QUALITY ASSURANCE PROJECT PLAN
LUMMI NATION DEPARTMENT OF HEALTH SUPPORT (NSSP) PROJECT

Version 1.0

Water Resources Division
Natural Resources Department
Lummi Indian Business Council

Prepared for EPA Region 10

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Lummi Nation Department of Health Support (NSSP) Project 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
2				
3				

SIGNATURE PAGE

Document: Lummi Nation Department of Health Support (National Shellfish Sanitation Program) Project

Version 1.0

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

Signature	**Date**
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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 1.0 for the Lummi Nation Ambient Surface Water Quality 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
- Department of Health Support (National Shellfish Sanitation Program) Project (this document)
- Nutrient, Metal, and Hydrocarbon Monitoring Project
- Continuous Water Level Monitoring Project
- Lummi Peninsula Groundwater Settlement Agreement Compliance Monitoring Project
- Nooksack River Watershed Microbial Source Tracking Study
- ZAPS Technologies LiquID Station Continuous Water Quality Monitoring Study

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

1.2 Project Organization (A4)

The Lummi Nation Department of Health (DOH) Support (National Shellfish Sanitation Program [NSSP]) 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 DOH Support (NSSP) 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 projects part of the WQM Program and individuals participating in the projects are provided in the WQM Program QMP (LWRD 2018d).

The Water Resources Specialist II is the primary staff person responsible for DOH Support (NSSP) Project coordination, including maintaining the official, approved QAPP. The Water Resources Specialist II and Water Resources Technician II are responsible for implementing the DOH Support (NSSP) Project. The Water Resources Specialist II supervises the Water Resources Technician II and provides approval and oversight of the DOH Support (NSSP) Project. The Water Resources Specialist II/Planner is responsible for coordination with the DOH Public Health Laboratory, and is the primary contact person at LWRD for coordination with the DOH Environmental Health Specialist IV for scheduling (see QMP for organizational chart). 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 DOH Support (NSSP) 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 DOH, in consultation with the Lummi Nation, is responsible to the federal Food and Drug Administration (FDA) to ensure that the National Shellfish Sanitation Program (NSSP) standards for certification of shellfish growing waters are met on the Reservation.[1] LWRD provides logistical support to DOH and to achieve project goals.

Fecal coliform concentrations and *in situ* water quality (temperature and salinity) have been monitored in Portage Bay and Lummi Bay by the LWRD in partnership with the DOH since 1989. Twelve (12) sample sites in Portage Bay and 12 sites in Lummi Bay are currently monitored. Portage Bay is sampled 12 times per year, 6 times per year by the DOH and 6 times per year by the LWRD on alternating months. Lummi Bay is sampled 6 times per year by the LWRD. Fecal coliform samples are analyzed by the state certified DOH laboratory in Shoreline, WA and *in situ* water quality parameters (temperature, pH, dissolved oxygen, specific conductivity, and salinity) are measured in the field by the LWRD.

Fecal coliform results are used to determine compliance with NSSP standards. *In situ* water quality parameters are used to determine the source of fecal coliform contamination (using salinity and salinity-based stratification), identify trends in water quality, and used to determine compliance with the *Water Quality Standards for Surface Waters of the Reservation* (Lummi Nation Water Quality Standards; Lummi Administrative Regulation [LAR] 17.07). 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.[2] The QMP provides a detailed description of Lummi Nation Waters and the geographical location of the Lummi Indian Reservation (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).

[1] Pursuant to the Shellfish Consent Decree (Order Regarding Shellfish Sanitation, *United States v. Washington [Shellfish]*, Civil Number 9213, Subproceeding 89-3, Western District of Washington, 1994).

[2] 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.

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 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 NSSP standards closed to harvest from April through June and October through December (DOH 2016).

The northern portion of Lummi Bay is vulnerable to contamination because major tributaries empty into this portion of Lummi Bay. In addition, the winds associated with precipitation events are usually from the south, which can limit circulation of runoff into Lummi Bay from contributing watersheds.

2.3 Project Context

The DOH Support (NSSP) 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 DOH Support (NSSP) 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, Lummi Nation 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.

