QUALITY ASSURANCE PROJECT PLAN
LUMMI NATION NUTRIENT, METAL, AND HYDROCARBON MONITORING 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 Nutrient, Metal, and Hydrocarbon 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
2				
3				

SIGNATURE PAGE

Document: Lummi Nation Nutrient, Metal, and Hydrocarbon Monitoring 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**
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 1.0 for the Lummi Nation Nutrient, Metal, and Hydrocarbon 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
- Nutrient, Metal, and Hydrocarbon Monitoring Project (this document)
- 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 Nutrient, Metal, and Hydrocarbon Monitoring Project (NMH 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 NMH 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 WQM Program projects and individuals participating in the WQM Program are provided in the QMP.

In summary, the Water Resources Specialist II is the primary staff person responsible for NMH Project coordination, including maintaining the official, approved QAPP. The Water Resources Specialist II and Water Resources Technician II are responsible for implementing the NMH Project. The Water Resources Specialist II supervises the Water Resources Technician II and provides approval and oversight to the NMH Project, including coordination with the independent contracted laboratory. The independent contracted laboratory, Edge Analytical, Incorporated (Edge; of Burlington, WA), subcontracts some analyses.[1] 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 NMH 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.

[1] Chlorophyll a and pheophytin analyses are currently subcontracted to ALS-Kelso of Kelso, WA and will be subcontracted to IEH Analytical Laboratories (Seattle, WA) upon their accreditation.

2. PROBLEM DEFINITION AND BACKGROUND (A5)

2.1 Project Summary

The Lummi Nation NMH Project has been ongoing since 1998, and is focused on monitoring nutrients, metals, and hydrocarbons in waters on, flowing onto, and through the Reservation at targeted locations. The NMH Project provides nutrient data at five surface water sites and metal and hydrocarbon data from three surface water sites. The NMH Project supplements the Ambient Surface Water Quality Monitoring (Surface Water Project) by providing detailed information about specific water quality parameters at representative and targeted sites. Summaries of other WQM Program projects are provided in the QMP.

Nutrients are measured quarterly at four freshwater sites and one marine site. Metals and hydrocarbons are measured quarterly at two freshwater site and one marine site. These water quality data are compared with results from the period of record to identify trends and compared to water quality criteria to evaluate compliance. Both on- and off-Reservation sources of nutrients, metals, and hydrocarbons are evaluated. The results of this project will advise regulatory actions, restoration efforts, and Total Maximum Daily Load development, 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). Nutrients, metals, and hydrocarbons can be essential or toxic to aquatic organisms, and can cause aquatic life, human health, aesthetic, and economic concerns depending on the concentration present. Nutrients, metals, and hydrocarbons in surface waters are also indicators of non-point source pollution. The sources and water quality concerns for nutrients, metals, and hydrocarbons are presented in the paragraphs below.

Excess nutrients are a concern for water quality due to environmental, human health, and economic factors. Excess nutrients can lead to algal blooms, which, in addition to creating unsightly and sometimes malodorous waters, can deplete the oxygen in the water to create hypoxic zones. Hypoxic zones can kill animals, including shellfish, that cannot move from the area. Some algae directly produce toxic compounds that can sicken or kill humans, fish and

[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.

other animals. Consumption of shellfish contaminated by certain algal toxins can cause amnesic, diarrhetic, neurotoxic, or paralytic shellfish poisoning. Sources of nutrients include agriculture, urban runoff, atmospheric deposition, land disposal, hydromodification/habitat modification, and spills (*e.g.,* manure) (LWRD 2015a).

Although metals, such as zinc and copper, are essential to biochemical processes, these same metals, and a variety of others, can be severely toxic to aquatic organisms and humans in high concentrations. Mercury and arsenic have the potential to bioaccumulate, and in high concentrations present a risk to human health. The toxicity and bioavailability of many metals depends on the oxidation state, form, and solubility of the metal, which are influenced by chemical characteristics of water such as pH, dissolved oxygen, and hardness. Metals occur naturally in aquatic ecosystems due to erosion and sedimentation from the weathering of rocks and soils. Other sources of metals include agriculture, urban runoff, atmospheric deposition, land disposal, and marinas and recreational boating activities (LWRD 2015a). Metals may also be present in effluent from wastewater treatment plants, industry, mining operations, and sewage or soils contaminated by previous industrial activity.

Hydrocarbon concentrations in surface waters that exceed microbial decomposition can affect the feeding and reproduction of aquatic life (*i.e.,* plants, insects, fish) and, as hydrocarbons can adhere to gills, fish respiration (Reeves 2000). Sources of hydrocarbons include urban runoff, agriculture, construction, atmospheric deposition, highway maintenance and runoff, land disposal, spills, waste storage or storage tank leaks, and recreational activities (*e.g.,* golf courses) (LWRD 2015a).

2.3 Project Context

The NMH 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 NMH 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. Action limits are also provided in the QMP.

2.4 Water Quality Standards

EPA approved Lummi Nation Water Quality Standards relating to nutrients and hydrocarbons are provided in 17 LAR 07.030 General Water Use and Criteria Classes §(e)(1) as narrative criteria. Section (e)(1)(A) addresses hydrocarbons and §(e)(1)(B-D) address nutrients. Section (e)(1)(D) specifically references nutrients and the potential for causing nuisance water quality conditions. Sections (e)(1)(B and C) apply to nutrients in that excess nutrients can affect water color and can create an offensive odor or taste. Table 2.1 lists narrative water quality criteria.

