QUALITY MANAGEMENT PLAN
LUMMI NATION WATER QUALITY MONITORING PROGRAM

Version 1.2

Water Resources Division
Natural Resources Department
Lummi Indian Business Council

Prepared for EPA Region 10

July 2021

Lummi Nation Water Quality Monitoring Program Quality Management Plan Approval:

Name and Title	Signature	Date
Leroy Deardorff Lummi Indian Business Council (LIBC) Natural Resources Department Deputy Director	for Leroy D.	7-13-21
Kara Kuhlman, CFM WQM Program Project Manager and Quality Assurance Manager LIBC Water Resources Manager		7/9/21
Jamie L. Mattson WQM Program Quality Assurance Officer LIBC Water Resources Specialist II/Planner	Jamie L. Mattson	7/12/2021
Hanna Winter WQM Program Coordinator LIBC Water Resources Specialist II		7/1/2021
Michael Ortiz EPA Project Manager EPA Tribal Coordinator	Michael Ortiz	08/11/2021
Donald M. Brown EPA Region 10 Quality Assurance Officer	KARIN FEDDERSEN-LETHE Digitally signed by KARIN FEDDERSEN-LETHE Date: 2021.08.11 12:13:06 -07'00'	

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DISTRIBUTION LIST

Merle Jefferson, Lummi Nation Natural Resources (LNR) Director
(360) 312-2328, merlej@lummi-nsn.gov

Leroy Deardorff, LNR Deputy Director
(360) 312-2318, leroyd@lummi-nsn.gov

Kara Kuhlman, LNR Water Resources Manager
(360) 312-2128, karak@lummi-nsn.gov

Jamie L. Mattson, LNR Water Resources Specialist II/Planner
(360) 312-2313, jamiem@lummi-nsn.gov

Hanna Winter, LNR Water Resources Specialist II
(360) 312-2312, hannaw@lummi-nsn.gov

Shamania James, LNR Water Resources Technician II
(360) 384-7101, shamaniaj@lummi-nsn.gov

Jeffrey Solomon, LNR Natural Resources Technician II
(360) 312-2128, jeffreys@lummi-nsn.gov

Craig Dolphin, LNR Database Manager
(360) 312-2304, craigd@lummi-nsn.gov

Michael Ortiz, EPA Tribal Coordinator
(206) 553-6234, Ortiz.michael@epa.gov

Donald M. Brown, EPA Region 10 Quality Assurance Officer
(206) 553-0717, Brown.DonaldM@epa.gov

Recipients identified on this distribution list will be sent updated versions of this document or copies of minor change letters for this document immediately after they are approved. Recipients listed may also obtain the most current copy of the approved QMP by contacting the Water Resources Manager.

REVISION RECORD

Approval	Date	Responsible Person	Description of Change	Location of Change
1	October 2018	Kara Kuhlman	Initial Approval and Release of Version 1.0	N/A
1.1	December 2019	Kara Kuhlman	Added new staff and corrected program responsibility	Distribution list, Section 4.1, Figure 4.1, Table 4.1
			Update water quality summary	Sections 3.5.1, 13.1
			Update number and names of sites	Sections 5, 5.1.3, 5.8.1, 9.4.1, Tables 5.1, 5.2, 5.3, Figures 5.2, 5.3
			Project update (ZAPS)	Section 5.9
			Update and clarify data entry and QA/QC process	Sections 6.3, 6.4, 7.1, 7.2.1, 7.3.2
			Water Quality Assessment Report change from annual to every two-years for a two-year reporting period	Section 6.6.2
			Add preliminary data check for data finalization	Section 7.3.4
			Add ability to share preliminary laboratory data with partner agencies and the public under certain circumstances	Section 7.6
			Update programs and supplies	Section 7.4, Table 9.1
			Add annual verification of laboratory accreditation	Section 9.5.2
			Clarify responsibility and process of evaluating purchased hardware and software	Section 7.7
			Clarify process of verifying work process changes are implemented	Section 10.1
1.2	July 2021	Kara Kuhlman	Update EPA Tribal Coordinator	Signature page, Distribution List
			Remove ZAPS Technologies LiquID Station Continuous Water Quality Monitoring Study and the associated sample station (SW076). The study has been completed.	Sections 1.0, 5.0, Figure 5.1, 5.2, Table 5.1, 5.9, 9.6.2

Approval	Date	Responsible Person	Description of Change	Location of Change
1.2	July 2021	Kara Kuhlman	Correct frequency of Water Quality Assessment Report from annual to every two years	Sections 2.2, 6.1, 7.3.3, 7.4, 8.3, 10.1, 10.2, 11.1
			Change STORET to WQX	Sections 2.2, 6.1, 6.6.1, 7.3, 7.3.2, 7.3.4, 7.6
			Correct chain of command and responsibilities of Water Resources Specialist II/Planner and Water Resources Specialist II.	Sections 2.2, 2.4, 4.1, 4.5, 6.6.2, 8.7, 8.8, 9.1, 9.2, 9.3, 9.6.1, 9.7, 10.1, 10.2, 11.1, 11.2, 11.3, Figure 4.1
			Correct sample station ID (SR005)	Table 5.1
			Add use of Whatcom Clean Water Program partner agency data when collected from Reservation boundary sites	Section 7.5.2
			Update supplies	Section 9.5.1, Table 9.1
			Referenced updated	Section 13.2
			Corrected method name to Volatile Suspended Solids (SM2540E)	Table 14.1

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SIGNATURE PAGE

Document: Lummi Nation Water Quality Monitoring Program Quality Management Plan

Version 1.2

The following technical staff has read this document. 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 ORGANIZATION

The Quality Management Plan for the Lummi Nation Water Quality Monitoring Program (WQM Program) is a hybrid document that:

1. Outlines the overall quality management system for the Lummi Nation Water Quality Monitoring Program
2. Provides detailed background and implementation information relevant to all projects contained within the Lummi Nation Water Quality Monitoring Program
3. Documents the applicability of the quality management system to the projects contained within the Lummi Nation Water Quality Monitoring Program

The Lummi Nation Water Quality Monitoring Program (WQM Program) is a program implemented by the Lummi Water Resources Division to monitor water quality in support of the Lummi Natural Resources Department goals. The WQM Program includes all water quality monitoring projects implemented by the Lummi Water Resources Division by reference. The quality management system is the system by which quality is ensured in the WQM Program. The Quality Management Plan (QMP) is this document, which provides a written record of the quality management system and how it applies to the WQM Program as a whole and to the projects contained within the WQM Program. The quality management system is a component of the WQM Program; references to the WQM Program in this document refer to the Lummi Nation Water Quality Monitoring Program, its projects, and its quality management system as a comprehensive unit.

This document, the *Quality Management Plan for the Lummi Nation Water Quality Monitoring Program Version 1.2*, supersedes the *Lummi Nation Water Quality Monitoring Program Quality Assurance Project Plan Version 4.0* (the 2010 QAPP; LWRD 2010).

The 2010 Quality Assurance Project Plan (QAPP) has been reviewed, revised and reorganized into a new quality management system framework. Whereas the 2010 QAPP included quality procedures for all WQM Program projects (*e.g.,* surface and ground water) and equipment under one QAPP, the new framework includes a Quality Management Plan (QMP; this document) as the umbrella document outlining the overall quality management system for the Lummi Nation WQM Program and QAPPs for each individual project. The individual projects are 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
- Continuous Aquifer Level Monitoring Project

- Lummi Peninsula Groundwater Settlement Agreement Compliance Monitoring Project

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

This document is organized following the guidelines presented in, *Environmental Protection Agency (EPA) Requirements for Quality Management Plans* (EPA 2001a, reissued 2006a). This QMP also includes sections detailing information typically included in project-level QAPPs; these sections are included here because the sections apply to all WQM Program projects implemented by the Lummi Nation Water Resources Division. This document also contains background and implementation information relevant to all WQM Program projects.

Table 1.1 summarizes the QMP elements required by the EPA (EPA 2001a, reissued 2006a) and the section of this document in which these requirements are addressed. Appendix A includes a table that summarizes all sections of this QMP with an explanation of the contents of the section, clarifying which sections address QMP elements and which address QAPP elements common to all WQM Program projects.

Table 1.1 QMP Element Requirements Crosswalk

QMP Element Requirement	Section in this QMP
Management and Organization	4. Management and Organization
Quality System Components	2.2 Quality Management System Components
Personnel Qualification and Training	4.2 Personnel Qualification 4.3 Training Requirements
Procurement of Items and Services	9.5 Procurement of Items and Services
Documents and Records	6. Documents and Records
Computer Hardware and Software	7.7 Computer Hardware and Software
Planning	8. Planning
Implementation of Work Processes	9. Implementation of Work Processes
Assessment and Response	10. Assessment and Response
Quality Improvement	11. Quality Improvement

2. QUALITY MANAGEMENT SYSTEM

This section documents the quality management system for the WQM Program, how the LWRD ensures data quality, and defines the primary responsibilities for managing and implementing each component of the quality management system. The quality management system is intended to ensure quality in work processes and products. It includes planning, implementation, documentation, and assessment.

2.1 Quality Management System Policy

The overall performance standard for the WQM Program is the collection of high-quality data sufficient to meet program goals (program goals listed in Section 3.1). Data must be of sufficient quality and spatial and temporal resolution to support scientifically valid and legally defensible decisions. The development and proper implementation of Quality Assurance/Quality Control (QA/QC) activities are integral to achieving collection of data that meet the overall performance standard.

The goals of the WQM Program quality management system are:

- To ensure that all data generated by or for the WQM Program are scientifically valid, legally defensible, of documented and adequate quality (*i.e.,* known precision, accuracy, bias, traceability, completeness, and representativeness), and have adequate spatial and temporal resolution to support program goals.
- To ensure that all water quality monitoring activities performed by the LWRD as part of the WQM Program have approved QAPPs and associated SOPs prior to the start of collection activities.
- To ensure that all QA/QC activities are properly implemented by field staff by providing easy access to all necessary documentation and training, as needed.
- To maintain open communication of quality issues and activities among management, staff, and contract laboratories.
- To perform assessments to determine the effectiveness of the quality management system and continually improve the quality management system.
- To accomplish QA/QC procedures in the most cost-effective manner without compromising data quality.

All projects contained within the WQM Program are subject to and supported by this quality management system. Details on WQM Program projects are provided in Section 5.

2.2 Quality Management System Components

This QMP outlines several components that support the goals of the quality management system. These components include systematic planning of projects and data collection activities, the writing of quality system documents to supplement this QMP, procedures for

implementing the quality management system, appropriate documentation and data management to ensure data quality, and ongoing and periodic formal and informal assessment of the quality management system. The components of the quality management system are summarized below.

- Planning:
    - This QMP
    - Identification of data needs and systematic planning of projects
    - Development of QAPPs and SOPs
    - Staff training
- Implementation:
    - Following QAPPs and SOPs
    - Appropriate corrective actions
    - Reporting to supervisors
    - Procurement of items and services
- Documentation:
    - Storage of hardcopy and electronic records
    - Data Management
        - Water Database and other databases
        - Data verification and validation
    - Data package: Water Quality Assessment Report prepared every two years and data download to EPA via the Water Quality Exchange (WQX0 annually
- Assessment:
    - Ongoing (at least annual) review and revision of quality management system documents (*i.e.,* QMP, QAPPs, SOPs)
    - Annual Technical Systems Audits
    - Annual Quality Assurance Audits
    - Annual review of data collected
    - Assessment of program and project goals
    - Revision or re-approval of all quality management system documents every five years

The Water Resources Manager, Water Resources Specialist II/Planner, and Water Resources Specialist II are responsible for quality management system planning elements. The Water Resources Specialist II is responsible for quality management system implementation elements. Documentation elements are the responsibility of the Database Manager and Water Resources Specialist II. Quality management system assessments are the responsibility of all LWRD staff involved in WQM Program projects, but formal assessments are conducted by the Water Resources Specialist II/Planner, the Quality Assurance Officer.

2.3 QMP Preparation

The QMP was prepared by the Water Resources Specialist II following the guidelines presented in, *EPA Requirements for Quality Management Plans* (EPA 2001a, reissued 2006a). The QMP was reviewed and approved by the Water Resources Specialist II/Planner, the Water Resources Manager, and the LNR Deputy Director. The QMP is also to be reviewed and approved by the EPA Tribal Coordinator and EPA Region 10 OEA Director.

2.4 QMP Distribution

The Water Resources Specialist II is responsible for ensuring that the individuals listed in the QMP distribution list have the most current version of this document. Records are maintained by the Water Resources Specialist II documenting substantive and minor version changes as well as the distribution of minor change letters and revised QMPs.

Substantive QMP updates are reviewed by the Water Resources Manager and transmitted to the EPA Project Manager and EPA Quality Assurance Officer by the Water Resources Manager for approval as an entire document. Identification and justification of changes are included with major updates resulting in a change in the number before the decimal point in the QMP version number (*e.g.,* change of name from Version 1.0 to 2.0).

Minor QMP updates are transmitted to the EPA Project Manager and EPA Quality Assurance Officer for approval via a letter that identifies changes and justifications. Minor updates include correction of mistakes and non-substantive changes to the QMP. Corrections of mistakes are tracked through the use of a lower case letter at the end of the QMP version number (*e.g.,* change of name from Version 1.0 to 1.0a). Non-substantive minor changes are tracked through change of the number following the decimal point in the QMP version number (*e.g.,* change of name from Version 1.0 to 1.1).

QMP updates and revision letters are provided to the individuals in the distribution list via electronic format.

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3. INTRODUCTION

The purpose of this section is to provide background information and context relevant to the WQM Program and the various projects implemented as part of the WQM Program. Summaries of each WQM Program project are provided in Section 5.

3.1 Program Goals

The Lummi Nation WQM Program is administered and implemented by the Lummi Water Resources Division (LWRD), a division within the Lummi Natural Resources Department (LNR), contained within the Lummi Indian Business Council (LIBC). The mission of the LNR is:

> To enhance, manage, and protect natural resources into perpetuity for the benefit of the Lummi People in accordance with the policy and procedures of the Lummi Nation.

The LWRD is responsible for protecting, restoring, and managing Lummi Nation water resources, including Reservation shorelines, in accordance with the policies, priorities, and guidelines of the Lummi Nation. The overall goal of the LWRD is:

> To protect the treaty rights to water of sufficient quantity and quality to support both the purposes of the Reservation as a permanent, economically viable homeland for the Lummi People, and to support a sustainable harvestable surplus of salmon and shellfish.

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 on and flowing onto the Reservation
3. To support the development and implementation of a water quality regulatory program (*e.g.,* Lummi Code of Laws [LCL] Title 17, Lummi Administrative Regulation [LAR] 17.07 Surface Water Quality Standards) on the Reservation

3.2 Program Context

The WQM Program is an important element of the Comprehensive Water Resources Management Program (CWRMP). The CWRMP was developed pursuant to LIBC resolutions 90-88 and 92-43, which directed the LWRD to develop a program to ensure that the planning and development of Lummi Indian Reservation (Reservation) water and land resources are safeguarded against surface and ground water degradation. Reliable information on the surface and ground water quality of the Reservation is required in order to effectively manage these resources. This QMP, as well as the project QAPPs and associated SOPs, document the quality

management system components needed to ensure the collection of high quality, scientifically valid, legally defensible surface and ground water data.

Related components of the CWRMP include the Nonpoint Source Pollution Management Program (LWRD 2001, 2002, 2015a, 2015b), Wellhead Protection Program (LWRD 1997, 2011b), Storm Water Management Program (LWRD 1998, 2011a), Wetland Management Program (LWRD 2000), and the Water Quality Standards Program (17 LAR 07). Two important milestones in the program development were the January 2004 adoption of the Lummi Nation Water Resources Protection Code (Title 17 of the LCL) and the August 2007 adoption of the Water Quality Standards for Surface Waters of the Reservation (approved by the EPA in September 2008; EPA 2008, 17 LAR 07).

3.3 Lummi Indian Reservation

The Lummi Nation is a federally recognized Tribe of Indians (78 FR 26386). The elected, eleven member LIBC is its governing body. There are more than 4,500 enrolled members of the Lummi Nation (LIBC 2016). The Lummi Indian Reservation (Reservation) is located in the northwest corner of Washington State (Figure 3.1). The Reservation is located along the western boundary of Whatcom County, Washington adjacent to the Strait of Georgia and Puget Sound. The Reservation is comprised of about 12,500 acres of uplands and 7,000 acres of tidelands. The Reservation has approximately 38 miles of marine shoreline and approximately 10 miles of freshwater/estuarine shoreline along the Lummi and Nooksack rivers and deltas.

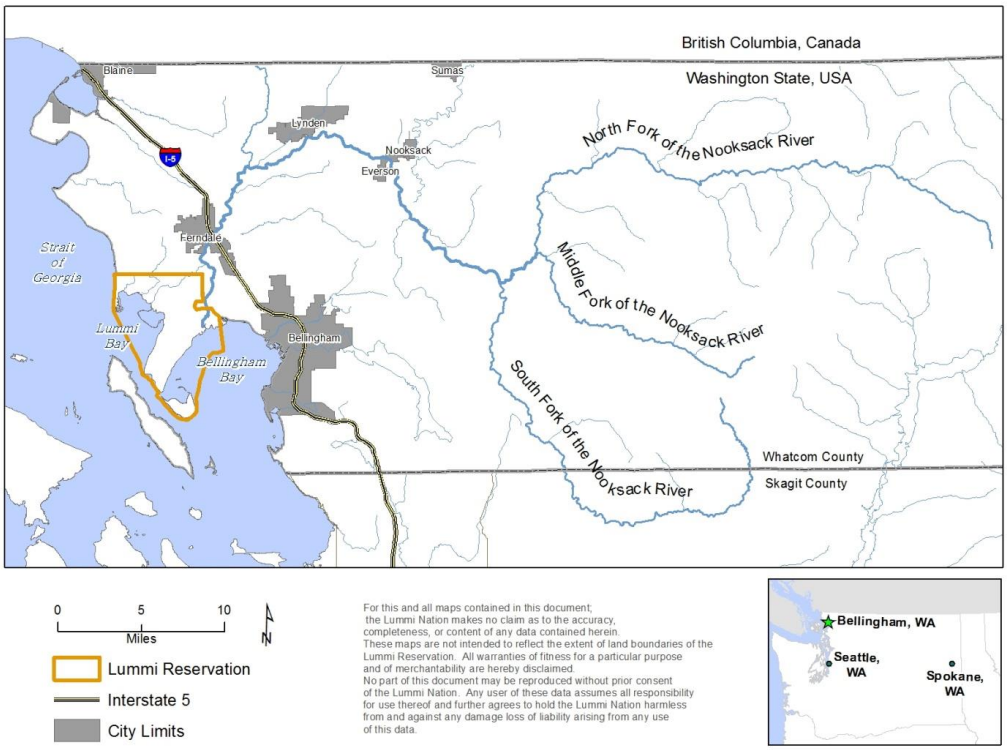

Figure 3.1 Regional Location of the Lummi Indian Reservation

Both the Nooksack River and Lummi River watersheds are under environmental pressures from rapid regional growth. The Lummi Nation has been in a period of economic development through self-governance. The majority of the high-density residential development on the Reservation to date has occurred along the marine shoreline. Recently, several new residential and municipal development projects have been completed or are under construction throughout the Reservation, including the completion of a new Tribal Administration Building, Sandy Point sewer extension, and the Kwina apartments. Growth on and near the Reservation requires the Lummi Nation's core environmental program to prioritize the development of a regulatory infrastructure that is technically and scientifically sound, legally defensible, and administratively efficient. This regulatory infrastructure needs to allow for growth while protecting tribal resources and the Reservation environment, and support both the tribe's goals and the EPA's policy of tribal self-governance and recognition of sovereignty.

3.4 Lummi Nation Waters

The Lummi Nation is the largest fishing tribe in the Puget Sound in terms of pounds of fish caught and number of species fished (NWIFC 2012). The Lummi Nation and its members have relied on their water resources since time immemorial for commercial, ceremonial, and subsistence purposes. Lummi Nation Waters are defined as:

> 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 (Lummi Code of Laws [LCL] 17.09).

Additional details on surface and ground water resources can be found in numerous LWRD publications (LWRD 2000, 2011a, 2011b, 2015a); a summary is provided in the *Lummi Nation Atlas* (LIBC 2016).

3.4.1 Surface Water

There are approximately 38 miles of marine shoreline surrounding most of the Reservation, with the exception of the northern boundary and portions of the eastern boundary. The surrounding tidelands are located within the Strait of Georgia, Lummi Bay, Hale Passage, Portage Bay, and Bellingham Bay. The Reservation tidelands contain significant resources for both the Lummi Nation and the region, including economically and culturally important populations of salmon, herring, oyster, manila clam, little neck clam, butter clam, horse clam, purple varnish clam, and Dungeness crab (LNR 2010a). The estuarine waters found on the Reservation provide habitat important to juvenile and adult salmon and numerous species of waterfowl, marine birds, and raptors (LNR 2010a).

In addition to marine waters, there are 18 rivers, streams, sloughs, and drainages on the Reservation, including the multiple distributary channels of the Nooksack River delta, comprising approximately 24.4 river/stream miles (Table 3.1). There are 11 defined rivers, streams, sloughs, and drainages in the Lummi Bay and Bellingham Bay/Portage Bay watersheds.

Six are Category 1 streams (streams that flow year-round during years of normal rainfall or are used by juvenile or adult salmonids) and five are Category 2 streams (streams that are intermittent or ephemeral during years of normal rainfall and are not known to be used by juvenile or adult salmonids) on the Reservation (LCL Title 17.06.080). All other unnamed drainages and agricultural ditches are classified as Category 2 streams. Five streams, rivers, sloughs, and drainages are completely within the boundaries of the Reservation.

Table 3.1 River and Stream Miles On-Reservation and Off-Reservation

River/Stream	Stream Category	Total Stream/River Miles	On-Reservation Stream/River Miles	Off-Reservation Stream/River Miles	On-Reservation Percent of Stream/River Miles
Lummi Bay Watershed					
Jordan Creek	1	6.6	2.1	4.5	32
Lummi River	1	5.0	3.6	1.4	70
Smuggler Slough	1	3.9	3.9	0	100
Slater Slough	2	1.3	1.3	0	100
Schell Creek	1	4.1	0.4	3.7	10
Onion Creek	2	2.2	1.8	0.4	81
Seapond Creek	2	1.7	1.7	0	100
Bellingham Bay/Portage Bay Watershed					
Nooksack River	1	150	5.1*	144.9	3
Kwina Slough	1	2.3	2.1	0.2	91
Lummi Shore Road Streams	2	2.3	2.3	0	100
Portage Island Streams	2	0.1	0.1	0	100

* Includes all distributary channel lengths in the Nooksack River delta.

There are no lakes on the Reservation, but there are approximately 13 ponds. Finfish and shellfish spawn, incubate, and grow within and adjacent to Lummi Nation Waters (LNR 2010a). The Lummi Nation also operates one shellfish (Lummi Bay) and three salmon hatcheries (Lummi Bay, Sandy Point, and Skookum Creek).

The 18 watersheds found on the Reservation (Table 3.2, Figure 3.2) vary in size from 134 acres up to 4,100 acres with the exception of the Nooksack River watershed, which is 500,000 acres, most of which (99.7%) is located off Reservation (LNR 2010b). These 18 watersheds are aggregated into two primary drainage areas: Lummi Bay and Bellingham Bay/Portage Bay. The Lummi Bay watershed is comprised of nine watersheds and includes Jordan Creek, the Lummi River, Smuggler Slough, Slater Slough, Schell Creek, Onion Creek, and Seapond Creek. The Bellingham Bay/Portage Bay watershed is comprised of nine watersheds and includes the Nooksack River, Kwina Slough, Lummi Shore Road streams, and Portage Island streams.

Bellingham Bay is contiguous with Portage Bay, which is located approximately 5 miles southwest of the Nooksack River delta between the Lummi peninsula and Portage Island. Portage Bay is located within the Reservation boundaries and receives freshwater from the rivers and streams contained within the Bellingham Bay watershed. For this reason, and due to the important shellfish resources within Portage Bay, the watershed is referred to as the Bellingham Bay/Portage Bay watershed. Eleven (11) of the 18 Reservation watersheds are completely within the Reservation boundary.

Table 3.2 Acres of Watersheds On-Reservation and Off-Reservation

Basin ID	Total Watershed Area (acres)	On-Reservation Watershed Area (acres)	Off-Reservation Watershed Area (acres)	Percent of Watershed On-Reservation
Lummi Bay Watershed				
C	494	494	0	100
H	549	549	0	100
I	1,059	1,059	0	100
K	4,091	3,354	737	82
M	Combined with Watershed L			
N	Combined with Watershed O			
L	2,307	133	2,174	6
O	2,747	1,552	1,195	57
P	4,097	228	3,869	6
Q	1,096	570	526	52
R	722	531	191	74
Bellingham Bay/Portage Bay Watershed				
A	280	280	0	100
B	617	617	0	100
D	894	894	0	100
E	218	218	0	100
F	251	251	0	100
G	883	883	0	100
J	134	134	0	100
S (Nooksack River)	518,033	1,296	516,737	0.3
T	392	392	0	100

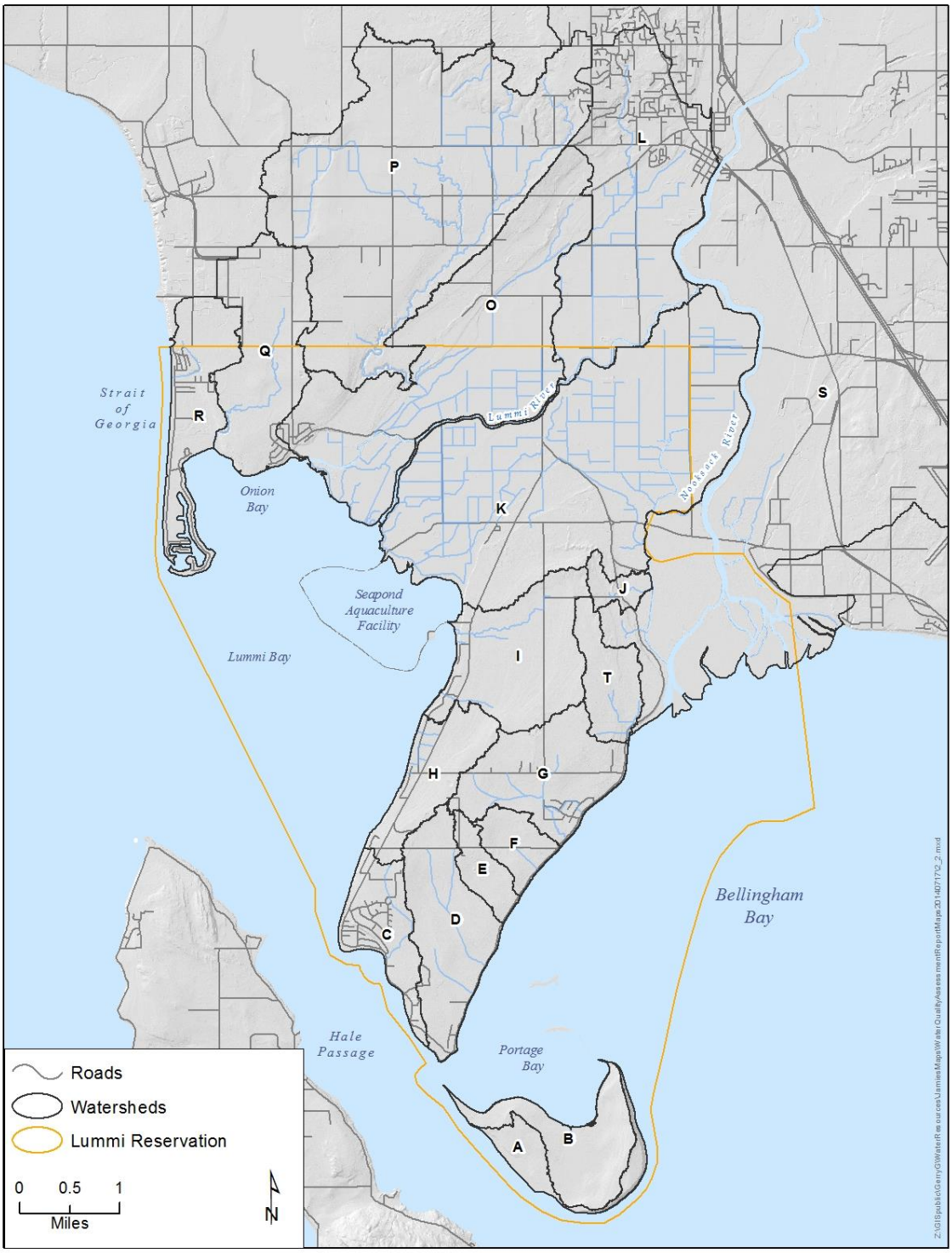

Figure 3.2 Lummi Nation Watersheds

The Nooksack River watershed (watershed S in Table 3.2 and Figure 3.2) comprises the majority of the Water Resources Inventory Area 1 (WRIA 1) located in Whatcom County, Washington State. From its headwaters in the northwestern Cascade Mountains, the Nooksack River drains approximately 809 square miles primarily in western Whatcom County, including agricultural areas and the developed lowlands surrounding the towns of Deming, Everson, Lynden, and Ferndale. The Nooksack River enters the eastern part of the Reservation before it discharges into the marine waters of Bellingham Bay. The Nooksack River is also the primary source of freshwater into Portage Bay (DOH 1997). Most of the Nooksack River watershed is upstream of the Reservation; approximately 0.3% of the Nooksack River watershed is located within the borders of the Reservation.