The DOH Support (NSSP) Project is also a component of the DOH NSSP monitoring in Portage Bay and Lummi Bay. Water quality is monitored and shellfish growing areas classified according to the results of shoreline surveys and water quality monitoring. The NSSP standards that apply to the shellfish growing areas of Portage Bay and Lummi Bay are provided below (FDA 2013):

- The fecal coliform median or geometric mean MPN or MF (mTEC) of the water sample results shall not exceed fourteen (14) per 100 ml, and
- The estimated 90th percentile shall not exceed an MPN or MF (mTEC) of:
    - 43 MPN per 100 ml for a five-tube decimal dilution test;
    - 49 MPN per 100 ml for a three-tube decimal dilution test; or
    - 31 CFU per 100 ml for a MF (mTEC) test.
    - The estimated 90th percentile shall be calculated by:

        (a) Calculating the arithmetic mean and standard deviation of the sample result logarithms (base 10);

        (b) Multiplying the standard deviation in (a) by 1.28;

        (c) Adding the product from (b) to the arithmetic mean;

        (d) Taking the antilog (base 10) of the results in (c) to get the estimated 90th percentile; and

        (e) The MPN values that signify the upper or lower range of sensitivity of the MPN tests in the 90th percentile calculation shall be increased or decreased by one significant number.

2.4 Project Justification

Shellfish harvesting areas monitored as part of the NSSP must be sampled a minimum of six times per year.[3]

Due to logistical difficulties – the shallow water and narrow tidal window for access to marine sample sites – DOH is prevented from sampling in Lummi Bay. The LWRD provides logistical support to DOH by collecting NSSP samples from Lummi Bay six times per year. The LWRD has the proximity to the sample sites and necessary equipment (*i.e.,* flat-bottom boat) needed to access the shallow Lummi Bay sites.

Shellfish harvesting has been closed or restricted in portions of Portage Bay due to non-attainment of NSSP fecal coliform standards, limiting the ability of the Lummi People to harvest shellfish for commercial, ceremonial, and subsistence purposes. Sampling frequency was increased from six times per year to twelve times per year in May 2014 to provide higher temporal resolution of fecal coliform trends. LWRD provides logistical support to DOH by collecting NSSP samples in Portage Bay six times per year to supplement DOH sampling six times per year.

In addition to providing logistical support to DOH, water quality parameters measured during NSSP sampling provides data regarding the water quality conditions in Lummi Bay and Portage Bay. Regular measurement of water quality parameters is required to accurately evaluate ambient conditions of Reservation waters and to determine whether these conditions comply with Lummi Nation Water Quality Standards. Because sites are visited six to twelve times annually on a random schedule, the ambient conditions of the marine waters of Lummi Bay and Portage Bay can be assessed through all four seasons and a variety of weather conditions. Sites are sampled "randomly" in that the season and weather are not used to bias sampling efforts, although a sufficient tidal height is required to access shallow marine sites and inclement weather can occasionally result in the rescheduling of random sampling events.

The data collected as part of this project are used to identify trends (annual and multi-year) and impairment, establish baseline conditions, and evaluate compliance with Lummi Nation Water Quality Standards and NSSP standards. Details on the justification of the experimental design for this project are provided in Section 6.

[3] NSSP sampling refers to sampling conducted as part of the National Shellfish Sanitation Program, a Food and Drug Administration program implemented in Washington State by the Department of Health (DOH). The DOH Support (NSSP) Project is a LWRD project that provides logistical support to the DOH in the collection of samples as part of the National Shellfish Sanitation Program. NSSP sampling can be conducted by either the DOH or LWRD.

3. PROJECT DESCRIPTION (A6)

Portage Bay and Lummi Bay have been monitored by the LWRD in partnership with the DOH since 1989. The objectives of the DOH Support (NSSP) Project to achieve the overall LWRD goal and the WQM Program goals (Section 2.3) include the following:

1. To evaluate compliance with NSSP fecal coliform standards;
2. Provide high quality data sufficient to establish baseline conditions of Lummi Nation Waters;
3. To evaluate compliance with water quality criteria; and
4. To support the development of a water quality regulatory program (*e.g.,* Lummi Code of Laws Title 17, Lummi Nation Water Quality Standards) on the Reservation.

3.1 Project Description

As previously described, the DOH, in consultation with the Lummi Nation, is responsible to the FDA to ensure that the NSSP standards for certification of shellfish growing waters are met on the Reservation.[4] LWRD conducts sampling in Portage Bay and Lummi Bay to provide logistical support to the DOH and to achieve project goals.

The primary focus of the DOH Support (NSSP) Project is to evaluate compliance of waters in Portage Bay and Lummi Bay to NSSP fecal coliform standards. Concurrently, the DOH Support (NSSP) Project evaluates seasonal and year-to-year trends in water quality and compares the ambient results to Lummi Nation Water Quality Standards.