Table 2.1 Narrative Water Quality Criteria

17 LAR 07.030 (e) Narrative Water Quality Criteria
(1) All surface waters of the Lummi Indian Reservation, including those within designated mixing zones, shall be free from substances attributable to point source discharges, nonpoint sources, vessel discharges, or instream activities in accordance with the following: (A) Floating solids, oil, and grease. All waters shall be free from visible oils, including crude oil and petroleum, scum, foam, grease, and other floating materials and suspended substances of a persistent nature resulting from anthropogenic causes. (B) Color. True color-producing materials resulting from anthropogenic causes shall not create an aesthetically undesirable condition; nor should color inhibit photosynthesis or otherwise impair the existing and designated uses of the water. (C) Odor and taste. Water contaminants from anthropogenic causes shall be limited to concentrations that will not impart unpalatable flavor to fish, or result in offensive odor or taste arising from the water, or otherwise interfere with the existing and designated uses of the water. (D) Nuisance conditions. Nutrients or other substances from anthropogenic causes shall not be present in concentrations which will produce objectionable algal densities or nuisance aquatic vegetation, result in a dominance of nuisance species, result in acute toxicity to any aquatic biota or wildlife, adversely affect public health or safety, or otherwise cause nuisance conditions. (E) Bottom deposits. All surface waters of the Lummi Indian Reservation shall be free from anthropogenic contaminants that may settle and have a deleterious effect on the aquatic biota or that will significantly alter the physical or chemical properties of the water or the bottom sediments. (F) Erosion. All waters shall be free from deleterious levels of soil particles resulting from erosion of land involved in earthwork, such as construction of public works, highways, or commercial or industrial developments, or the cultivation and management of agricultural or forested lands.

Lummi Nation Water Quality Standards relating to metals are provided in 17 LAR 07.040 Toxic Substances. Numeric Water Quality Standards as aquatic life and human health criteria are provided for arsenic, chromium (III and VI), copper, lead, mercury, and zinc. Toxic substances criteria also apply to ammonia, a nutrient that is toxic at high concentrations. Table 2.2 provides numeric water quality criteria for substances monitored as part of the NMH Project.

Table 2.2 Toxic Substance Criteria for Surface Waters of the Lummi Indian Reservation

Substance	Aquatic Life Criteria				Human Health Criteria		FR Citation/Source
	Freshwater		Saltwater		For Consumption of:		
	CMC Acute (µg/L)	CCC Chronic (µg/L)	CMC Acute (µg/L)	CCC Chronic (µg/L)	Water + Organism (µg/L)	Organism Only (µg/L)	
Ammonia	ll	mm	233	35	vv	vv	EPA822-R-99-014 EPA440/5-88-004 WAC 173-201A-040
Arsenic	340 A, D, K	150 A, D, K	69 A, D, bb	36 A, D, bb	0.0048 C, M, S	0.0064 C, M, S	65FR31682 57FR60848
Chromium (III)	570 D, E, K	74 D, E, K	Vv	vv	Z Total	vv	EPA820/B-96-001 65FR31682
Chromium (VI)	16 D, K	11 D, K	1,100 D, bb	50 D, bb	Z Total	vv	65FR31682
Copper	13 D, E, K, cc	9.0 D, E, K, cc	4.8 D, cc, ff	3.1 D, cc, ff	1,300 U	vv	65FR31682
Lead	65 D, E, bb, gg	2.5 D, E, bb, gg	210 D, bb	8.1 D, bb	vv	vv	EPA823-R-01-001 65FR31682
Mercury	1.4 D, K, hh	0.012 ww, xx	1.8 D, ee, hh	0.025 D, ee	0.0054	0.0055	62FR42160 65FR31682 WAC 173-201A-040
Zinc	120 D, E, K	120 D, E, K	90 D, bb	81 D, bb	2,400 U	3,100 U	65FR31682 65FR66443

Table 2.2 Footnotes

CMC Criteria maximum concentration.

CCC Criteria continuous concentration.

A This water quality criterion was derived from data for arsenic (III), but is applied here to total arsenic, which might imply that arsenic (III) and arsenic (V) are equally toxic to aquatic life and that their toxicities are additive. In the arsenic criteria document (EPA 440/5-84-033, January 1985), Species Mean Acute Values are given for both arsenic (III) and arsenic (V) for five species and the ratios of the Species Mean Acute Values (SMAVs) for each species range from 0.6 to 1.7. Chronic values are available for both arsenic (III) and arsenic (V) for one species; for the fathead minnow, the chronic value for arsenic (V) is 0.29 times the chronic value for arsenic (III). No data are known to be available concerning whether the toxicities of the forms of arsenic to aquatic organisms are additive.

C This criterion is based on carcinogenicity of 10^{-6} risk. Alternate risk levels may be obtained by moving the decimal point (*e.g.,* for a risk level of 10-5, move the decimal point in the criterion one place to the right).

D Freshwater and saltwater criteria for metals are expressed in terms of the dissolved metal in the water column. The water quality criteria value were calculated by using the previous 304(a) aquatic life criteria expressed in terms of total recoverable metal, and multiplying it by a conversion factor (CF). The term "Conversion Factor" (CF) represents the recommended conversion factor for converting a metal criterion expressed as the total recoverable fraction in the water column to a criterion expressed as the dissolved fraction in the water column. (Conversion Factors for saltwater CCCs are not currently available. Conversion factors derived for saltwater CMCs have been used for both saltwater CMCs and CCCs). See "Office of Water Policy and Technical Guidance on Interpretation and Implementation of Aquatic Life Metals Criteria, October 1, 1993, by Martha G. Prothro, Acting Assistant Administrator for Water, available from the Water Resource Center, USEPA, 401 M St., SW, mail code RC4100, Washington, DC 20460; and 40CFR 131.36(b)(1). Conversion factors applied in Table 4 can be found in Appendix A to the Preamble – Conversion Factors for Dissolved Metals.

E The freshwater criterion for this metal is expressed as a function of hardness (mg/L) in the water column. The value given here corresponds to a hardness of 100 mg/L. Criteria values for other hardness may be calculated from the following: CMC (dissolved) = $\exp\{m_A [\ln(\text{hardness})] + b_A\}$ (CF), or CCC (dissolved) = $\exp\{m_C [\ln(\text{hardness})] + b_C\}$ (CF) and the parameters specified in Appendix B- Parameters for Calculating Freshwater Dissolved Metals Criteria That Are Hardness-Dependent. In calculating criteria for hardness dependent metals, the ambient hardness is used, even if it is lower than 25 mg/l. If the ambient hardness is greater than 400 mg/l, then a hardness of 400 mg/l is used.

K This criterion is based on a 304(a) aquatic life criterion that was issued in the 1995 Updates: Water Quality Criteria Documents for the Protection of Aquatic Life in Ambient Water (EPA-820-B-96-001, September 1996). This value was derived using the GLI Guidelines (60FR15393-15399, March 23, 1995; 40CFR132 Appendix A); the difference between the 1985 Guidelines and the GLI Guidelines are explained on page iv of the 1995 Updates. None of the decisions concerning the derivation of this criterion were affected by any considerations that are specific to the Great Lakes.

