LUMMI NATION NONPOINT SOURCE POLLUTION ASSESSMENT REPORT: 2015 UPDATE

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EXECUTIVE SUMMARY

The Lummi Indian Reservation (Reservation) is located in northwest Washington State, approximately eight miles west of Bellingham, Washington. The Reservation is located along the western border of Whatcom County and at the southern extent of Georgia Strait and the northern extent of Puget Sound. Approximately 38 miles of highly productive marine shoreline surround the Reservation uplands on all but the north and northeast borders. The Reservation includes approximately 12,500 acres of uplands and 7,000 acres of tidelands.

The goal of the Lummi Nation Nonpoint Source (NPS) Management Program, which is a watershed-based approach that includes this NPS Pollution Assessment Report (NPSPAR) and a NPS Pollution Management Plan, is to effectively and efficiently control nonpoint sources of pollution on the Lummi Indian Reservation (Reservation). The watershed-based approach of the Lummi Nation NPS Management Program includes coordination with appropriate jurisdictions to control nonpoint sources of pollution in the watersheds that discharge to the Reservation.

The objectives of this NPS Pollution Assessment Report are: (1) to determine the current and potential impairments of Reservation water bodies due to NPS pollution, (2) to identify the primary NPS pollution types responsible for these impairments, and (3) to identify the resources available to address NPS pollution. The objectives of the NPS Pollution Management Plan are: (1) to identify management practices that will reduce NPS pollution on the Reservation; (2) to identify and implement on-the-ground projects that protect or restore water quality on the Reservation and in the watersheds that discharge to the Reservation; (3) to encourage public involvement and education directed toward reducing or eliminating NPS pollution sources; and (4) to coordinate with appropriate jurisdictions to reduce off-Reservation NPS pollution that adversely affects Reservation surface and ground water resources.

As described in the Lummi Nation Water Resources Protection Code (Lummi Code of Laws [LCL] Title 17) the Lummi Nation finds that contamination of surface and ground water resources on the Reservation has a direct, serious, and substantial effect on the political integrity, economic security, health, and welfare of the Lummi Nation, its members, and all persons present on the Reservation. Further, the Lummi Nation finds that those activities posing threats of such contamination, if left unregulated, could cause such adverse effects. Accordingly, the Lummi Natural Resources Department (LNR) developed and is implementing the NPS Pollution Management Program for the Reservation based on the foregoing findings and the following considerations:

- The Lummi Nation aims to achieve the “fishable and swimmable” goal of the Clean Water Act and the Lummi Nation Water Quality Standards.
- 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.

- There is a foreseeable continued conversion of forested and agricultural lands to residential, commercial, and community uses which will bring greater impacts to surface water quantity and quality.
- There is a need to minimize the adverse effects from development and maximize the protection of natural resources.
- As a finite resource, ground water is one of the most important and critical of the Lummi Nation's resources and is vulnerable to contamination from storm water and pollutants from human activity.
- Ample supplies of high quality ground water are essential to serve the purposes of the Reservation as a permanent, economically viable, homeland to the Lummi Nation and its members.
- Ninety-five percent of the residential water supply for the Reservation is pumped from local ground water wells and wellhead contamination threatens public health.
- Ground water contamination could lead to the loss of the primary water supply source for the Reservation.
- Alternative water supply sources are expensive and may not be available in amounts sufficient to replace existing supplies and to provide for future growth.
- The on-Reservation salmon hatchery is dependent on high quality ground and surface water.

Analysis of available water quality data and potential sources of NPS pollution shows that surface waters on and flowing onto the Reservation are currently or potentially affected by all types of NPS pollutants. These types of pollution include bacteria/pathogens, fine sediment, nutrients, oxygen demanding substances (which result in low dissolved oxygen levels), pH, temperature, metals, pesticides, household and industrial chemicals, and oil and grease. Nonpoint source pollution currently and/or potentially impairs the four major waterbodies (Nooksack River, Portage Bay/Bellingham Bay, Lummi River, and Lummi Bay/Strait of Georgia) and the ground water on the Reservation. The Lummi Nation NPS Pollution Management Program is focused on addressing the three current impairments of greatest concern: loss of salmonid habitat in the Nooksack River watershed and estuary; restrictions to ceremonial, subsistence, and commercial shellfish harvests in Portage Bay; and salt water intrusion and other contamination of the Reservation aquifers. Also identified in the NPS Pollution Assessment Report is the potential impairment to the Lummi Nation Waters that would result in restrictions to ceremonial, subsistence, and commercial shellfish harvests in Lummi Bay. These waters require NPS pollution control measures to restore or maintain desired water uses and/or, in the case of surface waters, to meet or maintain the Lummi Nation Water Quality Standards.

The primary NPS pollution categories responsible for the current and potential impairments of surface and ground water on the Reservation are agriculture, silviculture, hydromodification (including aquatic and riparian habitat modification), urban runoff, and both surface and ground water withdrawal. Other source categories, in particular atmospheric deposition, highway/road runoff, construction, and land disposal contribute to the impairment of Reservation water bodies, but are not known to produce significant impairment at this time. Control of each NPS pollution category should contribute to the improvement and maintenance of water quality on the Reservation. The primary sources of impairment should be the priority targets for NPS pollution management.

To reduce or eliminate the adverse effects of NPS pollution on surface and ground water and to achieve the NPS Pollution Management Program goals, appropriate best management practices (BMPs) must be effectively applied. Effective use of BMPs, coupled with land use zoning, should minimize or eliminate the NPS pollution effects on Reservation waters. Nonpoint source pollution on the Reservation is currently largely addressed through 15 interrelated Lummi Indian Business Council environmental programs and various Lummi Natural Resource Department activities that specifically target the primary current and potential impairments of Reservation water bodies. The NPS Pollution Management Plan for the Reservation supports and complements these programs and activities and emphasizes continued involvement in off-Reservation NPS pollution issues. Community involvement is a key element of the Lummi Nation NPS Pollution Management Program because surface and ground water movement does not adhere to property or political boundaries and because community participation in developing and implementing the NPS Pollution Management Program is necessary for the program to be successful.

This update of the 2001 Lummi Nation Nonpoint Source Pollution Assessment Report (LWRD 2001b) includes the following primary changes:

- Revised delineation of Reservation watersheds based on higher resolution topography data.
- Updated inventory of potential NPS pollution sources in the Reservation watersheds.
- Updated descriptions of the Lummi Surface and Ground Water Quality Monitoring Programs.
- Updated Lummi Surface Water Quality data.
- Updated impairments of Reservation water bodies.
- Updated descriptions of NPS pollution prevention and control programs.
- Updated descriptions of Best Management Practices (BMPs) for NPS pollution.

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1. INTRODUCTION

1.1. Definition of Nonpoint Source Pollution

Nonpoint source (NPS) pollution is all pollution that cannot be identified as point source pollution. The definition of a point source of pollution from Section 502(14) of the Clean Water Act (CWA) is the following:

> The term "point source" means any discernible, confined, and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged. This term does not include agricultural storm water discharges and return flows from irrigated agriculture.

Nonpoint source pollution is more aptly termed diffuse source pollution because its sources are numerous and widespread. Nonpoint source pollution occurs when water in any form (e.g., surface or ground water, snow, rain, or fog) picks up contaminants. This can happen in lawns or fields where fertilizer or pesticides have been applied, anywhere that oil or other pollutants have leaked or spilled and come into contact with water, and anywhere that soils are exposed to erosion through activities such as construction, cultivation, or clearing. In short, NPS pollution can originate nearly anywhere. Polluting actions by individuals often appear insignificant when considered alone, but considering that many people have done, are doing, and will engage in the same activity, the NPS pollution can add up to a significant problem. The cumulative effect of NPS pollution commonly results in impairment of surface and/or ground water.

The most effective way to reduce water pollution is to prevent contaminants from coming into contact with water. This proactive approach of pollution prevention requires proper handling, storage, and disposal of polluting materials as well as immediate clean up of spills. This in turn requires education, safe places to dispose of pollutants, and an awareness of the responsibility to do so. Where this is not possible (e.g., the wear of tires on roads), treatment of the water is required before it flows into a stream or infiltrates into the ground. Prevention of NPS pollution is far preferable to treatment because treatment is never 100 percent effective and can be very expensive.

Nonpoint source pollution also includes physical modification of waterbodies through direct means (e.g., channelization, diking, or draining) and indirect means such as surface water diversions or ground water withdrawals that alter the volume and timing of runoff (EPA 1993a). Impermeable surfaces (e.g., roofs, parking lots) and drainage improvements associated with most land uses increase the amount of storm water runoff and reduce the amount of time required for the storm water to reach surface waters. The increased volume of water in the receiving waters can alter the composition of the streambed, contribute larger amounts of sediment, and erode the banks as the shape of the channel changes to accommodate more frequent high flows. In contrast, when rain water in the Pacific Northwest falls on land that is in a natural or unimproved state, the rain water only occasionally flows across the surface (i.e., overland flow) to nearby waterbodies. Further, the rapid runoff of storm water associated with increased impermeable area and/or improved drainage decreases infiltration and results in less ground water to support aquifers and stream flow during dry periods. The resulting low flows can effectively increase the concentration of contaminants and/or the probability of violations of applicable water quality criteria.

In summary, NPS pollution largely results from the cumulative effects of individual actions that appear insignificant when viewed in isolation. Pollution prevention is the most effective method to minimize the effects of NPS pollution because individual sources are numerous and dispersed and because treatment options are expensive and can have limited effectiveness.

1.2. Reservation Resources

The Lummi Indian Reservation (Reservation) is located in northwest Washington State, approximately eight miles west of Bellingham, Washington (Figure 1.1). The Reservation is located along the western border of Whatcom County and at the southern extent of Georgia Strait and the northern extent of Puget Sound. Approximately 38 miles of highly productive marine shoreline surround the Reservation uplands on all but the north and northeast borders. In addition to marine waters, there are approximately 24.4 miles of rivers, streams, sloughs, and drainages on the Reservation including the multiple distributary channels of the Nooksack River delta. There are no lakes on the Reservation, but there are approximately 13 ponds. The Reservation includes approximately 12,500 acres of uplands and 7,000 acres of tidelands. The Nooksack River drains a watershed of approximately 786 square miles, flows through the Reservation near the mouth of the river, and discharges to Bellingham Bay (and partially to Lummi Bay during high flows). The Reservation is comprised of a five mile long peninsula (Lummi Peninsula), which borders Lummi Bay on the west and Bellingham Bay on the east; a northern upland area and the smaller peninsula of Sandy Point; the floodplains and deltas of the Lummi River (a.k.a. Red River) and the Nooksack River; Portage Island; and associated tidelands. Land ownership on the Lummi Indian Reservation is discussed in Section 3.5.4 and illustrated in Figure 3.8.

The Lummi Nation is the largest fishing tribe in the Puget Sound in terms of pounds of fish landed and number of species fished (NWIFC 2012) and has relied on their water resources since time immemorial for ceremonial, subsistence, and commercial purposes. The waters of the Reservation contain significant resources for both the Lummi Nation and the region. Numerous economically and culturally important species, including salmon, herring, oyster, manila clam, little neck clam, butter clam, horse clam, and Dungeness crab, are present in Lummi Nation waters (LNR 2010a). The estuarine waters of the Nooksack River and Lummi River deltas form the interface between marine and inland fresh water. Estuarine waters are important habitat for both juvenile and adult salmon as they acclimate to either saline or fresh waters during their seaward and landward migrations, respectively.

Figure 1.1 Regional Location of the Lummi Indian Reservation

Reservation waters also contain large eelgrass meadows and habitat for numerous species of waterfowl, marine birds, and raptors (including bald eagle and peregrine falcon). Nonpoint source pollution can result in economic and cultural hardship by decreasing the health and abundance of fish, shellfish, and wildlife; by causing the closure of commercial shellfish beds and by affecting human health through consumption of contaminated fish and shellfish. Because these water resources are vital for economic stability, growth, and the cultural and spiritual life of the community, the potential contamination of Lummi Nation surface waters has a direct, serious, and substantial effect on the health and welfare of the Lummi Nation, its members, and all persons present on the Reservation.