Fecal coliform concentrations and *in situ* water quality (temperature and salinity) have been monitored in Portage Bay and Lummi Bay by the LWRD in partnership with the DOH since 1989. Twelve (12) samples sites in Portage Bay and 12 sites in Lummi Bay are currently monitored. Figure 3.1 provides a map of sample site locations. Portage Bay is sampled 12 times per year, 6 times per year by the DOH and 6 times per year by the LWRD on alternating months. Lummi Bay is sampled 6 times per year by the LWRD.

[4] Pursuant to the Shellfish Consent Decree (Order Regarding Shellfish Sanitation, *United States v. Washington [Shellfish]*, Civil Number 9213, Subproceeding 89-3, Western District of Washington, 1994).

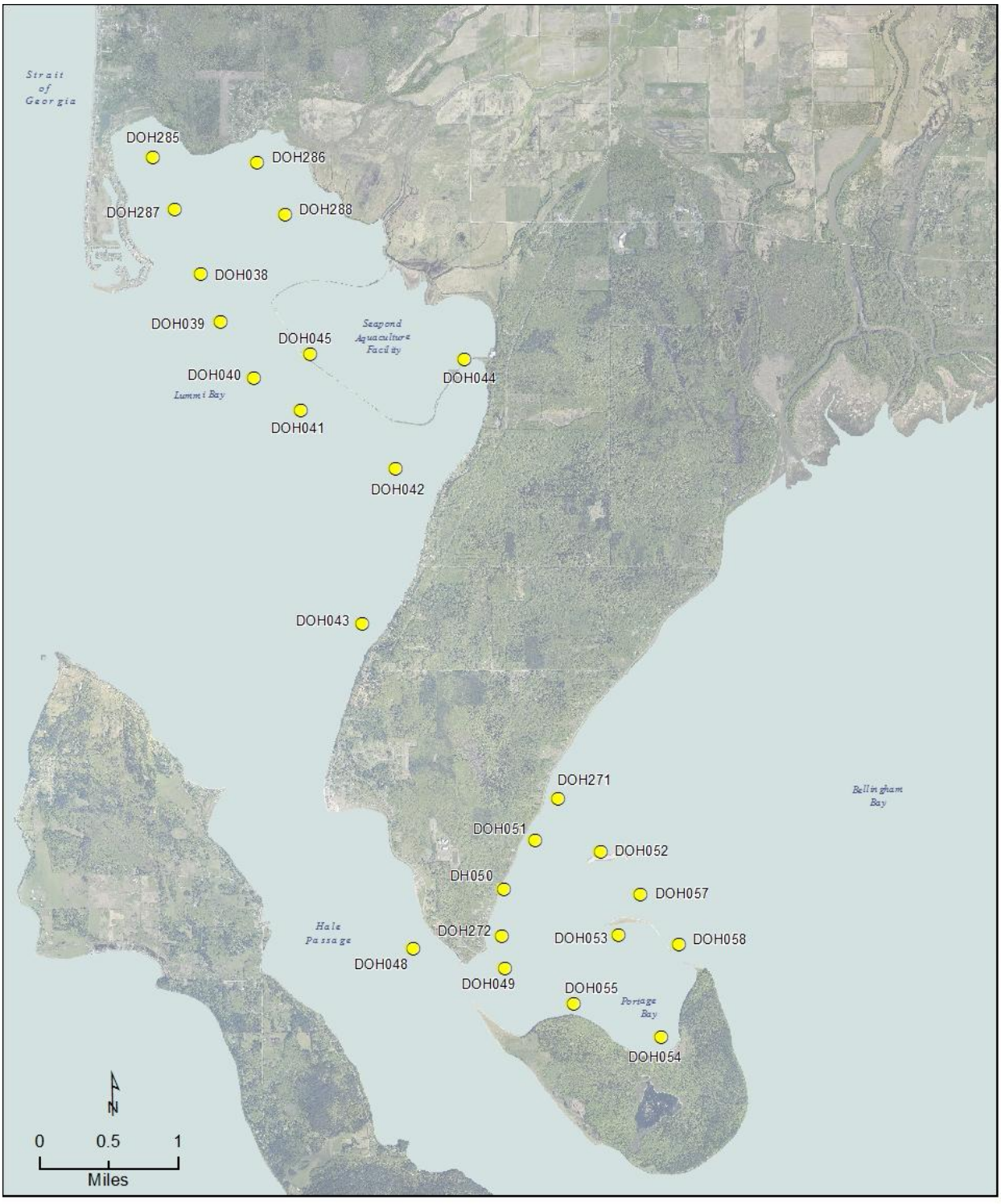

Figure 3.1 Location of Department of Health Support (NSSP) Project Sample Sites

Fecal coliform samples are analyzed by the state certified DOH laboratory in Shoreline, WA and *in situ* water quality parameters (temperature, pH, dissolved oxygen, specific conductivity, and salinity) are measured in the field by the LWRD using a multi-parameter water quality sonde. A bacteria sample for analysis at the DOH laboratory is collected at all sites. Secchi depth is measured *in situ.* In addition, air temperature, water depth, flow direction, and other site observations are recorded.

Summary statistics are calculated for each parameter, as needed. For fecal coliform, the 30-sample running geomean and 90th percentile are calculated for each sample site, following guidance by the FDA (2013) and provided in Section 2.3, and compared to NSSP standards. The Natural Resources Director and Natural Resources Deputy Director, with support from the Water Resources Manager, will use the results to determine whether to institute or lift voluntary shellfish harvest closures.

Summary statistics are also compared to Lummi Nation Water Quality Standards for each designated class. An annual summary of water quality data, comparison to the Lummi Nation Water Quality Standards, and comparison with results from the period of record is included in the annual Water Quality Assessment Report provided to the EPA to fulfill Clean Water Act Section 106 grant funding requirements (EPA 2006b) by March 31 of the following calendar year. Surface water quality data are uploaded via the Water Quality Exchange (WQX) framework to the EPA's STORET Data Warehouse by March 31 after the year of record.

Field visits and sample collection occurs January-December of each year. Data analysis and report preparation is conducted in January-March of the year following data collection. As described above, the data package (Water Quality Assessment Report and data transfer to STORET) is scheduled for March 31 of the year following data collection. It is anticipated that all sites will be sampled as scheduled (once per month or six times per year depending on the site). Sampling is occasionally limited due to sea conditions and safety concerns. As possible, sampling events cancelled due to safety concerns are rescheduled for a later time to ensure that minimum sampling requirements are met. Equipment failure, staffing limitations, and budget restraints may also restrict data collected and 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.

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4. QUALITY OBJECTIVES AND CRITERIA (A7)