M The EPA is currently reassessing the criteria for arsenic.

S This water quality criterion for arsenic refers to the inorganic form only.

U The organoleptic effect criterion is more stringent than the value for priority toxic pollutants.

Table 2.2 Footnotes (continued)

Z A more stringent MCL has been issued by the EPA. Refer to drinking water regulations (40 CFR 141) or Safe Drinking Water Hotline (1-800-426-4791) for values.

bb This water quality criterion is based on a 304(a) aquatic life criterion that was derived using the 1985 Guidelines (Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses, PB85-227049, January 1985) and was issued in one of the following criteria documents: Arsenic (EPA 440/5-84-033), Cadmium (EPA-822-R-01-001), Chromium (EPA 440/5-84-029), Copper (EPA 440/5-84-031), Cyanide (EPA 440/5- 84-028), Lead (EPA 440/5-84-027), Nickel (EPA 440/5-86-004), Pentachlorophenol (EPA 440/5-86-009), Toxaphene, (EPA 440/5-86-006), Zinc (EPA 440/5-87- 003).

cc When the concentration of dissolved organic carbon is elevated, copper is substantially less toxic and use of Water-Effect Ratios might be appropriate.

ee This water quality criterion was derived on page 43 of the mercury criteria document (EPA 440/5-84-026, January 1985). The saltwater CCC of 0.025 µg/L given on page 23 of the criteria document is based on the Final Residue Value procedure in the 1985 Guidelines. Since the publication of the Great Lakes Aquatic Life Criteria Guidelines in 1995 (60FR15393-15399, March 23, 1995), the EPA no longer uses the Final Residue Value procedure for deriving CCCs for new or revised 304(a) aquatic life criteria.

ff This recommended water quality criterion was derived in Ambient Water Quality Criteria Saltwater Copper Addendum (Draft, April 14, 1995) and was promulgated in the Interim final National Toxics Rule (60FR22228-222237, May 4, 1995). In 2007, EPA revised its freshwater copper criteria recommendations. Copper criteria will be updated to include use of the biotic ligand model (BLM) in the near future.

gg The EPA is actively working on this criterion; this water quality criterion may change substantially in the near future.

hh This recommended water quality criterion was derived from data for inorganic mercury (II), but is applied here to total mercury. If a substantial portion of the mercury in the water column is methylmercury, this criterion will probably be under protective. In addition, even though inorganic mercury is converted to methylmercury and methylmercury bioaccumulates to a great extent, this criterion does not account for uptake via the food chain because sufficient data were not available when the criterion was derived.

ll Ammonia criteria are pH, temperature, and life-stage dependent. The one-hour average concentration of total ammonia nitrogen (in mg N/L) does not exceed, more than once every three years on the average, the CMC (acute criterion) calculated using the following equations:

Where salmonid fish are present: $CMC = (0.275/(1 + 10^{7.204-pH})) + (39.0/(1 + 10^{pH-7.204}))$

Or where salmonid fish are not present: $CMC = (0.411/(1 + 10^{7.204-pH})) + (58.4/(1 + 10^{pH-7.204}))$

The Department will apply the CMC applicable to when salmonid fish are present at all times of the year unless the Department is provided reliable information (fish species distributions, spawning periods, rearing periods, and the duration of early life stages in the water body) that demonstrate that salmonid fish are absent.

vv There are no criteria due to the absence of criteria recommendations.

Table 2.2 Footnotes (continued)

ww A 4-day average concentration not to be exceeded more than once every three years on the average. If the CCC for mercury exceeds 0.012 ug/l more than once in a 3-year period in the ambient water, the edible portion of aquatic species of concern must be analyzed to determine whether the concentration of methylmercury exceeds the FDA action level.

xx These criteria are based on the total-recoverable fraction of the metal.

2.5 Project Justification

Regular measurement of nutrient, metal, and hydrocarbon parameters is required to accurately evaluate ambient conditions of the waters on, flowing onto, and through the Reservation to determine whether these conditions comply with Lummi Nation Water Quality Standards. Because sites are visited quarterly on a random schedule, nutrient, metal, and hydrocarbon concentrations in the surface waters of the Reservation can be assessed through all four seasons and a variety of weather conditions. Sites are sampled "randomly" in that the tides, season, and weather are not used to bias sampling efforts.[3]

The data collected as part of this project are used to identify trends (seasonal, annual, and multi-year) and impairment, establish baseline conditions, and evaluate compliance with Lummi Nation Water Quality Standards. Sample sites were selected to provide representative and targeted sampling of nutrients, metals, and hydrocarbons. Details on the justification of the experimental design are provided in Section 6.1.

[3] The exception to the general rule is specifically due to practical considerations; for marine sampling to occur, a sufficient tidal elevation is required to access marine sample sites by boat.

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3. PROJECT DESCRIPTION (A6)

The Lummi Nation NMH Project has been ongoing since 1998. The overall objective of the NMH Project is to achieve the overall LWRD mission and the WQM Program goals (Section 2.3). Specifically, the NMH Project objectives are:

1. Provide high quality data sufficient to establish baseline conditions of Lummi Nation Waters;
2. To evaluate compliance with water quality criteria;
3. To evaluate nutrient, metal, and hydrocarbon contributions from on- and off-Reservation sources; and
4. To support the development of a water quality regulatory program (*e.g.,* Lummi Code of Laws Title 17, Water Quality Standards) on the Reservation.

3.1 Project Description

Nutrients are measured quarterly at four freshwater sites and one marine site. Metals and hydrocarbons are measured quarterly at two freshwater site and one marine site. Freshwater sites are accessible from land, while marine sites are accessible by boat only. Figure 3.1 provides a map of sample site locations. Nutrient, metal, and hydrocarbon samples are collected for analysis at an independent contracted laboratory at all sites with flowing water.

Summary statistics are calculated for each parameter, as needed, and compared to Lummi Nation Water Quality Standards. An annual summary of water quality data, comparison to 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 funding requirements by March 31 of the following calendar year (EPA 2006b). Surface water quality data are uploaded to the EPA's STORET Data Warehouse via the Water Quality Exchange (WQX) framework by March 31 after the year of record.