In addition, because of the geographic and hydrogeologic conditions in the area, ground water resources on the Reservation are also vulnerable to pollution. Over 95 percent of the residential water supply for the Reservation is currently pumped from local ground water wells. The contamination of the aquifers that supply these wells would adversely affect the health of persons drinking or using water from these supplies. Ground water contamination could lead to the loss of the primary water supply source for the Reservation because it is very expensive to treat, and some damages to ground water caused by contamination may be unmitigable.

1.3. Goals and Objectives

The Lummi Nation's watershed-based NPS Pollution Management Program is a part of the Comprehensive Water Resources Management Program (CWRMP), which includes a Wellhead Protection Program, Storm Water Management Program, Wetland Management Program, and a Water Quality Standards Program. The CWRMP is being implemented by the Water Resources Division of the Lummi Natural Resources Department (LNR) and addresses the overall management of Reservation waters. The Lummi Nation Water Quality Standards (LWRD 2008a) provide criteria against which impacts from NPS pollution can be evaluated. The 2001 Nonpoint Source Pollution Assessment Report (NPSPAR) and this update provide the information necessary to update the 2002 NPS Pollution Management Plan for the Lummi Reservation.

The goal of the Lummi Nation Nonpoint Source (NPS) Management Program, which is a watershed-based approach that includes this NPS Pollution Assessment Report (NPSPAR) and a NPS Pollution Management Plan, is to effectively and efficiently control nonpoint sources of pollution on the Lummi Indian Reservation (Reservation). The watershed-based approach of the Lummi Nation NPS Management Program includes coordination with appropriate jurisdictions to control nonpoint sources of pollution in the watersheds that discharge to the Reservation.

The objectives of this NPS Pollution Assessment Report are: (1) to determine the current and potential impairments of Reservation water bodies due to NPS pollution, (2) to identify the primary NPS pollution types responsible for these impairments, and (3) to identify the resources available to address NPS pollution. The objectives of the NPS Pollution Management Plan are: (1) to identify management practices that will reduce NPS pollution on the Reservation; (2) to identify and implement on-the-ground projects that protect or restore water quality on the Reservation and in the watersheds that discharge to the

Reservation; (3) to encourage public involvement and education directed toward reducing or eliminating NPS pollution sources; and (4) to coordinate with appropriate jurisdictions to reduce off-Reservation NPS pollution that adversely affects Reservation surface and ground water resources.

As described in the Lummi Nation Water Resources Protection Code (Lummi Code of Laws [LCL] Title 17) the Lummi Nation finds that contamination of surface and ground water resources on the Reservation has a direct, serious, and substantial effect on the political integrity, economic security, health, and welfare of the Lummi Nation, its members, and all persons present on the Reservation. Further, the Lummi Nation finds that those activities posing threats of such contamination, if left unregulated, could cause such adverse effects. Accordingly, the Lummi Natural Resources Department (LNR) is developing and implementing the NPS Pollution Management Program for the Reservation based on the foregoing findings and the following considerations:

- The Lummi Nation aims to achieve the "fishable and swimmable" goal of the Clean Water Act and the Lummi Nation Water Quality Standards.
- 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.
- There is a foreseeable continued conversion of forested and agricultural lands to residential, commercial, and community uses which will bring greater impacts to surface water quantity and quality.
- There is a need to minimize the adverse effects from development and maximize the protection of natural resources.
- As a finite resource, ground water is one of the most important and critical of the Lummi Nation's resources and is vulnerable to contamination from storm water and pollutants from human activity.
- Ample supplies of high quality ground water are essential to serve the purposes of the Reservation as a permanent, economically viable homeland to the Lummi Nation and its members.
- Ninety-five percent of the residential water supply for the Reservation is pumped from local ground water wells and wellhead contamination threatens public health.
- Groundwater contamination could lead to the loss of the primary water supply source for the Reservation.
- Alternative water supply sources are expensive and may not be available in amounts sufficient to replace existing supplies and to provide for future growth.
- The on-Reservation salmon hatchery is dependent on high quality ground and surface water.

To reduce or eliminate the adverse effects of NPS pollution on surface and ground water and to achieve the NPS pollution management goals, appropriate best management practices (BMPs) must be effectively applied. Effective use of BMPs, coupled with land use zoning, should minimize or eliminate the NPS pollution effects on Reservation waters. Nonpoint source pollution on the Reservation is currently largely addressed through 15 interrelated Lummi Indian Business Council environmental programs and various Lummi Natural Resource Department activities that specifically target the primary current and potential impairments of Reservation water bodies. The NPS Pollution Management Program for the Reservation supports and complements these programs and activities and emphasizes continued involvement in off-Reservation NPS pollution management efforts. Community involvement is a key element of the Lummi Nation NPS Pollution Management Program because surface and ground water movement does not adhere to property or political boundaries and because community participation in developing and implementing the NPS Pollution Management Program is necessary for the program to be successful.

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- Updated descriptions of the Lummi Surface and Ground Water Quality Monitoring Programs.
- Updated Lummi Surface Water Quality data.
- Updated impairments of Reservation water bodies.
- Updated descriptions of NPS pollution prevention and control programs.
- Updated descriptions of Best Management Practices (BMPs) for NPS pollution.

1.4. Organization of Report

This report is divided into the following 11 sections:

- Section 1 is this introductory section.
- Section 2 describes the surface and ground water quality sampling methodology and the NPS pollution impairment assessment methodology.
- Section 3 provides a land use summary of the assessment area.
- Section 4 summarizes the quality of surface and ground waters on the Reservation.
- Section 5 summarizes the results of surface and ground water quality sampling on the Reservation and presents an inventory of potential categories of NPS pollution, a description of the impacts of NPS pollutants, and an assessment of the impairment of Reservation waters.
- Section 6 identifies the primary impairments of Reservation water bodies and the source categories responsible for these impairments.
- Section 7 describes the process used to select BMPs to address NPS pollution.
- Section 8 lists all potential NPS control programs available on- and off-Reservation and describes the existing NPS pollution reduction programs on the Reservation.
- Section 9 presents the conclusions of the NPS Pollution Assessment Report.
- Section 10 lists the references cited in this report.
- Section 11 lists the acronyms and abbreviations used in this report.

2. METHODS

This section describes the surface and ground water quality sampling methodology and nonpoint source pollution impairment assessment methodology utilized by the LNR to determine water body impairments and potential nonpoint pollution sources.

2.1. Surface Water

The surface water impairments of greatest concern to the Lummi Nation are those that currently or potentially cause salmonid habitat impairments in the Nooksack River watershed and estuary or that restrict ceremonial, subsistence, and commercial shellfish harvests in Lummi Bay and Bellingham/Portage Bay. Since the major sources of these impairments extend beyond the Reservation in the Lummi River and Nooksack River watersheds, impairments of these two river systems were assessed on a watershed wide basis. Data from the Lummi Water Resources Division (LWRD) Surface Water Quality Monitoring Program were used to assess the condition of surface waters on the Reservation and to describe how data were collected (LWRD 2014c). These data were collected starting in 1993 under CWA Section 106 grants and the General Assistance Program (GAP) grants awarded to the Lummi Nation by the U.S. Environmental Protection Agency (EPA) and tribal funding. The condition of surface waters off-Reservation was determined from the 2008 Washington State 303(d) list (Ecology 2009), which is still aligned with the Unified Watershed Assessment (Appendix A) prepared by the Lummi Natural Resources Department.

The LWRD employs both a fixed station network and a targeted water sampling design. The fixed station network is used for baseline water quality monitoring and includes 43 routine surface water sites (LWRD 2014c). Figure 2.1 shows the locations of the current LWRD water quality sampling sites on the Reservation and the DOH sample sites in Bellingham/Portage Bay. Many of the 43 sample sites are located along the Reservation border, with the majority of the contributing watershed located off-Reservation. Several intermittent streams and storm water systems are sampled as part of the Program, along with the marine waters of Lummi Bay, Bellingham/Portage Bay, and the Sandy Point Marina. A targeted sampling design approach is used to improve understanding of specific issues that warrant further investigation (e.g., a reported or observed manure spill, a fish or waterfowl kill near a pesticide application site, questions regarding water quality impacts of an automobile recycling facility, storm water discharge from a construction site, aquatic herbicide application sites). For a targeted design approach, sites from the fixed station monitoring network and other sites located both up- and down-stream from the identified potential pollutant source are sampled.

In consultation with the Lummi Nation and under 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 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. In Lummi Bay 12 sites are sampled by the LWRD to provide logistical assistance to the DOH and also to assist with the achievement of

Program goals. The DOH samples 12 sites in Bellingham/Portage Bay six times a year, which also assists in achievement of the Surface Water Quality Program goals. Starting in 2014, the LWRD started to supplement the sampling in Portage Bay to better characterize the fecal coliform levels – this LWRD sampling of Portage Bay occurs during months that the DOH are not sampling.

Information from all sample runs is used to establish baseline conditions, identify trends, and to evaluate compliance with water quality criteria. Some runs serve other purposes as well, for example, to determine if sources of fecal coliform bacteria in Bellingham/Portage Bay are local or from the Nooksack River watershed. The collection of water quality data along the Reservation boundary allows for compliance evaluation of waters flowing onto the Reservation by comparing the sample results with water quality criteria. The sample site selection also allows surface water quality to be evaluated along the length of the Lummi River floodplain water bodies and their tributaries. This water quality information is used to help identify pollution sources in the Lummi Bay Watershed.

Table 2.1 summarizes the surface water quality monitoring sampling schedule for the following parameters measured through the third quarter of 2013: water temperature, air temperature, water depth, specific conductivity, salinity, dissolved oxygen, pH, fecal coliform bacteria, *E. coli*, and enterococci. In accordance with its quality assurance plan, the contracted independent laboratory measures all bacteria from the same sample bottle, and fecal coliform bacteria and *E. coli* are measured from the same culture. The LWRD also collects continuous water temperature data at 9 surface water quality sites throughout the Reservation. The collected data are used to calculate the 7-day average of the daily maximum temperature for fresh water sites and the 1-day maximum temperature for marine water sites, which allows for a direct comparison with the applicable Lummi Water Quality Standards.

An evaluation of the ambient water quality sampling program during the third quarter of 2013 led to the suspension of sample collection at some locations, reduced sampling frequency at other locations, and an increase in the number of parameters sampled at one location. The resultant program modifications are described in Appendix D and summarized in Figure 2.1. The 2010 Quality Assurance/Quality Control Plan is being updated to reflect these changes.

Table 2.2 shows the specific nutrients, metals, and hydrocarbons analyzed at independent state or federally certified laboratories. Due to the costs of analyzing water quality samples for metals and petroleum hydrocarbons, these parameters are only measured quarterly at two of the water quality monitoring sites (one fresh water site downstream from a petroleum oil refinery and one marine water site within a recreational boat marina). Similarly, due to cost considerations, nutrients are measured quarterly at only five of the surface water quality monitoring sites. Depending on the specific intent of the sampling effort, nutrients analyzed range from ammonia, nitrate, and total phosphorus for "first flush" sample runs during the onset of the rainy season, to the same five parameters plus 5-day biochemical oxygen demand (BOD), nitrite, Total Kjeldahl Nitrogen (TKN), orthophosphate, total organic carbon, total suspended solids, total volatile suspended solids, alkalinity, pH, sulfate, sulfide, chlorophyll *a*, iron, and silicon. Metals analyzed include lead, zinc, copper, and chromium at

Site SW001 and Site SW014. The Site SW001 location is near the Sandy Point Marina and the Site SW014 location is along the stream that drains from the Phillips 66 petroleum oil refinery located along the western extent of the northern Reservation boundary. At both of these sites, pH and petroleum hydrocarbons are also measured.

