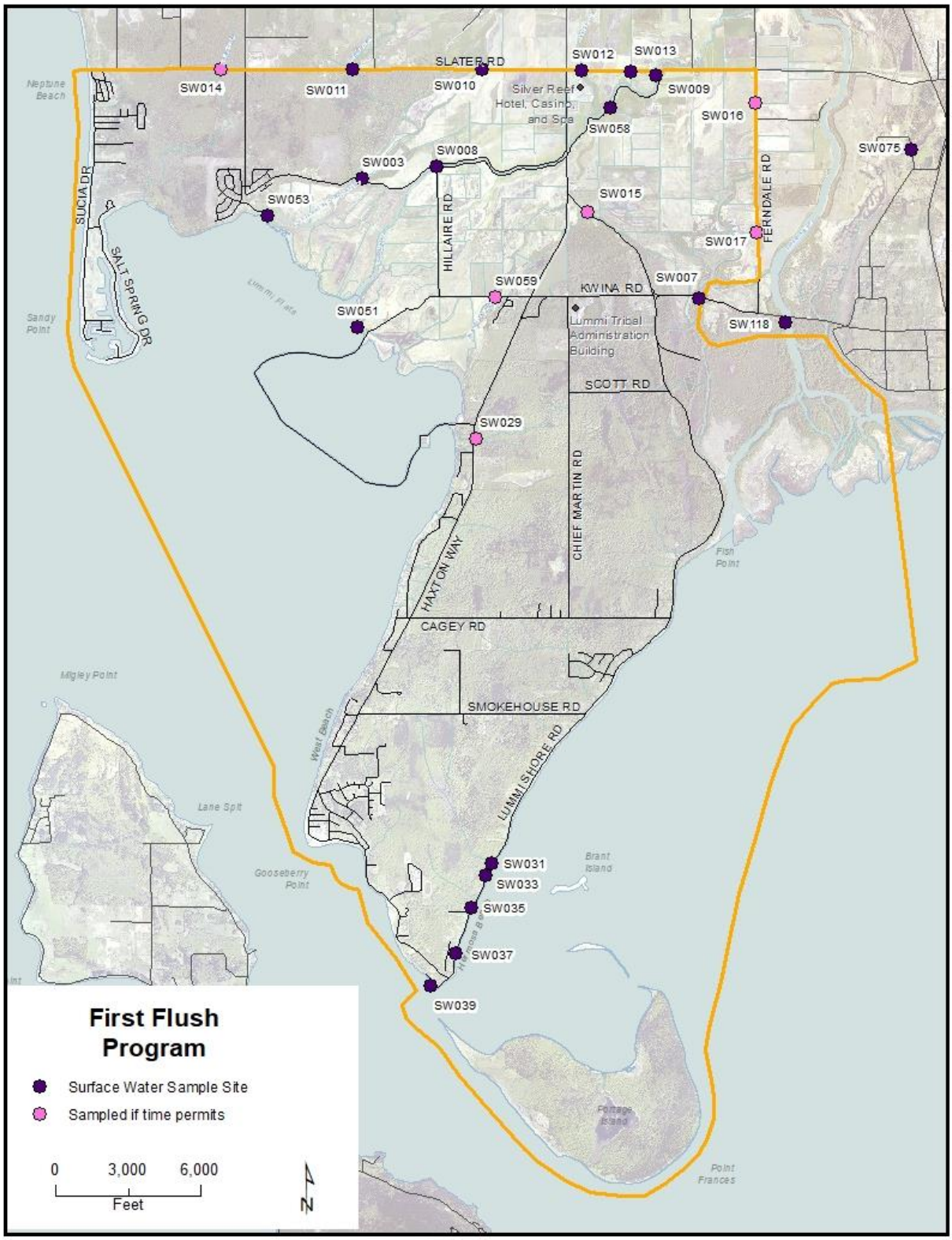

Figure 3.1 Location of First Flush Water Quality Monitoring Sites

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4. QUALITY OBJECTIVES AND CRITERIA (A7)

The overall performance standard for the First Flush Project is the collection of high-quality data sufficient to meet project goals. Data must be of sufficient quality (*i.e.,* known precision, accuracy, bias, traceability, completeness, and representativeness) to support scientifically valid and legally defensible decisions. Project quality control activities are designed to indicate data quality in the field and prompt corrective actions at that time, if necessary, as well as provide the necessary information to assess and quantify data quality and comparability for data analysis.

The First Flush Project is ongoing and is not designed to prove or disprove a specific hypothesis. The data are used to assist in identifying and addressing actual and potential impairments of water quality and for evaluation of water quality trends during first flush conditions against ambient conditions and regulatory criteria. Quality control activities are in place to ensure the reliability and usefulness of the water quality data for evaluation of trends, impairment, and compliance with Lummi Nation Water Quality Standards.

Summary statistics for all parameters are calculated, as needed, and used for comparison with previous results from the period of record, ambient background conditions, and relevant water quality criteria. See QMP for calculation of summary statistics, including field variability and quality control parameters. These summary data are presented in the Water Quality Assessment Report submitted to the EPA.

4.1 Measurement Performance/Acceptance Criteria

Quality assurance/quality control (QA/QC) procedures include: equipment calibration, accuracy checks, and maintenance activities as required by the equipment SOPs; aseptic bacteria sample collection and handling techniques, field blanks, and chain of custody procedures as required by the Bacteria Sample Collection SOP; and field duplicates (Section 8).

Acceptance criteria and detection limits vary depending on the parameter measured. Refer to the QMP for details (QMP Appendix C). Project action limits include measurements that exceed water quality criteria and measurements that are unusual or unexpected for the site. Additional details on project action limits are included in the QMP.

4.2 Precision

Manufacturer-stated resolution for air temperature, water temperature, salinity, specific conductivity, dissolved oxygen, and pH are listed in the instrument SOPs.

At least 10% of all field measurements are duplicated in the field during each sample run, except for samples collected for analysis at a laboratory. Field duplicates provide information on both the precision of the instrument used to measure the parameter and the natural field variability of the parameter. However, duplicate measurements are not routinely used to

calculate the precision of the instrument; they are primarily used as an indicator of field variability.

If quantification of precision of a particular parameter and instrument is required, standard error can be calculated from repeated accuracy checks with a known standard. However, quantification of precision in addition to manufacturer-stated resolution is not routinely conducted.

If a visual observation (*e.g.,* current or flow direction) changes during a site visit, it is noted in the database or field datasheet for the site.

4.3 Accuracy and Bias

The accuracy of the parameters measured is specified by the manufacturer (see instrument SOPs), laboratory (see Bacteria Sample Collection SOP), or cannot be specified because the measurement is approximate (see other parameter SOPs). Parameters measured using a water quality monitoring sonde (*i.e.,* the YSI 556 or YSI ProPlus) are calibrated and verified against National Institute of Standards and Technology traceable standards. The turbidimeter is calibrated and verified against manufacturer-supplied standards. If the instrument cannot be calibrated or an accuracy check is not within acceptance criteria, corrective actions are taken to determine and correct the problem (see instrument SOPs for details).