Sample collection occurs quarterly from January to December of each year. Typically, samples are collected in the middle of each quarter (*i.e.,* first quarter sampling occurs in February, second quarter sampling occurs in May, etc.). 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 delivery to EPA on March 31 of the year following data collection. It is anticipated that all sites will be sampled as scheduled (once per quarter). Sampling of marine sites is occasionally limited due to sea conditions and safety concerns. As possible, sampling events cancelled due to safety concerns are rescheduled to a later time to ensure minimum sampling requirements are met. Equipment failure, staffing limitations, and budget restraints may also restrict planned site visit frequency.

Quality Assurance/Quality Control (QA/QC) procedures include appropriate sample collection techniques and laboratory QA/QC protocols. Details of the QA/QC procedures are provided in Section 8 of this QAPP.

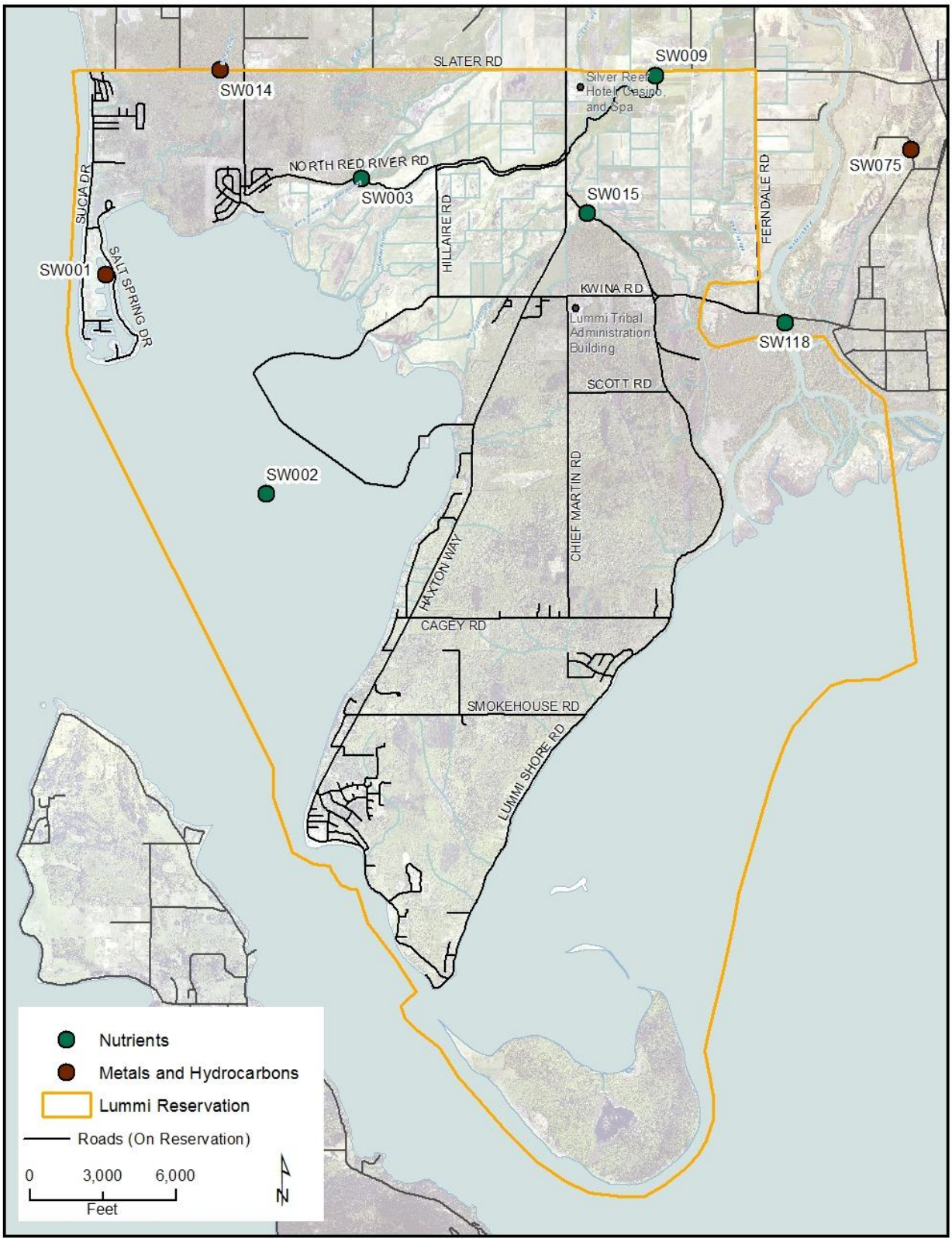

Figure 3.1 Location of Nutrient, Metal, and Hydrocarbon Monitoring Sites

3.2 Laboratory

Nutrient, metal, and hydrocarbon samples are analyzed by an independent contracted laboratory. Currently, the laboratory providing sample analyses as part of the NMH Project is Edge Analytical, Incorporated (Edge) located in Burlington, WA. The laboratory meets Washington State Department of Ecology environmental laboratory accreditation requirements for all analyses conducted as part of the NMH Project. Chlorophyll α and pheophytin analyses are subcontracted by Edge.[4] The subcontracted laboratory is accredited for the analyses it provides as part of the NMH Project.

[4] Chlorophyll a and pheophytin analyses are currently subcontracted to ALS-Kelso of Kelso, WA and will be subcontracted to IEH Analytical Laboratories (Seattle, WA) upon their accreditation.

4. QUALITY OBJECTIVES AND CRITERIA (A7)

The overall performance standard for the NMH 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 provide the necessary information to assess and quantify data quality and comparability for data analysis.

The NMH 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. 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 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: appropriate laboratory sample collection and handling techniques and chain of custody procedures as required by the Nutrient, Metal, and Hydrocarbon Sample Collection SOP; and laboratory QA/QC protocols (Section 8; QMP Appendix C).

Acceptance criteria and detection limits vary depending on the parameter measured. Detection limits and practical quantitation limits (PQLs) are provided in the QMP (QMP Appendix C). Project action limits include measurements that exceed Lummi Nation Water Quality Standards and that are unusual or unexpected for the site. Additional details on project action limits are included in the QMP.

4.2 Precision

The independent contracted laboratory, Edge Analytical, Incorporated, provides information on precision on all laboratory reports as duplicate difference (QMP Appendix C). Deficiencies in precision are evaluated on a case-by-case basis with the independent contracted laboratory and corrected for future monitoring.