The overall performance standard for the DOH Support (NSSP) 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. In addition, quality control activities provide the necessary information to assess and quantify data quality and comparability for data analysis.

The DOH Support (NSSP) 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 against regulatory criteria, including NSSP standards and Lummi Nation Water Quality Standards. 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 water quality criteria.

Summary statistics for all parameters are calculated, as needed, and used for comparison with previous results from the period of record 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 annual 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, temperature control samples, 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 equipment SOPs for details. 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 or method; they are primarily used as an indicator of field variability.

If quantification of precision of a particular parameter or 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 Water Database.

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 (NIST) traceable standards. If the instrument cannot be calibrated or the 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 sample procedures to minimize disturbance 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 DOH Support (NSSP) Project and with other Lummi Nation water quality projects (*e.g.,* Ambient Surface Water Quality Monitoring Project, First Flush Monitoring Project), as well as comparison with non-program sources of data, assuming quality control information is available for non-program data.

The DOH compiles the data collected as part of the DOH Support (NSSP) Project with data collected directly by DOH in the same sample locations to evaluate water quality in Lummi Bay and Portage Bay and to determine the classification of shellfish growing areas. The same laboratory methods are used to analyze fecal coliform samples collected by the LWRD and the DOH as the DOH Public Health Laboratory performs the sample analysis for all samples collected for the NSSP. Salinity and water temperature measurements are collected with similar instruments by the LWRD and the DOH to allow for comparability of these parameters.

4.6 Completeness

The goal of the DOH Support (NSSP) Project is for sample sites to be visited at least six times a year by the LWRD. NSSP requirements issued by the FDA require sample collection a minimum of six times per year for each shellfish growing area (FDA 2013).

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. Sea conditions may limit sample collection at some marine sites; however, when inclement weather requires the cancellation of sample collection due to safety concerns, efforts are taken to reschedule the sampling for a later time. As previously described, the LWRD sampling in Portage Bay is used to supplement sampling conducted by the DOH. As sampling in Portage Bay is scheduled to occur 12 times per year, missed sampling events are acceptable, but not recommended. Missed sampling events in Lummi Bay must be rescheduled for a later time to maintain six sampling events per year. Required data include fecal coliform, water temperature, and salinity.