More detailed descriptions of the LWRD Surface Water Sampling Program and collection methods can be found in the following reports: Lummi Nation Water Quality Monitoring Program Quality Assurance/Quality Control Plan – Version 4.0 (LWRD 2010), 2011 Lummi Nation Water Quality Assessment Report (LWRD 2014c), and Lummi Nation Water Quality Standards (LWRD 2008a). All of these documents can be downloaded from the following website: http://lnnr.lummi-nsn.gov/LummiWebsite/Website.php?PageID=5.

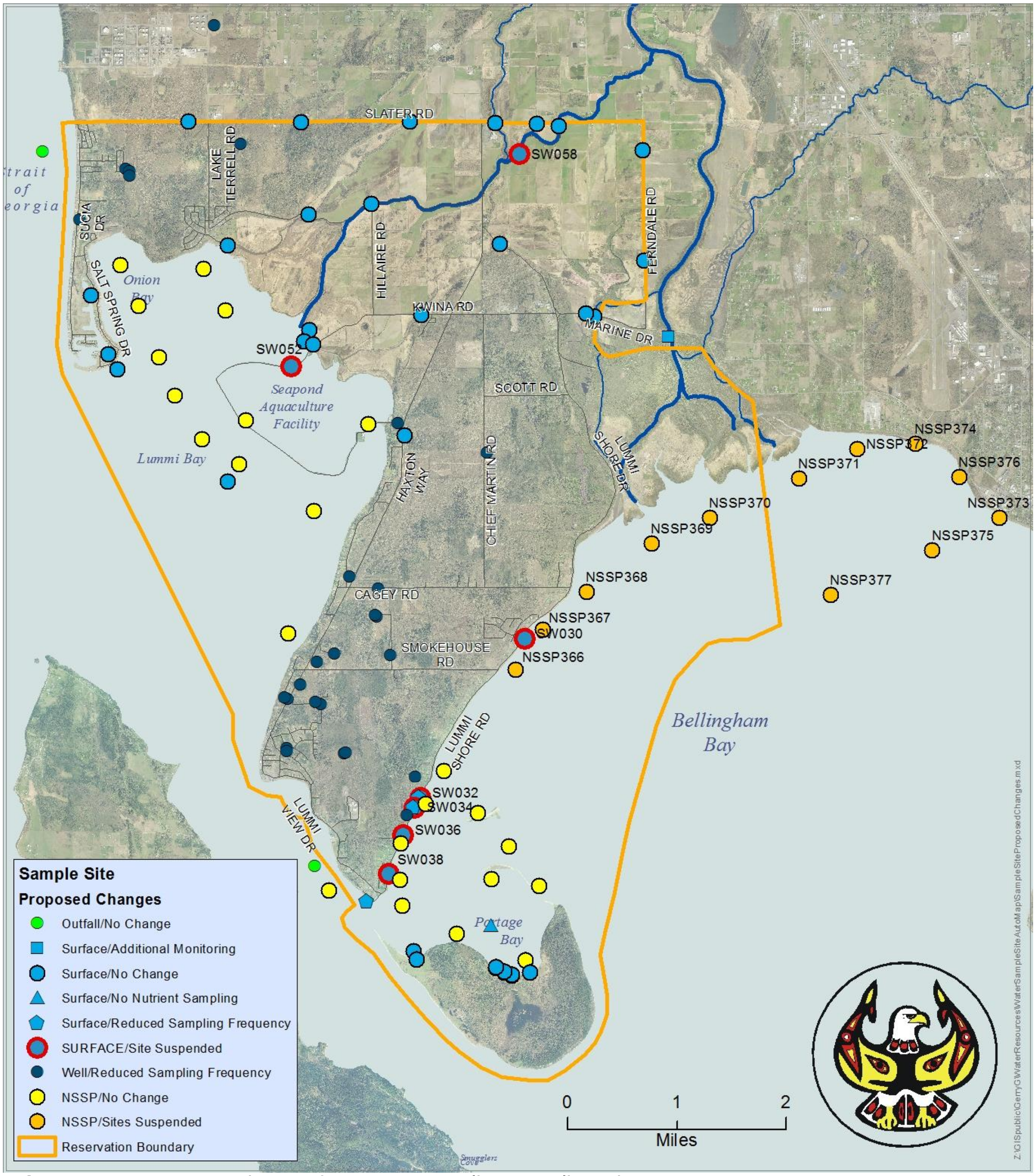

Figure 2.1 On-Reservation Surface Water Quality Sampling Sites

Table 2.1 Summary of Surface Water Quality Sampling Schedule

Run Name	Sample Sites(s) Included	Conventional Parameters Measured At Each Sample Site	Laboratory Samples Collected At Each Sample Site	Measurement Frequency	Notes
Floodplain East (FPE)	15, 16, 17, 51, 52, 55, 56, 59, 72, 118	Air temperature, salinity-based stratification, water temperature., salinity, specific conductivity, current/flow direction, dissolved oxygen (DO), flow, pH, water/level depth, turbidity, and general observations	Fecal coliforms, *E. coli*, and enterococcus	Monthly	Site 118 along the Nooksack River is measured in all surface water sample runs, providing information on a known pollutant source to Portage Bay. Site 51 is measured in both the FPE and FPW runs. Flow is only measured when appropriate channel conditions are present.
Floodplain West (FPW)	3, 8, 9, 10, 11, 12, 13, 14, 51, 53, 58, 118	Air temperature, salinity-based stratification, water temperature, salinity, specific conductivity, current/flow direction, DO, flow, pH, water/level depth, turbidity, and general observations	Fecal coliforms, *E. coli*, and enterococcus	Monthly	Site 118 along the Nooksack River is measured in all surface water sample runs, providing information on a known pollutant source to Portage Bay. Site 51 is measured in both the FPE and FPW runs. Flow is only measured when appropriate channel conditions are present.
Lummi Shore Road (LSR)	7, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 118	Air temperature, salinity-based stratification, water temperature, salinity, specific conductivity, current/flow direction, DO, flow, pH, water/level depth, turbidity, and general observations	Fecal coliforms, *E. coli*, and enterococcus	Monthly in coordination with the DOH sampling of Portage Bay Sites along Lummi Shore sampled from north to south or from south to north	Occasionally Site 118 is sampled at beginning and end of run if Portage Bay sampling occurs late in the morning or afternoon. Flow is only measured at upland sites along the Portage and Bellingham Bay shorelines.

Table 2.1 Summary of Surface Water Quality Sampling Schedule

Run Name	Sample Sites(s) Included	Conventional Parameters Measured At Each Sample Site	Laboratory Samples Collected At Each Sample Site	Measurement Frequency	Notes
Marine Boat-Accessible (Marine)	1, 2, 6, 19, 22, 23, 24, 25, 26, 27, 28	Salinity-based stratification, water temperature, salinity, specific conductivity, current/flow direction, dissolved oxygen (DO), flow, pH, Secchi depth, water/level depth, turbidity, and general observations	Fecal coliforms, *E. coli*, and enterococcus	Monthly, as needed	Measure flow at the Portage Island sites (sites numbered 24 through 28) when channel and flow conditions are appropriate.
Lummi Bay DOH Support	DOH 285, DOH 286, DOH 287, DOH 288, DOH 38, DOH 39, DOH 40, DOH 41, DOH 42, DOH 43, DOH 44, DOH 45	Salinity-based stratification, water temperature salinity, specific conductivity, current/flow direction, DO, flow, pH, Secchi depth, water level/depth, turbidity, and general observations	Fecal coliforms	Six times annually	The Washington State Department of Health (DOH) provides sample bottles and bacteria enumeration. Logistical difficulties prevent DOH staff from sampling Lummi Bay: tidal window for access to marine sample sites in Portage and Lummi bays is narrow, particularly in the summer (+8.5ft MLLW tide minimum is required). LNR staff collect bacteria samples and measure other parameters for comparison with water quality standards.
Portage Bay DOH Support	118	Air temperature, salinity-based stratification, water temperature, salinity, specific cond., current/flow direction, DO, pH, water level/depth, turbidity, and general observations	Fecal coliforms, *E. coli*, and enterococcus	Three times in one day the day before LSR sample run and DOH sampling of Portage Bay	

Table 2.1 Summary of Surface Water Quality Sampling Schedule

Run Name	Sample Sites(s) Included	Conventional Parameters Measured At Each Sample Site	Laboratory Samples Collected At Each Sample Site	Measurement Frequency	Notes
Lummi Bay Watershed, First Flush	11, 10, 12, 13, 9, 58, 8, 3, 53, 51, 118 Time permitting: 14, 59, 15, 16, and 17	Salinity-based stratification, water temperature, salinity, specific conductivity, current/flow direction, dissolved oxygen (DO), flow, pH, water level/depth, turbidity, and general observations	Fecal coliforms, *E. coli*, and enterococcus	As needed based upon predicted and observed runoff during the onset of the rainy season	Site 118 along the Nooksack River is measured in all surface water sample runs, providing information on a known pollutant source to Portage Bay. Site 51 is measured in both the FPE and FPW runs. Flow is only measured when appropriate channel conditions are present.
Bellingham Bay Watershed, First Flush	7, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 118	Salinity-based stratification, water temperature, salinity, specific conductivity, current/flow direction, dissolved oxygen (DO), flow, pH, water level/depth, turbidity, and general observations	Fecal coliforms, *E. coli*, and enterococcus	The day following the Lummi Bay First Flush sample run	Sites along Lummi Shore Road sampled from north to south or from south to north. Flow is only measured at upland sites along the Portage Bay and Bellingham Bay shorelines. Site 29 samples a relatively undeveloped Lummi Peninsula upland watershed and is used as a control site representing a watershed that is minimally affected by development.

Table 2.2 Parameters Analyzed at Independent Laboratories

Sample Site Number(s)	Group Name	Parameters	Frequency of Collection	Notes
1	Hydrocarbons	Diesel and Lube Oil range hydrocarbons	Quarterly, (depending on the year)	Sample collected in 1-L glass amber bottle. (Monday through Thursday only)
	Metals	Arsenic, Copper, Mercury, Tin, Zinc, Hardness, and pH with the temperature of the water sample at the time of measurement	Quarterly, depending on the year	Sample collected in 1-L plastic bottle. (Monday through Thursday only)
2, 3, 6, 9, 15	Nutrients	Alkalinity, Ammonia, Biochemical Oxygen Demand, Nitrate-N, Nitrite-N, Total Kjeldahl Nitrogen, Ortho Phosphate, Total Phosphorus, pH [with temperature at time of reading], Total Organic Carbon, Total Suspended Solids, Total Volatile Suspended Solids, and may include Iron, Sulfate, Chlorophyll a, Sulfide, Silicon and Chemical Oxygen Demand	Quarterly, (depending on the year)	Samples collected in 3 1-L plastic bottles (4 1-L plastic bottles for marine samples) and 2 40-mL amber vials with a preservative. Nitrite and Nitrate are normally combined. (Monday through Thursday only)
14	Hydrocarbons	Diesel and Lube Oil range hydrocarbons	Quarterly and First Flush (depending on the year)	Sample collected in 1-L glass amber bottle. (Monday through Thursday only)
	Metals	Chromium, Copper, Lead, Zinc, Hardness and pH with the temperature of the water sample at the time of measurement	Quarterly and First Flush (depending on the year)	Sample collected in 1-L plastic bottle. (Monday through Thursday only)

2.2. Ground Water

The contamination of Reservation ground water by salt water or other pollutants is a current and potential impairment of great concern to the Lummi Nation. Data from the LWRD Ground Water Monitoring Program was used to assess the condition of ground waters on the Reservation. These data were collected starting in 1993 under CWA Section 106 grants and the General Assistance Program (GAP) grants awarded to the Lummi Nation by the U.S. Environmental Protection Agency (EPA) and tribal funding. Twenty-eight ground water sample sites (Figure 2.2) were selected for regular monitoring to characterize the two major potable aquifer systems on the Reservation. Table 2.3 lists the well sampling groups, wells in each group, well number, parameters measured, and measurement frequency. The number of wells sampled has increased over the years and the parameters measured have changed to include pH and salinity. Wells were added to the Program as they were drilled or when access was granted to obtain better spatial resolution of aquifer conditions. Water level, pumping status, temperature, specific conductivity, pH, salinity, and chloride concentration are measured at least monthly or more frequently at each site. Well production is recorded from existing meters at the Lummi Water District water supply wells. If a well is not sampled when scheduled, the well is sampled as soon as possible afterwards.