4.4 Representativeness

Water quality measurements and laboratory samples are collected from a representative portion of the waterbody that is characteristic and removed from possible influences of the sampler. Representative portions are determined by visual means, measured water quality variation, and the location where samples have been collected historically. Shallow margins and uncharacteristic areas are avoided. Although water quality variation does not necessarily suggest non-representativeness due to the variable nature of surface waters on the Reservation, the variability of salinity, specific conductivity, temperature, and dissolved oxygen is evaluated while the sample site is being measured and any variability is recorded in the Water Database. Care is taken to minimize disturbance of the water column when collecting samples and taking measurements to determine if a waterbody is stratified. Details on selection of a representative location and disturbance minimization are provided in Sections 7.5 and 7.6.

4.5 Comparability

Data quality can be assessed and quantified for all data collected over the period of record. Although different brands of water quality meters or model types have been used over time, methods for collecting water quality data have not changed significantly since 1993. Equipment changes are documented in field log books, field datasheets, and the Water Database. Units of measurement have remained consistent throughout the period of record. The measures of accuracy, precision, and traceability have not changed and provide for the ability to assess these quality objectives for data collected over the entire period of record.

Information regarding data quality allows for comparison of data collected at different times over the period of record within the First Flush Project and with other Lummi Nation water quality projects within the WQM Program (*e.g.,* Surface Water Project, ZAPS, Department of Health Support NSSP Project), as well as comparison with non-WQM Program sources of data, assuming quality control information is available for non-WQM Program data. Site SW118 results may be compared with results from other sites within the Nooksack River watershed collected by agencies partnering in the Whatcom Clean Water Program or with data obtained from the ZAPS Continuous Monitoring Study.

The U.S. Geological Survey (USGS) maintains a gaging station on the Nooksack River at Ferndale (USGS 12213100) with turbidity, discharge, and gage height data available as daily minimum, maximum and average. The USGS also maintains a stage station on the Nooksack River at Marine Drive Bridge (USGS 12213145) providing real-time gage height data. Water quality data collected at site SW118 (Nooksack River at Marine Drive Bridge) may be compared to the Nooksack River gages to describe the general water quality and flow conditions in the Nooksack River.

4.6 Completeness

The goal of the First Flush Project is for sample sites to be sampled once per year during surface water flow following the first significant rains of the season. Surface water sample sites are grouped into sequential sample runs that provide spatially representative data. If the sequence is incomplete, it would be difficult to determine the source or location of a disturbance.

Data are considered complete when all efforts have been taken to collect the data. It is anticipated that all samples will be collected as outlined in the QAPP. Equipment failure, staffing limitations, budget reductions, or changing department priorities may also result in temporary reduction of sample collection.

Data gaps may affect future analysis of baseline conditions and comparison to regulatory criteria, but do not immediately compromise the integrity of the monitoring project because monitoring is not attempting to answer a specific hypothesis. Data gaps are addressed on a case-by-case basis. Missing data may be due to staff turnover, resource constraints, equipment failure, corrective actions, or logistical problems. Corrective actions are undertaken to remedy conditions that create missing data to prevent data gaps in the future (see instrument SOPs for details).

4.7 Range/Sensitivity

The sensitivity and range that can be measured depends on the equipment selected. See instrument SOPs for details. The goal of the First Flush Project is to collect data with sufficient resolution (sensitivity) to identify trends, evaluate water quality against appropriate Lummi Nation Water Quality Standards, evaluate fecal coliform contributions from on- and off-Reservation sources, and support the development and implementation of a water quality

regulatory program on the Reservation. Deficiencies in sensitivity are evaluated on a case-by-case basis and corrected for future monitoring.

5. DOCUMENTS AND RECORDS (A9)

5.1 Quality Assurance Project Plan Distribution

The Water Resources Specialist II is responsible for ensuring that the people listed on the Distribution List in this QAPP have the most current version of this QAPP. Records are maintained by the Water Resources Specialist II documenting substantial and minor version changes, and the Water Resources Manager is responsible for the distribution of minor change letters and revised QAPPs. Details on documenting QAPP revisions, including version number conventions, are included in the QMP.

5.2 Data Report Package

Results of the First Flush Project are included in the Water Quality Assessment Report, which summarizes the results of the WQM Program projects implemented by the LWRD for a two-year reporting period. The reports determine whether Lummi Nation Water Quality Standards are met and compare First Flush Project water quality data for the two-year reporting period with previous data from the period of record as well as background water quality data collected as part of the Surface Water Project. The report is provided to the EPA Project Officer every-other year by March 31 of the year after the two-year reporting period, following approval by the Water Resources Manager and the LNR Deputy Director.

The First Flush Project data are transmitted to the EPA annually via upload to the WQX framework upon approval by the Water Resources Manager and the LNR Deputy Director. Data collected as part of the First Flush Project are provided to the EPA Project Officer by March 31 of the subsequent calendar year.

5.3 Documentation and Storage

The QMP provides detailed requirements for project document storage, including field datasheets, lab results, and electronic data.

In summary, the Water Resources Specialist II is responsible for maintaining and storing all documents and records associated with the First Flush Project. Quality control reports, paper datasheets, and final lab results are stored in three-ring binders in the LWRD office. All paper records are scanned and saved on LIBC servers that are backed up nightly. All data are entered into the Water Database, which is saved on LIBC servers that are backed up nightly.

In this QAPP, reference to data or comments entered “into the Water Database” includes entry directly into the Water Database via the iPad or by recording onto hardcopy datasheets that are later transcribed into the Water Database. Details are included in the QMP and specific instructions on data entry are provided in the Water Database User Guide. The QMP also details what information should be recorded in the Water Database and the conventions for

making changes or correcting errors on hard copy datasheets or electronically in the Water Database.

6. EXPERIMENTAL DESIGN (B1)

The First Flush Project is based on a sample-run system, and is designed to achieve the following objectives:

1. To evaluate water quality during first flush conditions;
2. To evaluate compliance with water quality criteria;
3. To evaluate fecal coliform contributions from on- and off-Reservation sources; and
4. To support the development of a water quality regulatory program.

The First Flush Project is ongoing and not intended to prove or disprove a specific hypothesis.

6.1 Sample Runs and Structure

The First Flush Project is a run-based system comprised of two sample runs: Lummi Bay First Flush and Portage Bay First Flush.