The Nooksack River flow is comprised of groundwater and precipitation throughout the year supplemented by glacial melt and snowmelt from Mount Baker and adjacent peaks of the Cascade Mountain range during the summer months. The Nooksack River supports several important species of salmon and other aquatic life. The majority of the Nooksack River delta is located on the Reservation and is part of an important marine wetland-estuary complex.

Prior to 1860, the Nooksack River discharged to Lummi Bay via the Lummi River rather than to Bellingham Bay (Deardorff 1992, WSDC 1960). River flow was redirected to Bellingham Bay in 1860 and currently the Lummi River only receives water from the Nooksack River when the flows exceed approximately 9,600 cubic feet per second in the Nooksack River. The Lummi River currently drains much of the area west of the Nooksack River in the vicinity of Ferndale, Washington (14 square miles).

Due to the estuarine environment, nearly all surface waterbodies in the Lummi River and Nooksack River floodplains are exposed to marine influences, which include the presence of saline water, salinity-based stratification, and upstream flow during high tide. Most surface water sample sites are tidally influenced (water level and/or salinity) and have variable water column profiles and salinities (*e.g.,* stratified or well-mixed). In the Lummi Bay watershed, upland sampling sites become dry or saline during the summer months. As the wet season begins, usually during October or November, freshwater flows increase, diluting the salinity levels at tidally influenced surface water sites.

3.4.2 Groundwater

Two separate potable groundwater systems are present on the Reservation. One system is located in the northern upland area; groundwater flows onto the Reservation from the north and drains to the west, south, and east (Aspect Consulting 2009). The second potable groundwater system is located in the southern upland area of the Reservation (Lummi Peninsula) and is completely contained within the Reservation boundaries (LWRD 2011b, Aspect Consulting 2003). The floodplains of the Lummi and Nooksack rivers, which contain a surface aquifer that is saline (Cline 1974), separates the two potable groundwater systems (Figure 3.3). A third potable groundwater system may exist on Portage Island, but information on the water quality and the potential yield of this system is limited and inconclusive.

Currently ground water supplies over 95% of the potable water used on the Reservation. However, potable groundwater is available only within limited areas of the Reservation. Aquifers are generally recharged by local precipitation, and the groundwater yield of wells on the Reservation is typically low and can vary over short distances. In addition to potable water, the salmon hatchery at Lummi Bay is dependent on high quality ground and surface water.

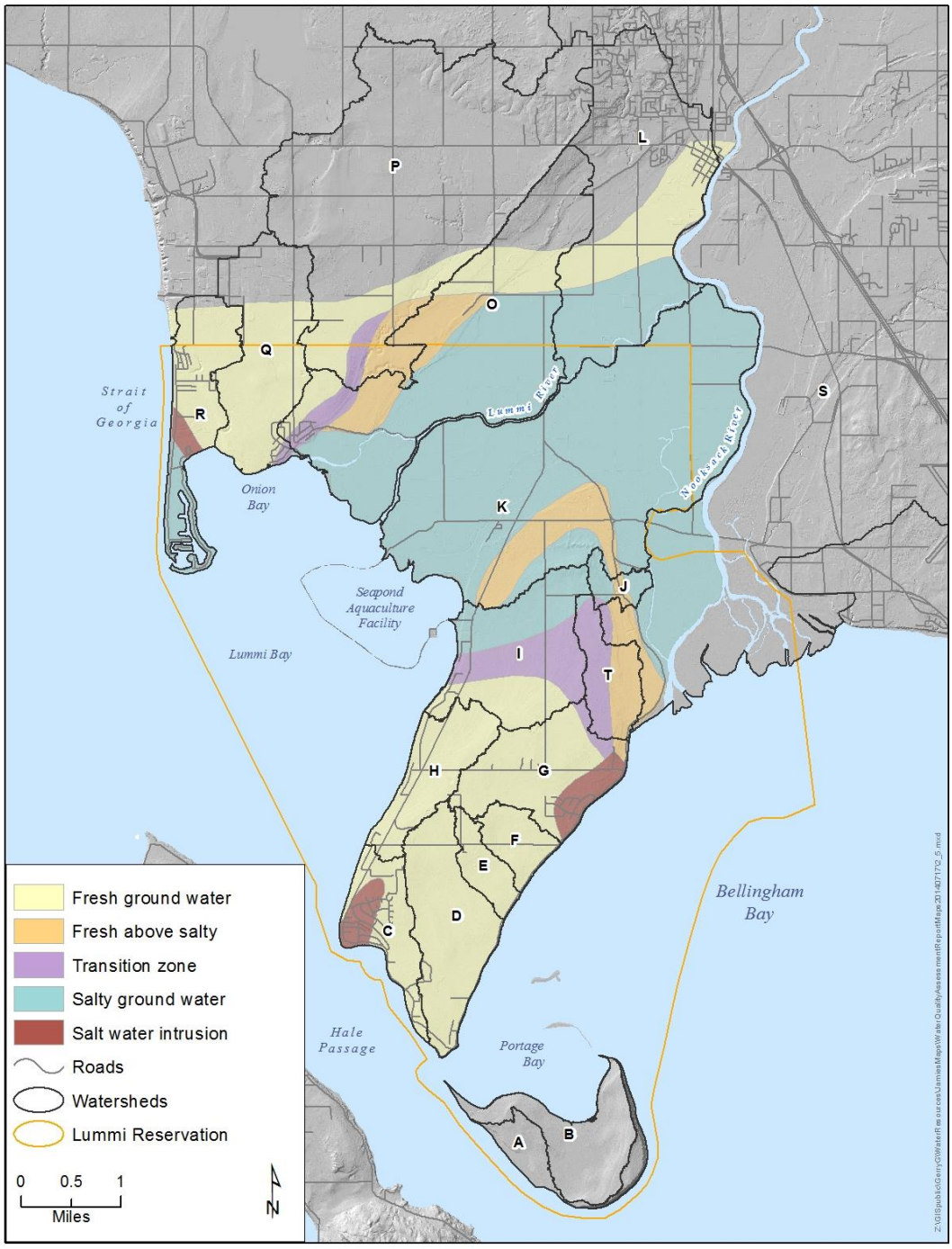

Figure 3.3 Lummi Reservation Groundwater Characteristics (adapted from Cline 1974)

3.5 Water Quality

Water resources are vital for the economic stability, political integrity, growth, and cultural and spiritual life of the Lummi community. The potential contamination of Lummi Nation Waters has a direct, serious, and substantial effect on the health and welfare of the Lummi Nation and its members and can result in economic and cultural hardship by decreasing the health and abundance of fish, shellfish, and wildlife found on the Reservation. There are numerous threats to Lummi Nation Waters, which are described in detail in the *Lummi Nation Nonpoint Source Pollution Assessment Report: 2015 Update* (LWRD 2015a), the *Lummi Nation Nonpoint Source Pollution Management Plan: 2015-2020* (LWRD 2015b) and other documents developed as part of the Lummi Nation CWRMP (LWRD 1997, 1998, 2000, and 2001) and associated updates (LWRD 2011a, 2011b).

The primary water quality concern for surface waters is fecal coliform contamination. The primary groundwater concerns are saltwater intrusion and water mining. These concerns are described in detail in the sections below. In addition, there are general water quality concerns (*e.g.,* temperature and dissolved oxygen) and water quantity (*i.e.,* instream flow) challenges in the Nooksack River watershed due to land development and land use practices.

3.5.1 Fecal Coliform Contamination

The resource-rich tidelands and estuaries of the Reservation, which receive almost all of the water that falls onto or passes through the Reservation, are culturally and economically important to the Lummi Nation. One of these resource-rich tidelands is located in Portage Bay and contains important shellfish beds harvested for commercial, ceremonial, and subsistence purposes by members of the Lummi Nation. Fecal coliform contamination from the Nooksack River presently and historically has threatened Portage Bay shellfish growing areas and resulted in shellfish harvest closures. As previously described, the Nooksack River is the primary source of freshwater into Portage Bay (DOH 1997).

In consultation with the Lummi Nation, 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), the Washington State Department of Health (DOH) 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. 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). According to the 1997 DOH Sanitary Survey of Portage Bay, fecal contamination of the Nooksack River was the result of poor manure management practices by dairy farms in the Nooksack River watershed, and these sources represent a high probability of being the principal source of fecal contamination in Portage Bay. 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.

In 2000, a Total Maximum Daily Load (TMDL) was published for the Nooksack River (Ecology 2000) and a TMDL implementation plan was executed (Ecology 2002). Improvement in water quality resulting in the reopening of shellfish beds in 2006 was generally attributed to the combined effects of inter-agency coordination, water quality monitoring in Portage Bay and the Nooksack River watershed, compliance enforcement inspections by the EPA and Washington State Department of Ecology, and technical assistance and financial support to Nooksack River watershed dairy operations and municipalities (LWRD and Salix 2006b). Although these efforts were initially successful in dramatically improving water quality in the Nooksack River watershed with essentially all of the TMDL targets being achieved at all of the water quality monitoring sites by the end of the first quarter in 2004, soon after the shellfish beds were reopened these improvements began to be reversed. The degradation trends of water quality in the Nooksack River and Portage Bay were obvious as early as 2010. In September 2014, a 335-acre portion of the Portage Bay shellfish growing area was voluntarily closed to harvest by the Lummi Nation to protect public health after two monitoring sites exceeded the NSSP fecal coliform standards. After poor water quality that affected additional sample sites was encountered again in November 2014, the DOH changed the classification of nearly 500 acres of the Portage Bay growing area, including the portions already under the voluntary closure, from “approved” to “conditionally approved” in March 2015 (DOH 2015). In April 2016, with an additional site exceeding the NSSP fecal coliform standards, another 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” (DOH 2016). The conditional closure prohibits commercial shellfish harvest from April 1 through June 30 and from October 1 through December 31 each year for shellfish management areas not achieving the NSSP fecal coliform standards. Due to the poor water quality and associated public health threat, the Lummi Nation has also closed these areas to ceremonial and subsistence harvests although this closure has a substantial impact to harvesters and their families.

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

3.5.2 Saltwater Intrusion and Groundwater Mining

Saltwater intrusion and groundwater mining are related concerns for potable groundwater resources found on the Reservation. Groundwater mining, the withdrawing of groundwater at a rate that exceeds the recharge rate of the supply aquifer, can reduce the long-term ability of freshwater aquifers to provide good quality groundwater for potable uses. Groundwater mining can also lead to saltwater intrusion, the movement of saline water into freshwater aquifers; when freshwater wells are over-pumped, the saline groundwater is pulled into the freshwater

aquifer due to pressure gradients. Saltwater intrusion can contaminate drinking water sources and reduce the supply of potable groundwater since well pump rates must be reduced or supply wells taken out of production to prevent further saltwater intrusion.

Groundwater resources on the Reservation are particularly vulnerable to saltwater intrusion because the Reservation is in a coastal area with most of the existing supply wells located within a half-mile of marine waters (LWRD 1997). Because of the proximity to marine waters and the local geology, the aquifers on the Reservation are subject to both horizontal and vertical saltwater intrusion if wells are over-pumped (LWRD 1997). The majority of residential development has occurred along the marine shoreline, placing the most vulnerable portion of aquifers at risk through pumping of groundwater near marine shorelines.

An ample supply of good quality groundwater is needed to serve the purposes of the Reservation as a permanent and economically viable homeland for the Lummi People. As a finite resource, groundwater is one of the most important and critical of the Lummi Nation's water resources. Because 95% of potable water used on the Reservation is groundwater, contamination of groundwater resources could lead to the loss of the primary water supply for the Reservation. Groundwater contamination is very expensive to treat, and in some cases can be impossible to reverse or mitigate. Alternative water supply sources are expensive and may not be available in amounts sufficient to replace existing supplies and to provide for future growth, thereby reducing tribal self governance and stability. Saltwater intrusion has already occurred in three areas of the Reservation (Figure 3.3) making prevention of further saltwater intrusion imperative for protecting on-Reservation drinking water sources.

3.6 Lummi Nation Surface Water Quality Standards

The *Water Quality Standards for Surface Waters of the Lummi Indian Reservation* (Lummi Nation Water Quality Standards) detail four surface water classes (AA Extraordinary, A Excellent, B Good, and Lake Class) and their characteristic uses, and provide water quality criteria for a variety of parameters for each class (17 LAR 07). Class AA Extraordinary waters support and provide the greatest number of characteristic uses, including salmonid migration, juvenile rearing, spawning, egg incubation, and fry emergence, and therefore have the most stringent water quality criteria. Table 3.3 provides details on the characteristic uses and water quality criteria for each surface water class.

The Lummi Nation Water Quality Standards also include numeric criteria for toxic substances, including metals, and narrative criteria for nutrients in accordance with nuisance conditions (17 LAR 07). Water quality criteria for toxic substances and nutrients are provided in the Nutrients, Metals, and Hydrocarbons Project QAPP (LWRD 2021g).

Table 3.3 Summary of Water Quality Criteria and Uses of the Various Classes of Lummi Indian Reservation Surface Waters

Class AA Extraordinary	Class A Excellent	Class B Good	Lake Class
General Characteristics			
Uniformly exceeds the requirements for all or substantially all uses	Meets or exceeds the requirements for all or substantially all uses	Meets or exceeds the requirements for most uses	Meets or exceeds the requirements for all or substantially all uses
Characteristic Uses			
(A) Water supply (domestic, commercial, municipal, industrial, agricultural). **(B)** Stock watering. **(C)** Fish and shellfish: Salmonid migration, juvenile rearing, spawning, egg incubation, fry emergence, and harvesting. Other fish migration, juvenile rearing, spawning, egg incubation, fry emergence, and harvesting. Clam, oyster, and mussel rearing, spawning, and harvesting. Crustaceans and other shellfish (crabs, shrimp, crayfish, scallops, geoduck, etc.) rearing, spawning, and harvesting. **(D)** Wildlife habitat. **(E)** Recreation (extraordinary primary contact, primary contact, sport fishing, boating, canoeing, and aesthetic enjoyment). **(F)** Commerce and navigation. **(G)** Tribal Cultural	**(A)** Water supply (domestic, commercial, municipal, industrial, agricultural). **(B)** Stock watering. **(C)** Fish and shellfish: Salmonid migration, juvenile rearing, and harvesting. Other fish migration, juvenile rearing, spawning, egg incubation, fry emergence, and harvesting. Clam, oyster, and mussel rearing, spawning, and harvesting. Crustaceans and other shellfish (crabs, shrimp, crayfish, scallops, geoduck, etc.) rearing, spawning, and harvesting. **(D)** Wildlife habitat. **(E)** Recreation (primary contact, sport fishing, boating, canoeing, and aesthetic enjoyment). **(F)** Commerce and navigation. **(G)** Tribal Cultural	**(A)** Water supply (industrial, agricultural). **(B)** Stock watering. **(C)** Fish and shellfish: Salmonid migration, juvenile rearing, and harvesting. Other fish migration, juvenile rearing, spawning, egg incubation, fry emergence, and harvesting. Clam, oyster, and mussel rearing and spawning. Crustaceans and other shellfish (crabs, shrimp, crayfish, scallops, geoduck, etc.) rearing and spawning. **(D)** Wildlife habitat. **(E)** Recreation (secondary contact, sport fishing, boating, and aesthetic enjoyment). **(F)** Commerce and navigation. **(G)** Tribal Cultural	**(A)** Water supply (domestic, commercial, municipal, industrial, agricultural). **(B)** Stock watering. **(C)** Fish and shellfish: Salmonid migration, juvenile rearing, spawning, egg incubation, fry emergence, and harvesting. Other fish migration, juvenile rearing, spawning, egg incubation, fry emergence, and harvesting. Clam and mussel rearing and spawning. Crayfish rearing and spawning. **(D)** Wildlife habitat. **(E)** Recreation (extraordinary primary contact, primary contact, sport fishing, boating, canoeing, and aesthetic enjoyment). **(F)** Commerce and navigation. **(G)** Tribal Cultural

Table 3.3 Summary of Water Quality Criteria and Uses of the Various Classes of Lummi Indian Reservation Surface Waters

Class AA Extraordinary	Class A Excellent	Class B Good	Lake Class
Freshwater Fecal Coliform Bacteria Geometric Mean Density			
Shall both not exceed 50 colonies/100 ml AND not exceed 100 colonies/100 ml in more than 10% of the samples obtained for calculation purposes	Shall both not exceed 100 colonies/100 ml AND not exceed 200 colonies/100 ml in more than 10% of the samples obtained for calculation purposes	Shall both not exceed 200 colonies/100 ml AND not exceed 400 colonies/100 ml in more than 10% of the samples obtained for calculation purposes	Shall both not exceed 50 colonies/100 ml AND not exceed 100 colonies/100 ml in more than 10% of the samples obtained for calculation purposes
Marine Water Fecal Coliform Bacteria Geometric Mean Density			
Shall both not exceed 14 colonies/100 ml AND not exceed 43 colonies/100 ml in more than 10% of the samples obtained for calculation purposes	Shall both not exceed 14 colonies/100 ml AND not exceed 43 colonies/100 ml in more than 10% of the samples obtained for calculation purposes	Shall both not exceed 100 colonies/100 ml AND not exceed 200 colonies/100 ml in more than 10% of the samples obtained for calculation purposes	N/A
Freshwater Enterococci			
Shall both not exceed a geometric mean density of 33 colonies/100 ml AND not exceed a single sample maximum allowable density of 61 colonies/100 ml	Shall both not exceed a geometric mean density of 33 colonies/100 ml AND not exceed a single sample maximum allowable density of 61 colonies/100 ml	Shall both not exceed a geometric mean density of 33 colonies/100 ml AND not exceed a single sample maximum allowable density of 78 colonies/100 ml	Shall both not exceed a geometric mean density of 33 colonies/100 ml AND not exceed a single sample maximum allowable density of 61 colonies/100 ml
Marine Water Enterococci			
Shall both not exceed a geometric mean density of 35 colonies/100 ml AND not exceed a single sample maximum allowable density of 104 colonies/100 ml	Shall both not exceed a geometric mean density of 35 colonies/100 ml AND not exceed a single sample maximum allowable density of 104 colonies/100 ml	Shall both not exceed a geometric mean density of 35 colonies/100 ml AND not exceed a single sample maximum allowable density of 158 colonies/100 ml	N/A

Table 3.3 Summary of Water Quality Criteria and Uses of the Various Classes of Lummi Indian Reservation Surface Waters

Class AA Extraordinary	Class A Excellent	Class B Good	Lake Class
Freshwater Dissolved Oxygen Concentration			
The seven-day mean minimum shall both not be less than 11.0 mg/l AND not have a spatial median intergravel dissolved oxygen concentration below 8.0 mg/l. If minimum spatial median intergravel dissolved, oxygen is 8.0 mg/l or greater, the minimum dissolved oxygen criterion is 9.0 mg/l. Where barometric pressure and temperature preclude attainment of criteria, dissolved oxygen must not be less than 95% of saturation.	Shall not be less than 8.0 mg/l. Where barometric pressure and temperature preclude attainment of criteria, dissolved oxygen must not be less than 90% of saturation.	Shall not be less than 6.5 mg/l.	No measurable decrease from natural conditions
Marine Water Dissolved Oxygen Concentration			
Shall exceed a 1-day minimum daily concentration of 7.0 mg/l	Shall exceed a 1-day minimum daily concentration of 6.0 mg/l	Shall exceed a 1-day minimum daily concentration of 5.0 mg/l	N/A
Freshwater Temperature			
Shall not exceed a 7-day average of the daily maximum value (7DADM) temperature of 16.0°C. For summertime spawning, temperature shall not exceed a 7DADM temperature of 13.0°C.	Shall not exceed a 7DADM temperature of 17.5°C.	Shall not exceed a 7DADM temperature of 17.5°C.	No measurable increase from natural conditions
Marine Water Temperature			
Shall not exceed a 1-day maximum temperature of 13.0°C	Shall not exceed a 1-day maximum temperature of 16.0°C	Shall not exceed a 1-day maximum temperature of 19.0°C	N/A
Freshwater pH			
6.5 – 8.5	6.5 – 8.5	6.5 – 8.5	No measurable change from natural conditions
Marine Water pH			
7.0 – 8.5	7.0 – 8.5	7.0 – 8.5	N/A

Table 3.3 Summary of Water Quality Criteria and Uses of the Various Classes of Lummi Indian Reservation Surface Waters

Class AA Extraordinary	Class A Excellent	Class B Good	Lake Class
Turbidity			
Shall not exceed 5 NTU over background turbidity when background turbidity is less than or equal to 50 NTU OR not increase by more than 10% when the background turbidity is greater than 50 NTU	Shall not exceed 5 NTU over background turbidity when background turbidity is less than or equal to 50 NTU OR not increase by more than 10% when the background turbidity is greater than 50 NTU	Shall not exceed 5 NTU over background turbidity when background turbidity is less than or equal to 50 NTU OR not increase by more than 20% when the background turbidity is greater than 50 NTU	Shall not exceed 5 NTU over background turbidity
Toxic, Radioactive, Or Deleterious Material Concentrations			
Shall be less than concentrations that have the potential either singularly or cumulatively to adversely affect characteristic water uses, cause acute or chronic conditions to the most sensitive biota dependent upon those waters, or adversely affect public health as determined by the Director.	Shall be less than concentrations that have the potential either singularly or cumulatively to adversely affect characteristic water uses, cause acute or chronic conditions to the most sensitive biota dependent upon those waters, or adversely affect public health as determined by the Director.	Shall be less than concentrations that have the potential either singularly or cumulatively to adversely affect characteristic water uses, cause acute or chronic conditions to the most sensitive biota dependent upon those waters, or adversely affect public health as determined by the Director.	Shall be less than concentrations that have the potential either singularly or cumulatively to adversely affect characteristic water uses, cause acute or chronic conditions to the most sensitive biota dependent upon those waters, or adversely affect public health as determined by the Director.
Aesthetic Values			
Shall not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch, or taste or taint the flesh of edible species	Shall not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch, or taste or taint the flesh of edible species	Shall not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch, or taste or taint the flesh of edible species	Shall not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch, or taste or taint the flesh of edible species

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4. MANAGEMENT AND ORGANIZATION

The purpose of this section is to document the overall policy, scope, applicability, and management responsibilities of the WQM Program and quality management system. This section documents the management structure and hierarchy of the organization and individuals involved in the WQM Program as well as roles and responsibilities for implementing the quality management system. This section also provides the procedures for assuring that all personnel performing work as part of the WQM Program have the necessary skills to effectively accomplish their work.

4.1 Management Organization and Roles

The LNR is an administrative division of the LIBC, which is the elected governing body of the Lummi Nation. The Lummi Fisheries and Natural Resources Commission provides policy direction to the LNR Director, and the LWRD Manager reports directly to the Director and Deputy Director of the LNR (Figure 4.1).

The Lummi Nation WQM Program is implemented by a number of key staff members. Table 4.1 identifies these key personnel, provides contact information, identifies their roles and responsibilities with respect to the WQM Program, and identifies their relative positions, position requirements, and their qualifications.

It is noted that staff composition is dynamic in that individual roles and responsibilities evolve over time. One of the LWRD goals is to provide training and on-the-job experience to enrolled Lummi tribal members so that they can gain familiarity with sound natural resources management practices. The training of a technician can take a minimum of 12 months but once proficiency is attained, these individuals typically seek positions with more responsibility. The Water Resources Technician position and all of the positions and individuals identified in this QMP are representative of the types of people needed to effectively implement the WQM Program.

The Director and Deputy Director are the policy decision makers for the LNR. The Director ensures that the Deputy Director has the resources necessary to fulfill project oversight responsibilities associated with the WQM Program. The Deputy Director in turn ensures that the Water Resources Manager has the resources necessary to fulfill project management responsibilities associated with the WQM Program.

The Water Resources Manager is responsible for administering contracts and overseeing the budget for the WQM Program. In addition, the Water Resources Manager serves as the WQM Program Project Manager and Quality Assurance Manager. The organization is too small to provide for a completely independent Quality Assurance Manager. The Water Resources Manager supervises, directly or indirectly, the Water Resources Specialist II/Planner, Water Resources Specialist II, and the Water Resources Technician II, and evaluates and analyzes the data collected as part of the WQM Program on an as-needed basis. The Water Resources Manager generally does not directly collect water quality data or coordinate the water quality

data collection. The Water Resources Manager makes recommendations to the Director and Deputy Director, who make decisions based upon data collected as part of the WQM Program.

The Water Resources Specialist II/Planner performs regular quality assurance audits that the Water Resources Manager evaluates for compliance with the quality management system and program goals.

The Water Resources Specialist II provides oversight of the WQM Program and supervises the Water Resources Technician II and Natural Resources Technician II. The Water Resources Specialist II is the primary staff person responsible for implementation of the WQM Program, including: project coordination; data evaluation and analysis; maintaining the official, approved QMP [this document], QAPPs, and SOPs; equipment maintenance; supply management. The Water Resources Specialist II is also responsible for coordination with the laboratory contracted for sample analysis, Edge Analytical, Inc. (located in Burlington, WA and Bellingham, WA), and for coordinating sample schedules for the DOH Support (NSSP) Project with the DOH Environmental Health Specialist IV. The Water Resources Specialist II, Water Resources Technician II, and Natural Resources Technician II are responsible for implementing the WQM Program projects following quality management system protocols outlined in this QMP, QAPPs and SOPs.

The Database Manager created and maintains the WQM Program databases (Water Database, Datalogger Database, and Lummi Well Reporting Database) and is the primary staff member responsible for database training and documentation.

The Database Manager, Water Resources Specialist II, and Water Resources Specialist II/Planner report directly to the Water Resources Manager.

The LWRD maintains a contract with an independent laboratory, Edge Analytical, Inc. (Edge; located in Burlington, WA and Bellingham, WA), for analysis of water quality samples as part of several projects. Edge subcontracts to ALS-Kelso, for certain analytical tests.[1] The DOH Public Health Laboratory (located in Shoreline, WA) provides analysis of samples collected as part of the DOH Support (NSSP) Program.

[1] Upon accreditation, Edge will subcontract certain analytical tests to IEH Analytical Laboratories

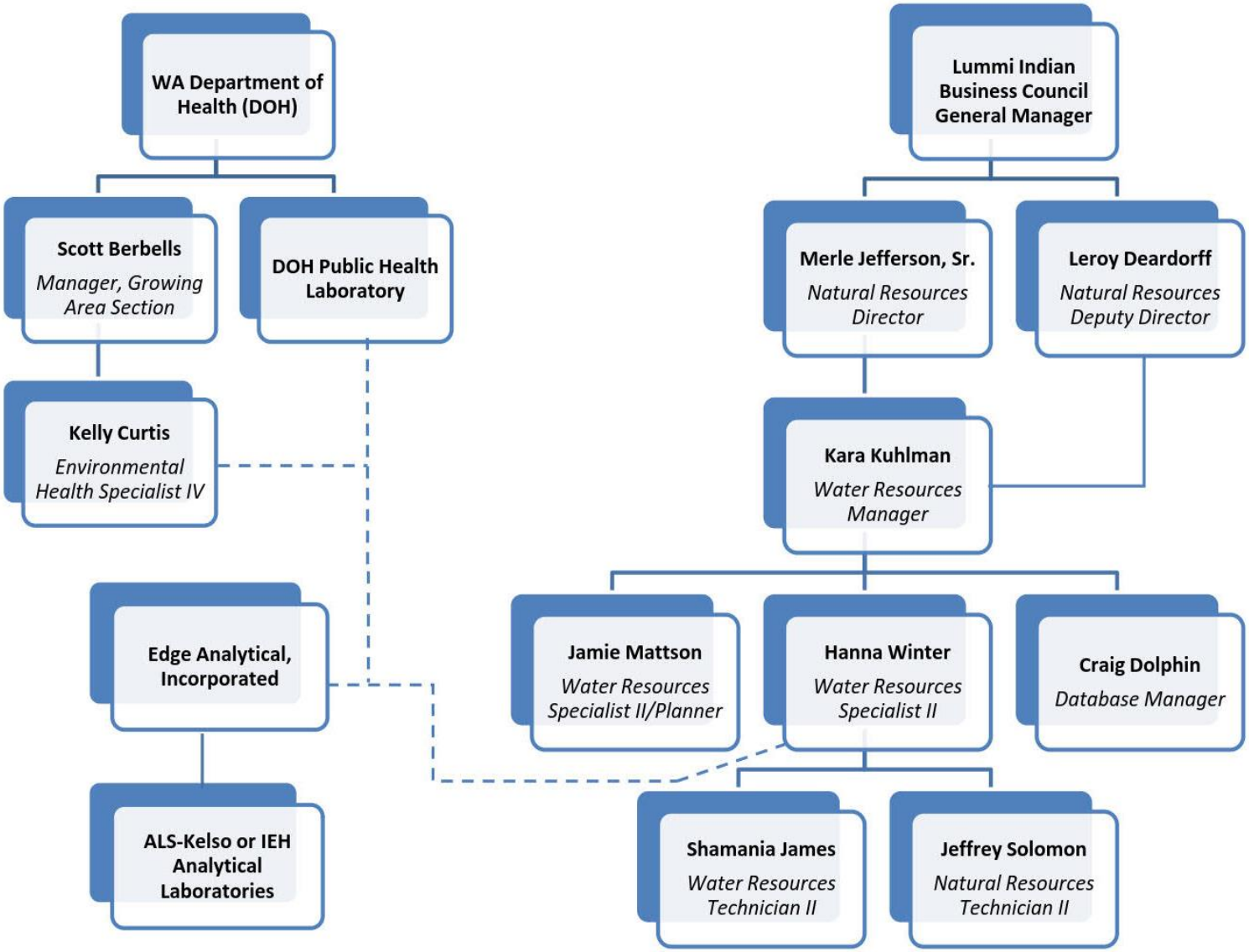

Figure 4.1 Lummi Natural Resources Key Staff and Contracted Laboratories Involved in the Lummi Nation Water Quality Monitoring Program

4.2 Personnel Qualification

The title, role, contact information, position requirements, and qualifications held by the current Water Resources Manager, Water Resources Specialist II/Planner, Water Resources Specialist II, and Water Resources Technician II are listed in Table 4.1.