Sample sites were selected to represent aquifer-wide conditions as practicable, but the spatial representativeness of these sampling points is limited by the lack of existing ground water wells in some parts of the Reservation – particularly along the interior of the Lummi Peninsula and the eastern part of the northwestern upland.

The primary sources of variability in measurements are seasonal changes (i.e., wet season and dry season) and pumping regimes (which are typically related to season). This variability is addressed through frequent sampling (sub-monthly to monthly), performing multiple water level measurements during sampling at each well, and recording the pumping rate, totalizer values (if metered), and pump status of the well at the time of measurement. Water quality is generally stable in the wells.

The chloride concentration, pumping rate and amounts, and water levels of the water supply wells provide critical information about aquifer condition, pumping regimes, and the need for protective measures as these data indicate whether seawater intrusion is occurring or if the likelihood of seawater intrusion has increased. For wells that are not used for water supply purposes (e.g., inactive wells), water level provides information about aquifer conditions. More detailed descriptions of the LWRD Ground Water Sampling Program and collection methods can be found in the Lummi Nation Water Quality Monitoring Program Quality Assurance/Quality Control Plan – Version 4.0 (LWRD 2010). See http://lnnr.lummi-nsn.gov/LummiWebsite/Website.php?PageID=5. The Lummi Tribal Sewer and Water district also samples the Tribal supply wells and the water distribution system for compliance with EPA Safe Drinking Water Standards (LTSWD 2011a, 2011b).

All surface and ground water data collected as part of the Surface and Ground Water Quality Monitoring Program is entered into a water quality database. Historic water quality data have also been entered into this database. The Water Quality Monitoring Database was not initially designed to manage continuously measured data from dataloggers used to record water levels or water temperatures in wells. During 2010, the Lummi Continuous Data Management System database was developed to assist with data management specifically for continuous datasets. In addition to the databases developed by LNR Staff members, a data analysis tool developed by Utah State University (USU) as part of the WRIA 1 Watershed Management Project (http://wria1project.whatcomcounty.org) became available. The Lummi Water Quality Monitoring database can export data in a format compatible with the USU data analysis tool, the STORET database, or the Excel spreadsheet program. The Lummi Water Quality Monitoring and Lummi Continuous Data Management System databases are also able to perform limited analyses of the data.

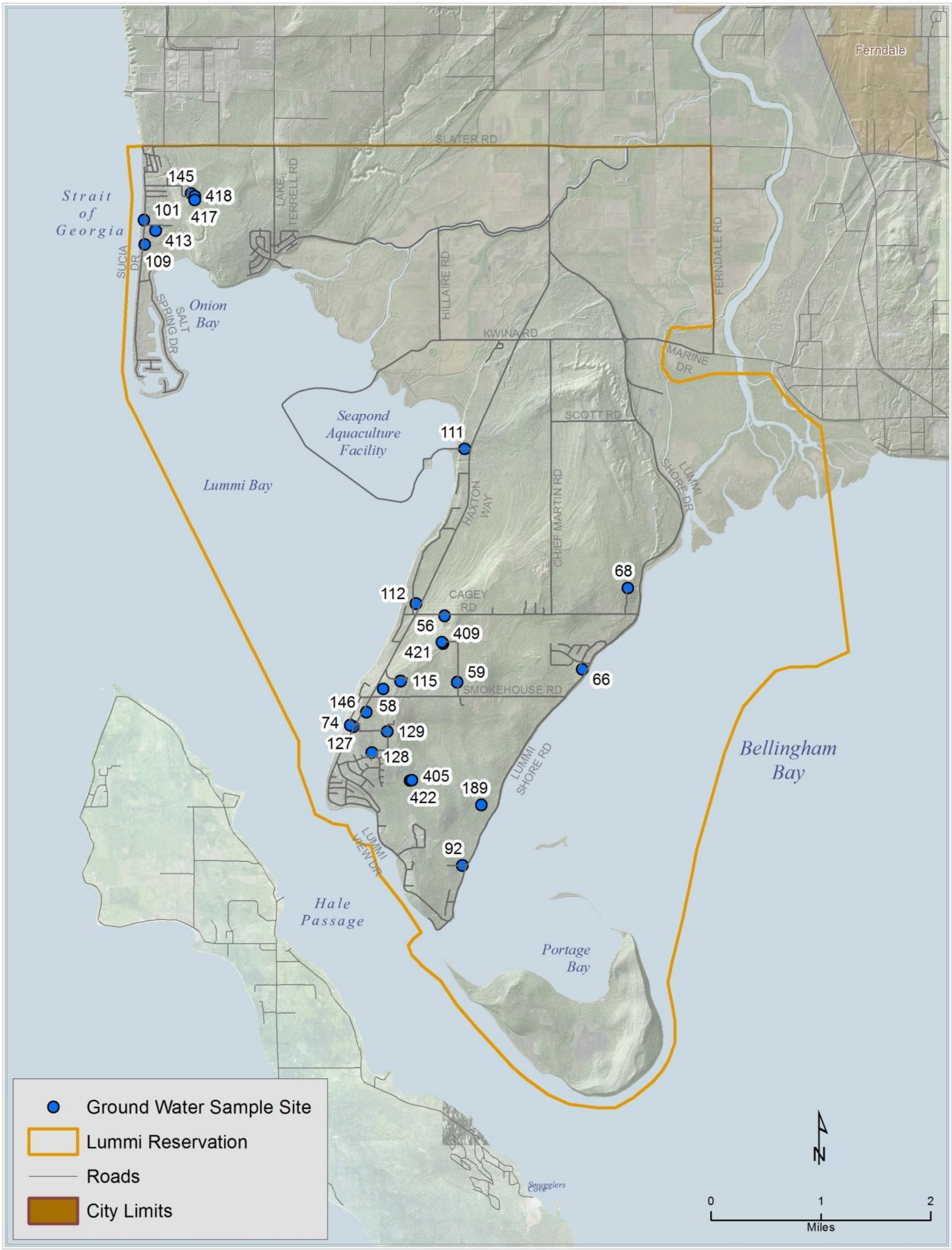

Figure 2.2 On-Reservation Ground Water Sampling Sites

Table 2.3 Ground Water Quality Monitoring Wells

Well Group	Wells	Well Number	Parameters Measured At Each Sample Site	Measurement Frequency
Domestic	R. Jefferson	112	Water level	Monthly
	K. Charles	74	Water level, chloride, temperature, specific conductivity, pH, salinity	Monthly
	Berg	143	Water level, chloride, temperature, specific conductivity, pH, salinity	Monthly
	Bewley	164	Water level	Monthly
	M. Egawa	189	Water level, chloride, temperature, specific conductivity, pH, salinity	Monthly
	J. Finkbonner	109	Chloride, temperature, specific conductivity, pH, salinity, water level infrequently	Monthly
	T. Teeter	413	Water level, chloride, temperature, specific conductivity, pH, salinity	Monthly
	Skolrood	101	Water level, chloride, temperature, specific conductivity, pH, salinity	Monthly
Potable Public Water Supply Wells	Balch	115	Water level, water use, chloride, temperature, specific conductivity, pH, salinity	Monthly, or more as needed
	Horizon	58	Water level, water use, chloride, temperature, specific conductivity, pH, salinity	Monthly, or more as needed
	Kinley Way (Kinley 1)	59	Water level, water use, chloride, temperature, specific conductivity, pH, salinity	Monthly, or more as needed
	Kinley 2	409	Water level, water use, chloride, temperature, specific conductivity, pH, salinity	Monthly, or more as needed
	Kinley 3	421	Water level, water use, chloride, temperature, specific conductivity, pH, salinity	Monthly, or more as needed
	Mackenzie 2	129	Water level, water use, chloride, temperature, specific conductivity, pH, salinity	Monthly, or more as needed
	Northwest Well 2 (NW2)	418	Water level, water use, chloride, temperature, specific conductivity, pH, salinity	Monthly, or more as needed
	West Shore	146	Water level, water use, chloride, temperature, specific conductivity, pH, salinity	Monthly, or more as needed
	Gooseberry Point 4	420	Water level, water use, chloride, temperature, specific conductivity, pH, salinity	Monthly, or more as needed
	Gooseberry Point 5	419	Water level, water use, chloride, temperature, specific conductivity, pH, salinity	Monthly, or more as needed
Monitoring Wells	Hopkins	111	Water level, datalogger upload	Monthly
	Cultee	56	Water level, datalogger upload	Monthly
	Revey	127	Water level, datalogger upload	Monthly
	Mackenzie 1	128	Water level, datalogger upload	Monthly
	Mackenzie 3	405	Water level, datalogger upload	Monthly
	Mackenzie 4	422	Water level	Monthly

Table 2.3 Ground Water Quality Monitoring Wells

Well Group	Wells	Well Number	Parameters Measured At Each Sample Site	Measurement Frequency
	Pierre	66	Water level, datalogger upload	Monthly
	Northwest Well 1 (NW1)	417	Water level, datalogger upload	Monthly
Other Wells	Johnson	145	Water level, datalogger upload, water use, chloride, temperature, specific conductivity, pH, salinity, tank level, and discharge from manifold in tank Flow rate and totalizer at all meters except M. Finkbonner (Nau) and Greg Finkbonner meters every visit to Johnson well. The latter two meters are measured monthly	Weekly or more frequently for water quality, water level, and water use
	Northwest Well 3 (NW3)	441	Water use, chloride, temperature, specific conductivity, pH, salinity	Monthly, or more as needed

2.3. Impairment

Surface waters on the Reservation that did not meet Lummi Water Quality Standards (LWRD 2008a) and surface waters off the Reservation that were placed on the 303(d) list were considered impaired by NPS pollution, unless a point source was specifically identified as the cause of the impairment. In this report, a high degree of impairment equates to non-attainment of, or a lack of support for, a designated use at some point in time and in some portion of the watershed. Moderate impairment is associated with interference with designated uses that fail to meet standards, but is nonetheless significant. A low degree of impairment means that interference with designated uses is likely, but probably not significant. Table 2.4 summarizes these definitions of degrees of impairment.

Non-attainment of the Lummi Water Quality Standards (on-Reservation) or a 303(d) listing (off-Reservation) for more than three tributaries or for the mainstem of the Lummi River or Nooksack River (including the three forks of the Nooksack) resulted in a determination of a high degree of impairment of the waterbody. Non-attainment of the Lummi Water Quality Standards or 303(d) listing for three or fewer tributaries was generally judged to be a moderate degree of impairment. If substantial sources of a pollutant are present in the watershed, but the water meets the Lummi Water Quality Standards or is not on the 303(d) listing (possibly because of a lack of sampling or testing), the determination of the degree of impairment was based on the available literature that addresses the pollution potential of land uses in the contributing watershed. In all cases, the degree of impairment reflects documented impacts and a literature-based assessment of undocumented potential impacts or the degree of impact associated with individual pollutants. The relative contributions of documented impacts and potential impacts in the determination of waterbody impairment varied for each waterbody.