The Lummi Bay First Flush run captures the drainage network of the Lummi Bay watershed from the Reservation boundary. The data collected during the Lummi Bay First Flush run are used to determine the quality of waters flowing onto the Reservation and into Lummi Bay following storm events. Water quality can also be evaluated along the length of the Lummi River floodplain waterbodies and their tributaries. These water quality data are used to help identify pollution sources in the Lummi Bay watershed.

The Portage Bay First Flush run captures the drainage network of the Bellingham Bay/Portage Bay watershed, including the Nooksack River. Bellingham Bay is contiguous with Portage Bay, and the information collected on this run is primarily focused on the Portage Bay portion of the greater Bellingham Bay watershed. Due to water quality concerns in Portage Bay, particularly as it relates to fecal coliform contamination of shellfish beds, the Bellingham Bay First Flush run provides information on freshwater sources of fecal coliform into Portage Bay from the Nooksack River, the primary source of freshwater and bacterial pollution in Portage Bay, and from the Reservation uplands along Lummi Shore Road.

First Flush Project sample runs are not scheduled in advance. First flush sample collection occurs at the onset of the rainy season, typically October or November. Conditions that trigger first flush sampling are precipitation events likely to produce runoff during the beginning of the wet season in the Lummi Bay and Portage Bay watersheds. Determination of when to conduct first flush sample runs is based upon:

1. Increases in Nooksack River discharge measured by the U.S. Geological Survey at the Ferndale, Washington gage (USGS undated)
2. Occurrence of lower salinities at sites along the Reservation boundary
3. The onset of surface water flow at sites that were previously dry
4. The intensity and duration of the storm event

The timing and magnitude of the response at sample sites is variable and only predictable to the level that a response may occur. However, information indicating that water quality and flow conditions are or are not being affected by the onset of the wet season is useful.

Occasionally, second flush monitoring is conducted in addition to first flush monitoring when a significant dry period occurs between storm events or periods of precipitation typical of the wet season. If first flush conditions occur outside of working hours, or other reasons preclude sampling, second flush sampling can conducted to provide information about surface runoff during rain events.

Typically, the Portage Bay First Flush run is sampled upon determination of first flush conditions and the Lummi Bay First Flush run is sampled the following day. These two runs can be combined with sampling occurring in both the Portage Bay and Lummi Bay watersheds on the day that first flush conditions are identified.

6.2 Sample Sites

The 24 surface water quality sample sites (Figure 3.1) were selected to achieve the project goals and includes 16 Class AA freshwater, 4 Class AA marine water, and 4 Class A freshwater sites. The Lummi Bay First Flush run is comprised of 11 sample sites, with 17 sites sampled if time permits. The Portage Bay First Flush run is comprised on 8 sample sites. The sample site distribution on the Reservation is dense in order to protect shellfish and freshwater resources and capture spatial variability associated with estuarine environments. Table 6.1 lists the sample sites, provides a description of their location, and water class designation (see QMP for discussion and details on Lummi Nation Water Quality Standards) organized by sample run. Note that Site SW118 (Nooksack River at Marine Drive Bridge) is sampled on both sample runs if the sample runs are conducted on different days.

Table 6.1 Location of First Flush Surface Water Quality Monitoring Sites and Water Class Designation

Sample Site ID	Sample Site Location	Water Class Designation
Lummi Bay First Flush Run		
SW003	Jordan Creek at North Red River Road	AA Fresh
SW008	Lummi River at Hillaire Road Bridge	AA Marine
SW009	Lummi River at Slater Road	AA Fresh
SW010	Drainage on Slater 200 yards west of Haxton	AA Fresh
SW011	Jordan Creek at Slater Road	AA Fresh, Eph.
SW012	Schell Creek at Slater Road	AA Fresh
SW013	Agricultural drainage between Schell Creek and Lummi River	AA Fresh
SW014*	Drainage from Phillips 66 stormwater treatment facility at Slater Road; flows into Onion Creek	AA Fresh, Eph.
SW015*	Smuggler Slough at Lummi Shore Drive	AA Fresh
SW016*	Drainage on Ferndale Road south of Slater Road	AA Fresh
SW017*	Drainage on Ferndale Road north of Marine Drive	AA Fresh
SW029*	Drainage from Lummi Peninsula uplands east of Haxton Road near Lummi Shellfish Hatchery	AA Fresh, Eph.
SW051	Lummi River Mouth	AA Marine
SW053	North Lummi River Distributary Mouth	AA Marine
SW058	Agricultural ditch that flows to Lummi River through culvert under South Red River Road	AA Marine
SW059*	Smuggler Slough at Kwina Road	AA Marine
Portage Bay First Flush Run		
SW007	Kwina Slough at Marine Drive	AA Fresh
SW031	Outflow along Lummi Shore Road	A Fresh
SW033	Outflow along Lummi Shore Road	A Fresh
SW035	Outflow along Lummi Shore Road at Adams Road	A Fresh
SW037	Outflow along Lummi Shore Road at Bay Lane	A Fresh
SW075	Silver Creek at Shady Lane, tributary to Nooksack River	Flows to AA Fresh

Table 6.1 Location of First Flush Surface Water Quality Monitoring Sites and Water Class Designation

Sample Site ID	Sample Site Location	Water Class Designation
Sampled During Both Runs		
SW004	Alternate Nooksack River site at Slater Road**	AA Fresh
SW118	Nooksack River at Marine Drive Bridge	AA Fresh

Eph. = Ephemeral
*Sites sampled if time permits
** Site SW004 is sampled when access to SW118 for sampling is unsafe or impractical.

Detailed maps, descriptions of sample locations, and driving directions to sample sites are provided to field personnel in the Field Reference Manual to ensure that sites are sampled on location (LWRD 2019). Sample site access is usually not a problem, except at Site SW118 (Nooksack River at Marine Drive Bridge) can occasionally become inaccessible due to flooding. Site SW004 (Nooksack River at Slater Road) is sampled when Site SW118 is inaccessible. If another sample site cannot be accessed during a sample run, and no previously identified alternative site is available, a sample may be collected nearby if the area is part of the same waterbody and is representative of the designated sample site area. When this occurs, the sampling location is described in the Water Database and the data collected identified as being collected "off station" because the sample was not collected at the established sample site. Details on documenting samples collected off station can be found in the QMP. If a site is completely inaccessible, the reason for the inaccessibility is determined. In general, sampling of individual sample sites without completing the entire sample run is avoided because the measurements and analysis will not have the context of the other sampling sites.

6.3 Water Quality Parameters

Table 6.2 lists the sample runs, sites included in each run, parameters measured, and laboratory samples collected. Water quality is generally measured *in situ* for salinity, specific conductivity, water temperature, dissolved oxygen, and pH. Salinity-based stratification is evaluated at all marine and tidally-influenced sites. If salinity-based stratification is present, *in situ* water quality parameters are measured for both the top and the bottom strata. Samples for laboratory analysis (fecal coliform, *E. coli*, enterococcus) are collected, labeled (site identifier, date, time, analysis, and collecting agency), placed on ice, and delivered to the laboratory using chain of custody procedures and the methods detailed in the Bacteria Sample Collection SOP. In addition, air temperature is measured and current/flow direction and water depth are evaluated.