For other water quality parameters (dissolved oxygen, specific conductivity, pH), 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 the monitoring is not attempting to answer a specific hypothesis. General 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 DOH Support (NSSP) Project is to collect data with sufficient resolution (sensitivity) to establish baseline conditions and identify trends, evaluate water quality against appropriate Lummi Nation Water Quality Standards and NSSP standards, 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 (A3) in this QAPP have the most current version of the 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

Fecal coliform results collected as part of the DOH Support (NSSP) Project are analyzed by the DOH to determine compliance with NSSP standards. Data are used for classification of shellfish growing areas in Lummi Bay and Portage Bay. Nonattainment of standards may result in closure of shellfish beds to harvest, as determined by the DOH and LNR Director.

Results of the DOH Support (NSSP) Project are included in the annual Water Quality Assessment Report, which summarizes the results of the WQM Program projects implemented by the LWRD. The reports determine whether Lummi Nation Water Quality Standards are achieved and include graphical time-series analysis of water quality data for the reporting period as well as for the period of record. The report is provided to the EPA Project Officer by March 31 of the subsequent calendar year, following approval by the Water Resources Manager and the LNR Deputy Director.

The DOH Support (NSSP) Project data are transmitted to the EPA for inclusion in the STORET Data Warehouse via upload to the WQX framework upon approval by the Water Resources Manager and the LNR Deputy Director. Data collected as part of the DOH Support (NSSP) 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 DOH Support (NSSP) 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 Water Database” includes entry directly into the Water Database via the iPad or by recording onto hardcopy field 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 hardcopy field datasheets or electronically in the Water Database.

6. EXPERIMENTAL DESIGN (B1)

The DOH Support (NSSP) Project is based on a sample-run system, and is designed to achieve the following objectives:

1. To evaluate compliance with NSSP fecal coliform standards;
2. Provide high quality data sufficient to establish baseline conditions of Lummi Nation Water;
3. To evaluate compliance with water quality criteria; and
4. To support the development of a water quality regulatory program (*e.g.,* Lummi Code of Laws Title 17, Lummi Nation Water Quality Standards) on the Reservation.

The DOH Support (NSSP) Project is ongoing and not intended to prove or disprove a specific hypothesis.

6.1 Sample Runs and Structure

The DOH Support (NSSP) Project is run-based system comprised of two sample runs: Lummi Bay DOH Support and Portage Bay DOH Support. These sample runs were developed and sites selected by the DOH under the NSSP, which certifies commercial shellfish harvest areas.

The Lummi Bay DOH Support run is sampled six times per year by LWRD. Due to logistical challenges in accessing the shallow sites in Lummi Bay, LWRD conducts all field sampling in Lummi Bay in support of the DOH under the NSSP. Sampling generally occurs every other month, and sampling is scheduled in advance with the DOH in six-month intervals.

The Portage Bay DOH Support run is sampled six times per year by LWRD and six times per year by DOH. Typically, sampling is conducted on alternate months by LWRD and DOH. Sampling dates are scheduled in advance with DOH in six-month intervals. As part of the Ambient Surface Water Quality Monitoring Project (Surface Water Project), additional samples are collected from the Nooksack River at Marine Drive Bridge (Site SW118) on the day of and the day prior to NSSP sampling in Portage Bay. During months when LWRD samples Portage Bay, site SW118 (Nooksack River at Marine Drive Bridge) is sampled on the same day as sampling conducted in Portage Bay. In months that DOH conducts NSSP sampling in Portage Bay, LWRD conducts the Lummi Shore Road (LSR) run (as part of the Surface Water Project and includes Site SW118); on months that LNR conducts NSSP sampling in Portage Bay, only Site SW118 is sampled. On the day prior to sampling in Portage Bay, several samples are collected in the Nooksack River watershed in a multi-agency partnership as part of the Whatcom Clean Water Program. Additional information on sampling of the Nooksack River is included in the Surface Water Project QAPP.

Table 6.1 outlines the sites included in each sample run, *in situ* parameters measured, laboratory samples collected, and sampling frequency.