Table 2.4 Summary of Degree of Impairment Definitions

Applicable Waters	High Impairment Criteria	Moderate Impairment Criteria	Low Impairment Criteria
All Waters	Non-attainment of or a lack of support for, a designated use at some point in time and in some portion of the watershed or aquifer.	Interference with designated uses that falls short of non-attainment but is nonetheless significant.	Interference with designated uses is likely, but probably not significant.
Surface Water	(1) Non-attainment of Lummi Water Quality Standards (on-Reservation) or a 303(d) listing (off-Reservation) for more than three tributaries or for the mainstem of the Lummi or Nooksack rivers (including the three forks of the Nooksack), or (2) Literature-based assessment of the pollution potential of land uses in the contributing watershed(s), or (3) non-attainment of the National Shellfish Sanitation Program (NSSP) standards.	(1) Non-attainment of Lummi Water Quality Standards or 303(d) listing for three or fewer tributaries, or (2) Literature-based assessment of the pollution potential of land uses in the contributing watershed(s).	Literature-based assessment of the pollution potential of land uses in the contributing watershed(s).
Ground Water	Saltwater intrusion, non-compliance with Safe Drinking Water Act requirements, or an assessment based on the number and productivity of affected wells and an assessment of the current or potential impacts associated with individual pollutants.		

Saltwater intrusion constitutes impairment of ground water because it makes the ground water non-potable. Although salty water can be treated to some degree, continued pumping is not recommended because it could maintain the problem or make it worse. Impairment of ground water by other contaminants was determined by noncompliance with Safe Drinking Water Act requirements or by a literature-based assessment of potential pollution from land uses in the affected watershed. The definitions of high, moderate, and low degrees of ground water impairment used in this report are the same as those for surface water. The degree of impairment was determined based on the number and productivity of affected wells and review of the current and/or potential impacts associated with individual pollutants (Table 2.4).

Nonpoint source pollution categories (e.g., agriculture, silviculture, hydromodification, and urban runoff) contributing pollutants to Reservation waters were ranked based on the estimated impact of associated pollutants on designated water uses. These impacts were determined using the categories and criteria listed in Section 6.2 and a literature-based assessment of the pollution potential of land uses/NPS pollution categories in the contributing watersheds. Table 2.5 lists the NPS pollution categories and subcategories used in this report and the types of NPS pollution assessed. In this report, a high level of impact means that the NPS pollution category contributes the majority of the NPS pollution responsible for a high degree of waterbody impairment. A moderate level of impact is associated with a significant, but not primary, source category or a moderate degree of impairment. A low level of impact is associated with a minor source of NPS pollution or a low degree of impairment.

Table 2.5 Nonpoint Source Pollution Categories, Subcategories, and Types

NPS Pollution Category[1]	NPS Pollution Subcategory[1]	Types of NPS Pollution
Agriculture	Non-Irrigated Crop Production	Bacteria/Pathogens Fine Sediment Habitat Alteration Metals Nutrients Oxygen Demanding Substances (Organic Enrichment) Pesticides, Household and Industrial Chemicals, and Oil and Grease pH Saltwater Intrusion Temperature
	Irrigated Crop Production	
	Specialty Crop Production	
	Pasture Grazing	
	Confined Animal Feeding Operations	
Silviculture	Harvesting, Restoration, Residue Management	
	Forest Management	
	Road Construction/Maintenance	
Construction	Highway/Road/Bridge	
	Land Development	
Urban Runoff/ Storm Sewers	Non-Industrial Permitted	
	Industrial Permitted	
	Other Urban Runoff	
	Highway/Road/Bridge Runoff	
	Erosion and Sedimentation	
Resource Extraction	Surface Mining (sand/gravel)	
Land Disposal	Landfills	
	On-Site Wastewater Systems	
Hydromodification/ Habitat Modification	Channelization	
	Flow Modification	
	Removal of Riparian Vegetation	
	Streambank Modification or Destabilization	
	Draining/Filling of Wetlands	
Marinas and Recreational Boating	Creosote Pilings	
Atmospheric Deposition		
Waste Storage/ Storage Tank Leaks		
Highway Maintenance and Runoff		
Spills		
Natural Sources		
Recreation Activities	Golf Courses	
Ground Water Withdrawal		

[1] EPA 1997a

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3. LAND USE SUMMARY

The topography, watersheds, climate, soil characteristics, and land uses on the Reservation affect the distribution of NPS pollution. This section briefly describes each of these elements.

3.1. Topography

The Lummi Reservation is comprised of two relatively large upland areas, a smaller upland area on Portage Island, and the lowland areas of the Lummi River and Nooksack River and the Sandy Point peninsula (Figure 3.1). The maximum elevation of the northwestern upland area of the Reservation is about 216 feet above the North American Vertical Datum 1988 (ft NAVD88). The southern upland area is the Lummi Peninsula with a maximum elevation of about 178 ft NAVD88. The floodplain of the Lummi River and Nooksack River, with an average elevation of approximately 10 ft NAVD88, is located between the northern and southern upland areas. The Nooksack River and the Nooksack River delta are located along the northeastern extent of the Reservation. The Sandy Point peninsula lies to the southwest of the northwestern upland. Portage Island lies at the southeastern tip of the Lummi Peninsula and has a maximum elevation of approximately 209 ft NAVD88.

The two relatively large upland areas are drained by short, intermittent streams and numerous springs both above and below the line of ordinary high water. These streams and springs discharge onto tribal tidelands along Bellingham Bay, Hale Passage, Lummi Bay, Onion Bay, Georgia Strait, or to the floodplains of the Lummi and Nooksack rivers. The floodplain areas are drained by a network of agricultural drainage ditches and the Lummi River and Nooksack River. The drainage on Portage Island consists of at least two intermittent streams that drain northward to Portage Bay. Springs along the upland areas of Portage Island and below the line of ordinary high water also discharge to marine waters and Reservation tidelands.

3.2. Reservation Watersheds

A watershed is a land area defined by topography that is drained by a stream system. Until recently, watershed boundaries were generally delineated using U.S. Geological Survey (USGS) topographic maps and, starting from a point on the stream system that is defined by the geology and topography as the watershed outlet, following the ridgelines shown by the contour lines. This method is commonly used in upland watersheds where the contour lines are relatively closely spaced and a single watershed outlet is apparent. In lowland areas with relatively flat topography, identifying the watershed outlet and associated boundaries is more difficult. Often in lowland or coastal areas there is not a single location or point that can be identified from the topography, geology, and/or hydrography as a watershed outlet.

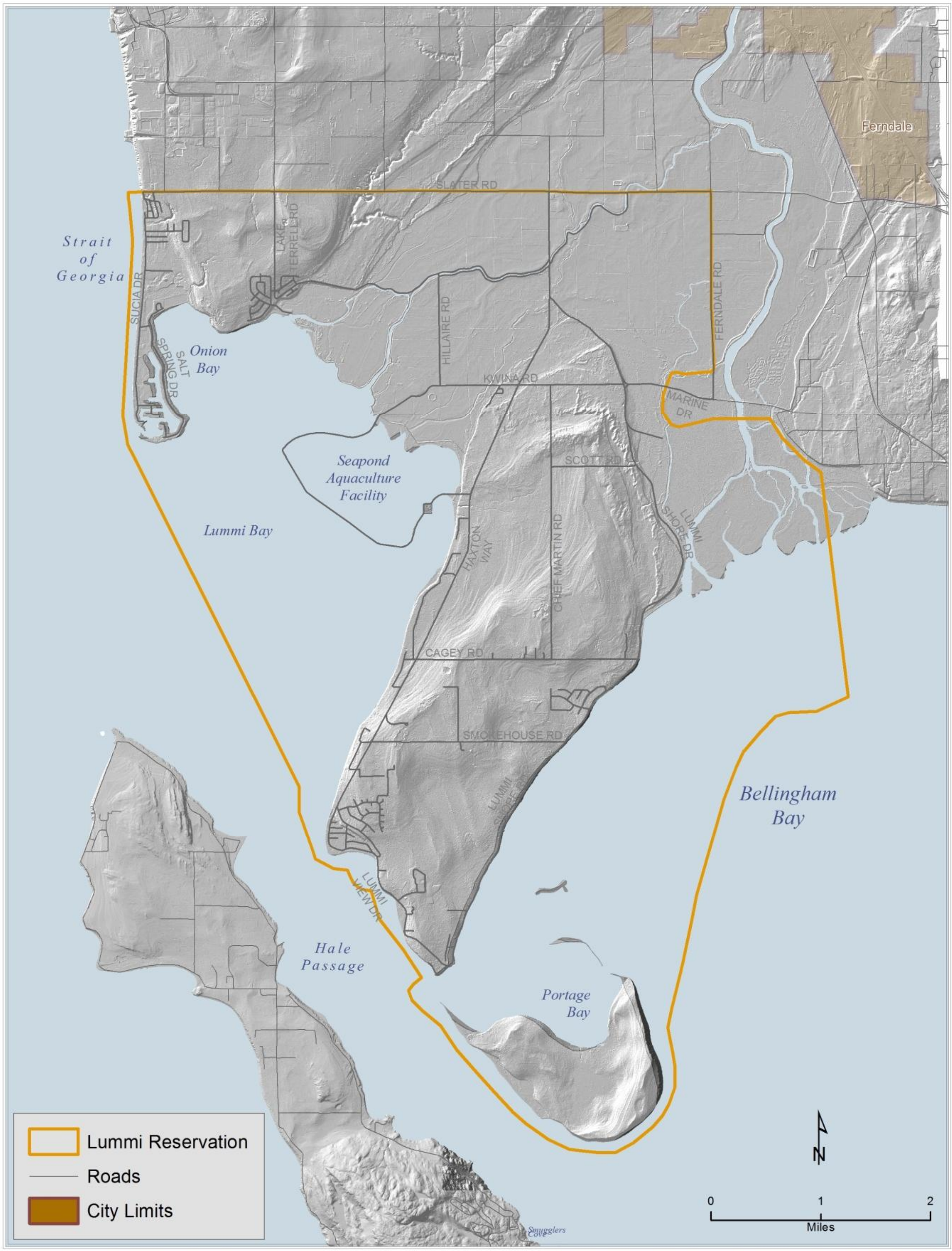

Figure 3.1 Topography of the Lummi Indian Reservation and Adjacent Areas

3.2.1. Reservation Watershed Delineation

In 2010, the Lummi Reservation watersheds were delineated using Light Distance and Ranging (LiDAR) data collected during 2005 (Terra Point 2005). Using the LiDAR bare-earth point data, digital terrain models (DTMs) were developed using several grid cell sizes and interpolation methods. A square root mean analysis was used to identify the surface model with elevation values most similar to control points established conventionally by a licensed professional land surveyor. A three-foot natural neighbor interpolation DTM was identified as the surface model with the highest level of precision and pixel sizes that were large enough to be manageably analyzed using available computer resources.

The three-foot natural neighbor DTM was incorporated into an ESRI ArcGIS 9.3 ArcHydro geodatabase along with point data of storm water facilities and line data of known stream channels and agricultural drainage ditches. The storm water data and surface water hydrography data were used to enforce hydrologic connectivity by computationally breaching LiDAR artifacts such as bridges or culvert passages under roads.

The hydrologically corrected surface model was analyzed using standard GIS procedures including sink filling, identifying flow directions, calculating flow accumulations, and identifying basin boundaries. The final basin boundaries were combined into watershed administrative units based on the watershed units developed as part of the 1998 watershed delineation (LWRD 2011a). The resultant watershed delineation is shown in Figure 3.2; a more detailed description of the watershed delineation process is presented in Appendix B.

In comparison to the original 1998 delineation, the 2010 watershed delineation resulted in approximately 933 acres being added to the watersheds that contribute overland flow to the Reservation and a net reduction in the number of watersheds from 19 to 18 watersheds. Two watersheds (M and N) from the 1998 delineation were discontinued. Watershed N was combined with Watershed O as the LiDAR delineation did not identify this area as a separate catchment. Watershed M was a small isolated island located at the mouth of the Lummi River channel and the Lummi River channel downstream from the Schell Creek confluence and waterward of the levees along the channel. This watershed was combined with Watershed L. Watershed T is a newly delineated watershed that isolated a portion of Watershed K from the 1998 delineation. Watershed S includes the entire Nooksack River drainage area, most of which is generally not covered by the LiDAR data. Although most of Watershed S extends off-Reservation and beyond the geographic extent of the LiDAR data, the LiDAR data were used to delineate the western extent of Watershed S on the Reservation. The acreage for Watershed S listed in Table 3.1 is the acreage total reported by the WRIA 1 Watershed Management Project (http://wria1project.whatcomcounty.org).