4.3 Accuracy and Bias

The independent contracted laboratory provides information on accuracy and bias on all laboratory reports as QC known recovery and recovery limits (QMP Appendix C). Deficiencies in accuracy and bias are evaluated on a case-by-case basis with the laboratory and corrected for future monitoring.

4.4 Representativeness

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. 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. Laboratory methods used are included with each parameter in the Water Database. Units of measurement have remained consistent throughout the period of record. Information regarding data quality allows for comparison of data collected at different times over the period of record within the NMH Project. Site SW118 (Nooksack River at Marine Drive Bridge) results may be compared with data obtained from the ZAPS Continuous Monitoring Study. Project results may also be compared with non-WQM Program sources of data, assuming quality control information is available for non-WQM Program data.

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. Nutrient 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 NMH Project is for sample sites to be visited quarterly (four times a year). Sampling events should be equally distributed throughout the year, but do not have to occur on specific days. 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 this QAPP. Sea conditions may limit sample collection at some marine sites; however, quarterly sampling of nutrients, metals, and hydrocarbons during monthly sampling as part of the Surface Water Project provides several opportunities within each quarter to complete collection of NMH Project samples. Equipment failure, staffing limitations, budget reductions, or changing department priorities may also result in temporary reduction of sample collection. If fewer than 75% of the planned samples are collected in a calendar year, the experimental design of this project will be re-evaluated.

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 site conditions (*i.e.,* sites are dry or not flowing), staff turnover, resource constraints, laboratory limitations, or logistical problems. Corrective actions are undertaken to remedy conditions that create missing data to prevent data gaps in the future (see Nutrient, Metal, and Hydrocarbon Sample Collection SOP).

4.7 Range/Sensitivity

The sensitivity and range that can be measured depends on the parameter methods (QMP Appendix C). The goal of the NMH 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, evaluate 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 with the independent contracted laboratory and corrected for future monitoring.

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5. DOCUMENTS AND RECORDS (A9)

5.1 Quality Assurance Project Plan Distribution

The Water Resources Specialist II is responsible for ensuring that the individuals listed on the Distribution List for 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

Results of the NMH 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 NMH 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 NMH 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 NMH 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 NMH Project goal is to achieve the following objectives:

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

The Lummi Nation NMH Project is focused on monitoring nutrients, metals, and hydrocarbons in Lummi Nation Waters at targeted locations. The NMH Project supplements the Surface Water Project by providing detailed information about specific water quality parameters at representative and targeted sites.

6.1 Sample Sites

Nutrients are measured quarterly at four freshwater sites and one marine site. Metals and hydrocarbons are measured quarterly at two freshwater sites and one marine site. Nutrient, metal, and hydrocarbon samples are typically collected in the middle of each quarter (*i.e.,* first quarter sampling occurs in February, second quarter sampling occurs in May, etc.). Sample sites included in the NMH Project are also included in the Surface Water Project. As sites are visited monthly as part of the Surface Water Project, NMH Project samples are collected concurrently with sampling of the sites as part of the Surface Water Project. Table 6.1 details the sample site, location, designation (marine or freshwater), and the corresponding Surface Water Project run during which NMH Project samples are also collected.

Table 6.1 Location of Surface Water Quality Monitoring Sites, Water Class Designation, and Run Name

Sample Site ID	Sample Site Location	Designation	Surface Water Project Run
Nutrients			
SW002	Lummi Bay southwest of Seapond Aquaculture Facility	Marine	SP&PI
SW003	Jordan Creek at North Red River Road	Fresh	FPW
SW009	Lummi River at Slater Road	Fresh	FPW
SW015	Smuggler Slough at Lummi Shore Drive	Fresh	FPE
SW118	Nooksack River at Marine Drive Bridge	Fresh	FPE or FPW
Metals and Hydrocarbons			
SW001	North end of Sandy Point Marina	Marine	SP&PI
SW014	Drainage from Phillips 66 stormwater treatment facility at Slater Road; flows into Onion Creek	Fresh, Eph.	FPW
SW075	Silver Creek at Shady Lane Bridge	Fresh[5]	Nooksack

Eph. = Ephemeral
SP&PI = Sandy Point and Portage Island
FPW = Flood Plain West
FPE = Flood Plain East

Sites sampled for nutrients, metals, and hydrocarbons as part of the NMH Project were selected to provide targeted and representative sampling of sites across the Reservation.

Site SW002 was selected to monitor nutrients in the marine waters of the Reservation at a representative location in Lummi Bay. Due to the cost of analyzing nutrient samples, only one marine nutrient site is currently included as part of the NMH Project. Sites SW003 (Jordan Creek) and SW009 (Lummi River) were selected to monitor nutrients in the Lummi River watershed, which discharges into Lummi Bay. Site SW009 monitors water quality as it enters the Reservation. Site SW015 (Smuggler Slough) was also selected to monitor nutrients in waters flowing into Lummi Bay. Site SW118 was selected to monitor nutrient inputs from the Nooksack River into Portage Bay and Bellingham Bay. Due to the large presence of agricultural land use in the Nooksack River watershed, there is a potential for the occurrence of excess nutrients in the Nooksack River.

Site SW001 was selected to monitor metals and hydrocarbons in the Sandy Point Marina. Site SW014 was selected to monitor metals and hydrocarbons present in waters entering the Reservation from a stormwater treatment facility associated with the Phillips 66 oil refinery

[5] Site SW075 is located off the Reservation, but flows to Lummi Nation Waters classified as Class AA Freshwater (Nooksack River north of line between Fish Point and Treaty Rock) (17 LAR 07).

located north of the Reservation boundary. These sites were selected because marinas, recreational boating, urban runoff, and industrial activities have been identified as potential sources of non-point source metal pollution (LWRD 2015a). In addition, recreational activities and urban runoff have also been identified as potential sources of hydrocarbons (LWRD 2015a).

Data collected as part of the NMH Project are used to establish baseline conditions, identify sources of pollution, and to evaluate compliance with Lummi Nation nutrient and metal Water Quality Standards. Nutrient data may be used to inform the development of numeric nutrient criteria. Both on- and off-Reservation sources of nutrients, metals, and hydrocarbons are evaluated. The results of this project will advise regulatory actions, restoration efforts, and Total Maximum Daily Load development in the Portage Bay and Lummi Bay watersheds, as determined by the Water Resources Manager, LNR Director, and LNR Deputy Director.