Table 6.2 First Flush Surface Water Quality Monitoring Sites, *In Situ* Parameters Measured, and Laboratory Samples Collected

Run Name	Site ID (SW)	*In Situ* Parameters Measured At Each Sample Site	Laboratory Samples Collected At Each Sample Site
Lummi Bay First Flush	3, 8, 9, 10, 11, 12, 13, 51, 53, 58, 118 14, 15, 16, 17, 29, 59 if time permits	Air temperature, salinity-based stratification, water temperature, salinity, specific conductivity, current/flow direction, dissolved oxygen (DO), pH, water depth, and general observations	Fecal coliform, *E. coli*, and enterococcus
Bellingham Bay First Flush	7, 31, 33, 35, 37, 39, 75, 118		

Ten percent of sites sampled are treated as duplicates, with all measurements, except bacteria sample collection, duplicated for each stratum. Sites are randomly selected for duplication, or sites can be selected for duplicate analysis because water quality parameters at the site are variable. Duplication provides information about the natural field variability concurrently with the inherent precision of the instrument or method used to measure the parameter. Duplicate measurements are recorded in the Water Database, and values are automatically averaged for reporting the parameter results of a particular site on a given day. If variability is present and is suspected to be caused by instrument malfunction or operator error, the problem is corrected, if possible. Measurements collected using a malfunctioning instrument or using improper technique are re-collected after the problem is remedied or are associated with the appropriate data qualifier in the Water Database (see QMP and the Water Database User Guide for details).

Critical information includes bacteria, salinity, and water temperature measurements for the Portage Bay First Flush run. All other data collection is critical in the sense that representative and complete data are required to meet project goals.

The parameters measured and analyzed provide substantial information about water quality and general environmental conditions. For example, air and water temperature, specific conductivity, salinity, dissolved oxygen, pH, presence of salinity-based stratification, water depth, and flow or current direction characterize site conditions, basic water chemistry, and site conditions providing insight into both the variation and the potential causes of variation of these parameters. As previously mentioned, the measurements also provide information for determination of regulatory compliance. Many of the parameters measured are associated with regulatory criteria (*i.e.,* water temperature, dissolved oxygen, pH, bacteria). To date the extent of these evaluations rarely includes citations or legal actions, but they guide follow-up actions to confirm and remedy potential problems (Section 11.2).

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7. SAMPLING METHODS (B2, B3, B4)

Sampling methods (B2), sample handling and custody (B3), and analytical methods (B4) for each parameter measured or sampled are described below. This section also describes sample handling and custody, safety during sampling, the water sampling sequence, procedures for selecting a representative location and avoiding contamination, a summary of what samples to collect and which parameters to measure under different site conditions, and a summary of practices specific to each parameter measured. Additional details on parameter measurement and sample collection are included in the parameter and equipment SOPs.

7.1 Sampling Method Overview

At each sample site, a bacteria sample is collected, placed on ice, and delivered to the independent contracted laboratory using chain of custody procedures for fecal coliform, *E. coli*, and enterococcus enumeration. Water quality is measured *in situ* using a multi-parameter water quality sonde for salinity, specific conductivity, water temperature, dissolved oxygen, and pH. Salinity-based stratification is evaluated at all marine and tidally-influenced sites. If salinity-based stratification is present, *in situ* water quality parameters are measured for both the top and the bottom strata. In addition, air temperature is measured, and current/flow direction and water depth are evaluated. Data are recorded in the Water Database as described in the QMP and Water Database User Guide.

7.2 Sample Handling and Custody (B3)

Details on sample handling and custody, including how samples are physically handled and transported to the laboratory, requirements for chain of custody procedures, and maximum holding times are provided in the Bacteria Sample Collection SOP. Information on the system for identifying samples and sample tracking is included in the QMP.

7.3 Safety

All field work is conducted by teams of two or more. All procedures listed in the Lummi Water Resources Division Health and Safety Plan (LWRD 2015) are followed while conducting laboratory and field work outlined in this QAPP. Safety is not addressed in detail in this document, however no water quality measurement is worth risking injury or death. To ensure that hazards are identified and addressed, field personnel must maintain a general awareness of hazards and possess the ability to respond appropriately. Field personnel must be aware of the environment, use common sense and training, and not exceed their abilities or limits. Field personnel always carry a cell phone and car charger, and notify their supervisor of planned field work, including the time of departure, the time of the scheduled return, and the general location of the field work.

7.4 Water Sampling Sequence

Upon arrival at a sample site, the following sequence is followed to collect surface water quality samples for bacteria analysis and measurement of water quality parameters.

1. Visual observation of sample site conditions and representative area.
    - See Section 7.5 for details on selecting a representative location.
    - Determine whether water at the site is flowing. Record in the Water Database if the site was dry (no water present), had insufficient water to sample, or was stagnant.
        - If site is dry, has insufficient water to sample, or is stagnant, the site is not sampled for any parameters.
        - If a site has flowing water of sufficient quantity and depth to sample, all water quality parameters are measured and a bacteria sample is collected.
2. Set up air temperature thermometer, visually observe current and flow direction, water level/depth, and waterbody condition throughout time at sample site.
3. Bacteria samples are collected first in the top six inches of the water column (below the surface) before any other water quality measurements are performed. Sample is collected in a representative portion of waterbody.
    - Bacteria samples are collected with a sampling wand when practicable.
    - Bacteria sample collection details are provided in the Bacteria Sample Collection SOP.
4. *In situ* water quality measurements are collected for water temperature, salinity, specific conductivity, dissolved oxygen, and pH at the previously identified representative portion of the waterbody.
    - Measurements are taken using the YSI 556 (or YSI ProPlus, if used as a backup) in the top six inches of water.
    - Details on using the YSI 556 and YSI ProPlus to collect water quality parameters and stabilization criteria are found in the instrument SOPs.
5. Site is checked for salinity-based stratification. The YSI 556 (or YSI ProPlus, if used as a backup) is lowered to slightly above the bottom of the waterbody, or as low as feasible. If salinity varies by more than 1.0 ppt, the site is considered stratified. Water temperature, salinity, specific conductivity, dissolved oxygen, and pH are measured for the lower stratum.
6. Finally, water level and/or depth and air temperature are measured and visual observations (*e.g.,* current/flow direction) are recorded.
    - Water level and/or depth can be estimated using the sampling wand or visual assessment following instructions provided in the Water Level/Depth SOP.
    - Details on measuring air temperature are provided in the Air Temperature SOP.