The 18 watersheds are aggregated into two primary drainage areas: Lummi Bay and Bellingham Bay (Figure 3.3). The Lummi Bay watershed is comprised of nine watersheds: C, H, I, K, L, O, P, Q, and R. It is noted that a portion of Watershed R discharges to Georgia Strait (Hydrologic Unit Code Level 171100020203) and that a portion of Watershed C discharges to Hale Passage. The Bellingham Bay watershed is also comprised of nine watersheds: A, B, D, E, F, G, J, S, and T. It is noted that all of Watershed A discharges to Hale Passage and that a portion of Watershed D also discharges to Hale Passage. As shown in Table 3.1, 11 of the 18 watersheds are completely within the Reservation boundary.

Approximately 0.1 percent of the Nooksack River watershed (Hydrologic Unit Code Level 171100040506) is on the Reservation.

3.2.2. Reservation Watershed Descriptions

In this section, the dominant land use, the occurrence of storm water and public water supply wells, and other characteristics of the 18 watersheds are summarized. The watershed characteristics are summarized in Table 3.1 and illustrated in Figure 3.2.

Watershed A: Watershed A is crescent shaped and located along the southern edge and eastern side of Portage Island. The watershed drains into either Hale Passage or Bellingham Bay. About 66 percent of the watershed is forested. The eastern part of the watershed is characterized by forested uplands and steep bluffs. The southern side is comprised of forested uplands and a mix of grasslands, wetlands, and ponded water located in a low lying area. Portage Island is an uninhabited island south of the Lummi Peninsula that is zoned as open space, is primarily used by tribal members for recreation and shellfish harvesting, and has no active ground water wells. Approximately 63 head of feral cattle lived on Portage Island as of June 2008. The cattle on Portage Island may have contributed to the fecal coliform bacteria contamination of surface waters on the island discharging into Portage Bay. The LIBC hired a contractor to remove the cattle from Portage Island due to the potential contamination of shellfish beds and decreased water quality. The cattle were largely removed by February 2012 but a few escaped the removal effort and remain on the island.

Watershed B: Watershed B is dominated by forested land (about 65 percent) and drains the northern and western sides of Portage Island. Storm water from Watershed B discharges primarily into Portage Bay, although a small amount of storm water from along the western extent of the watershed also drains to Hale Passage. Beef cattle were grazed on Portage Island in the past and the approximately 63 feral cattle remaining were largely removed by February 2012. The herd of feral cattle was thought to be the main source of high fecal coliform bacteria in the small Portage Island fresh water streams. Although fresh water streams on Portage Island were measured to have elevated fecal coliform levels, the small discharges from these streams and the resultant low level of fecal coliform loading from these streams indicates that Portage Island is not the source of recent (May 2014) high bacteria counts that led to a closure of shellfish harvesting areas. Portage Bay is an important shellfish growing area for the Lummi Nation. Relatively large wetland areas in the central part of Watershed B comprise approximately 29 percent of the total drainage area. These wetlands support one intermittent stream that discharges into Portage Bay. Although some tribal members seasonally camp on Portage Island, there are currently no people living year round on Portage Island and there are no active ground water wells in this watershed.

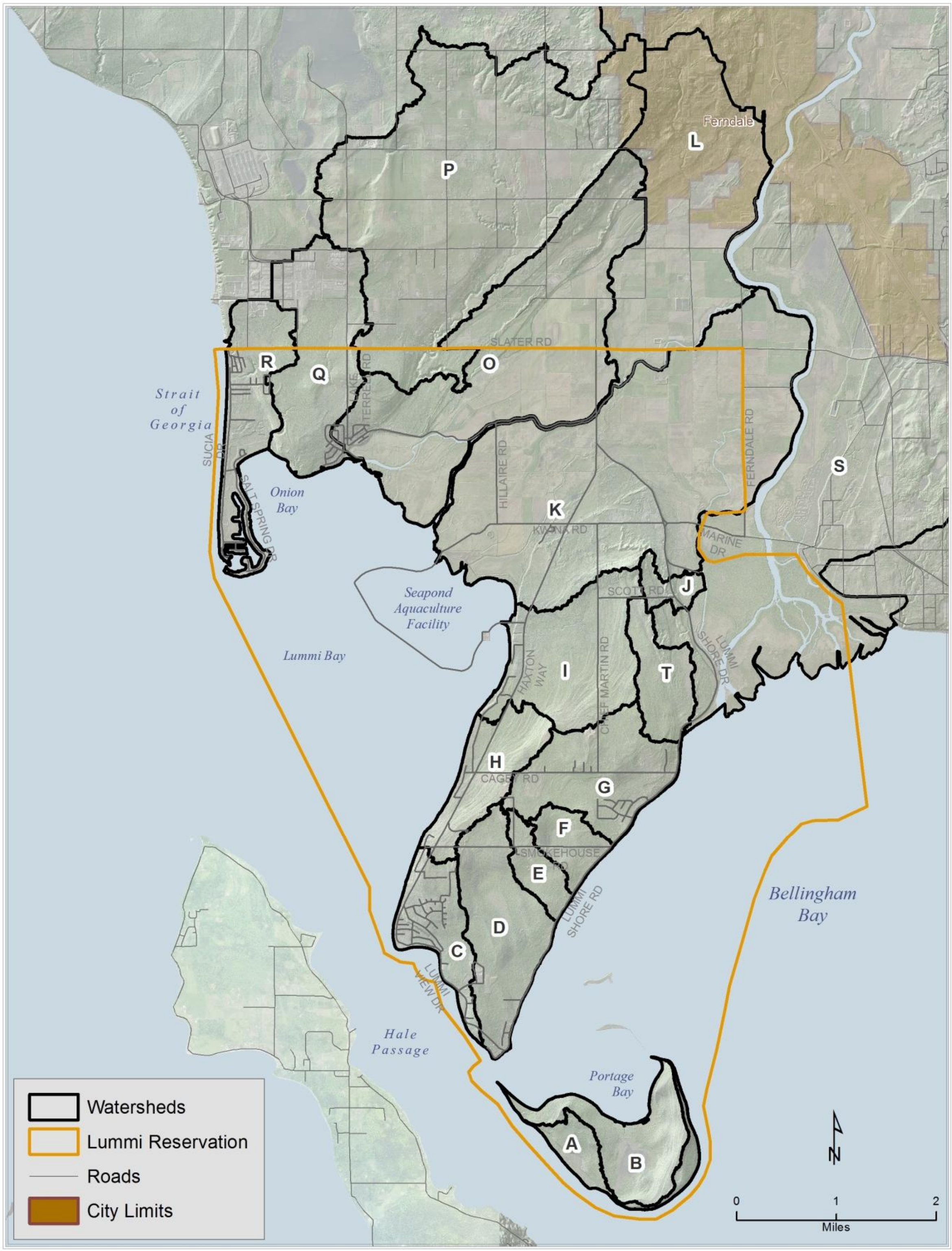

Figure 3.2 Lummi Indian Reservation Watersheds Delineated in 2010

Table 3.1 Size of Contributing Watersheds On- 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	134	2,173	6
	O	2,747	1,552	1,195	57
	P	4,097	227	3,870	6
	Q	1,096	570	526	52
	R	721	695	26	74
Totals		17,161	8,634	8,527	
Bellingham/Portage Bay Watershed	A	280	280	0	100
	B	617	617	0	100
	D	797	797	0	100
	E	218	218	0	100
	F	326	326	0	100
	G	883	883	0	100
	J	134	134	0	100
	S	515,914	640	515,274	0.1
	T	393	393	0	100
Totals		519,562	4,288	515,274	

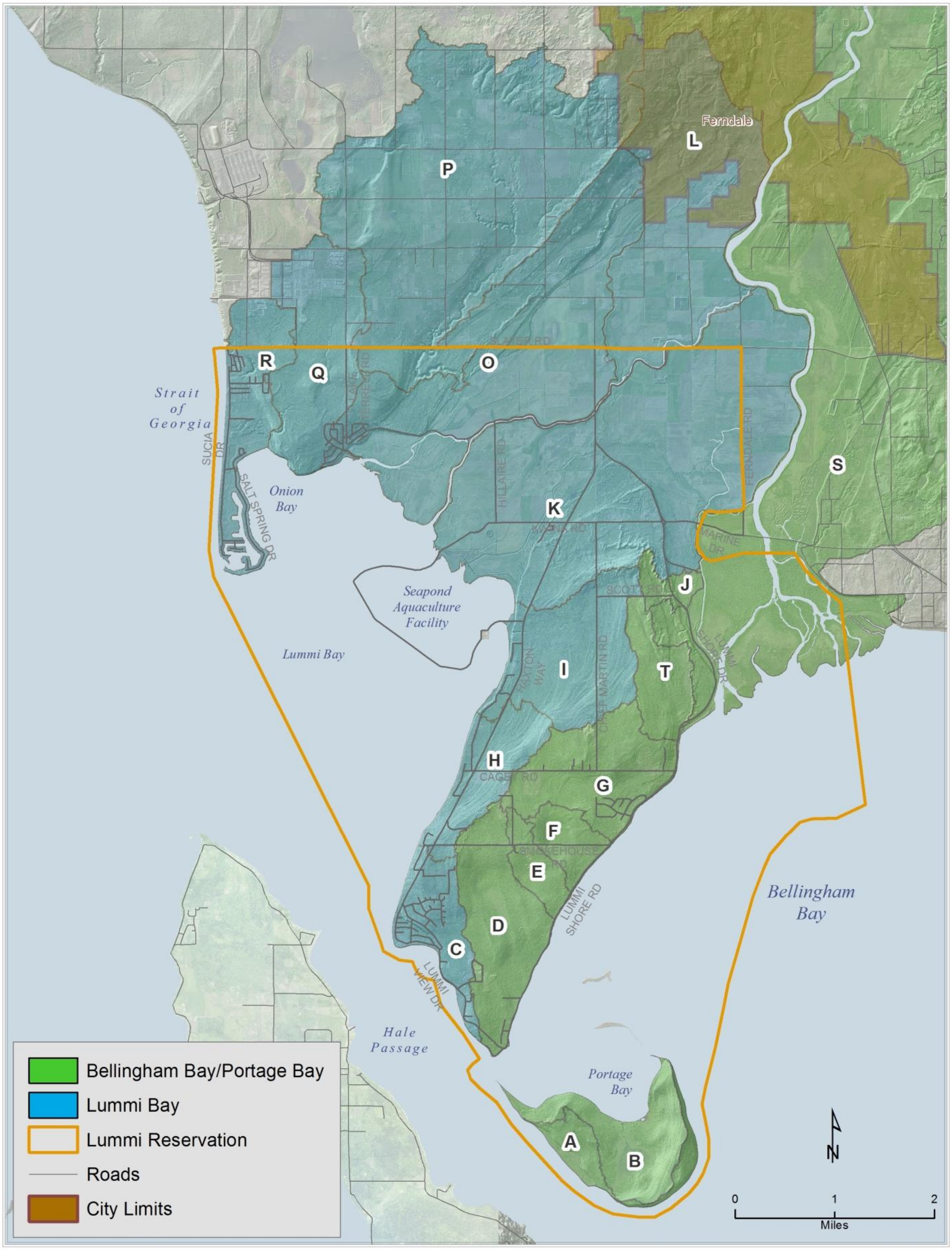

Figure 3.3 Lummi Bay and Bellingham/Portage Bay Drainage Areas

Watershed C: Watershed C is dominated by forested lands (54 percent) and drains the Gooseberry Point area. Storm water from this watershed is discharged into Hale Passage and to Lummi Bay. Gooseberry Point is one of the more densely populated (33 percent urban/residential) and heavily used watersheds on the Reservation. The Fisherman's Cove (boat storage and launching), Fisherman's Cove Mini Mart/Gas Station, a Ferry Terminal (operated by Whatcom County), a seafood buying facility leased by the Lummi Commercial Company, the Little Bear Creek Elder's Home, Finkbonner Shellfish, Stommish Grounds, and the Gooseberry Point Wastewater Treatment Plant are all located in this watershed. Watershed C also contains a relatively dense residential development along the lowlands and the MacKenzie Housing Subdivision and expansion (currently under construction) in the upland areas. The Lummi Nation K-12 school, the Lummi Youth Academy, and the Lummi Day Care have been built in portions of Watershed C and Watershed D since 2000. Salt water intrusion has occurred in the aquifer in the southwestern part of Watershed C. Several public supply wells near Gooseberry Point have been closed and decommissioned due to high chloride levels induced by overpumping in this watershed. The Lummi Nation currently operates two public supply wells in this watershed (West Shore and MacKenzie 2) and owns two other wells (Gooseberry 3 and 4). One non-tribal water association (Georgia Manor) also operates two water supply wells in the watershed. There are also approximately 30 individual domestic supply wells in the watershed.