Temporal and spatial resolution is limited by the expense of analyzing nutrient, metal, and hydrocarbon samples. However, random quarterly sampling of the targeted and representative sample sites provides sufficient resolution to observe seasonal and year-to-year trends. Sites are sampled "randomly" in that the tides, season, and weather are not used to bias sampling efforts.[6]

Detailed maps, descriptions of sample locations, and driving directions to sample sites are provided to field personnel in the *Lummi Nation Water Quality Monitoring Program Field Reference Manual* to ensure that sites are sampled on location (LWRD 2015c). With the exception of the marine samples, where tides and weather may occasionally preclude sampling, sample site access is usually not a problem. Site inaccessibility and "off station" sample collection are discussed in the QMP.

6.2 Water Quality Parameters

Table 6.2 lists the sample sites, type of analysis (nutrients, metals, or hydrocarbons), and specific parameters analyzed by the laboratory. Samples for laboratory analysis 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 Nutrient, Metal, and Hydrocarbon Sample Collection SOP.

[6] The exception to the general rule is specifically due to practical considerations; for marine sampling to occur, a sufficient tidal elevation is required to access marine sample sites by boat.

Table 6.2 Nutrient, Metal, and Hydrocarbon Monitoring Sites and Parameters Analyzed by Contracted Laboratory

Site ID	Group Name	Parameters for Analysis
SW002	Marine Nutrients	pH (with temperature at time of pH measurement), Alkalinity, Biochemical Oxygen Demand, Chemical Oxygen Demand, Total Suspended Solids, Total Volatile Suspended Solids,[a] Ammonia, Nitrate + Nitrate N, Total Kjeldahl Nitrogen, Orthophosphate, Total Phosphorus, Iron, Chlorophyll a, Pheophytin, Total Organic Carbon (TOC).
SW003, SW009, SW015, SW118	Freshwater Nutrients	pH (with temperature at time of pH measurement), Alkalinity, Biochemical Oxygen Demand, Chemical Oxygen Demand, Total Suspended Solids, Total Volatile Suspended Solids, Ammonia, Nitrate-N, Nitrite-N, Nitrate + Nitrate N, Total Kjeldahl Nitrogen, Orthophosphate, Total Phosphorus, Iron, Chlorophyll a, Pheophytin, Total Organic Carbon (TOC).
SW001	Marine Hydrocarbons	Diesel and Lube Oil Range Hydrocarbons
	Marine Metals	Arsenic, Copper, Mercury, Tin, Zinc, Hardness, and pH (temperature at time of pH measurement)
SW014, SW075	Freshwater Hydrocarbons	Diesel and Lube Oil Range Hydrocarbons
	Freshwater Metals	Chromium, Copper, Lead, Zinc, Hardness, and pH (temperature at time of pH measurement)

[a] Total Volatile Suspended Solids (TVSS) can also be referred to as Total Volatile Solids

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 laboratory analyses. Details on sample collection are included in the Nutrient, Metal, and Hydrocarbon Sample Collection SOP.

7.1 Sampling Method Overview

At each sample site, a laboratory sample is collected, placed on ice, and delivered to the independent contracted laboratory using chain of custody procedures outlined in the Nutrient, Metal, and Hydrocarbon Sample Collection SOP. Samples are only collected if water at the site is flowing (*i.e.,* water is present in sufficient quantity to sample and is not stagnant). Nutrient, metal, and hydrocarbon samples are collected after bacteria samples are collected and before *in situ* water quality parameters are measured as part of the Surface Water Project. 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 Nutrient, Metal, and Hydrocarbon Sample Collection SOP and QMP Appendix C. 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 2015b) 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 nutrient, metal, and hydrocarbon analysis.

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 iPad or field datasheet 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, no samples are collected.
        - If a site has flowing water of sufficient quantity and depth to sample, samples are collected.
2. Visually observe current and flow direction.
3. If bacteria sample is to be collected at the site, the bacteria sample is collected first following instructions provided in the Surface Water Project QAPP and the Bacteria Sample Collection SOP.
4. Nutrient, metal, and hydrocarbon samples are collected in the top twelve inches of the water column (below the surface).
    - Sample is collected in a representative portion of waterbody.
    - Nutrient, metal, and hydrocarbon samples are collected after bacteria sample collection, but before measurement of *in situ* water quality parameters as part of the Surface Water Project.
    - Nutrient, metal, and TOC samples are collected with a sampling wand when practicable. The yellow sampling wand and black adjustable holding rings are used for nutrient and metal sample collection. The blue sampling wand is used for TOC sample collection.
    - Hydrocarbon samples are collected by hand.
    - Samples are collected with the mouth of the bottle and movement of sampling into the flow of the water (*i.e.,* upstream). Details are provided in the Nutrient, Metal, and Hydrocarbon Sample Collection SOP.
5. If *in situ* water quality parameters are to be measured at the site as part of the Surface Water Project, these are measured after collection of nutrient, metal, and hydrocarbon samples.
6. Assess water at sample site to confirm that sampling is taking place at a representative location.

    - If 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 in the Water Database and indicate reason why.
        - Re-sample 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 representative water quality sample is obtained by following the methods described below. A representative water quality sample is collected when both the specific methods of sample collection (see Nutrient, Metal, and Hydrocarbon Sample Collection SOP) as well as the sequence of collection and measurement (Section 7.4), are followed.

Water quality samples are collected at a representative location. 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.
- 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 this in the Water Database.
    - If the site is sampled, assign 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 sample.
- If samples collected from non-representative location are retained for analysis, assign data qualifier and the reason in the Water Database.

7.6 Site Disturbance

Nutrient, metal, and hydrocarbon samples are collected after collection of bacteria samples and before measurement of *in situ* water quality parameters as part of the Surface Water Project. 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. 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

Nutrient, metal, and hydrocarbon samples are collected at all project sites with flowing water. All parameters are analyzed by the contracted laboratory, Edge, or its subcontractor. Table 6.2 lists the parameters measured for each nutrient and metal/hydrocarbon sample site. Table 7.1 summarizes the parameters measured, units, measurement method, sample holding container, method of sample preservation, and the maximum holding time for each of the measured parameters. General and noteworthy conditions are observed throughout the site visit and recorded as comments in the Water Database.