Table 6.1 DOH Support (NSSP) Project Sample Sites, *In Situ* Parameters Measured, Laboratory Samples Collected, and Frequency of Sampling

Run Name	Site ID	*In Situ* Parameters Measured At Each Sample Site	Laboratory Samples Collected At Each Sample Site	Frequency	Notes
Lummi Bay DOH Support (NSSP)	DH038, 39, 40, 41, 42, 43, 44, 45, 285, 286, 287, 288	Air temperature, salinity-based stratification, water temperature, salinity, specific conductivity, current/flow direction, dissolved oxygen, pH, water depth, Secchi depth (except DH044 and DH045), and general observations	Fecal coliform	Six times per year	Sampling scheduled in six-month intervals with DOH in advance.
Portage Bay DOH Support (NSSP)	DH048, 49, 50, 51, 52, 53, 54, 55, 57, 58, 271, 272			Six times per year (Also sampled six times per year by DOH; total of 12 times per year)	

DOH Support (NSSP) Project sampling is scheduled to occur on days with sufficient tidal height to allow for launching the boat and accessing shallow sites during daylight hours. Otherwise, sampling is "random" in that weather and season do not bias sampling dates. Occasionally, severe weather can create unsafe marine sampling conditions. If marine sample runs cannot be safely conducted, they are rescheduled with DOH for later in the month, if possible.

Information from both DOH Support (NSSP) Project sample runs is used to determine compliance with NSSP fecal coliform standards. In addition, data are used to establish baseline conditions, evaluate compliance with Lummi Nation Water Quality Standards, and identify trends in water quality.

The data collected during the Lummi Bay DOH Support run are used to evaluate downstream impacts of elevated fecal coliform bacteria levels measured along the Reservation boundary, which are sampled as part of the Surface Water Project.

The data collected during the Portage Bay DOH Support run are used to evaluate downstream impacts of elevated fecal coliform bacteria levels measured in the Nooksack River, which are also measured as part of the Surface Water Project on the day prior to and the day of NSSP sampling in Portage Bay. In addition, pairing sampling of the LSR sample run (as part of the

Surface Water Project) with sampling in Portage Bay by DOH provides information on sources of fecal coliform bacteria from the Reservation uplands and the Nooksack River. Details on sampling as part of the Surface Water Project are provided in the Surface Water Project QAPP.

6.2 Sample Sites

The 24 marine surface water quality sample sites (Figure 4.1, Table 7.1) were selected by DOH to provide representative sampling locations in shellfish harvesting areas in Lummi Bay and Portage Bay. All 12 sample sites in Lummi Bay are Class AA marine water sites. Eleven (11) sample sites in Portage Bay are Class A marine water sites, while one (DH048) is a Class AA marine water site.

All 12 sample sites in the Portage Bay DOH Support run are boat-accessible. Ten (10) of the 12 samples sites in the Lummi Bay DOH Support run are boat-accessible, while two (DH044 and DH045) are located in the Lummi Bay aquaculture pond are land-accessible.

Detailed maps and GPS coordinates of the sample sites are provided to field personnel to ensure that sites are sampled on location (LWRD 2015b). Except when tides and weather preclude safe sampling, sample site access is usually not a problem. If a sample site is inaccessible, for example due to fishing equipment (*i.e.,* crab pots or salmon nets) or debris, a sample may be collected as close to the sample site as possible. When this occurs, the sampling location is described on the Water Database and the data 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.

6.3 Water Quality Parameters

Table 6.1 lists the sample runs, sites included in each run, parameters measured, laboratory samples collected, and frequency of site assessment. Water quality is generally measured *in situ* for salinity, specific conductivity, water temperature, dissolved oxygen, and pH. Salinity-based stratification is evaluated at all 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) are collected, labeled (#1-12), 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, Secchi depth is measured *in situ* at marine sites accessed by boat. In addition, air temperature is measured and current/flow direction and water depth are evaluated.

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 database or field datasheet, and values are averaged automatically by the database 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 a data qualifier is associated with the result in the database (see QMP and Water Database User Guide for details).

Critical information includes bacteria, salinity, and water temperature. 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, Secchi depth, presence of salinity-based stratification, water depth, and flow or current direction characterize 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 with both NSSP fecal coliform standards and Lummi Nation Water Quality Standards.

National Shellfish Sanitation Program (NSSP) criteria are based on fecal coliform counts and there is no indication that this will change. For the Lummi and Portage Bay DOH Support sample runs, only fecal coliform samples are collected. For supporting data collected as part of the Surface Water Project (LSR and Site SW118), fecal coliform, *E. coli,* and enterococcus are also enumerated. Fecal coliform bacteria and *E. coli* are enumerated from the same plate to provide information about the presence of other bacterial species (*i.e., Klebsiella*) in fecal coliform counts and increase the comparability of the fecal coliform bacteria and *E. coli* results.