Watershed D: Watershed D is about 82 percent forested and drains largely to Bellingham Bay. Residential development is concentrated along Lummi Shore Road in the Hermosa Beach area adjacent to the rich tribal shellfish growing areas of Portage Bay. Hermosa Beach residents rely primarily on shallow, private, domestic ground water supply wells. The upland areas of this watershed are currently largely undeveloped for residential or other uses. Construction of roads and utilities for a residential development (Olsen Subdivision) containing 108 buildable lots is projected to begin in 2015. Wetlands extend over large areas along Lummi Shore Road north of Hermosa Beach. The Lummi Tribal Sewer and Water District provides potable water and wastewater collection services in this watershed but the Lummi Nation does not operate any public water supply wells in this watershed. Poor storm water management and coastal erosion along Lummi Shore Road contributed to the collapse of the road into Bellingham Bay in places. As a result of the deterioration, in 1998 Lummi Shore Road was re-aligned and shore defense works were installed along Bellingham Bay. The eastern section of Lummi View Drive was re-aligned along the southern extent of the peninsula during 2004 to move the roadway landward from the shoreline and the former road bed abandoned.

Watershed E: Watershed E is about 77 percent forested and drains to Bellingham Bay. Residential development is concentrated along Lummi Shore Road, Smokehouse Road, and Kinley Way. Smokehouse Village, comprised of four townhouse units and owned by the Lummi Housing Authority, is in Watershed E. The Lummi Nation operates one of the most productive public water supply wells of the Reservation (Kinley 1) in this watershed. Poor storm water management and coastal erosion along Lummi Shore Road contributed to the collapse of the road into Bellingham Bay in places. As a result of the deterioration, in 1998 Lummi Shore Road was re-aligned along the peninsula and shore defense works were installed along Bellingham Bay.

Watershed F: Watershed F is about 82 percent forested and drains to Bellingham Bay. Residential development is concentrated along Smokehouse and Lummi Shore roads. The Lummi Nation does not operate any public water supply wells in this watershed. Poor storm water management and coastal erosion along Lummi Shore Road contributed to the collapse of the road into Bellingham Bay in places. As a result of the deterioration, in 1998 Lummi Shore Road was re-aligned along the peninsula and shore defense works were installed along Bellingham Bay.

Watershed G: Watershed G is about 77 percent forested and drains to Bellingham Bay. This watershed contains the Kel Bay housing development, the former Lummi Auto Recyclers (see Appendix E), and the Crist Gravel Mine. The area north of Cagey Road and east of Chief Martin Road is a large wetland area that discharges to a wetland area south of Cagey Road and then through the drainage network of the largely unbuilt Kel Bay housing development. Residential development is concentrated along Lummi Shore Road, Cagey Road, and Lightening Bird Lane. The Lummi Nation does not operate any public water supply wells in this watershed; one non-tribal water association (Kel Bay/Bel Bay) operates a well in the watershed. The shoreline areas north of Smokehouse Road around the Kel Bay development have experienced salt water intrusion. Poor storm water management and coastal erosion along Lummi Shore Road contributed to the collapse of the road into Bellingham Bay in places. As a result of the deterioration, in 1998 Lummi Shore Road was re-aligned along the peninsula and shore defense works were installed.

Watershed H: Watershed H is about 83 percent forested and drains to the resource rich tidelands of Lummi Bay. The shoreline areas of this watershed are relatively dense residential areas. The Balch Road housing project and the Eagle Haven recreational vehicle park are located in the southern upland area of this watershed. The Lummi Nation currently operates four public water supply wells (Balch, Horizon, Kinley 2, and Kinley 3) in Watershed H. Two non-tribal water associations also operate water supply wells in the watershed (Sunset, Northgate-Leeward). In addition, there are at least 10 individual private domestic supply wells clustered along the shoreline of this watershed north of Smokehouse Road. The Lummi Nation operates a biosolids application site along Haxton Way north of Cagey Road in Watershed H.

Watershed I: Watershed I is about 85 percent forested with residential areas concentrated along the shoreline areas and Haxton Way. This watershed drains to Lummi Bay. The former Chief Martin Road Solid Waste Dump (closed in 1979) is located in this watershed. The Lummi Nation operates a shellfish hatchery in Watershed I. The Lummi Nation does not currently operate any public water supply wells in this watershed; one non-tribal water association (Harnden Island View) operates a water supply well near the shoreline of this watershed.

Watershed J: Watershed J is a small forested watershed that drains to wetland areas west of Kwina Slough in the Nooksack River floodplain. The former Lummi Shore Road solid waste dump (closed in 1972) is located in this watershed. The Lummi Nation does not currently operate any public water supply wells in this watershed.

Watershed K: Approximately 18 percent of Watershed K is located north of the Reservation boundary. Watershed K is about 49 percent covered with grasses and agricultural lands and about 25 percent wetland area. Watershed K currently contains one dairy operation. Water that enters the Reservation watersheds west of the Nooksack River levee largely discharges to the resource rich tribal tidelands in Lummi Bay. At the time of the 1997 storm water facilities inventory and 2010 update, there were nine culverts that drained to Lummi Bay but only one culvert in the floodplain west of the Nooksack River and Kwina Slough that allows water to drain southward under Marine Drive and into Bellingham Bay. Water in this single culvert, which is commonly dammed along the south side by beavers, has been observed flowing to the north toward Lummi Bay. There is also only a single culvert (with a tide gate) south of Marine Drive near the southern terminus of the Kwina Slough levee. This area south of Marine Drive and west of Kwina Slough is part of the former Nooksack River delta. It is now a large wetland area with numerous beaver dams and beaver lodges. The area north of Marine Drive (Smuggler's Slough and associated wetlands) has been rechanneled to increase salmonid habitat and change the drainage route of Smuggler's Slough. The Lummi Administration offices, Lummi Head Start, the Health Clinic, Kwina Apartments, and the Northwest Indian College (NWIC) campus are all located along Kwina Road in this watershed. The NWIC has begun to build new facilities and expanded their campus facilities to include dormitories at their new location along Lummi Shore Road. Construction of a new Tribal Administration Building along the south side of Kwina Road was completed during 2013 and many of the former administration buildings along the north side of Kwina Road were demolished. A Membrane Bio-Reactor (MBR) Wastewater Treatment Plant (constructed in 2004) and its associated underground injection well field is located in Watershed K. The residential areas are concentrated along Kwina Road, Lummi Shore Road, Tiopi Loop, and Haxton Way in this watershed. The Lummi Housing Authority recently completed 72 apartment units in 12 buildings along Kwina Road. Ground water in the floodplain and other areas of Watershed K are brackish or saline; the Lummi Nation does not currently operate any public water supply wells in this watershed.

Watershed L: Approximately 94 percent of Watershed L is located north of the Reservation boundary. Watershed L is about 49 percent grasses and agricultural land and discharges to the Lummi River. The Lummi ("Red") River discharges to the resource rich tidelands of Lummi Bay. This watershed contains several dairy operations, small animal farms, the City of Ferndale, and the City of Ferndale's wastewater treatment plant and associated biosolids application site. All of these facilities are located north of the Reservation boundary. The Lummi Nation does not currently operate any public water supply wells in this watershed.

Watershed M: Discontinued watershed. The LiDAR delineation did not identify this area as a separate catchment and the area was combined within Watershed L.

Watershed N: Discontinued watershed. The LiDAR delineation did not identify this area as a separate catchment and the area was combined with Watershed O.

Watershed O: Approximately 43 percent of Watershed O is located north of the Reservation boundary. Watershed O is about 53 percent grasses and agricultural land and discharges to the resource rich tidelands of Lummi Bay via the remnants of what was shown on some historic maps as McComb Slough and the Lummi River delta. Seeps have been observed along terraces just north of Slater Road. There are also several dairy operations and a gas station north of the Reservation boundary in this watershed. The Silver Reef Hotel, Casino & Spa, a Lummi Nation gas station and mini-mart are in this watershed. A portion of the Sandy Point Heights residential development along with a nine-hole golf course is located in Watershed O. There is also a residential concentration along North Red River Road. Although there are several wells north of the Reservation boundary, there are no active wells within the Reservation boundaries in Watershed O.

Watershed P: Approximately 94 percent of Watershed P is located north of the Reservation boundary. Watershed P is about 58 percent grasses and agricultural lands and discharges to Lummi Bay. The portion of the watershed on the Lummi Reservation is largely forested and wetlands. There are several dairy operations and numerous water supply wells in the watershed north of the Reservation. This watershed also contains a portion of Barlean's Fishing, Inc and Barlean's Organic Oils, LLC located north of the Reservation. There is reportedly a productive spring within the Reservation boundary but there are currently no active water supply wells in the portion of the watershed located on the Reservation. Lummi Nation has a well (NW 3) but the chloride and arsenic (naturally occurring) levels are too high to be used for public supply.

Watershed Q: Approximately 50 percent of Watershed Q is located north of the Reservation boundary. Watershed Q is about 60 percent forested and drains to Onion Bay. This watershed contains portions of the Phillips 66 petroleum oil refinery and Barlean's Fishing, Inc and Barlean's Organic Oils, LLC north of the Reservation. A portion of the Sandy Point Heights residential development is located in the watershed. The Lummi Nation operates three public supply wells (Johnson, NW1, and NW 2) in this watershed. The Johnson Well is primarily used to supply the salmon hatchery and some domestic use.

Watershed R: Approximately 26 percent of Watershed R is located north of the Reservation boundary. Watershed R is not dominated by a single land use but rather contains a mix of forested (29 percent), urban/residential/industrial (28 percent), and wetland areas (16 percent). This watershed drains to Georgia Strait, Onion Bay, and Lummi Bay. The Lummi Nation operates the Sandy Point Wastewater Treatment Plant and the Sandy Point Fish Hatchery in this watershed. The private Sandy Point Marina and dense residential development is located within the Reservation boundaries in Watershed R. Portions of the Phillips 66 petroleum oil refinery are located north of the Reservation boundaries in this watershed. Two non-tribal water associations (Sandy Point Improvement Company and Neptune Beach) operate multiple water supply wells on the Reservation in Watershed R.

Watershed S: Watershed S, which is the Nooksack River basin, is largely located upstream from the Reservation boundaries. As noted previously, the Nooksack River drains primarily into Bellingham Bay with flow discharging to Lummi Bay only during high flow conditions and/or when the levee is overtopped during flood events. On Reservation, Watershed S is mostly the Nooksack River delta, which is designated to be a portion of the Lummi Nation Wetland and Habitat Mitigation Bank. Residential development on Reservation is concentrated along Lummi Shore Drive along the southwestern extent of Watershed S. The Lummi Cemetery and Native American Shellfish buying facility are located in this watershed.