    - Details on recording current/flow direction are provided in the Current/Flow Direction SOP.
7. Visual observations are conducted during the entire period of time the sampler is at the sample site. If conditions change substantially (*e.g.,* current direction reverses, tidal channel fills or empties), the changes are recorded in the Water Database.
8. At 10% of sites, collect duplicate measurement of all parameters except bacteria sample collection.
9. Assess water quality variation at sample site to confirm that sampling is taking place at a representative location.
    - Note that water quality variation does not necessarily indicate that the measurements are taken in a non-representative location. Field variability of water quality conditions is common at many sample sites.
    - If prior laboratory samples were collected from non-representative areas, consider discarding the samples.
        - If samples are discarded, record this action and reason in the Water Database.
        - If samples are not discarded, associate data qualifier with the result in the Water Database and indicate reason why.
        - Consider re-sampling the site if feasible.

7.5 Representative Location

Surface water sample site locations were selected to provide representative water quality measurements for the waterbody. A water quality measurement that is representative of the specific waterbody and site sampled is obtained by following the methods described below. A representative water quality measurement is taken when both the specific methods of sample collection and measurement, as well as the sequence of collection and measurement (Section 7.4), are followed.

The following are considered when selecting a representative location at the sample site:

- Avoid areas along margins, where debris accumulates, and other areas that are not characteristic of the waterbody at the sample site
- Select an area that minimizes disturbance to the waterbody (Section 7.6)
- For wading sites, unless safety precludes wading into the water, avoid collecting samples along the shoreline where waves are breaking and washing across the beach
    - Sample seaward of debris and seaweed generally found in the water close to the shoreline
    - If samples are collected from within the wave or debris zone, associate data qualifier and the reason in the Water Database
    - Avoid areas of entrained air in the wave-wash zone

- If a representative location cannot be found, use professional judgment to determine whether the site should be sampled
    - If the site is not sampled due to inability to find a representative location, note in the Water Database
    - If the site is sampled, associate data qualifier due to non-representative sampling location in the Water Database
- If a site is sampled, and the site is recognized as non-representative after the sample is collected
    - Consider discarding the previously collected sample and re-collecting the water quality measurements and bacteria sample
    - If samples collected from non-representative location are retained for analysis, associate data qualifier and the reason in the Water Database

7.6 Site Disturbance

Bacteria samples are collected first followed by measurement of *in situ* water quality parameters. Ensure that the sample site is not disturbed prior to or during sample collection. A site is disturbed if sediments or other materials (*e.g.,* plants, benthic algae) settled at the bed of the waterbody are suspended into the water column, or debris falls into the water at the sample site. Fecal coliform bacteria in bottom sediments can remain viable for many weeks. Disturbing sediments can re-suspend these bacteria and result in temporary uncharacteristically high bacteria test results. Strategies for avoiding site disturbance include:

- Avoid walking in the waterbody or near the edge of the waterbody
- If wading into the waterbody is required, approach the sample site from the downstream/down-gradient side
- Use sampling wand to collect samples

7.7 Field Conditions

Upon arrival at the sample site, field personnel observe the site conditions, record the site conditions in the Water Database, and use their professional judgment to make an informed decision on whether the site should be sampled. Site conditions fall into two general categories:

1. If water is present, flowing, and of sufficient quantity to sample, the site is sampled for bacteria, *in situ* water quality, and associated parameters
2. If the site is dry, water is present but not in a sufficient quantity to sample, or water is present but is stagnant (*i.e.,* not flowing), the site is not sampled

Generally, site conditions during true first flush events include flowing water. However, flow at some sites is restricted by tide or irrigation gates (*e.g.,* SW013, SW053, and SW072). If several sites are not flowing, field personnel should reconsider whether first flush conditions are present.

7.8 Parameters Measured

Table 6.2 lists the parameters measured and the sampling frequency for every sample site. Table 7.1 summarizes the parameters measured, units, sampling equipment, measurement method, sample holding container, method of sample preservation, and the maximum holding time for each of the measured parameters. “General Observations” are not listed in Table 7.1 because they are not a specific method. General and noteworthy conditions are observed during the time period the sampler is at a sample site and recorded as comments in Water Database.

Cleaning of sample equipment follows manufacturer’s instructions and details listed in the equipment SOPs. Improper cleaning can cause damage to equipment. Sterile bacteria sample bottles are provided by the contracted laboratory and are not cleaned by LWRD staff.

Table 7.1 Lummi Nation Water Quality Sampling Methods

Parameter (units)	Measurement Equipment	Analytical Method	Sample Holding Container	Sample Preserv-ation[a]	Maximum Holding Time
Air Temperature (°C)	Armored non-toxic liquid-in-glass thermometer	See Air Temperature SOP #007	N/A	N/A	Immediately
Current and Flow Direction	N/A	See Current and Flow Direction SOP #009	N/A	N/A	N/A
Dissolved Oxygen (mg/L and % saturation)	YSI 556 or YSI ProPlus	See YSI 556 SOP #001, YSI ProPlus SOP #002 SM 4500-O G-2001	*In situ*	*In situ*	Immediately
Enterococcus (MPN/100ml)	Laboratory with Enterolert Test Kit	See Bacteria Sample Collection SOP #004 Enterolert Test Procedure	250 ml sterile plastic bottle with screw top (same bottle as for fecal coliform and *E. coli*)	Ice	6 hours[b]
Fecal Coliform and *E. Coli* (per 100ml)	Laboratory with membrane filter enumeration capabilities	See Bacteria Sample Collection SOP #004 Membrane filtration with elimination of rosolic acid SM 9222D-G	250 ml sterile plastic bottle with screw top (same bottle as for enterococcus)	Ice	6 hours[b]
PH (pH units)	YSI 556 or YSI ProPlus	See YSI 556 SOP #001, YSI ProPlus SOP #002 SM 4500-H+ B-2000	*In situ*	*In situ*	Immediately
Salinity (ppt)	YSI 556 or YSI ProPlus	See YSI 556 SOP #001, YSI ProPlus SOP #002	*In situ*	*In situ*	Immediately

Table 7.1 Lummi Nation Water Quality Sampling Methods

Parameter (units)	Measurement Equipment	Analytical Method	Sample Holding Container	Sample Preserv-ation[a]	Maximum Holding Time
Specific Conductivity (µS/cm)	YSI 556 or YSI ProPlus	See YSI 556 SOP #001, YSI ProPlus SOP #002 SM 2510 B-1997	*In situ*	*In situ*	Immediately
Surface Water Level/Depth (feet)	Sample wand, YSI 556, Secchi disk, or boat depth sounder	See Surface Water Level/Depth SOP #010	N/A	N/A	N/A
Water Temperature (°C)	YSI 556 or YSI ProPlus	See YSI 556 SOP #001, YSI ProPlus SOP #002 SM 2550 B-2000	*In situ*	*In situ*	Immediately

SM = Standard Methods (APHA various dates).
MPN = Most Probable Number
[a] Sample preservation methods listed are for the collection and delivery of samples to the laboratory by LWRD staff and do not include sample preservation methods performed at the independent contracted laboratory.
[b] Bacteria samples have a maximum holding time of 8 hours but must be delivered to the contracted laboratory within 6 hours to allow time for laboratory processing within the maximum holding time.