Table 4.1 Lummi Water Resources Division Position Requirements

Name/Title/Role/Contact	Position Requirements	Held Qualifications
Kara Kuhlman Water Resources Manager, WQM Program Project Manager and Quality Assurance Manager (360) 312-2128 karak@lummi-nsn.gov	Master of Science degree in a related field (Lummi Nation Code of Laws 17.02.020)	Certified Floodplain Manager, Master of Science degree in Environmental Science, Bachelor of Science degree in Environmental Science, 10 years professional experience.
Jamie Mattson Water Resources Specialist II/Planner, WQM Program Quality Assurance Officer (360) 312-2313 jamiem@lummi-nsn.gov	Bachelor of Science degree in a related field, Master of Science highly desired but not required	Bachelor of Science degree in Environmental Science with emphasis on water quality and minor in geology, 11 years professional experience.
Hanna Winter Water Resources Specialist II, WQM Program Coordinator (360) 312-2312 hannaw@lummi-nsn.gov	Bachelor of Science degree in environmental, physical, or one of the natural sciences	Master of Science degree in Environmental Science, Bachelor of Science degree in Environmental Science with emphasis on freshwater ecology and minor in environmental policy, 7 years professional experience.
Shamania James Water Resources Technician II (360) 384-7101 shamaniaj@lummi-nsn.gov	High school diploma or equivalent	Associate Degree in Arts and Sciences, 2 years professional experience.
Jeffrey Solomon Natural Resources Technician II (360) 312-2128 jeffreys@lummi-nsn.gov	High school diploma or equivalent	GED and 2 years college, 2 years professional experience.

4.3 Training Requirements

All staff involved in WQM Program implementation are required to read this QMP, project QAPPs, and instrument and method SOPs before conducting data generation activities or using data collected as part of the WQM Program.

Additional training requirements for individuals implementing the WQM Program are identified in Table 4.2. These requirements can be completed prior to or during employment with the

LWRD. All of this information is retained in personnel files held by the Water Resources Manager, and copies of training certificates are held by the employees and their supervisors. Supervisors and the Water Resources Manager are responsible for ensuring staff are qualified and trained.

Table 4.2 Training Requirements (Water Resources Specialist and Technician Positions)

Required	Desired
• Health care (basic first aid, cardiopulmonary resuscitation) • Computer proficiency (word processing, spreadsheet, presentation, database) • Boat use and safety • Incident Command System/National Incident Management System • Experience with or on-the-job training in: water quality sampling methods, groundwater sampling methods, quality assurance and quality control • 24-Hour Hazardous Materials Technician training	• First Responder Awareness training • First Responder Operations training • Electrical hazards and safety training • Global Positioning System applications • Construction site storm water management • Construction site storm water inspection • Management and supervision • Geographic Information Systems applications • Project design and management • Environmental regulations and ethics • Hydrologist Technician certification • Continuous data collection methods/protocol

4.4 Reviews

Staff training or retraining needs are assessed on an ongoing basis as issues arise, new programs are developed, or requirements evolve. Formal performance reviews and performance plan development are conducted annually in January for all LWRD staff as required by LIBC policy. Supervisors and staff identify opportunities for training to ensure that individuals involved in WQM Program implementation or review have and maintain the appropriate knowledge, skill, statutory, regulatory, or professional certifications, accreditations, licenses, or other formal qualification as necessary.

4.5 Communications

Regular and open communication between field staff and supervisors is integral to planning, assessing, and improving the WQM Program and quality management system. The Water Resources Specialist II reports any QA/QC issues or quality system failures to the Water Resources Manager. When problems are detected and not resolved through standard practices or are of a more complex nature than the staff conducting water quality sampling typically address, the Water Resources Specialist II, Water Resources Technician II, and the Water Resources Manager will jointly develop an action plan to remedy the problem with clear roles, responsibilities, and timelines.

Additional details on how management will assure that applicable elements of the quality management system are understood and implemented in all environmental programs are provided in Section 10.

5. WQM PROGRAM PROJECTS

Currently, there are five surface water projects and three groundwater projects implemented by the LWRD as part of the WQM Program. These projects and studies are listed below.

Surface water projects:

- Ambient Surface Water Quality Monitoring Project (Surface Water Project)
- Department of Health Support (NSSP) Project (DOH NSSP Project)
- First Flush Monitoring Project (First Flush Project)
- Nutrient, Metal, and Hydrocarbon (NMH) Project
- Continuous Temperature Monitoring (CTM) Project

Groundwater projects:

- Ambient Ground Water Quality and Quantity Monitoring Project (Ground Water Project)
- Continuous Aquifer Level Monitoring (CALM) Project
- Lummi Peninsula Groundwater Settlement Agreement Compliance Monitoring Project (Settlement Compliance Project)

As previously described, the QMP documents the overall quality management system for the WQM Program. All WQM Program projects implemented by the LWRD are subject to the quality management system outlined in this QMP. A detailed description of each project and the associated quality assurance components are outlined in individual project QAPPs. Most projects are associated with specific instruments or methods for measuring water quality parameters. Quality assurance components and instructions for use of these equipment and methods for parameter measurement associated with each project are outlined in SOPs. Figure 5.1 summarizes the organization of the WQM Program, including all projects and instruments or methods used. Figure 5.1 also illustrates the structure of the quality management system documents: the QMP, QAPPs, and SOPs. Citations of QAPPs and SOPs associated with the WQM Program and subject to this QMP are listed in Section 13.2.

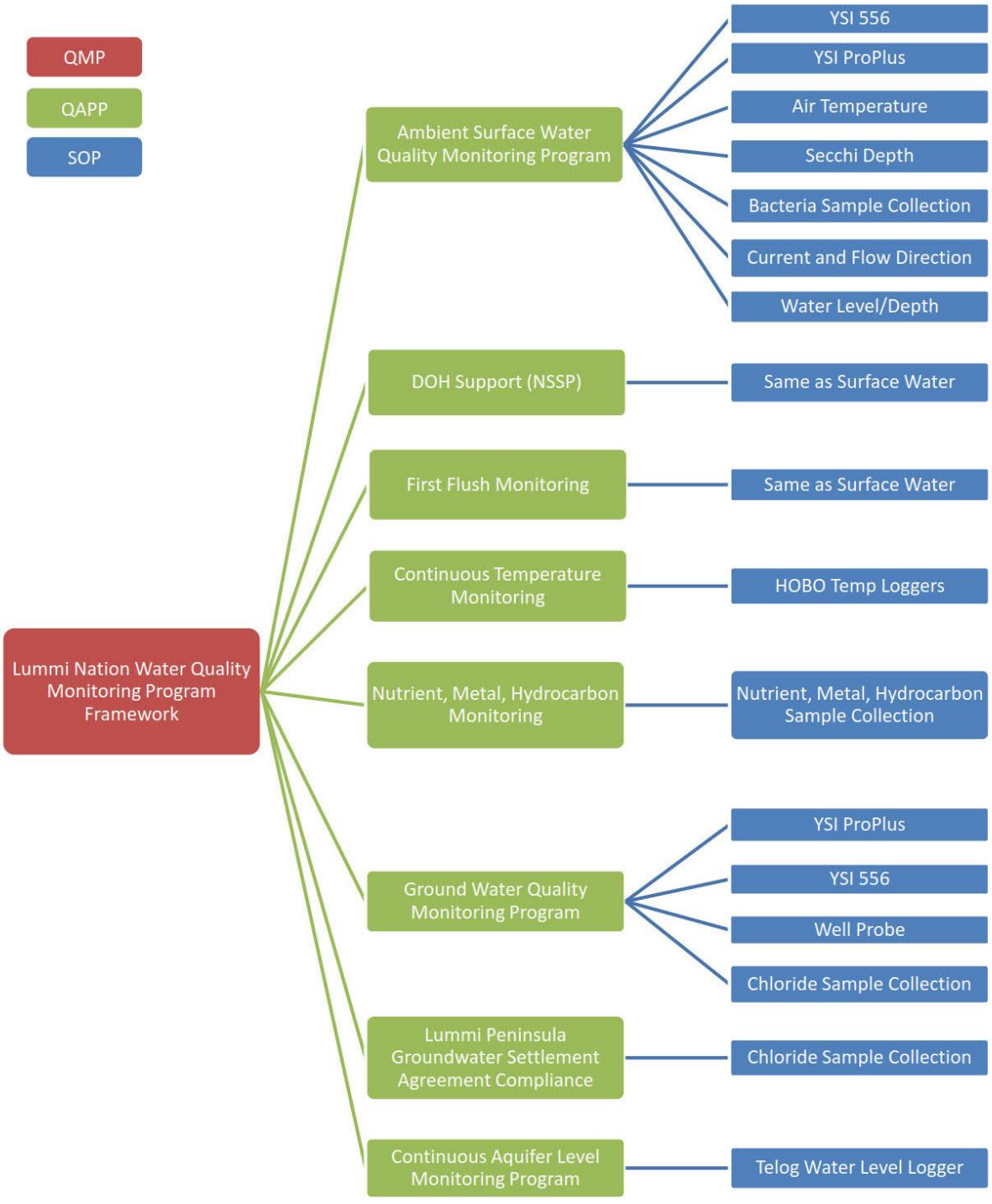

Figure 5.1 Components of the Quality Management System: QMP for the WQM Program, QAPPs for Each WQM Program Project, and SOPs for Each Instrument/Method

A total of 63 surface water and 32 groundwater sites are regularly monitored as part of the WQM Program (Figure 5.2, Figure 5.3, Table 5.1, and Table 5.2). The Ambient Surface Water Quality Monitoring Project (Surface Water Project) and Ambient Groundwater Quality and

Quantity Monitoring Project (Ground Water Project) are the LWRD's ongoing core monitoring projects that are complemented by other, shorter-term or more intensive projects. Several sample sites are included in more than one monitoring project. For example, the sample site at the Nooksack River at Marine Drive Bridge (SW118) is included in the Surface Water Project, First Flush Monitoring Project, CTM Project, and the NMH Project.

A summary of the projects implemented within the WQM Program is presented in the sections that follow. In addition, a summary of changes that have occurred since each project inception is also included.

The WQM Program projects are designed to achieve the following objectives, which support the goals of the WQM Program and the LWRD mission:

1. Provide high quality data sufficient to establish baseline conditions of Lummi Nation Water (surface water and groundwater)
2. To evaluate compliance with water quality criteria
3. To evaluate fecal coliform contributions from on- and off-Reservation sources
4. Protect groundwater supplies from saltwater intrusion and groundwater mining
5. To support the development of a water quality regulatory program

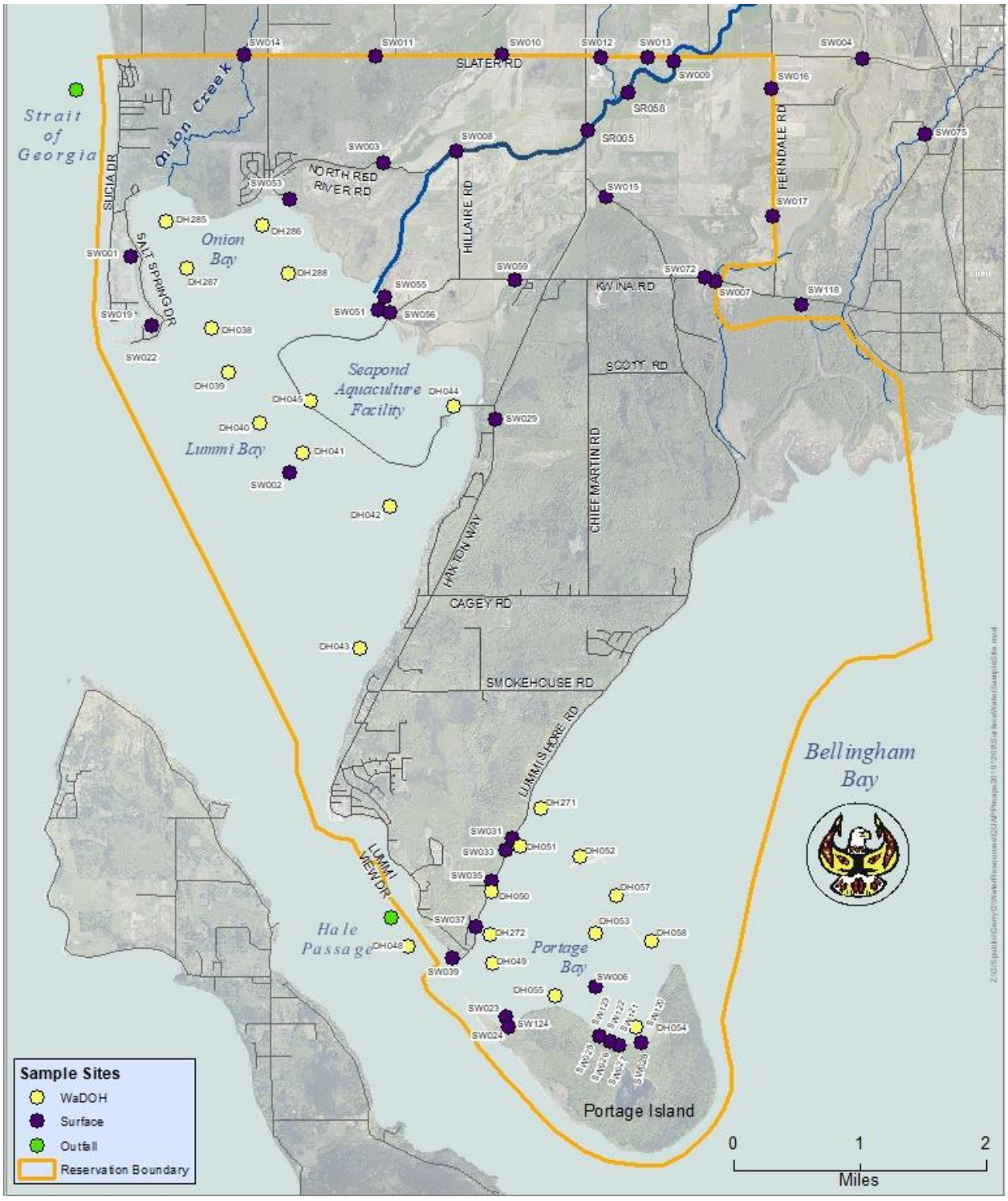

Figure 5.2 Water Quality Monitoring Program Surface Water Sample Sites

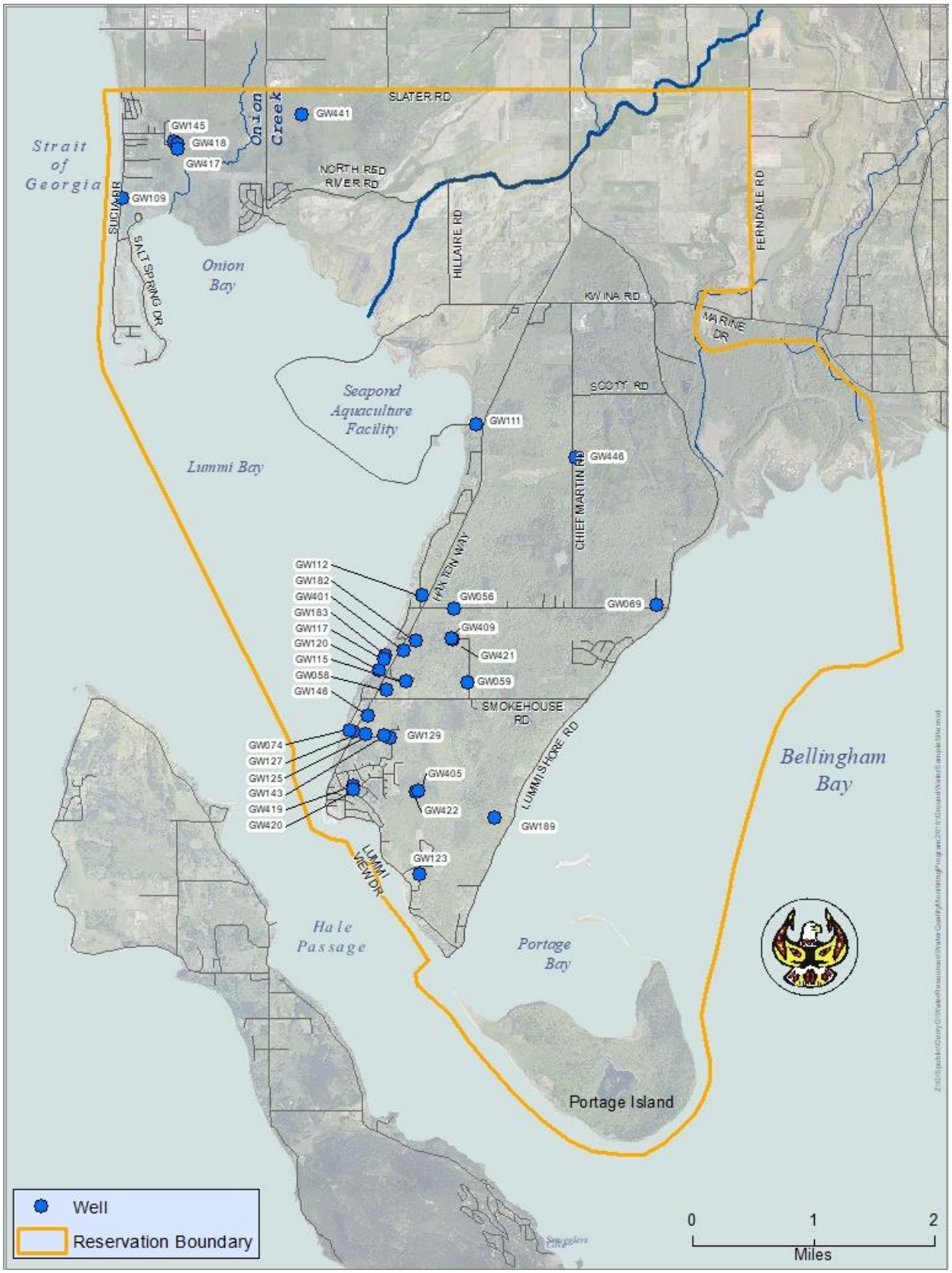

Figure 5.3 Water Quality Monitoring Program Groundwater Sample Sites

Table 5.1 Location of Surface Water Quality Monitoring Sites, Water Class Designation, and Associated Projects

Sample Site ID	Sample Site Location	Water Class Designation	Projects Included
SW001	North end of Sandy Point Marina	AA Marine	Surface Water, NMH
SW002	Lummi Bay southwest of Seapond Aquaculture Facility	AA Marine	Surface Water, NMH
SW003	Jordan Creek at North Red River Road	AA Fresh	Surface Water, First Flush, NMH, CTM
SW004	Alternate Nooksack River site at Slater Road[2]	Flows to AA Fresh[2]	Surface Water
SR005	Lummi River at Haxton Way pedestrian bridge	AA Fresh	Surface Water
SW006	Portage Bay, North of Portage Island	A Marine	Surface Water
SW007	Kwina Slough at Marine Drive	AA Fresh	Surface Water, First Flush
SW008	Lummi River at Hillaire Road Bridge	AA Marine	Surface Water, First Flush, CTM
SW009	Lummi River at Slater Road	AA Fresh	Surface Water, First Flush, NMH, CTM
SW010	Drainage on Slater 200 yards west of Haxton	AA Fresh	Surface Water, First Flush
SW011	Jordan Creek at Slater Road	AA Fresh, Eph.	Surface Water, First Flush, CTM
SW012	Schell Creek at Slater Road	AA Fresh	Surface Water, First Flush, CTM
SW013	Agricultural drainage between Schell Creek and Lummi River	AA Fresh	Surface Water, First Flush
SW014	Drainage from Phillips 66 stormwater treatment facility at Slater Road; flows to Onion Creek	AA Fresh, Eph.	Surface Water, First Flush, NMH
SW015	Smuggler Slough at Lummi Shore Drive	AA Fresh	Surface Water, First Flush, NMH, CTM
SW016	Drainage on Ferndale Road south of Slater Road	AA Fresh	Surface Water, First Flush
SW017	Drainage on Ferndale Road north of Marine Drive	AA Fresh	Surface Water, First Flush
SW019	South end of Sandy Point Marina	AA Marine	Surface Water
SW023	Portage Bay near beach on the northwest inner corner of Portage Island	A Marine	Surface Water
SW024	Drainage along road at beach on the northwest inner corner of Portage Island	A Fresh, Eph.	Surface Water
SW025	Drainage along road at beach on Portage Island	A Fresh, Eph.	Surface Water

[2] Site SW004 is sampled when access to SW118 for sampling is unsafe or impractical, such as during flooding conditions or river maintenance activities.

Table 5.1 Location of Surface Water Quality Monitoring Sites, Water Class Designation, and Associated Projects

Sample Site ID	Sample Site Location	Water Class Designation	Projects Included
SW026	Portage Island drainage	A Fresh, Eph.	Surface Water
SW027	Stream originating from wetland on Portage Island	A Fresh, Eph.	Surface Water
SW028	Portage Island drainage	A Fresh, Eph.	Surface Water
SW029	Drainage from Lummi Peninsula uplands east of Haxton Road near Lummi Shellfish Hatchery	AA Fresh, Eph.	Surface Water, First Flush
SW031	Outflow along Lummi Shore Road	A Fresh	Surface Water, First Flush
SW033	Outflow along Lummi Shore Road	A Fresh	Surface Water, First Flush
SW035	Outflow along Lummi Shore Road at Adams Road	A Fresh	Surface Water, First Flush
SW037	Outflow along Lummi Shore Road at Bay Lane	A Fresh	Surface Water, First Flush
SW039	West side of Portage Island Spit at south end of Lummi Peninsula	AA Marine	Surface Water, First Flush
SW051	Lummi River Mouth	AA Marine	Surface Water, First Flush, CTM
SW053	North Lummi River Distributary Mouth	AA Marine	Surface Water, First Flush, CTM
SW055	Drainage channel culvert outlet on east side of Lummi River levee road	AA Marine	Surface Water
SW056	Smuggler Slough outlet	AA Marine	Surface Water
SW058	Agricultural ditch that flows to Lummi River through culvert under South Red River Road	AA Marine	Surface Water, First Flush
SW059	Smuggler Slough at Kwina Road	AA Marine	Surface Water, CTM
SW072	Smuggler Slough at Self Regulating Tidegate at Marine Drive	AA Fresh	Surface Water
SW075	Silver Creek at Shady Lane Bridge	Flows to AA Fresh[3]	Surface Water, NMH
SW118	Nooksack River at Marine Drive Bridge	AA Fresh	Surface Water, First Flush, NMH, CTM
DH038	Lummi Bay east of Sandy Point	AA Marine	DOH Support
DH039	Lummi Bay	AA Marine	DOH Support
DH040	Lummi Bay	AA Marine	DOH Support
DH041	Lummi Bay	AA Marine	DOH Support
DH042	Lummi Bay	AA Marine	DOH Support

[3] 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).

Table 5.1 Location of Surface Water Quality Monitoring Sites, Water Class Designation, and Associated Projects

Sample Site ID	Sample Site Location	Water Class Designation	Projects Included
DH043	Lummi Bay near West Beach	AA Marine	DOH Support
DH044	Seapond Aquaculture Facility east	AA Marine	DOH Support
DH045	Seapond Aquaculture Facility west	AA Marine	DOH Support
DH048	Hale Passage	AA Marine	DOH Support
DH049	Portage Bay off shore of Hermosa Beach	A Marine	DOH Support
DH050	Portage Bay off shore of Hermosa Beach	A Marine	DOH Support
DH051	Portage Bay off shore of Hermosa Beach	A Marine	DOH Support
DH052	Portage Bay by Brandt Island	A Marine	DOH Support
DH053	Portage Bay by Brandt Spit	A Marine	DOH Support
DH054	Portage Bay off north-central side of Portage Island	A Marine	DOH Support
DH055	Portage Bay off northwestern side of Portage Island	A Marine	DOH Support
DH057	Portage Bay by Brandt Spit	A Marine	DOH Support
DH058	Portage Bay by Brandt Spit	A Marine	DOH Support
DH271	Portage Bay off shore of Hermosa Beach	A Marine	DOH Support
DH272	Portage Bay off shore of Hermosa Beach	A Marine	DOH Support
DH285	Lummi Bay in Onion Bay	AA Marine	DOH Support
DH286	Lummi Bay, Lummi Flats near outflow of North Red River distributary	AA Marine	DOH Support
DH287	Lummi Bay in Onion Bay	AA Marine	DOH Support
DH288	Lummi Bay, Lummi Flats	AA Marine	DOH Support

Abbreviations:
Surface Water = Ambient Surface Water Quality Monitoring Project
CTM = Continuous Temperature Monitoring Project
Eph. = Ephemeral
NMH = Nutrients, Metals, and Hydrocarbons Monitoring Project

Table 5.2 Ground Water Quality and Aquifer Level Monitoring Wells

Well Name	Well ID	Aquifer	Well Type	Projects Included
Cultee	GW056	Southern	Domestic (not in use)	CALM
Horizon	GW058	Southern	Supply	Ground Water, Settlement
Kinley 1	GW059	Southern	Supply	Ground Water, Settlement
Greene	GW069	Southern	Domestic	Settlement
Charles	GW074	Southern	Domestic	Ground Water, Settlement
Finkbonner, J	GW109	Northern	Domestic	Ground Water, Settlement
Hopkins	GW111	Southern	Supply (not in use)	CALM
Jefferson	GW112	Southern	Domestic (not in use)	Ground Water
Balch	GW115	Southern	Supply	Ground Water, Settlement
Herrmann	GW117	Southern	Domestic	Settlement
Dzyban and Morison	GW120	Southern	Domestic	Settlement
Kinley	GW123	Southern	Domestic	Settlement
Curtis and Wales	GW125	Southern	Domestic	Settlement
Revey	GW127	Southern	Domestic (not in use)	CALM
Mackenzie 2	GW129	Southern	Supply	Ground Water, Settlement
Berg	GW143	Southern	Domestic	Ground Water, Settlement
Johnson	GW145	Northern	Supply	Ground Water
West Shore	GW146	Southern	Supply	Ground Water, Settlement
Robbins and Freeman	GW182	Southern	Domestic	Settlement
Fadden	GW183	Southern	Domestic	Settlement
Egawa	GW189	Southern	Domestic	Ground Water, Settlement
Summers	GW401	Southern	Domestic	Settlement
Mackenzie 3	GW405	Southern	Supply (not in use)	CALM
Kinley 2	GW409	Southern	Supply	Ground Water, Settlement
Northwest Well 1	GW417	Northern	Supply	Ground Water
Northwest Well 2	GW418	Northern	Supply	Ground Water
Gooseberry Point 4	GW419	Southern	Supply (not in production)	Ground Water, Settlement
Gooseberry Point 5	GW420	Southern	Supply (not in production)	Ground Water, Settlement
Kinley 3	GW421	Southern	Supply	Ground Water, Settlement
Mackenzie 4	GW422	Southern	Supply (not in production)	Ground Water
Howell	GW446	Southern	Supply (not in production)	Ground Water
Northwest Well 3	GW441	Northern	Supply (not in production)	Ground Water

Abbreviations:
Ground Water = Ambient Ground Water Quality and Quantity Monitoring Project
CALM = Continuous Aquifer Level Monitoring Project
Settlement = Lummi Peninsula Ground Water Settlement Agreement

5.1 Ambient Surface Water Quality Monitoring Project

5.1.1 Summary

The Lummi Nation Ambient Surface Water Quality Monitoring Project (Surface Water Project) has been ongoing since 1993, and is focused on monitoring the water quality of waters flowing

onto and through the Reservation, including marine waters, freshwater drainages, Portage Island, and the Nooksack River. The Surface Water Project provides water quality data from 36 surface water sites on the Reservation to determine whether these waters meet Lummi Nation Water Quality Standards (17 LAR 07).