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, equipment required for sample runs, the water sampling sequence, procedures for selecting a representative location and avoiding contamination, and a summary of practices specific to each parameter measured. 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 DOH Public Health Laboratory using chain of custody procedures for fecal coliform enumeration. Water quality is generally 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 sites. If salinity-based stratification is present, *in situ* water quality parameters are measured for both the top and the bottom strata. Secchi depth is measured at boat-accessible sites. In addition, air temperature is measured and current/flow direction and water depth are evaluated at all sites. Data are recorded in the Water Database as described in the QMP and the 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 2015a) 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 wear life jackets (when performing boat-based sampling), carry a cell phone and car charger, and sign out on a message board at the LNR office. The sign-out indicates the

time of departure, the time of the scheduled return, and the general location of the field work. A float plan is required when using the boat for sample collection.

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.
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, Secchi depth, water level and/or depth, and air temperature are measured and visual observations (*e.g.,* current/flow direction) are recorded.
    - Measure Secchi depth at sites that are sampled from the boat.
        - Secchi depth can be measured concurrently with collection of bacteria sample and measurement of *in situ* water quality parameters as long as site contamination does not occur during Secchi depth measurement.

        - Details on using the Secchi disk for Secchi depth are provided in the Secchi Disk SOP.
    - Water level and/or depth can be measured using the Secchi disk (at marine sites), the sampling wand, visual assessment, or boat depth sounder. Details are found in the SOPs for water level and/or depth and Secchi disk.
    - 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, assign data qualifier to 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, assign data qualifier and the reason in the Water Database
    - Avoid areas of entrained air in the wave-wash zone

Most sample sites are generally representative of ambient conditions because sites are located in marine waters away from the shoreline. If the sample site appears unrepresentative, but a representative location is identified nearby, collect sample from the nearby, representative location. Note site sampled in the Water Database. If a representative location cannot be found, collect the sample and include a note describing reason for suspecting non-representativeness in the Water Database. Site notes are also included in the DOH chain of custody form.

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 Parameters Measured

Table 6.1 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. Secchi depth is measured at sites sampled from the boat. “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 the 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 DOH laboratory and are not cleaned by LWRD staff.

Table 7.1 DOH Support (NSSP) Project 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
Fecal Coliform (per 100ml)	Laboratory (DOH)	See Bacteria Sample Collection SOP #004 Five-tube MTF using an A-1 medium (MTF-A1) SM9221E2; APHA 2012	100 ml sterile plastic bottle with screw top	Ice or ice packs	30 hours
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
Secchi Depth (meters)	Eight-inch diameter Secchi disk marked alternately in black and white quadrants and measuring tape	See Secchi Disk SOP #008	None	*In situ*	Immediately

Table 7.1 DOH Support (NSSP) Project 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 refers to 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.

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.

7.7.1 Bacteria Sample Collection

A bacteria sample is collected using aseptic sampling techniques as outlined in the Bacteria Sample Collection SOP. Bacteria samples are collected in 100 ml sterile bottles provided by the DOH laboratory. The bottles are labeled with numbers 1-12 while site identifiers and other information are recorded on the chain of custody form. The samples are sent via Greyhound Bus to the DOH Public Health Laboratory in Shoreline, WA for fecal coliform enumeration.

7.7.2 In Situ *Water Quality*

In situ water quality is measured 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 Water Database.

Salinity-based stratification is assessed 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.

7.7.3 Secchi Depth

Secchi depth is measured at marine sites sampled from a boat following instructions provided in the Secchi Disk SOP.

7.7.4 Surface Water Level/Depth

Surface water level/depth can be measured using the Secchi disk, the water sampling wand, YSI 556, or the boat depth sounder. Details on estimating and measuring surface water level/depth are found in the Surface Water Level/Depth SOP and the Secchi Depth SOP.

7.7.5 Current and Flow Direction

Current and flow direction is visually estimated as a cardinal direction (*e.g.,* N, E, NE). Details on estimating current and flow direction are provided in the Current and Flow Direction SOP.

7.7.6 Air Temperature

Air temperature is measured using an armored non-toxic liquid-in-glass thermometer as described 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 DOH Support (NSSP) 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 DOH Support (NSSP) 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 method and 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 DOH Support (NSSP) Project include instrument calibration, pre-run, mid-run, and post-run accuracy checks, sterile sampling techniques, temperature controls, 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. Bacteria (fecal coliform) samples are analyzed by the DOH Public Health Laboratory in Shoreline.