For all individual parameters listed below, see parameter or instrument SOPs for details regarding procedures, performance criteria, and corrective actions. The QMP provides details on method validation.

7.8.1 Bacteria Sample Collection

A bacteria sample is collected at all sites with flowing water using aseptic sampling techniques as outlined in the Bacteria Sample Collection SOP. The bottle is labeled with the site identifier and other information as detailed in the SOP, and transported to the contracted laboratory, currently Edge Analytical, Incorporated in Bellingham, WA. Chain of custody forms are used to document sample information, analyses requested, and release of the samples to the laboratory staff.

7.8.2 In Situ *Water Quality*

In situ water quality is measured at all sites with flowing water using a multi-parameter water quality sonde with sensors for water temperature, salinity, specific conductivity, dissolved oxygen, and pH. The YSI 556 is the primary instrument used to measure *in situ* water quality parameters. The YSI ProPlus can be used as a back-up if the YSI 556 is unavailable or requires maintenance or repair.

As described in the SOPs for the YSI 556 and YSI ProPlus, the instrument must be calibrated and pass pre-run accuracy checks prior to use in the field. The SOPs for the instruments also detail use of the equipment to collect *in situ* water quality measurements, stabilization criteria, corrective actions, and QA/QC procedures.

As described above in Section 7.4, *in situ* water quality is measured in the top six inches of the waterbody. All parameter measurements are recorded in the iPad or field datasheet.

Salinity-based stratification is assessed for all marine and tidally-influenced sites by lowering the sensor to slightly above the bottom of the waterbody or as low as feasible. If salinity varies by more than 1.0 ppt, the site is considered stratified. Water temperature, salinity, specific conductivity, dissolved oxygen, and pH are recorded for the lower stratum when the site is stratified.

7.8.3 Surface Water Level/Depth

Surface water level/depth is measured at all sites all sites with flowing water. Surface water level/depth can be measured using the water sampling wand, YSI 556, or estimated visually. Details on estimating and measuring surface water level/depth are found in the Surface Water Level/Depth SOP.

7.8.4 Current and Flow Direction

Current and flow direction is visually estimated at all sites with flowing water as a cardinal direction (*e.g.,* N, E, NE) for open waters and as upstream/downstream for channels. Details on estimating current and flow direction are provided in the Current and Flow Direction SOP.

7.8.5 Air Temperature

Air temperature is measured using an armored non-toxic liquid-in-glass thermometer at all sites with flowing water. Details on measuring air temperature are provided in the Air Temperature SOP.

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8. QUALITY CONTROL AND EQUIPMENT USE

Quality Assurance/Quality Control (QA/QC) activities (B5), equipment testing, inspections, maintenance (B6), and calibration (B7) are described below. Detailed information for each parameter and instrument is provided in the parameter and instrument SOPs. This section provides a summary of required activities for each parameter and instrument as well as general QA/QC procedures for the First Flush Project.

Quality control activities are integral to equipment maintenance and provide information to the sampler and analyst about equipment condition and data reliability. The quality control activities can occur before, during, and after sample runs or regularly throughout the year. Equipment operation is assessed at startup and during operation as outlined in the equipment SOPs. Equipment problems or failure to meet QA/QC activity acceptance criteria initiates corrective actions. A summary of corrective actions are provided in Section 8.4 of this QAPP, with details provided in the individual equipment and method SOPs and the QMP. Determination and documentation of control action effectiveness is described in the QMP.

The goal of QA/QC activities for the First Flush Project is to ensure that measurements have a known accuracy, precision, and traceability. QA/QC activities for the project are listed in this section and in the equipment SOPs. Calculation of statistics is detailed in the QMP and summarized in Section 10.2.

8.1 Quality Control (B5)

Quality control procedures for the First Flush Project include instrument calibration, pre-run, mid-run, and post-run accuracy checks, sterile sampling techniques, sterile blanks, use of sample tracking forms, and field duplicates. Note that some parameters are estimated (*i.e.,* current/flow direction, surface water level/depth), and do not have acceptance criteria or QA/QC activities other than carefully following all instructions listed in the parameter SOPs.

8.1.1 In Situ *Water Quality*

The YSI 556 (or YSI ProPlus is used as a backup) is calibrated according to the equipment SOPs. The YSI 556 (or YSI ProPlus) is also accuracy checked according to the equipment SOPs prior to the commencement of a sample run (pre-run), during the mid-way point of the sample run (mid-run), and at the end of the sample run (post-run). Detailed calibration and accuracy check requirements are listed in the instrument SOPs.

8.1.2 Bacteria

Details on the QA/QC procedures for bacteria sample collection and analysis are provided in the Bacteria Sample Collection SOP.

8.1.2.1 Sterile Sampling Techniques

Field staff will ensure that all bacteria samples are collected using sterile techniques. This includes inspecting the laboratory-provided bacteria sample bottles for contamination prior to use and proper handling of the sample bottle during bacteria sample collection, storage, and transportation.

8.1.2.2 Sterile Blanks

Once per quarter, a sterile blank QA/QC sample is supplied to the independent contracted laboratory (currently Edge Analytical, Incorporated in Bellingham, WA) for analysis. The sterile blank verifies the ability of field personnel to collect, handle, and transport bacteria samples using sterile techniques (*i.e.,* without contaminating the sample). It also verifies the ability of the independent contracted laboratory to process and analyze the sample without contamination.

8.1.2.3 Sample Tracking

Every surface water sample site has a unique numerical identifier. The site identifier is used to track water quality measurements and bacteria samples collected at the site. Section 10.1 of this QAPP and the QMP provide details of sample tracking and data recording. Chain of custody forms are provided by the independent contracted laboratory and are used to handle and track samples from field collection to delivery to the laboratory. The number on the chain of custody form will follow the samples through analysis to final reporting.

8.1.2.4 Holding Times

Laboratory holding times are observed for all bacteria samples collected (Table 7.1).

8.1.2.5 Laboratory QA/QC

The independent contracted laboratory is responsible for maintaining data quality for laboratory-analyzed results. Quality assurance samples may include blanks, positive growth tests, and negative growth tests. Quality assurance practices will meet or exceed method and accreditation requirements as outlined in the laboratory QAPP or method SOP. A summary of laboratory QA/QC requirements are provided in the Quality Management Plan (QMP Appendix C).