Bacteria (fecal coliform, *Escherichia coli*, and enterococcus) samples and *in situ* water quality parameters (water temperature, salinity, specific conductivity, pH, and dissolved oxygen) are measured monthly at 21 sites and 6 times per year at 15 sites. The Surface Water Project provides data regarding the water quality and bacteria levels of waters entering the Reservation from off-Reservation sources, entering Portage Bay from the Nooksack River and on-Reservation sources, and entering Lummi Bay from off Reservation and on-Reservation sources. Data are used to determine whether these waters meet Lummi Nation Water Quality Standards.

5.1.2 Historic Project Changes

When the Surface Water Project was initiated in 1993, it consisted of eleven surface water sample sites numbered SW001 through SW011. Five sites (SW005, SW007, SW009, SW010, and SW011) are located along the upland Reservation boundary and were chosen to provide information about the quality of water flowing onto the Reservation. Three sites (SW001, SW002, and SW006) are located in marine waters and were chosen to document background water quality in Portage Bay, Lummi Bay, and the Sandy Point Marina. Two sites (SW003 and SW008) are located approximately mid-way between the upland Reservation boundary and marine waters to obtain a better spatial resolution of water quality in relationship to the upland Reservation boundary sites. Site SW004 is located on the Nooksack River at the Slater Road Bridge and was replaced by Site SW018 in 1997 and then by SW118 in 2007.[4]

The majority of the expansion of the surface water quality monitoring project occurred in the mid to late 1990s in response to fecal coliform contamination in Portage Bay and the resultant downgrade of commercial shellfish bed classification from “approved” to “restricted” under the NSSP. As previously mentioned, according to the 1997 DOH Sanitary Survey of Portage Bay, fecal contamination of the Nooksack River is the result of poor manure management practices by dairy farms in the Nooksack River watershed and represents a high probability of being the principal source of fecal contamination in Portage Bay (DOH 1997). Several freshwater and marine sites along Lummi Shore Road were added in 1998 as part of a study of fecal coliform contributions to Portage Bay from the Hermosa Beach area. The study concluded in 2001 and found that the runoff from the Hermosa Beach area was not a substantial source of fecal coliform bacteria to Portage Bay and also suggested that the Nooksack River was the source of elevated bacteria levels in Portage Bay (LWRD and Salix 2006b). The fecal coliform contamination of Portage Bay also prompted the increase in the number of sample sites located in Lummi Bay and the Lummi Bay watershed to better characterize the area, provide for

[4] Site SW004 was historically never measured by LWRD staff. Data for this site was obtained from the Washington State Department of Ecology. The site is now occasionally measured when flooding of the Nooksack River or maintenance activities preclude sampling at SW118 (Nooksack River at Marine Drive Bridge).

additional baseline information, and respond to potential and actual sources of pollution as Lummi Bay also contains significant shellfish resources.

A summary of historic additions (and subsequent changes) follows:

- Sites numbered SW012 through SW018 were added to measure all remaining surface waterbodies flowing onto the Reservation. Site SW018 was replaced with SW118 in 2007 to ensure safe access to the Nooksack River.
- Sites numbered SW019 through SW022 were added to evaluate potential contamination from populated areas with septic drain fields at the south end of Sandy Point. Three of these sites have been discontinued as sewer access has since been extended to the area.
- Sites numbered SW023 through SW039 along Lummi Shore Road were added as part of a 3-year intensive sampling project to better characterize potential local contributions of bacteria to Portage Bay from the Hermosa Beach area along the eastern shoreline of the Lummi Peninsula (LWRD and Salix 1999, 2006a, 2006b). Since completion of this study, five of the sites were discontinued (SW030, SW032, SW034, SW036, SW038).
- Sites numbered SW015, SW051, SW052, SW053, SW055, SW056, SW059, and SW072 were added to obtain higher spatial resolution within the Lummi Bay watershed (site SW052 has since been discontinued).
- Sites numbered SW120 through SW0124 were added to better characterize the marine receiving waters of drainages flowing into Portage Bay from Portage Island. These sites have since been discontinued as ongoing sampling as part of the Surface Water and DOH Support (NSSP) Projects in Portage Bay provide information about the marine receiving waters.

The number of parameters analyzed by an independently contracted laboratory has also increased over time. Bacteria sampling expanded from enumerating one bacteria type, usually fecal coliform or occasionally *E. coli*, per site to enumerating fecal coliform, *E. coli*, and enterococcus at each sample site.

Prior to 2008, the number of sample sites monitored and other job duties limited the ability of the Water Resources Specialist and Water Resources Technician to sample all of the sites each month. In April 2008, the WQM Program was evaluated and the LWRD was reorganized to include two Water Resources Specialists and a Water Resources Technician II. The staffing increases along with the purchase of time-saving monitoring equipment allowed for all Surface Water Project sites to be sampled monthly or more frequently as needed. The 2006 purchase of a 26-foot marine vessel has allowed for regular marine sampling during weather conditions that had historically made marine sampling unsafe resulting in rescheduled or cancelled marine sample runs.

5.1.3 Project Changes Since 2010

In September 2013, the Water Resources Manager recommended the Surface Water Project be adapted to eliminate the sampling of sites that were no longer essential to achieving project goals and to reduce the sampling frequency of certain sites while maintaining sufficient

temporal resolution for adequate data analysis (LWRD 2013a). The recommended changes were approved and sampling at seven sites was suspended indefinitely and the sampling frequency at five sites on the Lummi Shore Road (LSR) run was reduced from monthly to six times per year (Table 5.3). In addition, turbidity and flow measurement as part of the Surface Water Project have been suspended. Secchi depth is measured at marine sites in place of turbidity, but measurement of turbidity in freshwaters is not included in the Surface Water Project sampling.

In May 2015, sampling at site SW118 on the day prior to NSSP sampling in Portage Bay was added to the Surface Water Project as part of a county-wide, multiple agency partnership to collect multiple samples from the Nooksack River watershed on the same day.

In December 2015, site SW029 was moved from the LSR run to the Flood Plain East (FPE) run. Site SW029 was originally included as part of the LSR run as a legacy of the 1999-2001 study of fecal coliform contributions to Portage Bay from the Hermosa Beach area (sites along Lummi Shore Road). Site SW029 served as the reference site for the study because the site represents an undeveloped watershed on the Lummi Peninsula, and was used as a measure of background fecal coliform levels in the area. Since the Hermosa Beach study has been completed and site SW029 flows into Lummi Bay, the site was moved to the FPE run to ensure that it is sampled on the same day as other sites flowing into Lummi Bay. If necessary, the site can still be used as a reference site as it remains an undeveloped watershed on the Lummi Peninsula.

In March 2016, the Sandy Point and Portage Island (SP&PI) run was reduced from monthly to six times per year and sampling was suspended at six sites (SW022, SW120-124) (LWRD 2016). Site SW022 was initially added to the Surface Water Project in April 1998 to evaluate potential contamination from populated areas with septic drain fields at the south end of Sandy Point. Sampling at Site SW022 was discontinued because homes at Sandy Point were connected to the Lummi Tribal Sewer and Water District sewer lines in January 2014. Sites SW120 through SW124 are marine sites paired with tidally influenced freshwater sites on Portage Island that were added to the Surface Water Project in September 2008 to better understand fecal coliform contributions into Portage Bay originating from Portage Island. Sampling at these sites was suspended due to redundancy in measurement of water quality in the marine receiving waters as several other marine sites sampled as part of the Surface Water and DOH Support (NSSP) Projects provide water quality information about the receiving waters in Portage Bay. Reduced sampling at the remaining sites on the SP&PI run allows for the sampling of Portage Island sites on the same day as NSSP sampling in Portage Bay, and sampling of Sandy Point sites on the same day as NSSP sampling in Lummi Bay. As background conditions have been established at these sites over several years of ambient monitoring, reduced sampling frequency will maintain adequate temporal resolution for analysis of seasonal and year-to-year water quality trends.

In March 2016, a new sample site was added to the Surface Water Project: SW075 (Silver Creek at Shady Lane Bridge) (LWRD 2016). Silver Creek is a tributary to the Nooksack River delta with an industrial, commercial, and residential developed watershed. As water quality in Silver Creek is not currently monitored, adding a sampling site for Silver Creek would allow for

characterization of the contributions of Silver Creek to the water quality of the Nooksack River delta and Portage Bay.

Two sites in the Lummi River drainage have been added to increase the spatial resolution between then Reservation boundary and mouth of the Lummi River. In January 2018, monitoring at site SW059, an agricultural ditch, was returned to the Floodplain West run. In June 2019, monitoring at site SR005 was added to the Floodplain West run in response to an investigation into low dissolved oxygen and high fecal coliform observed in the Lummi River.

Table 5.3 summarizes changes to the Surface Water Project since 2010, when the previous quality assurance document for this project was issued.

Table 5.3 Summary of Changes to Lummi Nation Ambient Surface Water Quality Monitoring Project Since 2010

Site Identification	Change	Justification for Change
SW030	Sampling suspended	Redundant, safety, time-consuming.
SW032	Sampling suspended	Part of a three-year study (1998-2001) to evaluate water quality impacts of storm water originating along Lummi Shore Road to shellfish growing areas in Portage Bay; other sampling (freshwater inputs along Lummi Shore Road) remains.
SW034	Sampling suspended	
SW036	Sampling suspended	
SW038	Sampling suspended	
SW052	Sampling suspended	Redundant.
SW058	Sampling re-initiated in 2018	Initially suspended in 2013 because rarely flowing/stagnant, safety. Returned to the project in January 2018.
SW022	Sampling suspended	No longer area of concern due to sewer hook-up in area.
SW120-124	Sampling suspended	Redundant.
LSR run sites: SW031, SW033, SW035, SW037, SW039	Sampling frequency reduced from monthly to 6 times/year	Originally part of a three-year study (1998-2001) to evaluate water quality impacts of storm water originating along Lummi Shore Road to shellfish growing areas in Portage Bay; baseline bacteria established for this area.
SP&PI run sites: SW001, SW002, SW006, SW019, SW023-28	Sampling frequency reduced from monthly to 6 times/year in coordination with DOH sampling	Baseline conditions established for these areas; redundant as regular sampling in Portage Bay provides conditions of marine waters receiving freshwater flow from Portage Island sites.
SW029	Moved from LSR to FPE run	Originally the reference site for the three-year study referenced above. Moved to coordinate sampling with other sites flowing into Lummi Bay.
SW118	Additional sampling	Additional sampling the day prior to NSSP sampling in Portage Bay.
SW075	Add sampling site	Sample Site SW075 (Silver Creek at Shady Lane Bridge) added for monitoring of this Nooksack River tributary.

Table 5.3 Summary of Changes to Lummi Nation Ambient Surface Water Quality Monitoring Project Since 2010

Site Identification	Change	Justification for Change
SR005	Add to WQM Program	Sample Site SR005 (Lummi River at Haxton Way pedestrian crossing) added for monitoring of Lummi River system in response to investigation in June 2019.
All sites	Flow measurement suspended	Time-consuming and of marginal benefit without established stage-discharge relationships.
All sites	Turbidity measurement suspended	Marginal benefit without flow measurement and established stage-discharge relationships.

5.2 Department of Health Support (NSSP) Project

5.2.1 Summary

As previously described, in consultation with the Lummi Nation, DOH is responsible to the FDA to ensure that the NSSP standards for certification of shellfish growing waters are met on the Reservation.[5] Fecal coliform counts 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 sample sites in Portage Bay and twelve sample sites in Lummi Bay are currently monitored as part of the DOH Support (NSSP) Project. Portage Bay is sampled twelve times per year, six times per year by DOH and six times per year by LWRD on alternating months. Lummi Bay is sampled six times per year by LWRD. Fecal coliform samples analyzed by the DOH laboratory in Shoreline, WA and *in situ* water quality parameters (temperature, pH, dissolved oxygen, specific conductivity, and salinity) are collected by LWRD. Data are used to determine whether these waters meet both NSSP standards and Lummi Nation Water Quality Standards.

5.2.2 Project Changes

The DOH began NSSP sampling in 1989 at ten sites in Portage Bay and eight sites in Lummi Bay. In 2002, two sites were added to Portage Bay and four sites were added to Lummi Bay to increase spatial resolution. The frequency of sampling in Portage Bay was increased from six times per year to twelve times per year in May 2014 to provide higher temporal resolution of fecal coliform trends due to recent shellfish harvesting area closures.

[5] 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).

5.3 First Flush Monitoring Project

5.3.1 Summary

The First Flush Monitoring Project provides data regarding the water quality and bacteria counts of waters upon the start of the wet season. First flush monitoring involves the collection of bacteria (fecal coliform, *E. coli*, and enterococcus) samples and *in situ* water quality parameters (water temperature, salinity, specific conductivity, pH, and dissolved oxygen) when the freshwater drainages of the Lummi Bay and Bellingham Bay watersheds begin to flow after the first substantial rains at the commencement of the wet season (typically October or November). Eight sites in the Bellingham Bay watershed and ten to fifteen sites in the Lummi Bay watershed are included in the First Flush Monitoring Project.

5.3.2 Project Changes

Site SW029 was originally included as part of the Bellingham Bay First Flush sample run as a legacy of the 1999-2001 study of fecal coliform contributions to Portage Bay from the Hermosa Beach area (sites along Lummi Shore Road). As described above (Section 5.1.3), site SW029 served as the reference site for the study because the site represents an undeveloped watershed on the Lummi Peninsula, and was used as a measure of background fecal coliform levels in the area. Since the Hermosa Beach study has been completed and site SW029 flows into Lummi Bay, the site was moved to the Lummi Bay First Flush run to ensure that it is sampled on the same day as other sites flowing into Lummi Bay. If necessary, the site can still be used as a reference site as it remains an undeveloped watershed on the Lummi Peninsula.

5.4 Nutrients, Metals, and Hydrocarbons Project

5.4.1 Summary

The Lummi Nation Nutrients, Metals, and Hydrocarbons (NMH) Project has been ongoing since 1998, and is focused on monitoring nutrients, metals, and hydrocarbons in waters on and flowing onto the Reservation at representative and targeted locations. 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. Data collected as part of the NMH Project are used to evaluate on- and off-Reservation sources of nutrients, metals, and hydrocarbons and compared to Lummi Nation Water Quality Standards.

5.4.2 Project Changes

Twenty sites have been sampled for nutrients at various times since commencement of nutrient monitoring in 1998. In 2013, nutrient sampling at Site SW006 was discontinued due to high cost, challenges in analyzing marine samples for nutrients, and results indicating low nutrient concentrations at this site (LWRD 2013a). Site SW006 is still sampled for bacteria and *in situ* water quality parameters as part of the Surface Water Project.

Site SW118 (Nooksack River at Marine Drive Bridge) was added to the NMH Project in 2013 to monitor nutrient levels in the Nooksack River. Due to the large presence of agriculture in the watershed, there is a potential for the occurrence of excess nutrients in the Nooksack River. Site SW075 (Silver Creek at Shady Lane Bridge) was added to the NMH Project in 2016 to monitor metals and hydrocarbons in this rapidly developing watershed.

Six sites have been sampled for metals and hydrocarbons at various times since commencement of metals and hydrocarbons monitoring in 1999. Targeted water quality monitoring at three sites (SW100, SW101, and SW102) associated with an on-Reservation auto recycling company occurred from 2004 to 2012. The sampling of metals and hydrocarbons was discontinued at these sites because of high costs and results indicating low potential of metal and hydrocarbon contamination, particularly after all vehicles were removed from the facility in early 2011 (LWRD 2013b).

5.5 Continuous Temperature Monitoring Project

5.5.1 Summary

The Continuous Temperature Monitoring (CTM) Project provides continuous temperature data from ten surface water sites on the Reservation to determine whether these waters meet the Lummi Nation Water Quality Standards. Water temperature is measured every 30 minutes, and rolling 7-day averages of the daily maximum water temperature (7DADM) for freshwater sites and 1-day maximum water temperature for marine water sites are calculated. One reference site is also included for continuous monitoring of air temperature providing data used for QA/QC activities.

5.5.2 Project Changes

In 2013, the water temperature measurement interval was increased from 15 minutes to up to one hour (LWRD 2013a). This allowed for reduced frequency of site visits for data downloading from once per month to four times per year. In 2016, the water temperature measurement interval was set to 30 minutes to maintain quarterly site visit frequency while maximizing data collection.

5.6 Ambient Groundwater Quality and Quantity Monitoring Project

5.6.1 Summary

The Ambient Groundwater Quality and Quantity Monitoring Project (Ground Water Project) has been ongoing since 1993, and is focused on monitoring Reservation groundwater quality and aquifer levels. Chloride and water quality parameters (temperature, salinity, specific conductivity, and pH) are measured five times per year (April, June, August, October, and December) at 14 groundwater sites. Water level is measured five times per year at 18 ground water sites. The data collected within this project are used to identify trends (annual and multi-

year), establish baseline conditions, evaluate risk of saltwater intrusion, and generally monitor aquifer level variations.

5.6.2 Project Changes

The number of wells sampled has increased over the years. Wells have been added as they were drilled or when access was granted to obtain better spatial resolution of aquifer conditions. Wells have been removed as they were decommissioned. A total of 67 wells have been sampled for groundwater quality and 27 have been monitored for aquifer level since inception of the project.

During a review of the WQM Program in 2013, sampling of groundwater sites was reduced from once per month to five times per year (LWRD 2013a). Monthly sampling was no longer justified, given the high demands on field staff and ten years of baseline data indicating relatively stable water levels and chloride concentrations. Sampling five times per year on alternating months beginning in April, when ground water levels are expected to be the highest, through the dry period (June, August, October), when aquifers are most at-risk, to the beginning of the wet period (December) allows for continued trend monitoring sufficient to detect changes in aquifer condition with reduced staff efforts.

In January 2016, the Howell well (GW446) was moved from the monitoring wells run to the domestic wells run to match Ground Water Project sampling frequency.

The parameters measured have increased as the capability to measure additional parameters has become available; for example, specific conductivity measurement began in 1999 and salinity measurement began in 2009.

Chloride has been measured in a variety of ways as part of the Ground Water Project. Groundwater chloride concentration was measured using a LaMotte chloride field test kit from 1992 to 2011. In 2011, a chloride sensor for the YSI Professional Plus multi-parameter water quality sonde was purchased for measurement of chloride concentration in groundwater, and use of the LaMotte test kit was discontinued. Since April 2016, chloride samples are collected for analysis at a contracted laboratory to improve precision and accuracy. Historically, chloride samples have been periodically collected for analysis at a contracted laboratory since 1992. In addition, since 2008, chloride samples have been collected for analysis at a contracted laboratory as part of both the Lummi Peninsula Groundwater Settlement Agreement (Settlement Compliance Project).

5.7 Continuous Aquifer Level Monitoring Project

5.7.1 Summary

The Continuous Aquifer Level Monitoring (CALM) Project provides continuous aquifer water level data from four groundwater sites on the Reservation. Data collected from this project are used to identify seasonal, annual, and multi-year trends in water levels for the Lummi Peninsula aquifer. Data are also used to ensure that adequate water quantity is present for extraction of

groundwater for potable uses, and that pump rates at tribal supply wells are not causing overall aquifer levels to decrease.

5.7.2 Project Changes

The number of wells included in the CALM Project has varied over the years. Currently, four wells are included in the project. Five additional wells have historically been monitored as part of the CALM Project, but they have been discontinued for various reasons. Continuous monitoring at the Kinder-Morgan (GW442) and Northwest 1 (GW417) wells was discontinued because they were being monitored as part of a short-term study to examine water levels in the Northern Lummi Aquifer. A Lummi Tribal Water District aquifer level datalogger is currently deployed at the Johnson well (GW145), but access to the datalogger is impeded by well infrastructure. In 2016, an aquifer level datalogger will be deployed in one of the Northern Lummi Aquifer wells to reestablish monitoring of this aquifer. Continuous monitoring at the Mackenzie 1 (GW128) and Pierre (GW066) wells was discontinued when these wells were decommissioned in 2010 and 2014, respectively.

In 2013, the water level measurement interval was changed from 15 minutes to one hour (LWRD 2013a). This allowed for reduced frequency of site visits for data downloading from once per month to four times per year.

5.8 Lummi Peninsula Groundwater Settlement Agreement Compliance Monitoring Project

5.8.1 Summary

The Lummi Peninsula Groundwater Settlement Agreement Compliance Monitoring Project (Settlement Compliance Project) ensures compliance with the chloride and water use reporting required by the Lummi Peninsula Groundwater Settlement Agreement.[6] Chloride samples are collected once per year (in August) for small wells (*i.e.,* wells with three or fewer households connected) and three times per year (in April, August, and December) for large wells (*i.e.,* wells with more than three households connected, including tribal supply wells). Currently, 13 small wells and 7 large wells are sampled for chlorides. The chloride results are evaluated for trends and compared to chloride trigger levels and water use limits as outlined in the Settlement Agreement. Annual water use for the water year (October 1-September 30) and chloride results are included in well reports completed annually in November as required by the Settlement Agreement.

5.8.2 Project Changes

The number of wells included in the Settlement Compliance Project has decreased since the Settlement Agreement was signed in 2008. Ten wells have been removed from compliance monitoring because these households have been connected to water supplied by the Lummi

[6] Settlement Agreement Regarding Uses of Groundwater on Lummi Peninsula, *United States and Lummi Nation v. State of Washington, Department of Ecology, et al,* W.D. Wash C01-0047Z, Document 1264-2, November 13, 2007

Water District. One parcel was not subject to compliance monitoring because no well was present on the property. Two wells at Gooseberry Point were connected to the Lummi Water District as supply wells in 2012. These two wells (Gooseberry 4 [GW420] and Gooseberry 5 [GW419]) were included as part of the Settlement Compliance Project as large wells from December 2012 to August 2014. In 2014, the Gooseberry wells were taken out of production and are not currently (and are not expected to be in the future) used as supply wells. They are now included in the Settlement Compliance Project as small wells.

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6. DOCUMENTS AND RECORDS

The purpose of this section is to document appropriate controls for quality-related documents and records determined to be important to the goals of the LWRD and WQM Program. This section also includes sections related to documentation and records (QAPP Section A9) that are common to all projects implemented as part of the WQM Program.

6.1 Quality-Related Documents and Records

Quality-related documents and records consist of the QMP (this document), QAPPs, SOPs, data (as field datasheets and within the Water Database or other databases), laboratory results, and the Water Quality Assessment Report. All LWRD employees have access to these documents and records. Organized and well-maintained files are critical to the proper functioning of projects within the WQM Program.

The Project Manager will maintain, or will delegate maintenance of, paper and/or electronic files of relevant project documents, including:

- Current QMP
- Current (and past archived) QAPPs
- SOPs and manuals for field equipment
- Water Database containing water quality data and equipment QA/QC information
- Other databases, including the Continuous Monitoring Database and Lummi Well Reporting Database, containing water quality data
- Hardcopy field datasheets and spreadsheets containing QA/QC and field water quality data
- QA/QC forms
- Laboratory reports
- Water Quality Assessment Reports
- Records of submission to the EPA via WQX

Details on the preparation, review, and distribution of the QMP are provided in Sections 2.3 and 2.4. Details on the preparation, review, and distribution of QAPPs and SOPs are provided in Sections 8.7 and 8.8.

6.2 Field and QA/QC Data

All instrument calibrations, accuracy check details, instrument information, field measurements and observations will be recorded in the Water Database either by direct real-time data entry using a field iPad or by transcription of data recorded on hardcopy field datasheets.[7] Details on the Water Database are provided in Section 7.2.

[7] In this QMP, reference to data or comments entered "into the Water Database" includes entry directly into the

6.2.1 Field iPad

The field iPad (or equivalent tablet) is remotely connected to the LIBC network servers when a remote connection is available, which is approximately 95% of the time. Using the field iPad, field observations, site visit times, and *in situ* water quality parameters are entered into the database in real time. Data entry into the Water Database is QA/QC checked prior to finalization of the data. Detailed information regarding data entry, including screen shots of Water Database trip data entry pages, is included in the Water Database User Guide.

6.2.2 Hardcopy Field Datasheets

Field datasheets are used when direct entry into the Water Database is not possible, either due to poor remote connection or technical problems with the field iPad. Field datasheets are used for data entry during site visits and calibration sheets are used for calibration and QA/QC information; both are printed on write-in-the-rain paper and data are recorded in ink or pencil. Errors on datasheets are crossed out with one line and the date of the correction and initials of the person(s) that made the correction recorded.

Data and field notes recorded on datasheets will be transferred to the Water Database upon return to the office from the field. Where data are not transferred to the Water Database due to poor data quality, it is noted on the datasheet that measurements were made but the results were too inaccurate, imprecise, or un-traceable for the database. Alternatively, unreliable data can be entered into the Water Database and the appropriate qualifier can be assigned to ensure the data are appropriately graded during validation (Section 7.3.2). Data entry into the Water Database is QA/QC checked prior to finalization of the data.

Datasheets are scanned and saved in electronic format on secure LIBC network servers on the H://DigitalArchive drive and attached to the corresponding sample run record in the Water Database. Hardcopies are stapled to associated laboratory results (if applicable) and QA/QC forms and stored in binders in the LWRD office. Copies of field datasheets are included in Appendix B.

6.2.3 Data Recorded

All trip information is entered into the Water Database. Details regarding the Water Database are included in Section 7.2 and in the Water Database User Guide. Trip information includes all instrument calibration and accuracy check information, including:

- Instrument identification information (manufacturer and model)
- Measurement times
- Instrument parameter readings and associated units
- Reference parameter readings and associated units

Water Database via the iPad or by recording onto hardcopy field datasheets that are later transcribed into the Water Database.

- Identification information of any lab chemicals used, including lot/batch numbers and expiration dates

Trip information also includes all field notes, including:

- Name(s) of person(s) performing the work
- Site identification
- Site observations
- Date and time of site visit
- Parameter measurements and associated units
- Laboratory samples collected
- Quality control activities
- Corrective actions and outcomes

The Water Resources Specialist II is responsible for ensuring that all required information is collected or an explanation is recorded in the Water Database for why the information was not collected. Where additional information needs to be recorded for a site or there was a quality control activity that was not included, the information is recorded in one of two ways:

- Trip information can be recorded in the Run Comments under Trip Setup in the Water Database, or on the calibration record datasheet in the "weather and other run comments" section
- Site-specific information can be recorded in the Site Comments under each site in the Water Database or on the field datasheet

As previously described, documentation in the Water Database is QA/QC checked prior to finalization of the data. Maintenance activities, periodic calibrations and accuracy checks, and instrument replacement are recorded in the Water Database equipment module (Section 7.2.3).

6.2.4 QA/QC Forms

Field datasheets, final laboratory reports, and the completed QA/QC form are scanned and saved on the H://DigitalArchive drive on the LIBC network server and attached to the corresponding trip record in the Water Database. The first page of the QA/QC form is marked "scanned and saved" to denote that the documents have been scanned and saved to the appropriate Water Database trip. Hard copies including the QA/QC form, field datasheets, and final laboratory results are stapled, hole-punched, and stored chronologically in a 3-ring binder maintained by the Water Resources Specialist II in the LWRD office. All electronic data are stored on the LIBC network hard drive that is backed up nightly.

Details on the data entry QA/QC process and generation of QA/QC forms are provided in Section 7.2.2 and the Water Database User Guide, respectively.

6.2.5 Other Databases

Other databases may be used to store and view data for certain projects as specified in the project QAPP. The Continuous Monitoring Database is used to store data for the Continuous Temperature Monitoring Project and the Continuous Aquifer Level Monitoring Project. The Lummi Well Reporting Database is used for storing data associated with the Lummi Peninsula Groundwater Settlement Agreement. Details are provided in the individual project QAPPs for appropriate use of these databases.

6.3 Laboratory Results

Laboratory results are transferred to the Water Database upon receipt. Data entry into the Water Database is QA/QC checked prior to finalization of the data. All laboratory reports are saved electronically on secure LIBC network servers in the H://DigitalArchive drive and attached to the corresponding sample trip record in the Water Database. Hard copies of final laboratory reports are stapled to corresponding sample run QA/QC forms and field datasheets (if applicable) and placed in binders stored in the LWRD office.

Chain of custody forms are photocopied when samples are delivered to the certified and independent contracted laboratory. These copies are saved until final laboratory reports and the associated chain of custody form are received.

6.4 Period of Record

Data from the entire period of record have been entered into the Water Database and are stored in binders in the LWRD office. Routine scanning of hardcopy documents commenced in 2014. Pre-2014 records are in the process of being scanned and saved in electronic format on the secure LIBC network server in the H://DigitalArchive drive and attached to the corresponding sample trip record in the Water Database. Field datasheets and laboratory reports from the period of record are in the process of being saved in electronic format.

Currently, all hardcopies of calibration and field datasheets or field notebooks and QA/QC forms are stored in the LWRD office. Upon completion of scanning all hardcopy records, hardcopies will be stored for a period of seven years. Electronic scanned copies of all records will be stored indefinitely on the secure LIBC network server on the H://DigitalArchive drive.

6.5 Electronic Records

As described in the sections above, all hardcopy documents generated during data collection are scanned and saved in electronic format on the secure LIBC network server in the H://DigitalArchive drive and attached to the corresponding sample trip record in the Water Database. All data are stored in the Water Database in retrievable format on the secure LIBC hard drive. Quality management system documents, including the QMP, project QAPPs, and associated SOPs are saved in electronic format on the secure LIBC hard drive and are available on the LNR website (http://lnnr.lummi-nsn.gov/LummiWebsite/Website.php?PageID=1). The

QMP, QAPPs, and SOPs are distributed to individuals identified in each document's distribution list in electronic format by the Water Resources Manager.