Table 7.1 Methods for Laboratory Analysis of Nutrients, Metals, and Hydrocarbons

Parameter (units are mg/L unless otherwise listed)	Laboratory Method[a]	Sample Holding Container	Method Sample Preservation[b]	Maximum Holding Time[c]
Nutrients				
pH (pH units)	SM4500-H+B	1L plastic	Ice	Immediately 15 minutes
Total Alkalinity	SM2320 B	1L plastic	Ice	14 days
Biological Oxygen Demand (BOD)	SM5210 B	1L plastic	Ice	48 hours
Chemical Oxygen Demand (COD)	SM5220 D	1L plastic	Ice	28 days

Table 7.1 Methods for Laboratory Analysis of Nutrients, Metals, and Hydrocarbons

Parameter (units are mg/L unless otherwise listed)	Laboratory Method[a]	Sample Holding Container	Method Sample Preservation[b]	Maximum Holding Time[c]
Total Suspended Solids (TSS)	I-3765-85	1L plastic	Ice	7 days
Total Volatile Suspended Solids (TVSS)[d]	SM2540 E	1L plastic	Ice	7 days
Ammonia-N	EPA350.1	1L plastic	Ice	28 days
Nitrite-N (freshwater only)	SM4500-NO3 F	1L plastic	Ice	48 hours
Nitrate-N (freshwater only)	SM4500-NO3 F	1L plastic	Ice	48 hours
Nitrite+Nitrate-N	SM4500-NO3 F	1L plastic	Ice	48 hours
Total Kjeldahl Nitrogen (TKN)	EPA351.2	1L plastic	Ice	28 days
Ortho-Phosphate	SM4500-P F	1L plastic	Ice	48 hours
Total Phosphorus	SM4500-P F	1L plastic	Ice	28 days
Iron	EPA200.7	250 ml plastic	Ice	28 days
Chlorophyll a* (mg/m^2)	SM10200-H	1L plastic	Ice, Dark	24 hours
Pheophytin* (mg/m^2)	SM10200-H	1L plastic	Ice, Dark	24 hours
Total Organic Carbon (TOC)	SM5310 B	40 ml, glass	HCl, Ice	28 days
Metals				
Arsenic (marine only)	EPA200.8	250 ml plastic	Ice	28 days
Chromium (freshwater only)	EPA200.8	250 ml plastic	Ice	28 days
Copper	EPA200.8	250 ml plastic	Ice	28 days
Mercury (marine only)	EPA245.1	250 ml plastic	Ice	28 days
Lead (freshwater only)	EPA200.8	250 ml plastic	Ice	28 days
Tin (marine only)	EPA200.8	250 ml plastic	Ice	28 days
Zinc	EPA200.8	250 ml plastic	Ice	28 days
pH	SM4500-H+B	250 ml plastic	Ice	Immediately 15 minutes
Total Hardness (mg/L as $CaCO_3$)	EPA200.7	250 ml plastic	Ice	28 days
Hydrocarbons				
Diesel Range Hydrocarbons	NWTPHDX	500 ml, amber, glass	HCl, Ice	6 days

Table 7.1 Methods for Laboratory Analysis of Nutrients, Metals, and Hydrocarbons

Parameter (units are mg/L unless otherwise listed)	Laboratory Method[a]	Sample Holding Container	Method Sample Preservation[b]	Maximum Holding Time[c]
Lube Oil Range Hydrocarbons	NWTPHDX	500 ml, amber, glass	HCl, Ice	6 days

[a] SM refers to Standard Methods

[b] 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.

[c] All laboratory samples are delivered to the contracted laboratory within 8 hours of collection or less. Holding times listed in this table indicate the time during which the analysis must occur or the time in which the sample must be preserved or filtered.

[d] Total Volatile Suspended Solids (TVSS) also referred to as Total Volatile Solids.

*These parameters are analyzed by ALS-Kelso, a laboratory contracted by Edge Analytical, Incorporated. Upon accreditation, these parameters will be analyzed by IEH Analytical Laboratories.

The Nutrient, Metal, and Hydrocarbon Sample Collection SOP provides details regarding sample collection instructions and chain of custody procedures. The QMP provides details on laboratory practical quantitation limits, and recovery limits (QMP Appendix C) as well as method validation.

7.7.1 Nutrient Sample Collection

A nutrient sample is collected at nutrient monitoring sites with flowing water using aseptic sampling techniques as outlined in the Nutrient, Metal, and Hydrocarbon Sample Collection SOP. The yellow sampling wand and black adjustable holding ring are used to fill four 1L plastic bottles, provided by the independent contracted laboratory, with sample water for each site. In addition, the blue sampling wand is used to fill a sterile bacteria sample bottle with sample water and decanted into two 50 ml TOC vials for TOC analysis. The bottles are labeled with the site identifier and other information as detailed in the SOP and transported to the independent contracted laboratory. Chain of custody forms are used to document sample information, analyses requested, and release of the samples to laboratory staff.

7.7.2 Metal and Hydrocarbon Sample Collection

Metal and hydrocarbon samples are collected at monitoring sites with flowing water using aseptic sampling techniques as outlined in the Nutrient, Metal, and Hydrocarbon Sample Collection SOP. The yellow sampling wand and black adjustable holding ring are used to fill four 1L plastic bottles, provided by the independent contracted laboratory, with sample water for metal analysis. In addition, a 1L amber glass bottle without HCl preservative is filled by hand

and decanted into one 1L amber glass bottle with HCl preservative for hydrocarbon analysis. The bottles are labeled with the site identifier and other information as detailed in the SOP, and transported to the independent contracted laboratory. Chain of custody forms are used to document sample information, analyses requested, and release of the samples to laboratory staff.

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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 measured is provided in the Nutrient, Metal, and Hydrocarbon Sample Collection SOP and in QMP Appendix C. The goal of QA/QC activities for the NMH Project is to ensure that measurements have a known accuracy, precision, and traceability. QA/QC activities for the project are summarized in this section and described in detail in the Nutrient, Metal, and Hydrocarbon Sample Collection SOP and QMP Appendix C. Determination and documentation of control action effectiveness is described in the QMP. Calculation of statistics is detailed in the QMP and summarized in Section 10.2.