8.1.3 Field Duplicates

Duplicate measurement of all field parameters (with the exception of bacteria) is conducted at 10% of sample sites. Sites are randomly selected for duplication, or sites can be selected for duplicate analysis because water quality parameters at the site are variable. Duplication provides information about the natural field variability and the inherent precision of the instrument or method used to measure the parameter. Duplicate measurements are recorded in the Water Database and identified as duplicates of either the upper or lower stratum, and values are averaged automatically by the Water Database for reporting parameter results of a

particular site on a given day. If variability is present and is suspected to be caused by instrument malfunction or operator error, the problem is corrected, if possible.

8.2 Equipment Maintenance (B6) and Calibration (B7)

Equipment maintenance and calibration activities are the responsibility of the Water Resources Specialist II, who is assisted by the Water Resources Technician II.

Information regarding calibration and maintenance of water sampling equipment is provided in the instrument SOPs and user manuals. The YSI 556 and YSI ProPlus require periodic calibration. Details on actions to be taken when calibrations are unsuccessful are found in the equipment and parameter SOPs. All equipment is inspected, including checking battery charge, prior to use in the field and repaired as necessary. Instruments and other field sampling equipment are kept clean and in working order.

An equipment module is included as part of the Water Database. The equipment module sends the Water Resources Specialist II and Water Resources Technician II email reminders of needed maintenance activities and deadlines according to manufacturer specifications. Details on the equipment module are provided in the QMP.

8.3 Acceptance Criteria and Control Limits

Acceptance criteria and control limits depend on the parameter measured and equipment used. Details on what should be done when acceptance criteria are exceeded, calibrations are unsuccessful, or readings are otherwise suspect are found in the equipment and parameter SOPs. Details on how effectiveness of control activities are determined and documented are included in the QMP.

8.4 Corrective Actions

The goals of corrective actions are to solve the problems at hand and to eliminate or reduce the occurrence of the problems. Problems with equipment detected during equipment use, calibration, or during QA/QC activities result in actions to correct the problem (see individual instrument and parameter SOPs). Corrective actions depend upon the parameter being measured. If the problem cannot be resolved on-site, the measurement is discontinued until the problem is identified, remedied, and reliable results are obtained. For most parameters, backup equipment is available for use while the deficiency with the standard equipment is being remedied. Problems with equipment and measurements, corrective actions, and outcomes are recorded in the Water Database.

Details on documenting problems, corrective actions, and outcomes, including assigning data qualifiers, in the Water Database are provided in the QMP and Water Database User Guide.

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9. SUPPLIES AND CONSUMABLES (B8)

The Water Resources Specialist II is responsible for ensuring that critical supplies and consumables are unexpired, ready for use, and that a minimum two-month supply is always available. Details on supply ordering, stocking levels, and management are provided in the QMP. Details on equipment and supply inspection are listed in the equipment SOPs.

Supplies and consumables used in the First Flush Project include:

Data Recording:

- iPad
- Calibration and field data sheets in field clipboard
- Waterproof pen and pencil

General:

- Sample wand
- Distilled water in spray bottles
- Cooler
- Ice

Water Quality Sampling Equipment:

- Yellow Springs Instruments (YSI) 556 Multi Parameter System (MPS) (YSI 556) and associated reagents needed for calibration and accuracy checks as specified in the YSI 556 SOP. YSI 556 must meet all pre-run QA/QC requirements prior to use for collection of water quality parameters in the field.
    - The YSI Professional Plus (YSI ProPlus) can be used as a backup water quality sonde in the event that the YSI 556 is unavailable or inoperable. The YSI ProPlus must meet all pre-run QA/QC requirements prior to use for collection of water quality parameters in the field. See YSI ProPlus SOP for details on QA/QC requirements and associated reagents needed.
- 250 ml sterile bacteria bottles, provided by the contracted laboratory.
- Air thermometer

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10. DATA MANAGEMENT (B10)

The Water Resources Specialist II is responsible for data management of First Flush Project data with support and supervision provided by the Water Resources Manager and the Database Manager.

A detailed description of the data management process, including record keeping and QA/QC procedures, is included in the QMP. Components of the Water Database, including data archiving and uploading, hardware and software configurations, and automated data validation and verification tools, are included in the QMP. A summary of the data management process is provided here.

All sampling and related water quality data are entered into the Water Database, either in real time using the iPad or through transcription of data from field datasheets and laboratory reports. Data entry is manually verified, and a QA/QC report is generated for each trip. All paper records (*e.g.,* field datasheets, final lab reports, chain of custody forms, and QA/QC reports) are stored by the Water Resources Specialist II in the LWRD office. All electronic records are saved in the Water Database and in a data archive folder on the LIBC server, which is backed up nightly. Data are verified and validated according to their quality as outlined in the QMP. Verified data are transmitted to the EPA via WQX upon approval by the Water Resources Manager and the Deputy Director.

10.1 Sample Tracking and Data Recording

Details on data entry and use of the Water Database are provided in the QMP. A summary of sample tracking and data recording follows.

Every surface water sample site has a unique numerical identifier. The site identifier is used to track water quality measurements and bacteria samples collected at the site. Typically, water quality data and site observations for each site visit are entered directly into the Water Database in real time via an iPad. When datasheets are used, the site identifier is recorded (a copy of the surface water field datasheet is included in the QMP). The site identifier is also recorded on bacteria sample bottles and chain of custody forms to track the results of laboratory bacteria analysis. Detailed procedures on labeling of bacteria sample bottles, sample handling and transportation, and completion of chain of custody forms are provided in the Bacteria Sample Collection SOP. The Bacteria Sample Collection SOP also includes an example chain of custody form as an appendix.

All run details, QA/QC procedures completed (*i.e.,* instrument calibrations and accuracy checks), site visit observations, water quality parameter measurements, notes on measurements not taken and reasons why, issues, corrective actions, and outcomes are recorded either directly into the Water Database in real time using the iPad or are recorded on field datasheets. Notes and data from field datasheets are entered into the Water Database

within one week of trip date, if feasible, and data entry QA/QC is completed by the Water Resources Specialist II upon receipt of the final laboratory results for that trip.

10.2 Data Analysis

Calculation of precision (as available) and accuracy/bias, identification of outliers, and identification of data gaps provide the basis for quantifying data reliability for the First Flush Project. Details on data validation and verification, database maintenance, calculation of statistics, and identification of outliers and missing data are provided in the QMP.

Duplicate measurements are automatically averaged by the Water Database. Field variability can be calculated manually.

The Water Database includes an analysis module that allows for rapid and accurate filtering and querying of data for the period of record. The analysis module is in the process of being updated to automate analysis of various summary statistics. The Database Manager is responsible for changes to the Water Database with support from the Water Resources Specialist II. Additional data analysis details are supplied in the QMP.

10.3 Non-Direct Measurements (B9)

Non-direct measurements are used to assist with implementation of the First Flush Project and to provide context for project data. Non-direct measurements include USGS gage data for the Nooksack River and weather conditions. If included in the Water Database, this information is only entered as a trip or site visit comment.