6.6 Data Report Package

6.6.1 WQX

Water quality monitoring data are submitted to EPA through the Water Quality Exchange (WQX). Data verification and validation protocols and the subsequent rating of all collected data are completed prior to data transmission to the EPA. Water quality data collection funded by the EPA is scheduled for submission to the EPA via WQX by March 31 of the subsequent year to fulfill Clean Water Act Section 106 grant funding requirements (EPA 2006b).

6.6.2 Reporting

The Water Resources Specialist II prepares a Water Quality Assessment Report every two years that summarizes water quality and laboratory data for the two-year period, compares the results with Lummi Nation Water Quality Standards and data for the period of record, and documents attainment or non-attainment of designated uses.

The Water Quality Assessment Report will follow guidance provided in *Final Guidance on Awards of Grants to Indian Tribes under Section 106 of the Clean Water Act* (EPA 2006b) and *Data Assessment and Reporting Supplement to the Clean Water Act Section 106 Tribal Guidance* (EPA undated). The report includes the following summary statistics:

- Observations, mean, minimum, maximum by site for primary parameters (*e.g.,* water temperature, dissolved oxygen, pH, nitrate, ammonia) organized by water quality class for the reporting year and period of record.
- Number of sites monitored, total observations, mean, minimum, and maximum by water quality class for secondary parameters (*e.g.,* air temperature, alkalinity, arsenic, biological oxygen demand) for the reporting year and period of record.
- Number of new observations (for the reporting year), maximum value observed, geometric mean, geometric 90th percentile, and number of geometric observations used to generate summary statistics by site for bacterial parameters (*i.e.,* enterococcus, *E. coli*, and fecal coliform) organized by water quality class for the last 30 samples.
- Maps summarizing compliance with primary and bacterial parameter criteria by site.
- Number of sites monitored, number of sites compliant, number of non-compliant sites, number of sites with insufficient data, and compliance rate by parameter (*e.g.,* pH, dissolved oxygen, fecal coliform, enterococcus) organized by water quality class for the reporting year.

These reports are reviewed by the Water Resources Manager and approved by the Water Resources Manager and the Deputy Director. The approved reports are to be transmitted to the EPA every-other year by March 31 the year following the two-year reporting period to fulfill Clean Water Act Section 106 grant funding requirements (EPA 2006b).

The Water Resources Manager submits semi-annual (twice per year) progress reports to the EPA Project Officer that describe program status, problems, remedies, and schedules. Other reporting required by WQM Program projects are detailed in individual project QAPPs (*e.g.,* Lummi Peninsula Groundwater Settlement Agreement Compliance Monitoring Project).

7. DATA MANAGEMENT

This section includes aspects of data management common to all WQM Program projects. This information is typically included in project-level QAPPs (Section B10), but is included in this QMP because data management is a common component of most projects within the WQM Program and is an important element of the overall quality management system.

7.1 Field Work, Data Entry, and QA/QC Tracking

The process of conducting field work, recording field data and laboratory results, and conducting QA/QC checks on data entry involves the following steps:

1. Live data entry in the field
    - Assignment of manual data qualifiers
    - Delivery of laboratory samples to LNR contracted laboratory
2. Transcription of data recorded on field datasheets
3. Field data finalization
    - Water Database assigns automatic data qualifiers based on QA/QC data
4. Field data entry QA/QC check
5. Laboratory data entry
    - Assignment of manual data qualifiers based on laboratory results
6. Laboratory data entry QA/QC check
    - Water Database automatically grades the data
7. Data validation

In order to track the various steps in the above described data management process, a Field Work and Data Tracker spreadsheet is used. The Excel spreadsheet documents the date of field work, sample run conducted, laboratory to which samples were delivered (if applicable), and has columns for datasheet data entry, field data QA/QC, laboratory result receipt, laboratory result data entry, laboratory data QA/QC, and attachments. The Field Work and Data Tracker spreadsheet is managed and saved by the Water Resources Specialist II.

In addition to the spreadsheet, several file folders assist in the organization of data documentation. These folders are managed and stored by the Water Resources Specialist II. These files, and their contents, include:

- ***Sent to lab***: chain of custody forms for samples delivered to the laboratory.
    - Chain of custody forms are saved until final laboratory results have been received.
- ***Field data entry needed***: field datasheets to be entered into the Water Database.
    - When field datasheets are entered into the Water Database, the field data are finalized and placed in the Field data entry QA/QC folder.

- ***Field data entry QA needed:*** field datasheets requiring field data entry QA/QC.
    - Field data entry QA/QC form is printed and attached to the field datasheets.
    - When field data entry QA/QC is completed, the field data entry QA/QC form is attached to the field datasheets and placed in the *need lab results* folder.
- ***Need lab results***: field data entry QA/QC form and field datasheets requiring receipt of lab data prior to next steps.
    - When preliminary lab results are received, the results are attached to the chain of custody form from the *sent to lab* folder, field data entry QA/QC form, and field datasheets. All documents are paper clipped together and moved to the *lab data entry needed* folder.
- ***Lab data entry needed***: final laboratory results to be entered into the Water Database.
    - When laboratory data are entered into the Water Database, laboratory results are attached to field data entry QA/QC form and field datasheets and moved to the *Lab data QA needed* folder.
- ***Lab data QA needed***: final laboratory results for trips requiring laboratory data QA/QC. Attached are the field data entry QA/QC form and datasheets.
    - The chain of custody form can be recycled after receipt of the final laboratory results and attached final chain of custody form.
    - When laboratory data QA/QC is completed, the laboratory QA/QC form, field data entry QA/QC form, final laboratory results, and datasheets are scanned, PDFs saved to the Water Database and archives folder, and hard copies are stapled and stored in three-ring binders managed by the Water Resources Specialist II.

7.2 Water Database

The Water Database is a custom built Microsoft Access-based database created by the Database Manager to store data collected as part of most WQM Program projects as well as project, site, and equipment details. All data and QA/QC data collected as part of the WQM Program, with the exception of continuous monitoring data, are stored in the Water Database.[8] The Water Database is stored on secure LIBC network servers that are backed up nightly. The Water Database has four modules:

- Setup: stores information on sites, parameters, projects, runs, and laboratories
- Equipment: stores equipment information and maintenance and QA/QC activities
- Data Entry: stores trip information, including sample runs conducted, parameters measured, laboratory sample results, and trip-based QA/QC data

[8] Continuous monitoring data include temperature and aquifer water level. The data verification and validation methods for these programs are described in the Continuous Temperature Monitoring Project QAPP and Continuous Aquifer Level Monitoring Project QAPP respectively. Continuous data are stored in the Datalogger Database. QA/QC data for these projects are stored in Excel datasheets and in the Water Database as specified by the relevant project QAPP.

- Analysis: tool for querying, analyzing, and exporting water quality data stored in the database

The four Water Database modules work together to automatically populate fields in the database with frequently used information. When a trip[9] is set up on the data entry module, the selection of a particular run automatically populates the instruments used, sites to be sampled, associated projects, parameters to be measured, and QA/QC activities to be conducted from the trip setup and equipment modules. Details on entering information into the setup and equipment modules are provided in the Water Database User Manual. The Water Resources Specialist II is responsible for ensuring that all information in the setup and equipment modules are correctly entered, and monitoring the appropriate population of fields during database use.

The Database Manager is responsible for maintaining and updating the structure of the Water Database and providing support to LWRD personnel using the database for data entry and analysis. The Database Manager, Water Resources Specialist II/Planner, Water Resources Specialist II, and Water Resources Technician II are responsible for reviewing, verifying, and validating project data and information.

7.2.1 Data Entry

Typically, field data are entered directly into the Water Database in real-time using a field iPad, while the LNR laboratory desktop computer is used for entry of instrument calibration, QA/QC, and maintenance activities. When measurements are read out and recorded by different individuals, the individual recording measurements will repeat the reading once it has been entered into the field iPad to allow the individual who reads out the measurement to double-check that the datum was recorded accurately. When remote access to the database is not available on the field iPad, data are recorded onto hardcopy field datasheets during site visits. Data are transcribed from the datasheets to the Water Database within two weeks of the field visit by the Water Resources Technician II with the support of the Water Resources Specialist II. Laboratory results are also transferred into the Water Database within two weeks of receipt.

During data entry, any manual data qualifiers needed are added (Section 7.3.2). Questionable field data are associated with the appropriate qualifier code. Laboratory-related qualifier codes are added when laboratory holding times are exceeded or lab quality checks were not successful. If laboratory data are associated with qualifiers that indicate the result is an estimated value, an F qualifier is assigned with a full description of the reason for the qualifier. Laboratory non-detects are recorded as a value one decimal point below the lower detection limit (LDL) or practical quantification limit (PQL). The Water Database automatically records non-detect laboratory results as one decimal point below the LDL or PQL when the LDL or PQL is entered (see Water Database User Guide). Laboratory results reported as below the LDL or PQL are transcribed as reported. For all laboratory results, LDL and PQL are transcribed into the

[9] A "trip" is the sampling event that occurs on a given day. A "run" is a given series of sites that are visited as part of a given project within the WQM Program. Projects are made up of one or several runs (*e.g.,* the Surface Water Project consists of four sample runs). One or more runs can be conducted for a given trip.

database if they are listed. Laboratory results reported as above the maximum detection limit are transcribed as reported, and the maximum detection limit is entered into the database.

To ensure that all data are entered into the Water Database, the individual transcribing the data, either from field datasheets or laboratory results, marks each result with a check mark as it is entered into the database. When transcription into the database is complete, the individual marks the page with "d/e", their initials, and the date. Details on data entry into the Water Database are provided in the Water Database User Guide.

7.2.2 Water Database QA/QC

Data for each trip undergoes field and laboratory data entry QA/QC checks conducted by the Water Resources Specialist II. The Water Resources Specialist II maintains a field work and data tracker spreadsheet to track the progress of data entry and QA/QC checks for each trip (Section 7.1).

Upon transcription of any data from datasheets, a field data entry QA/QC form generated by the Water Database is printed. Any paper records (*i.e.,* datasheets) are checked for accurate data entry by manually verifying the reported values in the Water Database QA/QC form against the datasheets. Check marks are placed next to every entry on the field data entry QA/QC form to document that the value was verified. Any values that have been incorrectly entered are corrected and the change is noted in the QA/QC form and denoted by the reviewer's initials. All data entered directly into the database are checked to ensure that data has been entered appropriately using professional judgment. Errors could include obvious data entry errors, such as unreasonable parameter measurements, or data entry into the incorrect field (*e.g.,* entering DO % saturation into the DO mg/L field). The error is corrected if it can be reliably done. Otherwise, the record is deleted with an explanation recorded into the site visit comments, or the record is assigned a data qualifier due to unreliability of the data. An upright line is placed next to every entry directly entered into the database to document that the value was verified; corrected values are marked with the reviewer's initials. For each site, the reviewer will ensure that the appropriate toggles indicating whether the site was sampled (*i.e.,* whether data were collected) and whether water was present at the site are marked. Upon complete review of the trip data in the QA/QC form, the Water Resources Specialist II signs and dates the form and finalizes the field data in the Water Database.

Upon receipt of final laboratory results, a laboratory data entry QA/QC form generated by the Water Database is printed. Laboratory results are checked for accurate data entry by manually verifying the reported values in the laboratory data entry QA/QC form against the laboratory reports. Check marks are placed next to every entry on the laboratory data entry QA/QC form to document that the value was verified. Any values that have been incorrectly entered are corrected and the change is noted in the QA/QC form and denoted by the reviewer's initials. Finally, data qualifiers are reviewed to ensure that the correct data qualifiers have been assigned and results are graded appropriately. Upon complete review of the laboratory data in the QA/QC form, the Water Resources Specialist II signs and dates the form.

Datasheets, final laboratory reports, and the completed QA/QC forms are scanned and saved on the H://DigitalArchive drive on the LIBC network server and attached to the corresponding

trip record in the Water Database. The first page of the QA/QC form is marked "scanned and saved" to denote that the documents have been scanned and saved to the appropriate Water Database trip. Hard copies including the QA/QC forms, field datasheets, and final laboratory results are stapled, hole-punched, and stored chronologically in 3-ring binders maintained by the Water Resources Specialist II in the LWRD office.

7.2.3 Equipment Module

The Water Database equipment module stores information regarding QA/QC activities required for each piece of equipment currently in use and historically used for data collection as part of the WQM Program. Calibration and accuracy check activities required for pre-run, mid-run, and post-run QA/QC of instruments are automatically populated into the trip QA/QC sections by the Water Database. Reminders about periodic QA/QC and maintenance activities are emailed by the Water Database to the Water Resources Specialist II and Water Resources Technician II when they are due. Completed activities are logged in the action history for each instrument to document when certain maintenance and periodic QA/QC activities were completed.

The Water Resources Specialist II is responsible for ensuring that the equipment module is correctly populated with the required QA/QC and maintenance activities for each instrument. Details on QA/QC and maintenance activities are provided in the instrument SOPs. Details on entering these activities into the Water Database are provided in the Water Database User Guide.

7.3 Data Verification and Validation (D1, D2)

This section describes the process for verifying and validating data collected as part of the WQM Program. Data are verified and validated prior to submission to EPA via WQX or for use in reporting.

As previously described, the overall performance standard for the WQM Program is the collection of high-quality data sufficient to meet program 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.

Data verification is the process of evaluating the correctness and compliance of a data set with the requirements outlined in project QAPPs and equipment/method SOPs. Data verification steps include:

- Equipment calibration and QA/QC checks outlined in SOPs
- Data collection following methods outlined in SOPs
- Data entry QA/QC review (Section 7.2.2)
- Assigning data qualifiers to questionable data when requirements outlined in project QAPPs and equipment/method SOPs are not followed or acceptance criteria are not met (Section 7.3.2)

Data validation is a sample-specific process that evaluates the data to determine the analytical quality of a specific data set. Data validation steps include:

- Assigning a validation status (grade) based on data qualifiers (Section 7.3.1)
- Review of validation status (grades) (Section 7.3.3)

7.3.1 Data Validation (Grading)

All data collected as part of the WQM Program are assigned a grade to indicate the validation status of the results. The grade indicates the analytical quality of the data, and determines whether the data are acceptable for use in analysis and reporting. Grading categories include the following:

- **Preliminary:** not yet validated
- **Rejected:** validated but not to be used because the value is flawed
- **Final:** validated and acceptable/publishable

The grade assigned depends on the quality of the data, which is indicated by the presence, type, and number of data qualifiers assigned.

7.3.2 Qualifiers

As described above, the criteria used to determine the data validation grade assigned to each result depends on the number and nature of any qualifiers that are associated with the result. Data qualifier codes are listed in Table 7.1.

Table 7.1 Data Qualifier Codes

Code	Description	Added Manually If	Qualifier Added by Database If
Automatic Rejection			
H	Holding time exceeded.	Lab report notes that time for sample to reach lab exceeds limits.	N/A
Q	The result did not pass the lab quality checks and there was an insufficient amount of the sample for re-analysis.	Serious problem with lab QA, such as detection in a blank, or broken chain of custody. If necessary, additional information can be added to site comments field.	N/A
R	Rejected; the sample results are unusable due to the quality of the data generated because certain criteria were not met. The analyte may or may not be present in the sample.	QA procedures were not followed and there is reason to believe the result is unreliable. If necessary, additional information can be added to site visit comments field.	N/A

Table 7.1 Data Qualifier Codes

Code	Description	Added Manually If	Qualifier Added by Database If
Two or More Will Result in Rejection			
I	Estimated value; failed initial (pre-run) calibration.	No successful pre-run calibration result for the equipment and parameter (if required by equipment SOP but *not* entered into equipment module).	No successful pre-run calibration result for the equipment and parameter (if required by equipment SOP *and* entered into equipment module).
F	Estimated value; failed initial pre-run or mid-run accuracy check.	No successful pre-run or mid-run accuracy check for the equipment and parameter (if required by the equipment SOP but *not* entered into equipment module).	No successful pre-run or mid-run accuracy check for the equipment and parameter (if required by the equipment SOP *and* entered into equipment module).
FEQ	Field equipment questionable; failed post-run accuracy check.	No successful post-run accuracy check for the equipment and parameter (if required by equipment SOP but *not* entered into equipment module).	No successful post-run accuracy check for the equipment and parameter (if required by equipment SOP *and* entered into equipment module).
RNAF	Result not affected by noted QC issue.	Field/lab QA procedures may not have been followed in all respects but issue is unlikely to impact on reliability of the result. If necessary, additional information can be added to site visit comments field.	Overriding equipment SOP during data entry, using expired buffers during QA, etc.

The Water Database will automatically assign qualifiers to results based on the QA/QC information associated with each trip. These qualifiers include I, F, and FEQ. If a pre-run calibration is required for a given parameter in the equipment SOP but the calibration was unsuccessful (*i.e.,* did not meet acceptance criteria) or was not conducted, the Water Database will assign the qualifier I. If a pre- or mid-run accuracy check is required for a given parameter in the equipment SOP but the accuracy check was unsuccessful or was not conducted, the Water Database will assign the qualifier F. If a post-run accuracy check is required for a given parameter in the equipment SOP but the accuracy check was unsuccessful or was not conducted, the Water Database will assign the qualifier FEQ. These qualifiers will only be added if the equipment SOP requires calibration and/or accuracy checks for a given parameter and the acceptance criteria have been entered into the Water Database equipment module. If no equipment SOP or acceptance criteria are provided, the database will not automatically add a qualifier. These qualifiers can be assigned manually if equipment SOPs or acceptance criteria

exist, but are not entered into the Water Database. If SOPs require more than one accuracy check per parameter (*i.e.,* dissolved oxygen accuracy is checked at 0% and 100% saturation at all check-points), both accuracy checks must be successful; if one of multiple accuracy checks at a given check-point fails to meet the acceptance criteria, a qualifier will be assigned. However, the database will not automatically add a qualifier if SOPs require more than one accuracy check per parameter, but only one is conducted; in this case, **the qualifier must be added manually**.

The RNAF qualifier indicates the results are not affected by a noted QC issue. The Water Database will automatically assign this qualifier to values if certain QC procedures are not followed, including overriding the equipment SOP function in the Water Database, or by using expired buffers during QA/QC activities. The RNAF can also be assigned manually for occasions when QA/QC procedures have not been followed, but the issues are unlikely to impact the reliability of the result. Additionally, details about the reason the qualifier was added are included in the trip or site visit comments.

If two or more qualifiers (I, F, FEQ, or RNAF) are associated with a given parameter, all measurement values for the parameter for that trip will be rejected (*i.e.,* graded as Rejected by the database). If one or no qualifiers (I, F, FEQ, or RNAF) are associated with a given parameter, the measurement value will be accepted and graded as Final.

Laboratory-related qualifier codes must be entered manually during data entry of laboratory results. If laboratory data are estimated, the F qualifier is associated with the result with an explanation of the reason provided in the final laboratory report. This qualifier code will not result in automatic rejection of the values but will alert data users of potential data quality concerns. If laboratory holding times are exceeded or lab quality checks were not successful, the result will be assigned a qualifier code H or Q, respectively. These qualifier codes result in automatic rejection of the values.

Similarly, the qualifier code R results in an automatic rejection of a given result. The R qualifier is assigned manually by the sampler when the sample results are unusable due to the quality of the data generated, either because QA/QC procedures were not followed and/or there is a reason to believe that the results are unreliable. An R qualifier code is assigned by LWRD staff based on professional judgment, and a note in the trip or site visit comments is included to explain why the R qualifier was assigned.

For all manually-added qualifiers, a brief description of the reason the qualifier was added is included as part of the data flagging process in the Water Database (see Water Database User Guide for details). In addition, a brief description explaining why the qualifier was assigned may be included in the trip or site visit comments.

The final result status (grade) and qualifiers are included with data submitted to EPA via WQX.

7.3.2.1 Questionable Data

Samples with questionable or unreliable data quality are manually marked as suspect by LWRD staff in the Water Database; marking samples suspect involves adding a data qualifier to the suspect measurements. Data qualifiers are assigned to a site-specific measurement or all

measurements for a particular parameter during the trip depending on the reason for suspecting poor data quality.

As described above, the Water Database automatically flags measurements if equipment QA/QC checks are not conducted or fail to meet acceptance criteria as long as these required checks are entered into the equipment module. If QA/QC checks are required by equipment SOPs but not entered into the equipment module or other reasons for suspecting poor data quality are present, data qualifiers are added manually. Data qualifiers associated with QA/QC issues follow the guidelines described above and in Table 7.1. Other reasons for suspect data are flagged as follows:

- RNAF (Result Not Affected) for data that are, based on professional judgment, questionable but acceptable if no other qualifiers are assigned (*i.e.,* all required instrument QA/QC checks meet acceptance criteria). Examples include: parameter measurement did not meet stabilization criteria but are reasonable for the given site or the sample was collected from a non-representative location.
- R (Rejected) for data that are, based on professional judgment, unreliable and unusable. Examples include: using expired standards during calibration; measurement collected using improper methods or a malfunctioning instrument.

For all questionable results, a brief description of the reason the qualifier was added is included as part of the data qualifier. In addition, an explanation of why the qualifier was assigned may be included in the trip or site visit comments.

7.3.3 Review of Grades

Prior to finalizing data, the Water Resources Specialist II will review the Water Database-assigned validation status (grading) of data collected in the calendar year. The Water Resources Specialist II will review a minimum of 10% of Rejected data to ensure that database-assigned Rejected grades are accurate. If improperly assigned failing grades are identified, a minimum additional 10% of failing grades will be reviewed. As time allows, randomly selected Final grades will be reviewed to ensure that database-assigned Final grades are accurate.

Review of grade forms (*i.e.,* rejected results reports) are signed and stored in the binders managed by the Water Resources Specialist II. A PDF of the form is also saved in the H:/ drive.

7.3.4 Check for Preliminary Data

To ensure that all data entered into the Water Database were verified and validated, a search for data in Preliminary status is conducted for the reporting period. Data are not finalized until all Preliminary status data that will be submitted to EPA via WQX are verified and validated.

7.4 Summary Statistics

Only data verified, validated, and graded “Final” will be used to calculate summary statistics. Rejected data will not be used in calculation of summary statistics. Summary statistics calculated depend on the project and parameter in question, and the requirements of Lummi

Nation Water Quality Standards and NSSP standards. For example, for continuous temperature data, the seven-day average of the daily maximum value (7DADM) is calculated for all freshwater sites and a daily maximum value is calculated for all marine sites. For fecal coliform and enterococcus data, the 30-sample geometric mean and 90th percentile are calculated. Summary statistics for all parameters are calculated, as needed, and used for comparison with results from the period of record and relevant water quality criteria. These summary data are presented in the Water Quality Assessment Report.

Statistics such as bias, precision, and accuracy are not routinely calculated at this time. These statistics are calculated on an as-needed basis and are specific to the question being asked.

Field variability is not routinely calculated. When it is found to be of interest, relative percent difference is calculated to determine field variability of duplicate results using the following equation:

Relative Percent Difference = (ABS(Value1-Value2))/(average(Value1,Value2)) *100%

There are no acceptance limits for true field variability; generally, field variability is quantified in order to understand field conditions. Many surface water sites are tidally influenced, and duplicate field measurements can have wide variability when stratified waters are mixing or when tidal influence is present. At sites where high field variability cannot be explained by changing field conditions (*i.e.,* tidal influence, mixing), the acceptance criteria for the parameter as outlined in the equipment SOP are used (*e.g.,* YSI 556 SOP).

For laboratory duplicates, the contracted laboratory is responsible for ensuring that lab duplicates meet acceptance criteria as outlined in the method and/or the laboratory QAPP. Laboratory duplicate results are not routinely calculated or assessed, however, relative percent difference will be calculated using the equation above or as reported by the laboratory in order to quantify lab variability and method precision.

During preparation of the Water Quality Assessment Report, data are checked visually to identify outliers, missing data, and potential water quality trends. The following visual checks may be used:

- Data are plotted over time to check for missing data, abnormalities, or trends.
- Data from the current year are graphically compared to the period of record to check for seasonal or annual trends.
- Data from sites along the same stream or drainage network are graphically compared to identify potential sources of pollution or water quality impairment, and changes in water quality along the length of the drainage.

Trend analysis (*e.g.,* correlation, regression) may be used to examine possible trends identified by visual inspection of the data. Calculation of upper and lower 5th percentiles may also be used to screen for outliers, potential data errors, or impairment.

Some summary statistics can be automatically generated using the Water Database analysis module. Other analyses are executed using Microsoft Excel or R.

7.5 External Data

7.5.1 Laboratory Data

The DOH provides bacteria results within a few weeks of sample collection, and sooner via email if there is a problem with either sample collection or elevated fecal coliform levels. DOH data are available from the DOH-managed FTP site.[10]

Data generated by independently contracted laboratories, currently Edge Analytical, Inc. (Burlington WA and Bellingham WA) and its subcontractor ALS-Kelso (Kelso, WA), are provided by email and/or mail.[11] Final reports include results of QA/QC activities and indicate data quality.

7.5.2 Other Data

Any data used within the WQM Program must be of sufficient quality (*i.e.,* known precision, accuracy, bias, traceability, completeness, and representativeness), but the acceptable level of data quality varies with the type of information needed. All data external to the WQM Program will be clearly marked as such and will include any metadata and data qualifiers available from the collecting agency or organization.

Samples collected in Portage Bay by the DOH as part of the NSSP are also recorded into the Water Database. Results are obtained from the DOH-managed FTP site and data are transcribed into the Water Database for inclusion in calculation of geometric mean and 90th percentile statistics.

Predicted tidal elevation information is obtained from online tide charts. Actual tidal information is obtained from the National Oceanic and Atmospheric Administration (NOAA) National Buoy Center tide gage at Cherry Point (Station CHYW1 – 9449424) located along the Georgia Strait coast north of the Reservation.[12]

The U.S. Geological Survey (USGS) operates a gaging station located on the Nooksack River at Ferndale, Washington (12213100).[13] Discharge, gage height, and turbidity are currently measured at this site. Historically, temperature has also been measured at this site; however, due to budget limitations, temperature measurements have not been collected since February 2015. Temperature measurement may recommence at this site if funding becomes available. Preliminary data are only used if appropriate for the end use and if data must be used before they are finalized by the USGS. For example, preliminary discharge information that is subject to revision is acceptable for evaluating real-time Nooksack River discharge.

Data collected by the Whatcom Clean Water Program partner agencies in the Nooksack River watershed may be used to determine sources of fecal coliform contamination. Data collected by Whatcom Clean Water Program partner agencies in freshwaters drainages as they flow onto

[10] ftp://ftp.doh.wa.gov/MarineWater/PreliminaryWaterData/. Last accessed November 2016.
[11] Upon accreditation, Edge will subcontract certain analyses to IEH Analytical Laboratories (Seattle WA).
[12] http://www.ndbc.noaa.gov/station_page.php?station=chyw1. Last accessed November 2016.
[13] http://waterdata.usgs.gov/usa/nwis/uv?site_no=12213100. Last accessed November 2016.

the Reservation (e.g., the Lummi River, Schell Creek, and Jordan Creek) may be used to supplement data collected by LNR. When partner agency fecal coliform data are used to calculate metrics, the data sources will be specified.

Water quality data, including continuous temperature data or nutrient analyses, collected by other LNR departments (*e.g.,* Restoration Division) may be used to supplement data collected as part of the WQM Program.

7.6 Reconcilliation With User Requirements (D3)

The projects within the WQM Program are ongoing and not designed to prove or disprove specific hypotheses. Data uncertainties are documented through the qualifying and grading process. As described above in Section 7.3.1, validated data will be graded "Final" or "Rejected." Data that have not yet been validated are labeled "Preliminary." The validation grade is determined by the number and type of data quality qualifiers associated with each value. These qualifiers and the validation grade are linked directly with the data and provide the data user with data quality information sufficient to determine appropriate uses of the data. Rejected data should not be used for data analysis or decision-making. Final data have been verified and validated, and determined to be of sufficient quality to use for data analysis and decision-making. The Water Resources Specialist II/Planner is responsible for quantifying or qualifying data quality to data users.

Laboratory data collected as part of the WQM Program may be shared with outside agencies and made publicly available (e.g., Whatcom Clean Water Program online preliminary data maps), but not for reporting, prior to data validation and grading in certain instances with specific limitations. Sharing of data must be approved by the Water Resources Manager as being in line with WQM Program and LWRD goals, must have appropriate laboratory qualifiers associated, and must be marked preliminary. Preliminary laboratory data are updated with validated and graded data annually upon final QA/QC and submission to EPA via WQX.

7.7 Computer Hardware and Software

All electronic data, including the Water Database, are stored on secure LIBC network hard drives that are backed up nightly. The LIBC network hard drives, computers (laptops and desktops), and field tablets must meet LIBC policies and Information Technology department guidelines for security.

The LIBC Information Technology department is responsible for managing the network hard drives and backing up data stored on these hard drives nightly. The Database Manager is responsible for developing, maintaining, and updating the Water Database. The Water Resources Specialist II and Water Resources Specialist II/Planner are responsible for testing and using the Water Database.