8.1 Quality Control (B5)

Quality control procedures for the NMH Project include appropriate sampling techniques, use of sample tracking forms, and laboratory QA/QC procedures.

8.1.1 Sample Collection

Details on the QA/QC procedures for sample collection are provided in the Nutrient, Metal, and Hydrocarbon Sample Collection SOP.

8.1.1.1 Sampling Techniques

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

8.1.1.2 Sample Tracking

Every surface water sample site has a unique numerical identifier. The site identifier is used to track laboratory samples collected at the site. Section 10.1 of this QAPP and the QMP provide details on 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.

8.1.1.3 Holding Times

Laboratory holding times are observed for all samples collected (Table 7.1). Samples are delivered to the independent contracted laboratory on the day the samples are collected to ensure that all analyses can be performed within the maximum holding times.

8.1.2 Laboratory QA/QC

The independent contracted laboratory is responsible for maintaining data quality for laboratory-analyzed results. Quality assurance samples may include blanks, matrix spikes, laboratory duplicates, and/or standards. 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).

8.2 Equipment Maintenance (B6) and Calibration (B7)

Equipment used as part of the NMH Project do not require calibration or maintenance activities. Equipment, including sampling wands and sample bottles, are kept clean and in working order by the Water Resources Specialist II and Water Resources Technician II. Laboratory bottles are inspected upon receipt, as described in the Nutrient, Metal, and Hydrocarbon Sample Collection SOP. As previously mentioned, equipment used by the independent contracted laboratory are calibrated, accuracy checked, and maintained as required by the laboratory's QA/QC plan.

8.3 Acceptance Criteria and Control Limits

Acceptance criteria and control limits depend on the parameter measured. Laboratory personnel are responsible for determining whether results meet acceptance criteria (see QMP Appendix C). Corrective actions, including re-analyzing the sample, are taken as determined by laboratory staff. Deficiencies in laboratory results (precision, accuracy, range) are evaluated on a case-by-case basis with the independent contracted laboratory and remedied for future monitoring. Details on determination and documentation of effectiveness of control activities are included in the QMP.

8.4 Corrective Actions

If samples are collected in an unrepresentative location, the site is re-sampled, if feasible. If re-sampling is not possible, field staff use their professional judgment to consider the options: (1) discarding the sample or (2) continuing with analysis of an unrepresentative sample. If samples are discarded and not re-sampled or a sample from an unrepresentative location is analyzed by

the laboratory, notes of explanation are provided in the Water Database. Unrepresentative samples are assigned a data qualifier in the database (see QMP and Water Database User Guide for details).

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9. SUPPLIES AND CONSUMABLES (B8)

Equipment required for implementing the NMH Project are stored in the LNR lab and storage locker. Equipment is kept in good working order and supplies are regularly inventoried and stocked by the Water Resources Specialist II and Water Resources Technician II to ensure availability. 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 Nutrient, Metal, and Hydrocarbon Sample Collection SOP.

Note that sampling for the NMH Project occurs concurrently with regular sampling as part of the Surface Water Project (see Surface Water Project QAPP for details on additional equipment needed).

Supplies and consumables used in the NMH Project include:

Data Recording:

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

General:

- Cooler
- Ice

Water Quality Sampling Equipment:

- Blue extendable sampling wand
- Yellow extendable sampling wand
- Black adjustable holding rings
- Sample bottles, provided by the contracted laboratory:
    - 1 L plastic bottles for nutrient and metal samples
    - 1 L amber glass bottles with HCl for hydrocarbon samples
    - 1 L amber glass bottles without HCl for hydrocarbon sample collection
    - 250 ml sterile bacteria bottles for TOC sample collection
    - 50 ml TOC vials

- For marine sites:
    - 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

10. DATA MANAGEMENT (B10)

The Water Resources Specialist II is responsible for data management of NMH 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 laboratory results are entered into the Water Database. Data entry is manually verified, and a QA/QC report is generated for each trip. All paper records (*e.g.,* 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 secure LIBC servers, which are 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 LNR Deputy Director.

10.1 Sample Tracking and Data Recording

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

Every surface water sample site has a unique numerical identifier. The site identifier is used to track nutrient, metal, and hydrocarbon samples collected at the site for analysis at a laboratory by recording the site identifier on bacteria sample bottles and chain of custody forms. Detailed procedures on labeling of sample bottles, sample handling and transportation, and completion of chain of custody forms are provided in the Nutrient, Metal, and Hydrocarbon Sample Collection SOP. The Nutrient, Metal, and Hydrocarbon Sample Collection SOP also includes an example chain of custody form as an appendix.

All site visit information, observations, samples collected, notes on samples not collected and reasons why are recorded either directly into the Water Database in real time using the iPad or are recorded on field datasheets. Notes on field datasheets and laboratory results are entered into the Water Database within one week of trip date or receipt of results, if feasible. 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 NMH Project. Details on data validation and verification, database maintenance, calculation of statistics, and identification of outliers and missing data are provided in the QMP.

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 and Water Resources Technician 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 NMH 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 at marine sites, 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.

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.

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 the 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. 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. The Lummi Nation Water Resources Manager is immediately alerted if elevated concentrations of nutrients, metals, or hydrocarbons 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 and the Water Resources Manager will jointly develop an action plan to remedy the problem with clear roles, responsibilities, and timelines.

The Water Resources Specialist II prepares an annual Water Quality Assessment Report that summarizes the collected 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 LNR 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 program status, problems, remedies, and schedules.

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12. ACRONYMS AND ABBREVIATIONS

CWRMP	Comprehensive Water Resources Management Program
EPA	Environmental Protection Agency
LIBC	Lummi Indian Business Council
LNR	Lummi Natural Resources Department
LWRD	Lummi Water Resources Division
NMH	Nutrients, Metals, and Hydrocarbons [Project]
PQL	Practical Quantitation Limit
QAPP	Quality Assurance Project Plan
QMP	Quality Management Plan
QA/QC	Quality Assurance/Quality Control
SM	Standard Method
SOP	Standard Operating Procedure
TOC	Total Organic Carbon
USGS	U.S. Geological Survey
WQM	Water Quality Monitoring [Program]
WQX	Water Quality Exchange

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