USGS gage data (USGS 12213100[2] and USGS 12213145[3]) may be used to determine Nooksack River discharge and flood stage to inform the analysis of water quality conditions at Site SW118 (Nooksack River at Marine Drive Bridge). Weather conditions are routinely recorded for all trips to inform the analysis of water quality results that may be affected by weather. Additional details on documentation of non-direct measurement and external data, including data quality, are included in the QMP.

10.4 Data Review and Usability (D1, D2, D3)

Data review, verification, and validation requirements (D1), verification and validation methods (D2), and reconciliation with user requirements (D3) are discussed in detail in the QMP.

[2] http://waterdata.usgs.gov/usa/nwis/uv?site_no=12213100. Last accessed November 2015.
[3] http://waterdata.usgs.gov/wa/nwis/uv/?site_no=12213145&PARAmeter_cd=00060,00065. Last accessed January 2016.

11. OVERSIGHT AND REPORTING

11.1 Assessments and Response Actions (C1)

Section 1 of this QAPP and the QMP list the key personnel and their responsibilities. In summary, the person conducting the monitoring (primarily the Water Resources Specialist II and Water Resources Technician II) is responsible for performing all inspections, QA/QC activities, and data management. The Water Resources Specialist II is responsible for screening the data as necessary, with support from the Database Manager. The Database Manager is responsible for transmitting the data to EPA via WQX. The Water Resources Manager ensures that QA/QC objectives and reporting requirements are achieved.

Operator error and equipment problems detected during accuracy check and other QA/QC activities will initiate actions to correct the problem. Corrective actions and troubleshooting information are supplied in the equipment SOPs. Quality control activities also inform potential data correction factors that may be applied, as appropriate. Project action limits and assessments are described in the QMP.

11.2 Reports to Management (C2)

The Water Resources Specialist II is responsible for evaluating water quality, laboratory, and QA/QC data and reporting to the Water Resources Manager regularly and as needed if problems are detected. When problems are detected and not resolved through standard practices or are of a more complex nature than the staff conducting water quality sampling typically address, the Water Resources Specialist II, Water Resources Technician II, and the Water Resources Manager will jointly develop an action plan to remedy the problem with clear roles, responsibilities, and timelines. The Water Resources Manager is immediately alerted if elevated levels of fecal coliform bacteria are detected. Assessments are described in the QMP.

The Water Resources Specialist II prepares a Water Quality Assessment Report that summarizes the collected water quality and laboratory data for the two-year reporting period, compares the results with Lummi Nation Water Quality Standards, ambient water quality data, and the data for the period of record, and documents attainment or non-attainment of designated uses. These reports are reviewed and approved by the Water Resources Manager and the Deputy Director, and approved reports are transmitted to the EPA every-other year by March 31st of the year following the two-year reporting period. The Water Resources Manager submits bi-annual (twice per year) progress reports to the EPA Project Officer that describe project status, problems, remedies, and schedules.

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12. ACRONYMS AND ABBREVIATIONS

CWRMP	Comprehensive Water Resources Management Program
DOH	Washington State Department of Health
EPA	Environmental Protection Agency
LIBC	Lummi Indian Business Council
LNR	Lummi Natural Resources Department
LWRD	Lummi Water Resources Division
NSSP	National Shellfish Sanitation Program
QAPP	Quality Assurance Project Plan
QMP	Quality Management Plan
QA/QC	Quality Assurance/Quality Control
SOP	Standard Operating Procedure
USGS	U.S. Geological Survey
WQM	Lummi Nation Water Quality Monitoring [Program]
WQX	Water Quality Exchange
YSI 556	Yellow Springs Instruments 556 Multi Parameter System
YSI ProPlus	Yellow Springs Instruments Professional Plus

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13. REFERENCES

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13.2 QMP, QAPPs, SOPs

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SAMPLE PLAN ALTERATION FORM
(QAPP Addendum – SPAF #1)

QAPP Title, Author (company), Revision, and Approval Date of standing 'parent' QAPP:

Quality Assurance Project Plan: First Flush Monitoring Project, Version 1.2a
Water Resources Division, Natural Resources Department, Lummi Indian Business Council
July 2021

Project Name and assigned Region 10 Project Code:

Material to be Sampled:

Water

Measurement Parameters:

No changes in measurement parameters

Standard Procedure for Field Collection and Laboratory Analysis (cite references):

Add sample site SW135 to the First Flush Monitoring Project on the Lummi Bay First Flush run and update site counts.

Reason for Change in Field Procedure or Analytical Variation:

Site SW135 will be added to the First Flush Monitoring Project (Lummi Bay First Flush run) to capture first flush water quality conditions at site SW135, a freshwater site located in the Lummi River which discharges to Lummi Bay. Addition of this site will provide a refinement in the spatial resolution of samples from the Lummi River during first flush monitoring, as inclusion of this site will capture conditions in the Lummi River downstream of the confluence of three freshwater sites sampled at the northern Reservation boundary (sites SW012, SW013, and SW009) and upstream of tidally-influenced marine site SW008.

Variation from Field or Analytical Procedure (reference specific QAPP sections):

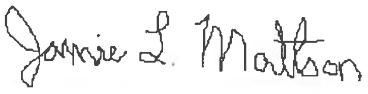
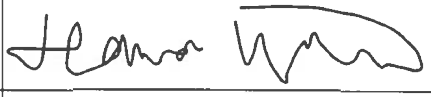
Add sample site SW135 to the First Flush Monitoring Project on the Lummi Bay First Flush run (Figure 3.1, Table 6.1, Table 6.2).
Update number of sites monitored to 25 (Section 2.1, 3.1, 6.2), number of Class AA freshwater sites from 16 to 17 (Section 6.2), and the number of sites on the Lummi Bay First Flush run from 11 to 12 (Section 6.2).

Special Equipment, Materials, or Personnel Required:

No changes

CONTACT	APPROVAL SIGNATURE	DATE
Leroy Deardorff, Lummi Indian Business Council (LIBC) Natural Resources Department Deputy Director		2-20-21

SAMPLE PLAN ALTERATION FORM
(QAPP Addendum – SPAF #1)

Water Quality Monitoring (WQM) Program Manager: Kara Kuhlman, CFM LIBC Water Resources Manager		12-20-2021
WQM Program Quality Assurance Officer: Jamie L. Mattson, LIBC Water Resources Specialist II/Planner		12/20/2021
WQM Program Coordinator: Hanna Winter, LIBC Water Resources Specialist II		12/20/2021
EPA Project Manager: Michael Ortiz, EPA Tribal Coordinator		12/20/2021
EPA QA Manager: Donald M. Brown, EPA Region 10 Quality Assurance Officer		12/20/2021