The Database Manager is also responsible for maintaining and updating the compatibility of the Water Database with the WQX and ensuring that water quality data are successfully submitted to EPA.

Other computer software used, including HOBOware for continuous temperature monitoring and Telogers for Windows for continuous aquifer level monitoring, must meet the data needs of the project. The Water Resources Specialist II, with the approval of the Water Resources Manager, is responsible for evaluating computer software (other than the databases managed by the Database Manager) to ensure that the data needs of the project will be met. The LIBC Information Technology department is responsible for evaluating software and hardware for compliance with LIBC information technology policies, including security and privacy policies, and installing software.

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8. PLANNING

The purpose of this section is to document how individual data operations will be planned to ensure that data or information collected are of the needed and expected quality for their desired use.

8.1 Planning Goals and Objectives

As previously described, 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
3. To support the development and implementation of a water quality regulatory program (*e.g.,* LCL Title 17, LAR 17.07, Surface Water Quality Standards) on the Reservation

These goals support the goals of the LWRD and LNR (details in Section 3.1).

The planning objective of the WQM Program is to ensure a sufficient quantity of quality data is collected to support the use of the data. The planning process is intended to document all activities related to the generation, analysis, and use of data.

8.2 Identification of Data Users and Suppliers

Lummi Nation Water Quality Monitoring Program data users include: LWRD water quality assessment staff and manager, other LNR divisions, the LNR Director and Deputy Director, LIBC policy staff, EPA, DOH, Whatcom County Public Works Natural Resources Division, Washington State Department of Ecology, and other external groups (*e.g.,* Whatcom Clean Water Program). Data suppliers include LWRD, other LNR divisions (*e.g.,* Restoration Division), DOH, contract laboratories, EPA Region 10, USGS, NOAA, and possibly other external data generators.

8.3 Scheduling and Resources

The Water Resources Manager is responsible for developing and allocating budgets for the WQM Program, and communicating any project changes that may be required due to budget constraints to the Water Resources Specialist II. The Water Resources Specialist II is responsible for implementing the WQM Program projects, including scheduling sample collection activities. Data are exported via WQX annually, Water Quality Assessment Reports are prepared every other year, and twice-per-year progress reports are submitted to the EPA to fulfill Clean Water Act Section 106 grant funding requirements (EPA 2006b).

8.4 Program Planning

Data collection as part of the WQM Program is systematically planned. During the process of planning for water quality data collection, the following steps are taken:

- Identify the question to be answered
    - Project goals
- Determine how the question will be answered
    - Data needs
    - Experimental design
- Ensure that the planned data collection activities will provide data that are sufficient to answer the question
    - Performance criteria
    - QA/QC procedures
    - Development of QAPPs and SOPs
- Ensure that the planned data analysis, evaluation, and assessment will answer the question

8.4.1 Data Needs

In order to meet WQM Program goals, several projects have been developed to ensure the collection of a sufficient quantity and quality of data. Each project operates under a QAPP that details the project goals and ensures that the data collected meet these project goals. Identification of data use is required prior to development of a monitoring project or collection of data; the end use of the data will determine the experimental design and associated QA/QC activities required for sufficient data quality.

Temporal resolution of data depends on the project goals. While some projects require sampling monthly or less frequently, other projects require continuous monitoring. The Continuous Temperature Monitoring Project requires continuous temperature data collection because the Lummi Surface Water Quality freshwater criterion for temperature is expressed as a seven-day average of the daily maximum value (7DADM). Multiple temperature measurements are required to capture the maximum value for each day, calculate the average over seven days, and to determine whether monitoring sites meet the criterion. The Continuous Aquifer Level Monitoring Project requires continuous water level measurements in order to track seasonal and annual changes in aquifer levels. These types of measurements would not be possible without the deployment of continuous temperature and water level sensors.

Sampling as part of most WQM Program projects occur “randomly” in that the tides, season, and weather are not used to bias sampling efforts.[14] Regular, random sampling of

[14] 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. This affects the ability to collect samples as part of the Surface Water Project (SP&PI and LSR runs) and the DOH Support NSSP Project.

representative sites captures temporal variability that allows the assessment of seasonal, annual, and multi-year trends in water quality.

Spatial resolution of the data also depends on the project goals. For most projects, the sample site distribution on the Reservation is dense in order to protect sensitive resources (*e.g.,* shellfish and groundwater) and to sufficiently capture spatial variability. The selection of sample sites for each project ensures that water quality in different geographical regions of the Reservation is represented, and data can provide targeted information for each watershed or aquifer. The dense sampling network combined with regular random sampling also provides insight into the range of water quality temporally and spatially as individual sample sites respond more or less quickly to environmental conditions. For some projects, spatial distribution of sample sites is limited by the availability of sites or time (*i.e.,* staffing availability and budget). All projects provide sufficient spatial resolution to provide adequate data quality and fulfill project goals.

Data collected as part of the WQM Program are used to identify trends (annual and multi-year) and impairment, establish baseline conditions, and evaluate compliance with Lummi Nation Water Quality Standards. Occasionally, data are used in regulatory activities (*i.e.,* issuance of citations) or to inform development or revision of the Lummi Nation Water Quality Standards.

8.4.2 Performance Criteria

The overall performance standard for the WQM Program is the collection of high-quality data sufficient to meet program goals. Data must be of sufficient quality (*i.e.,* known precision, accuracy, bias, traceability, completeness, and representativeness) to support scientifically valid, legally defensible decisions based upon the water quality data.

Data collected as part of the WQM Program must be of measureable quality. While data quality depends on project goals, all data are reviewed, verified, and validated prior to use internally or distribution to external organizations (*i.e.,* submission to EPA via WQX).

Performance criteria for planning of activities conducted as part of the WQM Program include:

1. Projects must detail quality objectives for precision, accuracy, completeness, comparability, and representativeness. This information is detailed in a project QAPP.
2. Equipment or parameter measurement methods must detail instrument range, accuracy, and resolution. In addition, performance criteria for calibrations and accuracy checks, as well as maintenance activities, are required. This information is detailed in equipment and parameter SOPs.
3. Data management must be structured so that project and equipment or parameter measurement quality objectives and performance criteria are tracked. This information is detailed in Section 7 of this QMP or in the relevant project QAPP.
4. Data are verified, qualified, validated, and graded according to the details in Section 7.3 of this QMP or as detailed in the relevant project QAPP.

Project action limits include measurements that exceed water quality criteria and measurements that are unusual or unexpected for the site (Section 9.2).

Project QAPPs detail quality objectives and equipment SOPs provide specific performance criteria. Generally, performance criteria and project quality objectives must be met in order to ensure that data are of sufficient quality to support project goals. If performance criteria or project quality objectives are not met, data quality is evaluated on a case-by-case basis to determine whether the data are reliable for reporting purposes. If project quality objectives are not met, an evaluation of the project is conducted in order to improve data quality. If equipment performance criteria are not met, corrective actions are conducted to return instrument function to within acceptance criteria. Details are described in the individual project QAPPs and equipment SOPs.

8.4.3 QA/QC Activities

Quality Assurance/Quality Control activities are developed and selected during the systematic planning of projects to ensure that data needs and performance criteria are met. Key variables that determine or directly affect the quality of results are identified and controlled according to the specifications established during the planning or design process. Quality assurance for the quality management system outlined in this QMP is determined through the assessment and response process described in Section 10.

8.5 External Data

Analytical support provided by contracted laboratories or their subcontractors must meet accreditation requirements for all analyses conducted. Details on use of other external data are provided in Section 7.5.

8.6 Analysis, Evaluation, and Assessment of Data

Data collected as part of the WQM Program are used to identify trends (seasonal, annual, and multi-year) and impairment, establish baseline conditions, and evaluate compliance with water quality criteria. Specific analyses performed are outlined in project QAPPs. Details on data management, including verification and validation protocols, are provided in Section 7.3.

8.7 QAPP Preparation, Approval, and Revisions

All WQM Program projects involving the collection of environmental samples by LWRD personnel are required to have an approved QAPP prior to collection and analysis of any samples. Project QAPPs will include associated instrument or parameter method SOPs by reference. QAPPs are prepared following the requirements and guidance provided in *EPA Requirements for Quality Assurance Project Plans* (EPA 2001b, reissued 2006a) with the companion document *Guidance for Quality Assurance Project Plans* (EPA 2002). Other items required in project QAPPs include:

- Project goals and objectives
- Data needs and justification of experimental design

- Quality objectives for precision, accuracy, completeness, comparability, and representativeness
- Performance criteria
- QA/QC procedures
- Reference to associated SOPs

QAPPs are prepared by the Water Resources Specialist II, reviewed by the Water Resources Manager, and approved by the Water Resources Manager and the LNR Deputy Director. QAPPs are also reviewed and approved by the EPA Tribal Coordinator and EPA Region 10 OEA Director.

Project QAPPs are intended to be regularly used by personnel implementing the WQM Program, and are reviewed and revised in an ongoing manner. Obsolete documentation is removed and new procedures are added, as needed. Revisions to the QAPP are documented in writing. Every five years, all ongoing project QAPPs will undergo an exhaustive review and revision. Study-based project QAPPs will detail the length of the study and will expire at the end of the study period, unless the QAPP is revised to extend the study. Otherwise, study-based project QAPPs will not be revised or renewed. Obsolete QAPPs are retired from the quality management system document list.

The Water Resources Specialist II is responsible for ensuring that the individuals listed in the QAPP distribution list have the most current version of the document. Records are maintained by the Water Resources Specialist II documenting substantive and minor version changes as well as the distribution of minor change letters and revised QAPPs.

Substantive QAPP updates are reviewed by the Water Resources Manager and transmitted to the EPA Project Manager and EPA Quality Assurance Officer by the Water Resources Manager for approval as an entire document. Identification and justification of changes are included with major updates resulting in a change in the number before the decimal point in the QAPP version number (*e.g.,* change of name from Version 1.0 to 2.0).

Minor QAPP updates are transmitted to the EPA Project Manager and EPA Quality Assurance Officer for approval via a letter that identifies changes and justifications. Minor updates include correction of mistakes and non-substantive changes to the QAPP. Corrections of mistakes are tracked through the use of a lower case letter at the end of the QAPP version number (*e.g.,* change of name from Version 1.0 to 1.0a). Non-substantive minor changes are tracked through change of the number following the decimal point in the QAPP version number (*e.g.,* change of name from Version 1.0 to 1.1). QAPP updates and revision letters are provided to the individuals in the distribution list via electronic format.

8.8 SOP Preparation, Approval, and Revisions

All instruments and methods used by LWRD personnel to collect water quality measurements as part of the WQM Program are required to have an approved SOP prior to collection and analysis of any samples. SOPs are associated with various projects, and are included in project QAPPs by reference. SOPs are prepared following the guidance provided in *Guidance for*

Preparing Standard Operating Procedures (SOPs) (EPA 2007). SOPs must include (as appropriate):

- Instrument specifications, including range, accuracy, and resolution
- QA/QC procedures, including calibrations and accuracy checks
- Parameter measurement methods
- Stabilization criteria
- Corrective actions
- Maintenance activities

SOPs are prepared by the Water Resources Specialist II, reviewed by the Water Resources Manager, and approved by the Water Resources Manager and the LNR Deputy Director. SOPs are also reviewed and approved by the EPA Tribal Coordinator and EPA Region 10 OEA Director.

SOPs are intended to be regularly used by personnel implementing the WQM Program, and are reviewed and revised in an ongoing manner. Obsolete documentation is removed and new field and lab techniques are added, as needed. Revisions to the SOPs are documented in writing as necessary. Every five years, all SOPs will undergo an exhaustive review and revision. Obsolete SOPs are retired from the quality management system document list.

The Water Resources Specialist II is responsible for ensuring that the individuals listed in the QAPP distribution list have the most current version of the SOPs associated with a given QAPP, as SOPs are included in project QAPPs by reference. Records are maintained by the Water Resources Specialist II documenting substantive and minor version changes as well as the distribution of minor change letters and revised SOPs.

Substantive SOP updates are reviewed by the Water Resources Manager and transmitted to the EPA Project Manager and EPA Quality Assurance Officer by the Water Resources Manager for approval as an entire document. A letter or memorandum included with the revised SOP will identify which QAPPs are affected by changes to SOPs. Identification and justification of changes are included with major updates resulting in a change in the number before the decimal point in the SOP version number (*e.g.,* change of name from Version 1.0 to 2.0).

Minor updates to SOPs are transmitted to the EPA Project Manager and EPA Quality Assurance Officer for approval via a letter that identifies changes and justifications, and identifies which QAPPs are affected by changes to SOPs. Minor updates include correction of mistakes and non-substantive changes to the SOPs. Corrections of mistakes are tracked through the use of a lower case letter at the end of the SOP version number (*e.g.,* change of name from Version 1.0 to 1.0a). Non-substantive minor changes are tracked through change of the number following the decimal point in the SOP version number (*e.g.,* change of name from Version 1.0 to 1.1).

SOP updates and revision letters are provided to the individuals in the distribution list via electronic format.

9. IMPLEMENTATION OF WORK PROCESSES

The purpose of this section is to document how the WQM Program will be implemented to ensure that data or information collected are of the needed and expected quality for their desired use. This section includes information required for inclusion in QMPs as well as QAPP components common to all projects within the WQM Program.

9.1 QAPP and SOP Implementation

The LWRD has developed QAPPs for all of the projects within the WQM Program and SOPs for all equipment used and parameters measured as part of these projects. These documents provide the operating policies and procedures, including QA/QC activities, for all project activities in writing. QAPPs and SOPs are made available for all staff involved in implementing or reviewing WQM Program projects or making parameter measurements to be used as part of the WQM Program.

It is the responsibility of the Water Resources Specialist II to ensure that the QMP, QAPPs, and SOPs are properly implemented. The Water Resources Specialist II and Water Resources Technician II are responsible for following the procedures contained in the SOPs and QAPPs or documenting any deviations. Corrective actions, as outlined in the relevant SOP or QAPP and described in Section 9.7 below, can be taken in the field when performance standards are not met. If data continue to not meet performance standards, the Water Resources Specialist II consults with the Water Resources Manager to develop a strategy to address data quality concerns.

Changes to project QAPPs or instrument SOPs are documented and approved in writing through an amended QAPP or SOP, for substantive changes, or a letter outlining the changes, for non-substantive changes, as described in Sections 8.7 and 8.8.

9.2 Project Action Limits

The overall performance standard for the WQM Program is the collection of high-quality data sufficient to meet department and project goals. Data must be of sufficient quality (*i.e.,* known precision, accuracy, bias, traceability, completeness, and representativeness) to support scientifically valid, legally defensible decisions. Project design, methods, and QAPPs are revised if data quality is not sufficient to meet project goals.

As the projects within the WQM Program are ongoing and not designed to test a specific hypothesis, there are no formal project action limits. Although exceedances of Lummi Nation Water Quality Standards or groundwater chloride trigger limits may result in regulatory actions, the results of the WQM Program projects are not used to issue stop work orders.

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. Problems include elevated fecal coliform counts, elevated chloride levels, and declining well water levels. When problems are detected and not resolved through

standard practices or are of a more complex nature than the staff conducting water quality sampling typically address, the Water Resources Specialist II, Water Resources Technician II, and the Water Resources Manager will jointly develop an action plan to remedy the problem with clear roles, responsibilities, and timelines.

For example, the Water Resources Specialist II reviews the bacteria results and data quality of bacteria results provided by the laboratory and immediately alerts the Water Resources Manager if elevated levels of fecal coliform bacteria are detected. If the sample site location indicates that an elevated pollutant level originates from off-Reservation sites, representatives from the Washington State Department of Ecology, the Washington State Department of Agriculture, and/or Whatcom County are notified of the elevated count and are requested to investigate possible sources. If the sample site location indicates that an elevated pollutant level originates on-Reservation, the LWRD staff conducts a follow-up investigation.

9.3 Site Representativeness

The representativeness of surface water sample sites is examined twice annually, preferably once during the dry season and once during the wet season. Site representativeness is determined by conducting an informal cross-section survey for vertical and horizontal variability. *In situ* parameters are measured at five horizontal locations on a cross-section of the stream or river at the sample site. At each horizontal location, the parameter is measured at a minimum of two depths. If horizontal or vertical variability in the parameter readings is present in excess of the instrument's precision, relocation of the sampling site to a more representative location is considered. The Water Resources Specialist II will evaluate the feasibility of relocating the sampling location, with support and approval by the Water Resources Manager for the final decision.

9.4 Sample Tracking

Every sample site has a unique numerical identifier. The site identifier is recorded during site visits for all parameters measured and laboratory samples collected. Site information, including a description of the site and GPS coordinates, are included in the Water Database.

9.4.1 Naming Conventions

Sites sampled as part of the DOH Support (NSSP) Project are numbered according to DOH site naming conventions. All DOH sites begin with "DH" and are numbered sequentially with three digit numbers according to the order of site establishment by DOH. Note that there are breaks in the numbering sequence for DOH sample sites within the DOH Support (NSSP) Project because six sites were added to the project after the initial sites were established.

Groundwater sites begin with "GW" and are numbered sequentially with three digit numbers. Water Database stores data and/or well location information for 446 groundwater sites numbered GW001 through GW446, including some wells that are located off-Reservation.

Surface water sample sites begin with "SW" and are numbered sequentially with three digit numbers. Water Database stores data and site location information for 133 surface water sites

numbered SW001 through SW133. These sites have been historically and/or are currently sampled.

Spill response sample sites begin with "SR" and are numbered sequentially with three digit numbers. Spill response sample sites are established when new sites will be sampled multiple times due to spill response or other water quality concerns. There are currently 23 spill response sample sites numbered SR001 through SR023.

9.4.2 Multiple Samples per Day

When a site is sampled more than once during a day, the site identifier is recorded as the sample site number followed by a letter, starting with the letter "A" and moving sequentially through the alphabet for each subsequent sample at that site on that day. This facilitates identification of samples collected at different times throughout a day. For example, the first sample of the day at Site SW118 is SW118A, followed by SW118B, and so on.

9.4.3 Site Accessibility

Detailed maps, descriptions of sample locations, and driving directions to sample sites are provided to field personnel to ensure that sites are sampled on location (LWRD 2019). Access to sample sites accessible by land is usually not a problem. For marine sample sites, tides and weather may occasionally preclude sampling. Occasionally, an individual sample site cannot be accessed during the sample run. When sites are inaccessible, field personnel use professional judgment on a case-by-case basis to make a determination to: 1) return to the site at a later time to collect a sample; 2) reschedule the sample run; 3) skip the site and continue the sample run; or 4) collect a sample off-station. The decision is made by the Water Resources Specialist II. The determination depends on the need for the data, and the completeness of the data set for that parameter, sample site, and sample run. When sites are inaccessible, the reason is determined and remedied on-site or soon thereafter, if possible. If the problem is temporary (*e.g.,* a big hornet nest, flooding), the problem can usually be remedied within a few days and a sample may be collected at that time. Off-station sampling may occur as long as the sample is representative of the general sample site area (see next section). If the site can no longer be accessed, it is replaced.

9.4.4 Off-Station Sampling

If a sample cannot be collected in the designated sample site location, the sample may be collected nearby if the area is part of the same waterbody and is representative of the general sample site area. When this occurs, the sampling location is described in the iPad or field datasheet and the data collected identified as being collected "off station" because the sample was not collected at the established sample site.

When surface water is sampled for lab analysis at a location close to, but not at, an existing sample site, the sample site identifier is the numeric identification of the nearest sample site followed by the compass direction (N, NE, E, SE, S, SW, W, NW) from the nearest sample site to the sampling location, and the estimated distance from the nearest sample site in feet (*e.g.,* a sample collected 20 feet southeast of Site SW032 would be Site SW032SE20). In the site notes,

the location sampled is described with an explanation of why the regularly sampled location was not accessible. If necessary, a plan-view schematic map may also be drawn on the field datasheet to show the location of site sampled. Groundwater sites are considered sampled off-station if the water sample is collected from a different tap. A note about the location of the tap sampled is provided in the site comments section of the Water Database when groundwater is sampled off-station.

If the normal sampling location at a sample site cannot be regularly sampled, the sampling location will be moved and renumbered according to the naming conventions described in Section 9.4.1. An explanation of the reason for the change is noted in the setup module of the Water Database.

9.4.5 New Station Sampling

Occasionally, sampling not related to an existing QAPP may be conducted on an as-needed basis. For example, sampling may occur in connection to spill events (*e.g.,* manure, oil, hazardous waste) or during reconnaissance field sampling (*e.g.,* Nooksack River). In these instances, the sampling methods used will conform to the methods and quality control activities specified in the parameter or equipment SOPs or stricter methods if necessary.

Sampling may or may not occur at established sample sites. When sampling at new sample sites occurs, a description of the site location is recorded on field datasheets and GPS coordinates are logged so that the sites can be re-visited and incorporated into the Geographic Information Systems (GIS) sample site dataset. Sample site identifiers for this type of sample site are the number “99” followed by a letter in alphabetical order starting with “A” for the first sample collected that day. If the same sample sites are sampled again as part of the same event, the same sample site identifier is used for each sample site for the duration of the event. Alternatively, a name can be given as a sample site identifier for distinct locations, such as stream or tributary mouths, confluences, and upstream or downstream of bridges.

If a new sample site is determined to be a valuable location for regular sampling, the sample site will be renamed according to the naming conventions described in Section 9.4.1.

9.5 Procurement of Items and Services

The purpose of this section is to document the procedures for purchased items and services that directly affect the quality of data collected as part of the WQM Program. This section also includes information regarding the inspection and acceptance of critical supplies and consumables (QAPP Section B8) used for WQM Program projects.

9.5.1 Inspection/Acceptance of Supplies and Consumables (B8)

Critical supplies and consumables with acceptance criteria are listed in Table 9.1. 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. Supplies are purchased and delivered through the LIBC Purchasing Department and can usually be obtained within five working days after placement of an order. Distilled water is readily

available at stores on and adjacent to the Reservation. Equipment, supplies, and consumables are stored securely in the LNR lab. Order information, purchase orders, invoices, and delivery slips are stored on the LIBC server and in binders stored in the LWRD office.

Supplies and consumables are inspected when received and corrective actions taken if they do not meet acceptance criteria. The inventory is checked monthly and materials ordered or discarded as needed. Hazardous materials (*e.g.,* broken mercury thermometers) are securely stored in sealed containers, labeled with contents and date, and transported to a hazardous materials disposal site (currently Whatcom County Disposal of Toxics in Bellingham, WA). All other materials are thoroughly diluted and disposed of at the LNR lab. Most calibration and accuracy check standards are in large-volume quantities and not disposed of after a single use.

For large-volume consumables (*i.e.,* calibration standards for multi-parameter water quality sondes), the date that the container was received, opened, and emptied is written onto the container label and logged into the laboratory supply tracking spreadsheet. Tracking of receipt, opening, and empty dates assists in the timely ordering of an appropriate amount of consumables, and provides a log of the amount of materials used. Replacement parts for meters, with the exception of dissolved oxygen sensor membranes, are not kept in stock because, in most cases, only the manufacturer can perform repairs. Redundancy of supplies ensures that back-up equipment are available in the event that one instrument is unavailable or requires repairs before use. Additional back-up equipment may be available from the Stock Assessment or Habitat Restoration divisions of the LNR.

Sample bottles for laboratory analysis are provided by the laboratory (DOH or contract laboratory Edge). Laboratory bottles are inspected upon receipt and prominently marked with an “X” if the bottle cap is off or loose, or the cap or bottle is damaged. These bottles are disposed of at the office if they are broken, do not contain hazardous materials, or are not re-useable. Bottles that are unbroken and can be reused or contain hazardous materials are returned to the laboratory for disposal.

Table 9.1 Critical Supplies and Consumables with Acceptance Criteria

Consumables and Supplies	Acceptance Criteria	Stocking Level
Data Recording		
iPad	Charged and in working order	1 (datasheets are used as backup)
Field Laptop	Charged and in working order	1
Calibration Record Datasheet	Printed on Rite-in-the-Rain paper	10 to 15 spare forms
Field Datasheets	Printed on Rite-in-the-Rain paper	30 to 50 spare forms each for surface water and groundwater
Pens or Pencils	Ball-point pens capable of writing on Rite-in-the-Rain paper in any position or pencils	5 minimum
Stopwatch or timer	Stopwatch is accurate and functional	1 (alternately, can use cell phone with timer)

Table 9.1 Critical Supplies and Consumables with Acceptance Criteria

Consumables and Supplies	Acceptance Criteria	Stocking Level
General		
Sampling wand	Clean and not damaged	2 minimum: one for bacteria sample collection and one for large bottle sample collection
Bleach	Fresh and container not damaged	1 one-half gallon bottles
Distilled water	Capped and not contaminated	1 gallon minimum
Distilled and deionized water	Capped and not contaminated	as needed
Ice	Clean and fresh (do not allow water to accumulate in cooler)	2 bags
Gloves	Clean and not damaged	2 boxes with at least 25 pair; 1 box unopened
Glassware: 1 L volumetric flasks and 1, 10, 20 ml volumetric pipets	Clean and not damaged	1 each
Glassware: 200 ml volumetric flasks	Clean and not damaged	2 minimum
Pipet pump	Clean and not damaged	1
Sampling Containers for both laboratory and non-laboratory analysis		
1-L wide-mouth plastic bottle for ground water	Clean and not damaged	2 minimum
100 ml sterile sample bottles for bacteria (DOH supplied)	Supplied by laboratory. Top must be securely in place and bottle not damaged.	30 minimum
250 ml sterile sample bottles for bacteria (Edge supplied)	Supplied by laboratory. Top must be securely in place with autoclave tape and bottle not damaged.	30 minimum
250 ml bottles for chlorides	Supplied by laboratory. Top must be securely in place and bottle not damaged.	10 minimum
Metals/Hydrocarbons kit: 250 ml plastic (for pH) 1 L plastic (for marine metals and hardness) 500 ml plastic (for freshwater metals and hardness) 2x 500-ml amber glass with HCl (for hydrocarbons)	Supplied by laboratory. Tops must be securely in place and bottles not damaged.	Five complete sets minimum

Table 9.1 Critical Supplies and Consumables with Acceptance Criteria

Consumables and Supplies	Acceptance Criteria	Stocking Level
Nutrient kit: 1 L plastic (for various analyses) 1 L plastic (for BOD) 1 L plastic foil-wrapped with $MgCO_3$ (for Chlorophyll a) 1 L plastic with H_2SO_4 preservative (pH<2) (for various analyses) 250 ml plastic (for iron) 250 ml plastic (for TOC sample collection) 60 ml glass amber vial with HCl preservative for TOC	Supplied by laboratory. Tops must be securely in place and bottles not damaged.	Seven complete sets minimum
Air Temperature		
Armored, non-toxic, liquid-in-glass thermometer	Operating properly and passing QC activities	2
Multi-Parameter Water Quality Sondes		
YSI 556 MPS	Operating properly and passing QC activities	1
YSI ProPlus	Operating properly and passing QC activities	1
Calibration and Accuracy Check Standards		
Reference thermometer	Certified NIST-traceable. Clean and not damaged.	2
1,000 µS/cm conductivity standard	Certified NIST-traceable. Material not expired.	2 to 4 fresh 500 ml bottles
50,000 µS/cm conductivity standard	Certified NIST-traceable. Material not expired.	2 to 4 fresh 500 ml bottles
pH buffer 4	Certified NIST-traceable. Material not expired.	2 fresh 500 ml bottles
pH buffer 7	Certified NIST-traceable. Material not expired.	4 fresh 500 ml bottles
pH buffer 10	Certified NIST-traceable. Material not expired.	4 fresh 500 ml bottles
1000 mg/l chloride standard	Certified NIST-traceable. Material not expired.	2 fresh 500 ml bottles (only required when YSI ProPlus chloride sensor is installed and in use)
Sterile water	Provided by Edge	3
NIST traceable zero dissolved oxygen standard	Certified NIST-traceable. Material not expired.	3 fresh 500-ml bottles

Table 9.1 Critical Supplies and Consumables with Acceptance Criteria

Consumables and Supplies	Acceptance Criteria	Stocking Level
Multi-Parameter Water Quality Sonde Maintenance Supplies		
Small multi-head screwdriver (or separate Philips head and flathead screwdrivers)	Clean and not damaged	2
DO sensor membranes and electrolyte solution	Clean and not damaged	2 kits
O-rings	Clean and not damaged	10
O-ring lubricant	Container not damaged	2 tubes
C-Cell Batteries	Fresh and charged	8 batteries
Water Samples Collected for Analysis at a Laboratory		
Chain of custody forms and/or DOH sampling form	Clean and not damaged	10
Sample shipping papers	Clean and not damaged	5
Reuseable cooler	Clean and not damaged	2
Cooler(s) for sample shipment	Clean and not damaged; provided by DOH	6
Reusable ice blocks	Clean, functional	10 frozen
Secchi Depth		
Secchi disk	Clean and not damaged	1
Water Depth		
GPS unit with depth sounder (on boat)	Operational	1
Sampling wand (see above)		
Secchi Disk (see above)		
Turbidity		
Hach 2100 Q Portable turbidimeter	Operating properly and passing QC activities	1 (similar instrument available within LNR as backup)
Certified EPA-approved formazin StablCal primary calibration standards (20, 100, 800 NTU) and verification standard (10 NTU)	Fresh (not expired and within shelf life)	1 set, replace prior to expiration (or alternative; see SOP or relevant QAPP)
4000 NTU formazin standard solution	Fresh (not expired and within shelf life)	1 L (or alternative; see SOP or relevant QAPP)
Gelex secondary turbidity standards (0-10, 10-100, 100-1000 NTU)	Clean and not damaged or scratched; value assigned as outlined in SOP	1 set (or alternative; see SOP or relevant QAPP)
Matched and indexed turbidity vials	Indexed, clean, and not damaged or scratched	3
Silicone Oil	Fresh (not expired)	2 (1 spare unopened)
Lint free cloth	Clean	2
AA Batteries	Fresh and charged	8 (1 replacement set)

Table 9.1 Critical Supplies and Consumables with Acceptance Criteria

Consumables and Supplies	Acceptance Criteria	Stocking Level
Well Water Level		
Waterline Envirotech Electric 500-ft Well Probe	Operating properly and not bent or stretched (unless stretch corrections determined by manufacturer)	2
9-V battery	Fresh and charged	2 (1 replacement)
Ground Water Sampling Supplies		
Ground water hose	Clean and not damaged	2
Flat head screwdriver	Clean and not damaged	2
Crescent wrench	Clean and not damaged	2
Needle-nose vise grips	Clean and not damaged	2
Wire cutters	Clean and not damaged	2
Surplus nuts and bolts	Clean and not damaged	Variable, at least 3 of each size
Continuous Temperature Monitoring Equipment		
HOBO Water Temp Pro v2 temperature loggers	Operating properly and meeting QA/QC requirements	12
HOBO Water Temp shuttle and USB cable	Operating properly	1
Cable	Clean and not damaged	50 feet
U shaped stainless steel cable clamps	Not damaged	10
Bricks or cinder blocks	Not damaged	10
Rebar	Not damaged	5
Continuous Aquifer Level Monitoring Equipment		
Telog water level loggers	Operating properly and meeting QA/QC requirements	8
Digital voltage multimeter	Operating properly	1
Desiccant packs	Dried and properly sealed	8
Battery packs	Fresh and charged	8
Velcro	Clean and useable	1 package
Scissors	Clean and useable	1
Strain relief cable	Not damaged	5

NIST = National Institute of Standards and Technology

9.5.2 Contract Laboratories

Contracted laboratories providing analytical services are required to be accredited by either the United States or Washington State[15] for the analyses they will provide. Laboratory accreditation will be verified by the Water Resources Specialist II annually during contract preparation. Contracts with laboratories and laboratory budgets are developed annually by the Water Resources Manager. LIBC contract policies require open competition for contracts. Currently,

[15] The Lummi Nation does not currently operate an accreditation program.

laboratory analysis services are provided by Edge Analytical, Inc. (locations in Burlington, WA and Bellingham, WA), which is accredited by the Washington State Department of Ecology for all analyses provided.[16] Samples collected as part of the DOH Support (NSSP) Project are analyzed by the DOH Public Health Laboratory. The DOH Public Health Laboratory is accredited by the FDA for fecal coliform analysis as part of the NSSP. Laboratory analysis range, precision, and accuracy must be sufficient to meet project goals. Laboratory QA/QC procedures and criteria are summarized in Appendix C. Procedures for assessment and improvement of laboratory performance are described in Sections 10 and 11.