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 Temperature Control

Temperature control samples are collected for each sample run as part of the DOH Support (NSSP) Project. A sample bottle is filled with sample water at the beginning of the sample run to serve as a temperature control sample for the remainder of the sample run and delivery to the DOH Public Health Laboratory. The temperature control sample is treated the same way throughout the sample run. The DOH Public Health Laboratory staff measure the temperature of the temperature control standard upon receipt.

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 DOH 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 DOH Public Health Laboratory is required to meet FDA requirements in the analysis of fecal coliform samples for the NSSP. Methods must follow guidance by the American Public Health Association in its *Recommended Procedures for the Examination of Seawater and Shellfish* (APHA 1970, periodically revised). The DOH Public Health 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 FDA requirements under the NSSP.

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. Duplicates are averaged in 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, 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.

9. SUPPLIES AND CONSUMABLES (B8)

Equipment required for implementing the Surface Water Project are stored in the LNR lab and storage locker. 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 DOH Support (NSSP) Project include:

Data Recording:

- iPad
- Calibration and field data sheets in field clipboard
- Waterproof pen and/or pencil
- Permanent pen (*e.g.,* Sharpie)

General:

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

Water Quality Sampling Equipment:

- Yellow Springs Instruments (YSI) 556 Multi Parameter System (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.
- Sterile bacteria bottles, provided by the DOH Laboratory
- Air thermometer

For boat-accessible marine sampling:

- Secchi disk
- Spill Response Boat equipped with GPS unit and depth sounder
- Safety equipment for boat, including life vests, fire extinguisher, flares, tools, radios, etc
- Completed float plan

Sample Shipping Equipment:

- Polystyrene shipping containers
- Re-useable ice packs
- DOH chain of custody forms
- Shipping paperwork
- Packaging equipment: plastic bags, newspaper, packing tape, red pen

10. DATA MANAGEMENT (B10)

The Water Resources Specialist II is responsible for data management of DOH Support (NSSP) 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 for inclusion in the STORET Data Warehouse via upload to 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 the chain of custody form 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 DOH Support (NSSP) 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 30-sample geometric mean and 90th percentile are calculated for each growing area as described in Section 2.3 and compared to the appropriate NSSP standard. Currently, the DOH Public Health Laboratory utilizes a five-tube decimal dilution test. The DOH conducts the official geometric mean and 90th percentile calculations for compliance with the NSSP. The LWRD monitors changes in the geometric mean and 90th percentile throughout the year as new results are obtained. These results are also used to determine compliance with Lummi Nation Water Quality Standards.

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 DOH Support (NSSP) Project and to provide context for project data. Non-direct measurements include tidal elevation, and weather and sea conditions. If included in the Water Database, this information is only entered as a trip or site visit comment.

Tidal elevation and sea condition information are used to determine when and whether to collect samples for the DOH Support (NSSP) Project, which requires use of the LNR Spill Response Boat to access sample sites. Weather conditions are routinely recorded for all trips to inform the analysis of water quality results that may be affected by weather.

Data collected by DOH for the NSSP are also entered into the Water Database. Fecal coliform enumeration is conducted by the DOH Public Health Laboratory following the procedures described in this QAPP. Data collected by partner agencies involved in the Whatcom Clean Water Program may be used to determine fecal coliform contributions from the Nooksack River watershed to Portage Bay to help inform strategies for reducing fecal coliform counts in the Portage Bay shellfish growing area.

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.

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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, but also the Water Resources Specialist II/Planner 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 STORET. 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 Specialist II/Planner, 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, or calculated geometric mean or 90th percentiles are nearing the NSSP standards. Assessments are described in the QMP.

The Water Resources Specialist II prepares an annual Water Quality Assessment Report that summarizes the collected water quality and laboratory data, compares the results with Lummi Nation Water Quality Standards 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 by March 31st annually. 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
FDA	Food and Drug Administration
LAR	Lummi Administrative Regulation
LIBC	Lummi Indian Business Council
LNR	Lummi Natural Resources Department
LSR	Lummi Shore Road
LWRD	Lummi Water Resources Division
NIST	National Institute of Standards and Technology
NSSP	National Shellfish Sanitation Program
QAPP	Quality Assurance Project Plan
QMP	Quality Management Plan
QA/QC	Quality Assurance/Quality Control
SOP	Standard Operating Procedure
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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