9.6 Equipment

9.6.1 New Equipment

Selection and purchase of new equipment follows LIBC Purchasing Department requirements, including procurement of a Purchase Order approved by the Purchasing Department, and may include competitive bids and/or Sensitive Item Request forms. The Water Resources Specialist II is responsible for researching potential new equipment purchases and ensuring that equipment specifications align with department and project goals. Memoranda are developed comparing new equipment options and outlining recommendations. Comparisons and recommendations are reviewed and approved by the Water Resources Manager.

All equipment require completed and approved SOPs for use in collecting project data. SOP requirements and procedures are provided in Section 8.8. If equipment must be used before SOPs are developed and approved, manufacturer's instructions are followed in the interim and all data are considered preliminary. Measurements made using new equipment prior to approval of the SOP are evaluated after SOP approval to determine whether equipment use meets the QA/QC requirements of the SOP. Measurements that do not meet SOP requirements are associated with a data qualifier in the Water Database with a brief explanation (Section 7.3.2).

New equipment information, including QA/QC and maintenance activities, is entered into the Water Database equipment module as described in Section 7.2.3 and the Water Database User Guide.

When new equipment is purchased to replace existing equipment, the new equipment is used side-by-side with the existing equipment until the relationship between the results of the two instruments can be established. However, this may not be possible when new instruments replace equipment that can no longer be used. All changes in equipment are recorded in the Water Database at the first time of use. Assessment of the relationship between the instruments is based, to the extent possible, on the results of side-by-side calibrations, field measurements, and quality control activities. A memorandum outlining the results of any side-by-side assessments conducted and implications for data comparability is prepared and saved in the Water Database equipment module.

[16] Chlorophyll and pheophytin analyses are subcontracted to ALS-Kelso located in Kelso, WA. Upon accreditation, these analyses will be subcontracted to IEH Analytical Laboratories of Seattle, WA.

9.6.2 Method Validation

Although not generally expected to be used for sample analysis as part of the WQM Program projects, nonstandard or unapproved laboratory methods may occasionally be implemented (*e.g.,* unusual matrices are being analyzed). Use of nonstandard or unapproved methods is evaluated on a case-by-case basis. For nonstandard or unapproved methods to be utilized, data quality must be adequate for the intended use of the data. Detection limits, quantitation limits, typical recoveries, and analytical precision and bias are used to evaluate appropriateness of the proposed method. In all cases, nonstandard and unapproved laboratory method data quality indicators are included in metadata to inform data users of potential limitations.

The exception to the general policy regarding nonstandard methods is the use of a hand-held sensor for measuring chloride as part of the Ground Water Project. Although contracted laboratory procedures for measuring chloride follow standard approved laboratory methods, the methods used to measure chloride using a sensor on the multi-parameter water quality sonde (YSI Professional Plus) does not yet have an approved method. The Ground Water Project QAPP provides the alternatives for measuring chloride, including implications and restrictions on data use due to nonstandard methods.

9.6.3 Non-Routine Samples

Occasionally, non-routine parameter sampling occurs. Non-routine sampling includes the measurement of a new parameter not included as part of any project, or measurement of a parameter not generally included in one project, but is analyzed as part of another project (*e.g.,* collection of bacteria samples from groundwater wells). Quality control activities for non-routine samples are addressed on a case-by-case basis. Strategies and resources to consider include:

- Procedures included in the QAPPs and SOPs within the WQM Program
- Procedures provided by the laboratory
- Manufacturer's instructions
- *National Field Manual for the Collection of Water-Quality Data* (USGS variously dated)
- *Standard Methods for the Examination of Water and Wastewater* (APHA variously dated)
- Consultation with others who perform the same or similar measurements and data collection activities

For non-routine sampling that becomes incorporated into regular sampling, a SOP for the sampling will be developed following the guidelines in Section 8.8 and the new sampling will be added to the relevant project QAPPs per Section 8.7.

9.7 Corrective Actions

The goals of corrective actions are (1) to solve the problem at hand and (2) to eliminate or reduce the occurrence of the problem in the future. It may be necessary to employ corrective

actions during site visits as part of the WQM Program. Problems with equipment detected during equipment use, calibration, or during QA/QC activities should be remedied by attempting corrective actions. Corrective actions depend on the parameter measured and instrument used; details are provided in the parameter and instrument SOPs. General guidance for corrective actions related to implementing this QMP are summarized below.

Problems that require corrective actions during sampling are categorized into three types: variability of the water sampled, operator error, and equipment error or malfunction. One or all of these may be responsible for the problem encountered. Steps to identify the specific causes of the problem vary between and within measurement types, but the general approach used to identify the source of a problem is to compare the sampling method against the manufacturer's instructions and the methods listed in the SOP and to follow troubleshooting steps in the SOP or equipment manual. Typical steps include: repeating the measurement; re-collecting, re-measuring, and/or re-analyzing the sample water; checking for fouling of probes or equipment; checking for poor connections or seals on equipment; checking battery condition; and measuring against a traceable standard.

If the problem is encountered in the field and cannot be resolved on-site or the time required to perform corrective actions would preclude conducting a sample run, a determination is made on a case-by-case basis to:

1. Continue the sample run without measuring the parameters requiring corrective actions,
2. Remedy the problem and conduct a portion of the sample run,
3. Use backup equipment (if available), or
4. Cancel and re-schedule the sample run.

The decision is made by the Water Resources Specialist II in consultation with the Water Resources Manager, as needed, and documented in the Water Database. Primary factors that influence the decision are: the need for the data; the completeness of the data set for that parameter, sample site, and sample run; and whether data quality for the parameters can be quantified or not. If a backup instrument is used to complete a sample run, the full range of QA/QC activities must be applied to the replacement equipment. In limited circumstances, malfunctioning equipment can be used to measure certain parameters if the error can be quantified and accuracy checks are performed with every measurement (see SOPs for details).

If the problem encountered was not corrected, the measurement is discontinued until the problem is identified, remedied, and reliable results are obtained. Measurements collected using malfunctioning equipment are associated with a data qualifier in the Water Database (Section 7.3.2). For most parameters, backup equipment is available for use while the deficiency with the standard equipment is being remedied. If SOPs and the equipment manuals are not adequate to solve the problem, the manufacturer or others that perform the same or similar measurements are consulted, and additional materials such as the *National Field Manual for the Collection of Water-Quality Data* (USGS variously dated) and the most recent version of *Standard Methods for the Examination of Water and Wastewater* (APHA variously dated) are used.

Problems with equipment and measurements, corrective actions, and outcomes are recorded in the Water Database. See the Water Database User Guide for details on entering comments.

9.8 Effectiveness of Control Actions

Statistics for control actions, such as sample bias and precision, are not routinely calculated. Data that meet QA/QC acceptance criteria are reported to have the accuracy outlined by the acceptance criteria. Sample bias and precision are calculated on a case-by-case basis, if needed.

The Water Resources Specialist II is responsible for ensuring that QA/QC procedures are followed and regular maintenance activities are completed. If QA/QC acceptance criteria are not met, corrective actions are taken to remedy the problem. If failure to meet QA/QC acceptance criteria leads to rejection of data, the problem is remedied before the instrument is further used to measure the parameter in the field. All issues with equipment are documented in the Water Database and a data qualifier is assigned, as appropriate. See Section 9.7 and SOPs for details on troubleshooting and corrective actions and Section 7.3.2 for details on assigning data qualifiers to questionable data.

If control actions fail to ensure field measurements meet parameter acceptance criteria, even after corrective actions, changes to equipment or method SOPs, project QAPPs, or other documents are considered to ensure that data quality meet project goals. See Section 10 for project quality system assessment and Section 11 for quality improvement strategies and procedures.

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10. ASSESSMENT AND RESPONSE

This section describes how the LWRD will assess the effectiveness of its quality management system to make sure that the procedures in this QMP and associated QAPPs and SOPs are developed and implemented successfully. The quality management system is assessed informally on an ongoing basis. Informal review of the quality management system occurs during implementation of the projects and during data verification, validation, and analysis while formal assessment occurs during annual quality assessments and as part of a five-year program review.

10.1 Informal Assessments

The Water Resources Technician II and Water Resources Specialist II, who are responsible for conducting WQM Program field sampling and implementing QA/QC procedures as outlined in this QMP, QAPPs, and SOPs, informally monitor the effectiveness of the quality management system by noting QA/QC issues and potential sources of data quality concerns encountered in the field. The Water Resources Specialist II also informally monitors the quality management system's effectiveness through QA/QC activities associated with data entry into the Water Database, noting recurring problems and investigating aberrations, and through continuing research on field, instrument, and laboratory methods. The Water Resources Specialist II is responsible for verifying that work process changes (e.g., SOPs) are implemented by field staff. This will include training, as needed, and work process supervision by the Water Resources Specialist II to ensure that the changes are appropriately implemented. Recommended changes are approved by the Water Resources Manager.

In conjunction with preparation of the Water Quality Assessment Report, the Water Resources Specialist II reviews the automated grading of data collected during the calendar year. If the grading system is not sufficiently reliable, changes to the Water Database methodology are reviewed in consultation with the Database Manager.

10.2 Formal Assessments

At least annually, the Water Resources Specialist II/Planner will conduct a Technical Systems Audit to provide oversight of field operations. The Technical Systems Audit involves the Water Resources Specialist II/Planner accompanying the Water Resources Specialist II and Water Resources Technician II on one groundwater and one surface water field sampling trip. The Water Resources Specialist II/Planner will observe the field sampling process to ensure instrument calibration, field sampling techniques, data recording, and QA/QC activities are conducted as outlined in this QMP, the project QAPPs, and instrument SOPs. The Technical Systems Audit also involves review of the documentation process through the review of a minimum of five trips in the Water Database for appropriate data entry and documentation. Any deficiencies and required changes are communicated to the field staff.

With the support of the Water Resources Specialist II, the Water Resources Specialist II/Planner performs periodic Quality Assurance Audits that the Water Resources Manager evaluates for

compliance with the quality management system, WQM Program, and individual project goals. Following review of the Water Quality Assessment Report, the Water Resources Specialist II/Planner will evaluate the extent to which the current quality management system goals are met, the extent to which the current WQM Program meets Program goals, the extent to which the individual projects meet project goals, and whether any new issues or problems have arisen that may require further examination (*e.g.,* development of a new project, revision of project goals, additional sample sites). The Quality Assurance Audit also involves evaluation of the appropriateness of continuing to use existing equipment/methods to measure parameters for each project based on project goals and equipment/method resolution, precision, and QA/QC results. 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, and the Water Resources Manager will jointly develop an action plan to remedy the problem with clear roles, responsibilities, and timelines.

The LNR is too small of an organization to maintain an entirely separate Quality Assurance Officer or Manager. Informal and ongoing review of the quality management system is conducted by all staff involved in water quality sampling as part of the WQM Program. Formal review of the quality system is conducted annually by the Water Resources Specialist II/Planner (Quality Assurance Officer), with assistance by the Water Resources Specialist II, and is reviewed by the Water Resources Manager (Project Manager and Quality Assurance Manager).

This QMP is valid for a period of five years. The QMP and associated QAPPs and SOPs are reviewed and re-approved, updated, or replaced every five years. The Water Resources Specialist II is responsible for reviewing and updating the QMP, QAPPs, and SOPs with review and approval by the Water Resources Manager (Project Manager and Quality Assurance Manager). Approval by the LNR Deputy Director, EPA Tribal Coordinator, and EPA Region 10 OEA Director is also required.

10.3 Laboratory Assessments

Laboratory analyses are conducted by independently contracted laboratories. At this time, LWRD submits samples to the EPA Region 10 Laboratory, the DOH Public Health Laboratory, and Edge Analytical, Inc., who subcontracts some of the analyses to ALS-Kelso.[17] Laboratory quality management systems are not directly reviewed by LWRD staff. The independently contracted laboratory must meet accreditation requirements for the analyses performed (Section 8.5) and are expected to follow their internal quality control policies (Appendix C). If minimum detection limits are not sufficient for project needs, LWRD staff will work with the contracted laboratory to determine strategies for meeting project data needs within the technological limits of laboratory analysis.

[17] Upon accreditation, Edge Analytical, Inc. will subcontract some analyses to IEH Analytical Laboratories.

10.4 Project Assessments

Project QAPPs and associated SOPs are informally assessed on an ongoing basis by the Water Resources Specialist II. Annually, all projects will be assessed to ensure that project experimental design continues to support WQM Program and project goals. Shifting project goals may result in the development of new projects or changes in the experimental design or methodology of existing projects. Project changes are documented in QAPPs and associated SOPs as described in Sections 8.7 and 8.8.

10.5 Management and Response

As previously described, the LNR is too small of an organization to have a dedicated quality assurance officer who is not involved in the management of or collection of water quality samples for the WQM Program. Supervisors are responsible for ensuring that staff have the necessary level of competence, experience, and training to safely and effectively implement the WQM Program. Assessments and recommendations are reviewed by the Water Resources Specialist II/Planner (Quality Assurance Officer) and approved by the Water Resources Manager (Quality Assurance Manager).

All personnel responsible for conducting assessments have the authority and access to: managers, documents, and records to identify quality problems and noteworthy practices; propose recommendations for resolving quality problems or implementing changes in practices; and independently confirm implementation and effectiveness of solutions. Supervisors are responsible for ensuring that assessment staff have the resources available to thoroughly conduct quality system assessments.

Upon identification of quality problems, personnel inform their supervisor of the problem and provide recommendations for quality management system changes. All recommendations are reviewed and approved by the Water Resources Manager prior to implementation of changes. Corrective actions are documented through the use of a Corrective Action Plan, when necessary (Section 11.2). Disputes encountered as a result of assessments are reviewed and resolved by the Water Resources Manager.

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11. QUALITY IMPROVEMENT

The purpose of this section is to document how the LWRD will improve the quality management system for the WQM Program. The effectiveness of current quality management system procedures and practices is evaluated by the Water Resources Specialist II, Water Resources Specialist II/Planner (Quality Assurance Officer), and the Water Resources Program Manager (Project Manager and Quality Assurance Manager) on an ongoing basis (Section 10).

The goal of quality improvement is to ensure that conditions adverse to quality are prevented, identified, corrected, and documented. All quality management system changes are documented in the QMP as described in Section 2.3. Any associated changes in individual project QAPPs are documented as described in Section 8.7 of this QMP.

11.1 Improvement Strategies

The quality management system is continually improved by LWRD staff responsible for implementing the WQM Program. The goal is to prevent quality problems from occurring or recurring, when possible, and reporting opportunities as well as quality problems to supervisors as they are identified. Problems are identified promptly and corrected as soon as practicable and corrective actions are documented and tracked to evaluate success.

During field data collection, including QA/QC activities, the Water Resources Specialist II and Water Resources Technician II are responsible for ensuring that conditions adverse to quality are prevented, promptly identified, corrected as soon as practicable, and documented. Recurring problems that compromise data quality encountered in the field or while using data collection equipment are evaluated by the Water Resources Specialist II. A strategy outlining appropriate corrective actions to prevent reoccurrence is developed, which may include replacement of equipment, additional QA/QC activities, or new maintenance procedures. Informal assessment of the success of troubleshooting and corrective actions is conducted as described in Section 10.1.

The Water Resources Specialist II stays informed of changes in technology and sampling techniques, including instrument or laboratory methods, maintenance activities, manufacturer QA/QC recommendations, and new equipment or laboratory analysis methods. Open communication is encouraged between field personnel, office personnel, contracted laboratory personnel, and the Quality Assurance Officer and Manager. Early and frequent communication between individuals involved in WQM Program projects are needed to prevent or to identify and correct quality issues in a timely manner.

Deficiencies in QA/QC activities are automatically flagged by the Water Database (Section 7.3.2). During preparation of the Water Quality Assessment Report, data quality is reviewed for adequacy (Section 7.3.3). Data that do not meet quality requirements are not used for data analysis or reporting. If the quantity of data that do not meet quality objectives exceeds the completeness threshold, then parameter measurement, site location, analysis method, and other aspects that may compromise data quality are evaluated for potential corrective actions

or alternatives. The Water Resources Technician II and Water Resources Specialist II provide support to the Database Manager in evaluating and revising the Water Database.

11.2 Corrective Action Plan

Data quality deficiencies are reviewed by the Water Resources Specialist II. If necessary, a formal plan for corrective action is developed to document the following:

- Root causes
- Nature and extent of the problem
- Programmatic impact (*e.g.,* unique or generic)
- Required corrective actions, including actions needed to prevent recurrence
- Means by which corrective action completion will be documented and verified
- Timetables
- Individuals responsible for implementing corrective action

The Water Resources Manager reviews and approves the corrective action plan, as needed, to ensure that changes to the quality management system support the collection of high quality data sufficient to meet program goals.

11.3 Laboratory Quality

The Water Resources Specialist II is in regular communication with the independent contracted laboratory providing analytical services to the LWRD. The Water Resources Specialist II and laboratory staff will periodically evaluate analytical methods and identify improvement opportunities.

12. ACRONYMS AND ABBREVIATIONS

7DADM	7-Day Average of the Daily Maximum
APHA	American Public Health Association
CALM	Continuous Aquifer Level Monitoring [Project]
CTM	Continuous Temperature Monitoring [Project]
CWRMP	Comprehensive Water Resources Management Program
DOH	Washington State Department of Health
EPA	Environmental Protection Agency
FDA	Food and Drug Administration
FPE	Flood Plain East
GIS	Geographical Information Systems
LAR	Lummi Administrative Regulation
LCL	Lummi Code of Laws
LDL	Lower Detection Limit
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
NMH	Nutrients, Metals, and Hydrocarbons [Project]
NOAA	National Oceanic and Atmospheric Administration
NSSP	National Shellfish Sanitation Program
PQL	Practical Quantitation Limit
PUD	Public Utility District
QAPP	Quality Assurance Project Plan
QMP	Quality Management Plan
QA/QC	Quality Assurance/Quality Control
SOP	Standard Operating Procedure
SP&PI	Sandy Point and Portage Island
TMDL	Total Maximum Daily Load

TOC	Total Organic Carbon
USGS	U.S. Geological Survey
WRIA	Water Resources Inventory Area
WQM	Lummi Nation Water Quality Monitoring [Program]
WQX	Water Quality Exchange
YSI	Yellow Springs Instruments

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14. APPENDICES

Appendix A. QMP/QAPP Sections Crosswalk

Appendix B. Datasheets

Appendix C. Laboratory QA/QC Information

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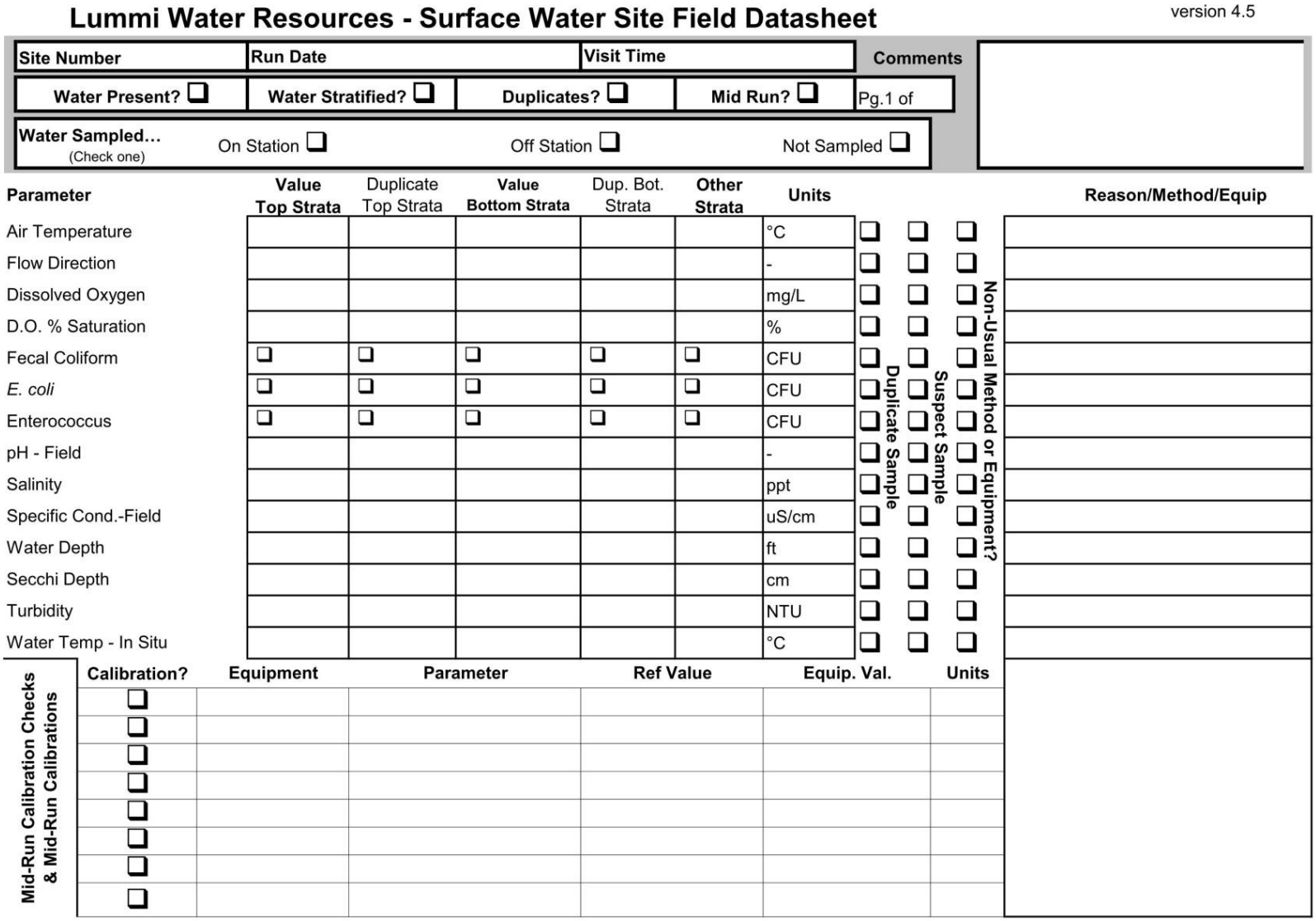
Appendix A. QMP/QAPP SECTIONS CROSSWALK

Section Number	QMP Section Name	QMP Element	QAPP Element
1.	**DOCUMENT ORGANIZATION**		
2.	**QUALITY MANAGEMENT SYSTEM**		
2.1	*Quality Management System Policy*	Quality Policy of the Organization	
2.2	*Quality Management System Components*	Quality System Components	
3.	**INTRODUCTION**		
3.1	*Program Goals*	*Mission of the Organization*	
3.2	*Program Context*		
3.3	*Lummi Indian Reservation*		*A6. Project/Task Description; Geographical Location*
3.4	*Lummi Nation Waters*		*A5. Problem Definition/Background*
3.5	*Water Quality*		*A5. Problem Definition/Background*
3.6	*Lummi Nation Surface Water Quality Standards*		*A5. Problem Definition/Background*
4.	**MANAGEMENT AND ORGANIZATION**	**Management and Organization**	
4.1	*Management Organization and Roles*		*A4 Project/Task Organization*
4.2	*Personnel Qualifications*		
4.3	*Training Requirements*		*A8. Special Training/Certifications*
4.4	*Reviews*		
4.5	*Communications*	*Assurance of Effective Communication*	
5.	**WQM PROGRAM PROJECTS**	**Management and Organization; Programs Supported by the Quality System**	**Summary of all programs**
6.	**DOCUMENTS AND RECORDS**	**Documents and Records**	**A9. Documentation and Records**
7.	**DATA MANAGEMENT**		**B10. Data Management**
7.1	*Field Work, Data Entry, and QA/QC Tracking*		
7.2	*Water Database*		
7.3	*Data Verification and Validation (D1, D2)*		*D1. Data Review, Verification, and Validation* *D2. Verification and Validation Methods*
7.4	*Summary Statistics*		*B5. Quality Control; Calculation of Statistics*
7.5	*External Data*		
7.6	*Reconciliation with User Requirements (D3)*		*D3. Reconciliation with User Requirements*

Section Number	QMP Section Name	QMP Element	QAPP Element
7.7	*Computer Hardware and Software*	*Computer Hardware and Software*	
8.	**PLANNING**	**Planning**	
8.1	*Planning Goals and Objectives*		
8.2	*Identification of Data Users and Suppliers*		
8.3	*Scheduling and Resources*		
8.4	*Program Planning*		
8.5	*External Data*		
8.6	*Analysis, Evaluation, and Assessment of Data*		
8.7	*QAPP Preparation, Approval, and Revisions*	*QAPP Requirements; including removal of obsolete documentation*	
8.8	*SOP Preparation, Approval, and Revisions*	*SOP Requirements; including removal of obsolete documentation*	
9.	**IMPLEMENTATION OF WORK PROCESSES**	**Implementation of Work Processes**	
9.1	*QAPP AND SOP Implementation*		
9.2	*Project Action Limits*		*A7. Quality Objectives and Criteria; Project Action Limits* *C2. Assessments and Response Actions; Stop Work Orders*
9.3	*Site Representativeness*		
9.4	*Sample Tracking*		*B3. Sample Handling and Custody; Documentation*
9.5	*Procurement of Items and Services*	*Procurement of Items and Services*	
9.5.1	Inspection/acceptance for supplies and consumables (B8)		B8. Inspection/Acceptance for Supplies and Consumables
9.6	*Equipment*		
9.6.2	Method Validation		B4. Analytical Methods; Method Validation
9.7	*Corrective Actions*		*B2. Sampling Methods; Corrective Actions*
9.8	*Effectiveness of Control Actions*		*B5. Quality Control; Effectiveness of Control Actions*
10.	**ASSESSMENT AND RESPONSE**	**Assessment and Response**	**C1. Assessments and Response Actions** **C2. Reports to Management**
11.	**QUALITY IMPROVEMENT**	**Quality Improvement**	

Appendix B. DATASHEETS



Lummi Water Resources - Surface Water Site Field Datasheet

version 4.5

Site Number	Run Date	Visit Time	Comments
Water Present? ❑	Water Stratified? ❑	Duplicates? ❑	Mid Run? ❑	Pg.1 of

Water Sampled… (Check one) On Station ❑ Off Station ❑ Not Sampled ❑

Parameter	Value Top Strata	Duplicate Top Strata	Value Bottom Strata	Dup. Bot. Strata	Other Strata	Units	Duplicate Sample	Suspect Sample	Non-Usual Method or Equipment?	Reason/Method/Equip
Air Temperature						°C	❑	❑	❑	
Flow Direction						-	❑	❑	❑	
Dissolved Oxygen						mg/L	❑	❑	❑	
D.O. % Saturation						%	❑	❑	❑	
Fecal Coliform	❑	❑	❑	❑	❑	CFU	❑	❑	❑	
E. coli	❑	❑	❑	❑	❑	CFU	❑	❑	❑	
Enterococcus	❑	❑	❑	❑	❑	CFU	❑	❑	❑	
pH - Field						-	❑	❑	❑	
Salinity						ppt	❑	❑	❑	
Specific Cond.-Field						uS/cm	❑	❑	❑	
Water Depth						ft	❑	❑	❑	
Secchi Depth						cm	❑	❑	❑	
Turbidity						NTU	❑	❑	❑	
Water Temp - In Situ						°C	❑	❑	❑	

Mid-Run Calibration Checks & Mid-Run Calibrations

Calibration?	Equipment	Parameter	Ref Value	Equip. Val.	Units
❑					
❑					
❑					
❑					
❑					
❑					
❑					

Figure 14.1 Surface Water Site Field Datasheet (front page)

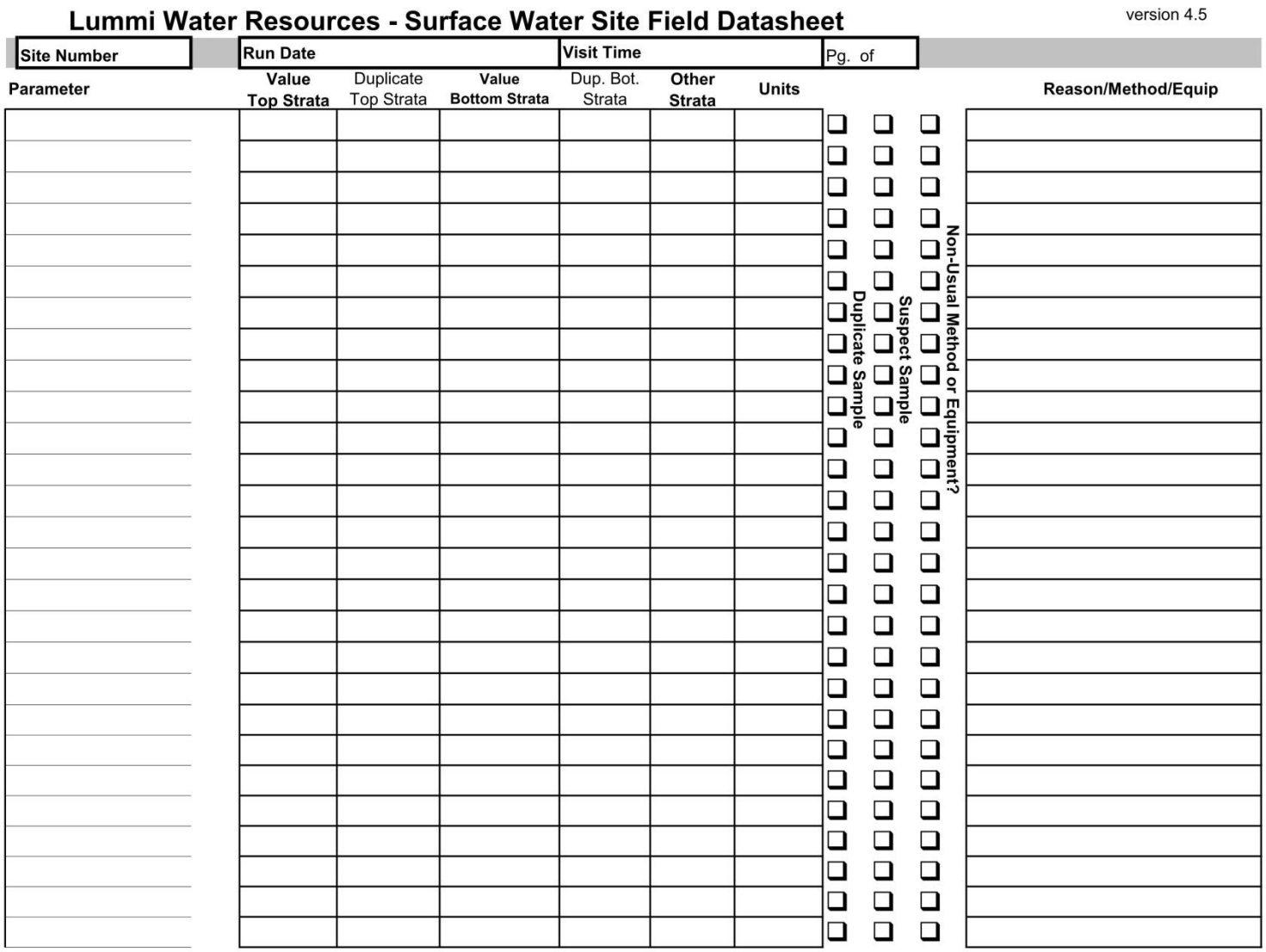
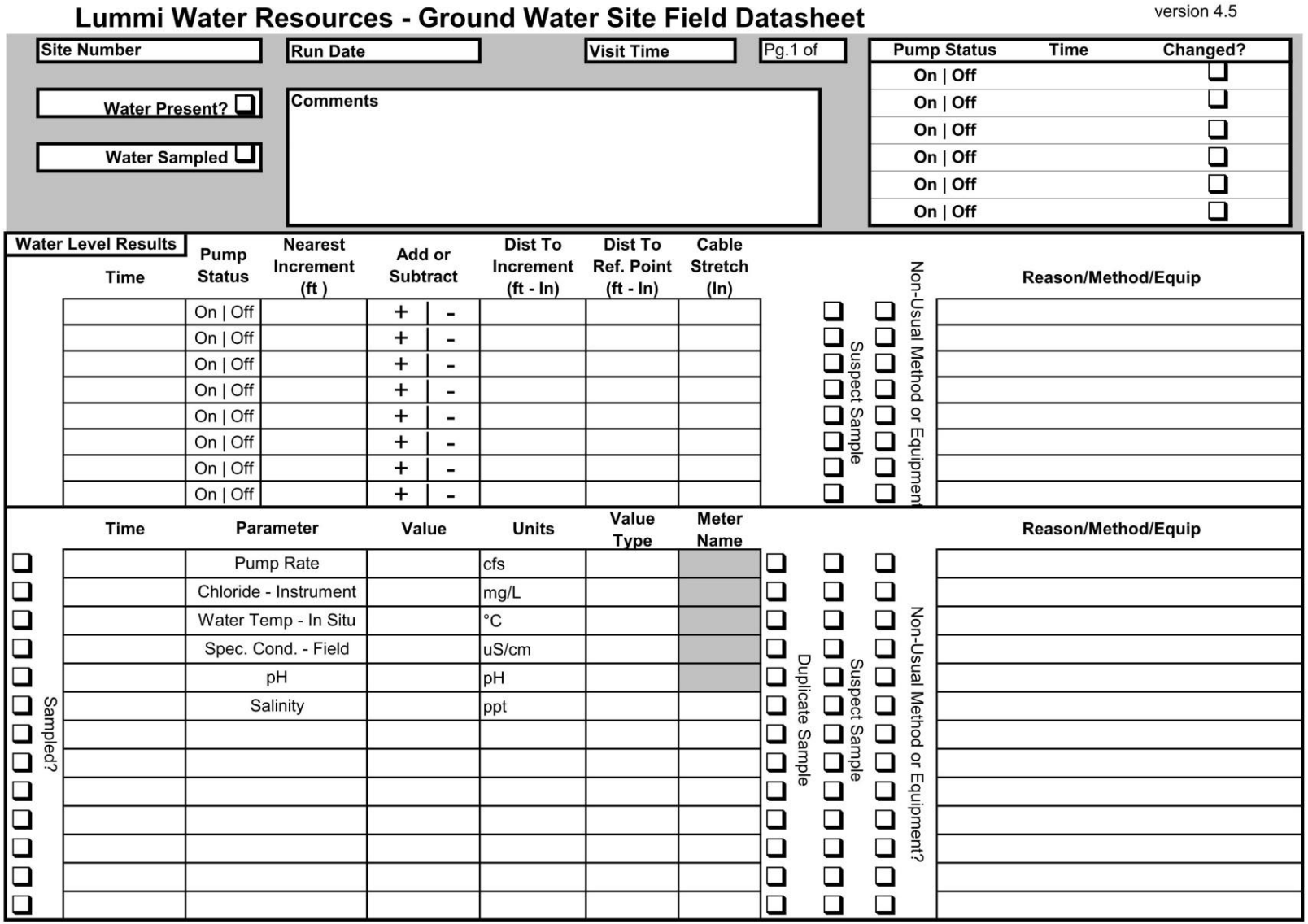


Figure 14.2 Surface Water Site Field Datasheet (back page)



Lummi Water Resources - Ground Water Site Field Datasheet

version 4.5

Site Number | Run Date | Visit Time | Pg.1 of

Water Present? ❑

Water Sampled ❑

Comments

Pump Status	Time	Changed?
On | Off		❑
On | Off		❑
On | Off		❑
On | Off		❑
On | Off		❑
On | Off		❑

Water Level Results

Time	Pump Status	Nearest Increment (ft)	Add or Subtract	Dist To Increment (ft - In)	Dist To Ref. Point (ft - In)	Cable Stretch (In)	Suspect Sample	Non-Usual Method or Equipment	Reason/Method/Equip
	On | Off		+ -				❑	❑	
	On | Off		+ -				❑	❑	
	On | Off		+ -				❑	❑	
	On | Off		+ -				❑	❑	
	On | Off		+ -				❑	❑	
	On | Off		+ -				❑	❑	
	On | Off		+ -				❑	❑	
	On | Off		+ -				❑	❑	

Sampled?	Time	Parameter	Value	Units	Value Type	Meter Name	Duplicate Sample	Suspect Sample	Non-Usual Method or Equipment?	Reason/Method/Equip
❑		Pump Rate		cfs			❑	❑	❑	
❑		Chloride - Instrument		mg/L			❑	❑	❑	
❑		Water Temp - In Situ		°C			❑	❑	❑	
❑		Spec. Cond. - Field		uS/cm			❑	❑	❑	
❑		pH		pH			❑	❑	❑	
❑		Salinity		ppt			❑	❑	❑	
❑							❑	❑	❑	
❑							❑	❑	❑	
❑							❑	❑	❑	
❑							❑	❑	❑	
❑							❑	❑	❑	
❑							❑	❑	❑	
❑							❑	❑	❑	

Figure 14.3 Ground Water Site Field Datasheets (front page)

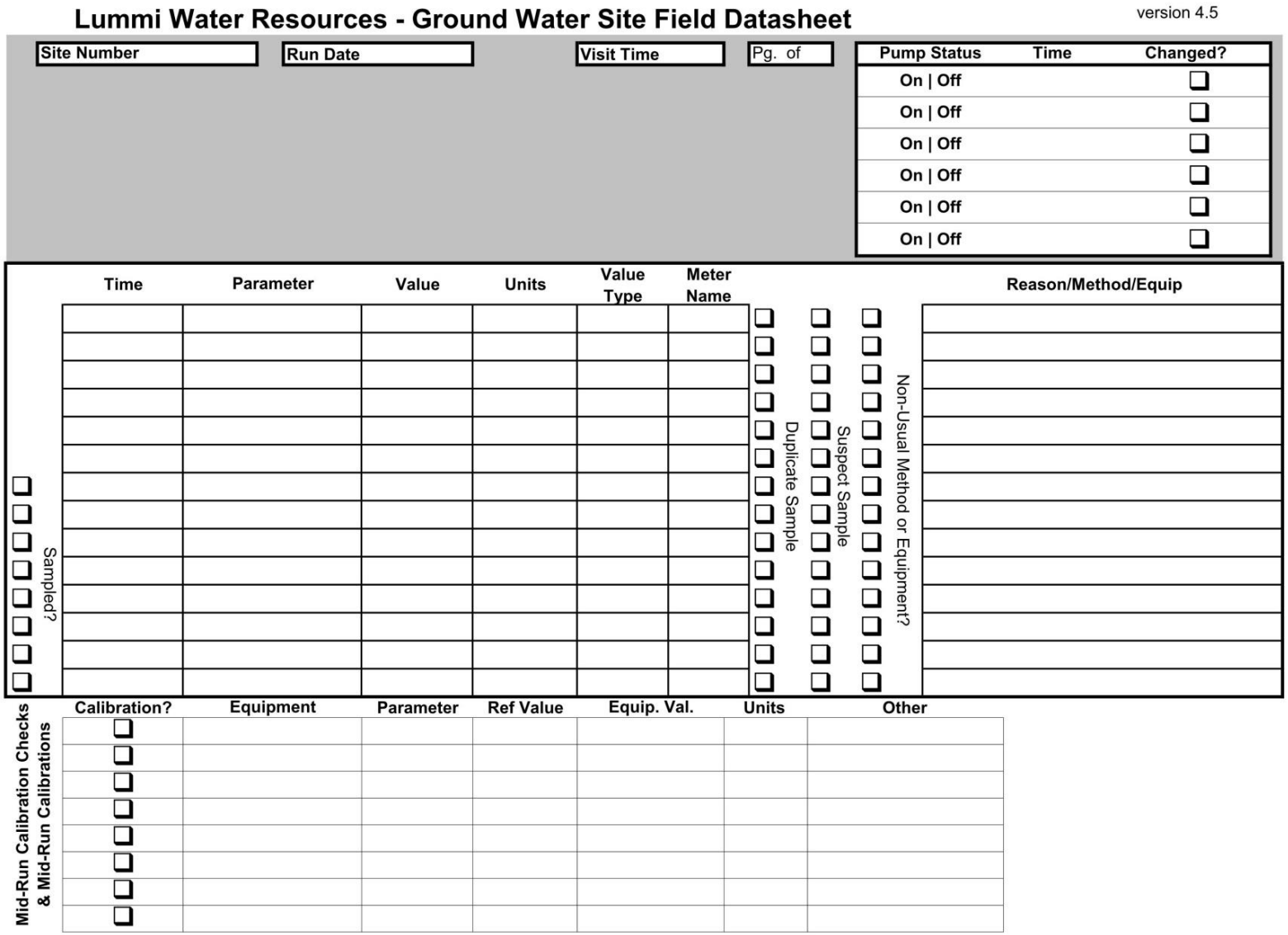
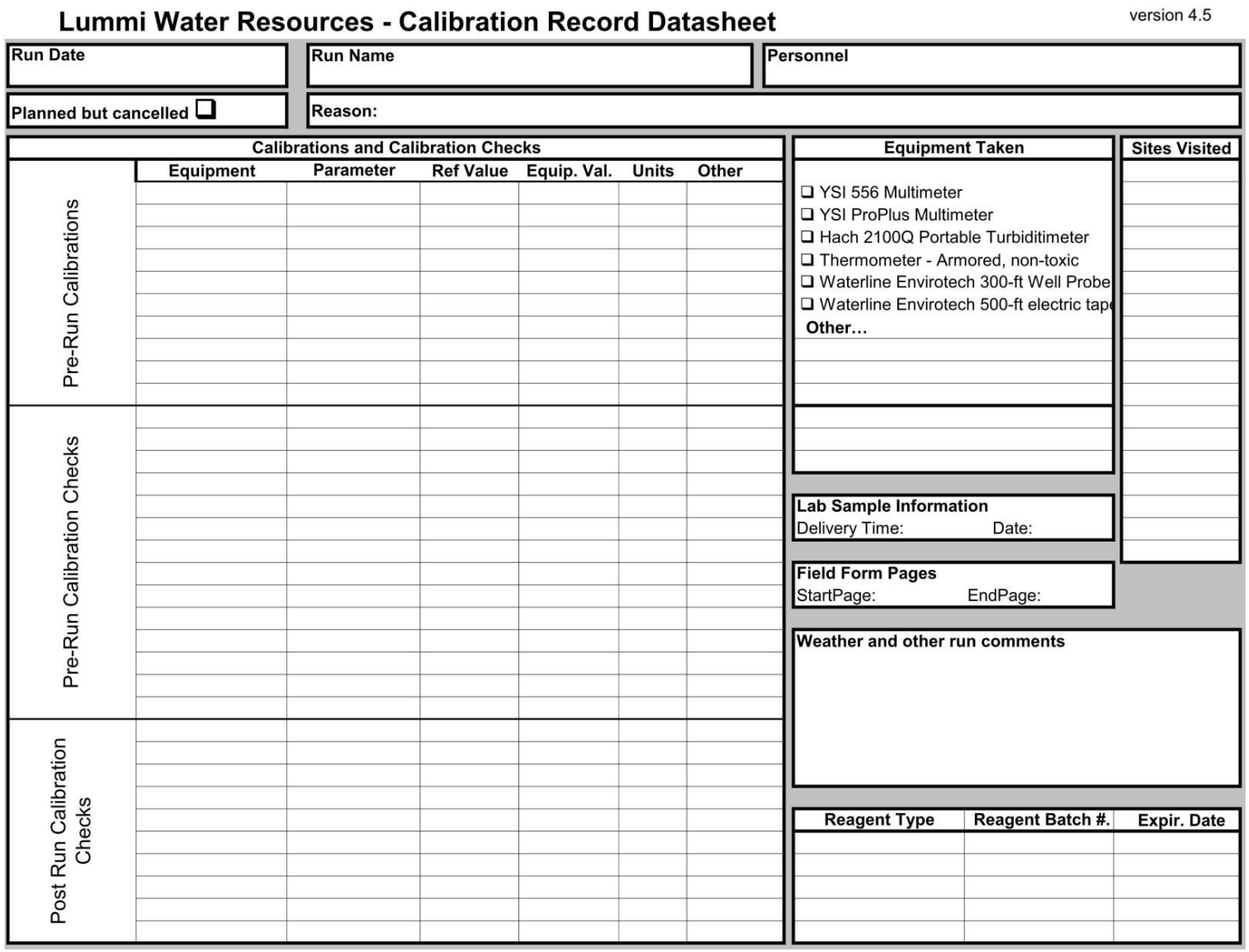


Figure 14.4 Ground Water Site Field Datasheets (back page)



Lummi Water Resources - Calibration Record Datasheet

version 4.5

Run Date	Run Name	Personnel

Planned but cancelled ❑	Reason:

Calibrations and Calibration Checks

	Equipment	Parameter	Ref Value	Equip. Val.	Units	Other
Pre-Run Calibrations						
Pre-Run Calibration Checks						
Post Run Calibration Checks						

Equipment Taken

- ❑ YSI 556 Multimeter
- ❑ YSI ProPlus Multimeter
- ❑ Hach 2100Q Portable Turbiditimeter
- ❑ Thermometer - Armored, non-toxic
- ❑ Waterline Envirotech 300-ft Well Probe
- ❑ Waterline Envirotech 500-ft electric tape

Other…

Sites Visited

Lab Sample Information
Delivery Time: Date:

Field Form Pages
StartPage: EndPage:

Weather and other run comments

Reagent Type	Reagent Batch #.	Expir. Date

Figure 14.5 Calibration Record Datasheet

Appendix C. LABORATORY QA/QC INFORMATION

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 following tables.

Table 14.1 Laboratory Methods, Detection Limits, Practical Quantitation Limits, and QA/QC Criteria for Nutrients, Metals, Hydrocarbons, and Groundwater Laboratory Samples Analyzed at Contracted Laboratory

Table 14.2 Laboratory Methods, Detection Limits, and QA/QC Criteria for Microbiological Laboratory Samples Analyzed at Contracted Laboratory

Table 14.1 Laboratory Methods, Detection Limits, Practical Quantitation Limits, and QA/QC Criteria for Nutrients, Metals, Hydrocarbons, and Groundwater Laboratory Samples Analyzed at Contracted Laboratory

Parameter	Analytical Method	Practical Quantitation Limits	Method Detection Limit (MDL)	QC Criteria				
				Method Blank/Lab Reagent Blank	Lab Fortified Blank	Quality Control Sample	Duplicate	Lab Fortified Matrix
pH	SM4500-H+ B	0-14 pH units	N/A	N/A	N/A	±20 %	±45 %	N/A
Alkalinity	SM2320 B	1 mg/L	N/A	0.3 mg/L	±10 %	±10 %	±20 %	±20 %
Biochemical Oxygen Demand	SM5210 B	1 mg/L	N/A	0.3 mg/L	±30 %	±30 %	±20 %	N/A
Chemical Oxygen Demand	SM5220 D	10 mg/L	4 mg/L	3 mg/L	±10 %	±10 %	±20 %	±20 %
Total Suspended Solids	I-3765-85	4 mg/L	N/A	2 mg/L	N/A	±20 %	±5 %	N/A
Volatile Suspended Solids	SM2540 E	0.10%	N/A	0.03%	N/A	N/A	±20 %	N/A
Ammonia	350.1	0.010 mg/L	0.0012 mg/L	0.003 mg/L	±10 %	±15 %	±20 %	±30 %
Nitrate-N	SM4500-NO3 F	0.010 mg/L	0.0007 mg/L	0.003 mg/L	±10 %	±10 %	±20 %	±20 %
Nitrite-N	SM4500-NO3 F	0.005 mg/L	0.0008 mg/L	0.002 mg/L	±10 %	±10 %	±20 %	±20 %
Nitrate + Nitrate N	SM4500-NO3 F	0.010 mg/L	-	0.003 mg/L	±10 %	±10 %	±20 %	±20 %
Total Kjeldahl Nitrogen	351.2	0.20 mg/L	0.0047 mg/L	0.06 mg/L	±10 %	±15 %	±20 %	±30 %
Orthophosphate	SM4500-P F	0.010 mg/L	0.0014 mg/L	0.005 mg/L	±10 %	±10 %	±20 %	±30 %
Total Phosphorus	SM4500-P F	0.010 mg/L	0.0026 mg/L	0.005 mg/L	±10 %	±10 %	±20 %	±30 %
Chloride	300.0	0.1 mg/L	0.0107 mg/L	0.03 mg/L	±10 %	±10 %	±20 %	±10 %
Iron	200.7	0.050 mg/L	0.0012 mg/L	0.005 mg/L	±15 %	±15 %	±20 %	±30 %
Chlorophyll a and Pheophytin*	SM10200-H	0.8 mg/m^3	unknown	N/A	N/A	88-113 %	±20 %	N/A
Total Organic Carbon	SM5310 B	0.15 mg/L	N/A	0.05 mg/L	±10 %	±10 %	±20 %	±30 %
Arsenic	200.8	0.0005 mg/L	0.0000218 mg/L	0.0002 mg/L	±15 %	±10 %	±20 %	±30 %
Chromium	200.8	0.001 mg/L	0.0000203 mg/L	0.0003 mg/L	±15 %	±10 %	±20 %	±30 %

Parameter	Analytical Method	Practical Quantitation Limits	Method Detection Limit (MDL)	QC Criteria				
				Method Blank/Lab Reagent Blank	Lab Fortified Blank	Quality Control Sample	Duplicate	Lab Fortified Matrix
Lead	200.8	0.0005 mg/L	0.0000067 mg/L	0.0002 mg/L	±15 %	±10 %	±20 %	±30 %
Copper	200.8	0.002 mg/L	0.0000276 mg/L	0.0006 mg/L	±15 %	±10 %	±20 %	±30 %
Mercury	245.1	0.0002 mg/L	0.000006 mg/L	0.00001 mg/L	±15 %	±10 %	±20 %	±30 %
Tin	200.8	0.001 mg/L	N/A	0.0003 mg/L	±15 %	±10 %	±20 %	±30 %
Zinc	200.8	0.0025 mg/L	0.0005519 mg/L	0.0008 mg/L	±15 %	±10 %	±20 %	±30 %
Hardness	200.7	3.30 mg/L	0.01 mg/L	1 mg/L	±15 %	±10 %	±20 %	±30 %
Diesel (C12-C24)	NWTPH-Dx	0.1 mg/L	0.07 mg/L	0.03mg/L	±30 %	±30 %	±30 %	±30 %
Heavy Hydrocarbons (>C24)	NWTPH-Dx	0.1 mg/L	0.1 mg/L	0.03mg/L	±30 %	±30 %	±30 %	±30 %

*Analysis provided by subcontractor ALS-Kelso (Kelso, WA) or, upon accreditation, IEH Analytical Laboratories (Seattle, WA)

Table 14.2 Laboratory Methods, Detection Limits, and QA/QC Criteria for Microbiological Laboratory Samples Analyzed at Contracted Laboratory

Parameter	Analytical Method	Lower Detection Limit	QC Type	Quality Control Sample	Criteria
Fecal Coliform	SM9222D	2 CFU/100ml	Media QC	Positive (*E. coli* and *Klebsiella pneumonia*)	Presence
				Negative (*Enterobacter aerogenes*)	Absence
				Sterile	Absence
			Method QC	Sterile (pre-filtration, post-filtration, and mid-filtration)	Absence
				Lab duplicate (every 10-20 samples)	Log[RPD] < 3.27*mean(log[$S_{1...15}$])*
				Fecal confirmation (once per month)	Under development
Escherichia coli	SM9222G	2 CFU/100ml	Media QC	Positive (*E. coli*)	Presence
				Negative (*Klebsiella pneumonia*)	Absence
				Sterile	Absence
			Method QC	Lab duplicate (every 10-20 samples)	Log[RPD] < 3.27*mean(log[$S_{1...15}$])*
Enterococcus	SM9230D (Enterolert)	10 MPN/100ml	Media QC	Positive (*Enterococcus faecalis*)	Presence
				Negative (*Staphylococcus aureus*)	Absence
				Sterile	Absence
			Method QC	Blank	Absence
				Lab duplicate (once per day)	Log[RPD] < 3.27*mean(log[$S_{1...15}$])*

*Where $S_{1...15}$ represents the 15 laboratory samples analyzed prior to the sample and its duplicate. The criterion changes for each duplicate. The log of the range (as relative percent difference) of the sample and its duplicate must be less than 3.27 multiplied by the mean of the last 15 samples after log transformation.

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

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

Quality Management Plan: Lummi Nation Water Quality Monitoring Program, Version 1.2
Water Resources Division, Natural Resources Department, Lummi Indian Business Council
July 2021

Project Name and assigned Region 10 Project Code:

Material to be Sampled:

Water

Measurement Parameters:

No change in measurement parameters

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

1) Change site number SR005 to SW135
2) Add SW135 to the First Flush Monitoring Project
3) Change the frequency of site representativeness checks from twice per year to once per year

Reason for Change in Field Procedure or Analytical Variation:

1) Site SR005 was initially established as a spill response site. This location was previously added to the Ambient Surface Water Quality Monitoring Project. Since the site is now a long-term surface water quality monitoring site, it has been renamed SW135 as specified in Quality Management Plan Section 9.4.1.
2) See reason for change in First Flush Monitoring Project QAPP Version 1.2a Addendum SPAF #1
3) Twice per year checks of site representativeness are time consuming given limited staff time. Vertical and horizontal variability will be checked once annually, with wet season and dry season visits on alternating years.

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

Changes affect Quality Management Plan sections:

1) Change site number SR005 to SW135 (Table 5.1, Section 5.1.3, Table 5.3).
2) Add SW135 to the First Flush Monitoring Project (Table 5.1).
3) Change the frequency of site representativeness checks from twice per year to once per year (Section 9.3).

Special Equipment, Materials, or Personnel Required:

No change

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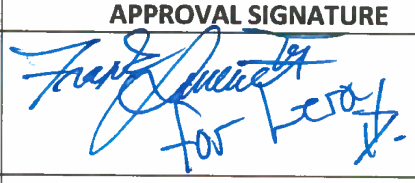
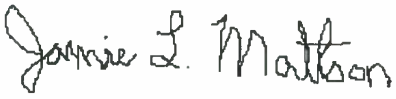
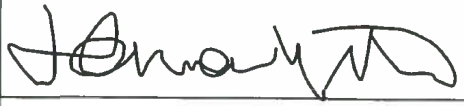
CONTACT	APPROVAL SIGNATURE	DATE
Leroy Deardorff, Lummi Indian Business Council (LIBC) Natural Resources Department Deputy Director		12-20-21
Water Quality Monitoring (WQM) Program Manager: Kara Kuhlman, CFM LIBC Water Resources Manager		12-20-2021
WQM Program Quality Assurance Officer: Jamie L. Mattson, LIBC Water Resources Specialist II/Planner		12/20/2021
WQM Program Coordinator: Hanna Winter, LIBC Water Resources Specialist II		12/20/2021
EPA Project Manager: Michael Ortiz, EPA Tribal Coordinator	Michael Ortiz	12/20/2021
EPA QA Manager: Donald M. Brown, EPA Region 10 Quality Assurance Officer	Meghan Dunn	12/20/2021