Land use activities upstream from where the Nooksack River enters the Reservation affect both the quality and quantity of water available for tribal uses. Approximately 220 acres of tribal shellfish beds in Portage Bay were closed by the Lummi Nation and Washington Department of Health from November 1996 to May 2006 due to bacterial contamination attributed to poor dairy nutrient management practices in the Nooksack River watershed (DOH 1997, Ecology 2000). The efforts undertaken to address the closure are described below in Section 5.4.1. All Portage Bay shellfish growing areas were reclassified as "approved" in May 2006. However, a increasing fecal coliform bacteria levels indicating that animal waste management practices off-Reservation are no longer effectively reducing fecal coliform contamination in the Nooksack River watershed became apparent soon after the shellfish beds were re-opened. Continuing elevated fecal coliform levels resulted in the Nooksack River watershed being designated as one of two focus areas of the Washington Governor's Shellfish Initiative in November 2011. Despite increased efforts to manage NPS pollution sources, the NSSP standards were not achieved at three of the sampling stations in Portage Bay. This failure led to the Lummi Nation voluntarily closing 335 acres of growing area to harvest during September 2014. However, water quality in Portage Bay continued to deteriorate through 2014 resulting in additional sampling stations no longer attaining the NSSP standards. In consultation with the Lummi Nation, the Washington Department of Health issued an administrative order on March 19, 2015 that conditionally closed 496 acres of shellfish growing areas. Harvest of shellfish in these growing areas is prohibited from April through June and from October through December.

Watershed T: Watershed T is a newly delineated watershed on the Reservation. Watershed T is dominated by forested land (about 85 percent) and drains into Bellingham Bay. The majority of this watershed is undeveloped.

Of the 18 watersheds identified on the Reservation, nine drain primarily to Bellingham Bay and the tribal tidelands there, and nine drain primarily to Lummi Bay and its tribal tidelands. Because they support activities such as dairy operations, urban, rural, and industrial development, and wastewater treatment, watersheds C, G, K, L, O, Q, R and S are of the highest interest for Non Point Source pollution study and control.

3.2.3. Nonpoint Source Pollution Categories

Many types of activities contribute to Nonpoint Source (NPS) pollution on the Lummi Reservation. These activities are conducted both on the Reservation and within the watersheds that discharge to the Reservation (including the entire Nooksack River basin). Table 3.2 lists the categories and subcategories of NPS pollution, the associated potential contaminants, and the affected watersheds and water bodies on the Reservation.

Table 3.2 Inventory of Potential Nonpoint Source Pollution Sources in Reservation Watersheds

NPS Category	NPS Subcategory	Potential Contaminant Sources	Potential Contaminants[1]	Watershed(s)	Receiving Water Bodies	Comments
Agriculture	Irrigated Crop Production and Specialty Crop Production	Farm lands used for raspberry, strawberry, blueberry, silage, forage, potato, grain, and other row crops	Pesticides (e.g., insecticides, herbicides, fungicides), fertilizers, pesticides and fertilizer residue from containers or storage areas; automotive wastes (e.g., gasoline, antifreeze, transmission fluid, battery acid, engine and radiator flushes, engine and metal degreasers, hydraulic fluids, and motor oil), hydromodifications (stream flow depletion, drainage affecting the magnitude and timing of runoff	K, L, O, P, S	Bellingham Bay, Lummi Bay, Lummi River, Nooksack River	• Substantial agricultural lands upstream from the Reservation boundaries and on the Reservation in the floodplain of the Lummi and Nooksack rivers • Small areas of agricultural land in the upland areas of the Reservation
	Pasture Grazing and Confined Animal Feeding Operations	Horses, goats, dairy cows, cattle, sheep, bison, and/or llamas	Livestock sewage wastes; nitrates; phosphates; chloride; coliform and non-coliform bacteria; viruses; chemical sprays for controlling insect, bacterial, viral, and fungal pests on livestock	A, B, K, L, O, P, Q, R, S	Bellingham Bay, Lummi Bay, Onion Bay, Georgia Strait, Lummi River, Nooksack River, Portage Bay	• Substantial dairy operations upstream from the Reservation boundaries and on the Reservation in the floodplain of the Lummi and Nooksack rivers • Smaller numbers of livestock on Reservation
Silviculture	Harvesting, Restoration, Residue Management, and Road Construction Maintenance	Commercial timber harvests, revegetation, road construction	Pesticides (e.g., insecticides, herbicides, fungicides), oils, waste oils, solvents, grease, hydraulic fluids, transmission fluids, antifreeze, acids, hydromodifications (stream flow depletion, drainage affecting the magnitude and timing of runoff, and sediment	D, E, F, G, H, I, J, K, L, O, P, Q, R, S, T	Bellingham Bay, Portage Bay, Hale Passage, Lummi Bay, Onion Bay, Georgia Strait, Lummi River, Nooksack River	• Large timber harvests in the upper watershed of the Nooksack River off-Reservation • Abandoned Timber Road Inventory being conducted by LNR Timber and Fish division • Approximately 50 acres of timber harvested on-Reservation annually
Construction	Land Development	Machinery, earthmoving, soil compaction, vegetation removal	Oils, waste oils, solvents, grease, hydraulic fluids, transmission fluids, antifreeze, acids, paints, miscellaneous cutting oils, miscellaneous wastes, and sediment	C, D, E, F, G, H, I, J, K, L, O, P, Q, R, S, T	Bellingham Bay, Portage Bay, Hale Passage, Lummi Bay, Onion Bay, Georgia Strait, Lummi River, Nooksack River	• Temporary sources • Location and size of construction activity varied • Land disturbing activities greater than one acre require NPDES permit coverage for storm water • Best Management Practices are required for all ground disturbing activities on the Reservation, regulated through Technical Review

Table 3.2 Inventory of Potential Nonpoint Source Pollution Sources in Reservation Watersheds

NPS Category	NPS Subcategory	Potential Contaminant Sources	Potential Contaminants[1]	Watershed(s)	Receiving Water Bodies	Comments
						Committee and Lummi Water Resources Protection Code.
Urban Runoff/Storm Sewers	Non-Industrial Permitted	Miscellaneous Commercial Business in Ferndale and the Nooksack River Basin	Solvents, pesticides, acids, alkalis, waste oils, machinery/vehicle servicing wastes, gasoline or diesel fuel from storage tanks, general building wastes, automotive wastes	L,O,S	Lummi Bay, Lummi River, Bellingham Bay	• Large number of potential contaminants • Potential hazard of contaminants
	Industrial Permitted	Lummi Auto Recyclers (Note: This facility was closed by the operator by March 31, 2011 following the removal of all scrap vehicles from the facility)	Waste oils, solvents, acids, paints, antifreeze, and automobile wastes	G	Bellingham Bay	• Large number of potential contaminants • Storm water determined to discharge to depressional wetland with no outlet • Lummi Water Resources Division sampled storm water runoff periodically for potential contaminants • Business closed by March 31, 2012 after all motor vehicles hulls removed from the site • Appendix E summarizes findings
Urban Runoff/Storm Sewers	Industrial Permitted	Phillips 66 Refining and Marketing (petroleum oil refinery)	Hydrocarbons, solvents, metals, miscellaneous organics, sludges, oily metal shavings, lubricant and cutting oils, degreasers, metal marking fluids, corrosive fluids, other hazardous and nonhazardous materials and wastes, diesel fuel, herbicides for rights-of-way, creosote for preserving railroad ties	Q, R	Lummi Bay, Onion Bay, Georgia Strait	• Large number of potential contaminants • Potential hazard of contaminants • Formerly ConocoPhillips, Tosco, Mobil.
	Industrial Permitted	Miscellaneous Industries in the Nooksack River Basin	Hydrocarbons, solvents, metals, miscellaneous organics, sludges, oily metal shavings, lubricant and cutting oils, degreasers, metal marking fluids, corrosive fluids, other hazardous and nonhazardous materials and wastes, diesel fuel, herbicides for rights-of-way, creosote for preserving railroad ties, automotive wastes	S	Bellingham Bay	• Large number of potential contaminants • Potential hazard of contaminants
	Other Urban Runoff	Single or multi-family homes	Household cleaners, oven cleaners, drain cleaners, toilet cleaners, disinfectants, metal polishes, jewelry cleaners, shoe polishes,	C, D, E, F, G, H, I, J, K, L, O, P, Q, R, S, T	Bellingham Bay, Lummi Bay, Onion Bay,	• Many residential areas are concentrated along the shorelines of the

Table 3.2 Inventory of Potential Nonpoint Source Pollution Sources in Reservation Watersheds

NPS Category	NPS Subcategory	Potential Contaminant Sources	Potential Contaminants[1]	Watershed(s)	Receiving Water Bodies	Comments
			synthetic detergents, bleach, laundry soil and stain removers, spot removers and dry cleaning fluid, solvents, lye or caustic soda, pesticides, photochemicals, printing ink, paints, varnishes, stains, dyes, wood preservatives (creosote), paint and lacquer thinners, paint and varnish removers and deglossers, paint brush cleaners, floor and furniture strippers, automotive wastes, waste oils, diesel fuel, kerosene, #2 heating oil, grease, degreasers for driveways and garages, metal degreasers, asphalt and roofing tar, tar removers, lubricants, rustproofers, car and boat wash detergents, car and boat waxes and polishes, rock salt, refrigerants, fertilizers, herbicides, insecticides, fungicides, septage, coliform and noncoliform bacteria, viruses, nitrates, heavy metals, synthetic detergents, cooking and motor oils, bleach, septic tank cleaner chemicals, effluents from barnyards, feedlots, septic tanks, gasoline, water treatment chemicals, and well pumping that induces salt water intrusion into Reservation aquifers		Georgia Strait, Lummi River, Nooksack River, Portage Bay, Hale Passage	Reservation • Residential areas also concentrated along the Nooksack River in towns such as Ferndale, Lynden, and Deming • A Lummi Nation Integrated Solid Waste Management Plan was adopted in 2014, which also addresses household hazardous waste disposal
	Other Urban Runoff	Northwest Indian College	Automotive wastes, general building wastes	K	Lummi Bay	• Student housing has been added • Phase 1 of the new south campus is completed on Kwina Road • Phase 2 of the new south campus is expected to be built in the coming years on Kwina Road
	Other Urban Runoff	Lummi Nation K-12 School, Youth Academy, and Daycare Center	Automotive wastes, general building wastes	C, D	Lummi Bay, Hale Passage, Portage Bay	• New Lummi Nation K-12 School completed in 2004 • Bus yard and maintenance facility onsite
	Other Urban Runoff	Lummi Tribal Health Center	Automotive wastes, general building wastes	K	Lummi Bay	• Expansion recently completed • Includes the Lummi

Table 3.2 Inventory of Potential Nonpoint Source Pollution Sources in Reservation Watersheds

NPS Category	NPS Subcategory	Potential Contaminant Sources	Potential Contaminants[1]	Watershed(s)	Receiving Water Bodies	Comments
						Fitness Center and tennis, basketball, and pickleball courts
	Other Urban Runoff	Tribal governmental offices	Solvents, pesticides, acids, alkalis, waste oils, machinery/vehicle servicing wastes, general building wastes	C, K	Lummi Bay, Bellingham Bay, Hale Passage	• Addition of a new tribal court building in 2005 • Lummi Commercial Company (LCC) offices moved to location along Lummi Bay • All underground storage tanks (UST) removed from the tribal center • A new Tribal Administrative Center opened during 2013 at the corner of Kwina Road and Chief Martin Road
	Other Urban Runoff	Wex li em Community Building	Automotive wastes, general building wastes	C	Hale Passage	• Periodic but frequent use throughout year
	Other Urban Runoff	Cemetery	Leachate, lawn and garden maintenance chemicals, automotive wastes	S	Bellingham Bay	• Expansion completed during 2014
	Other Urban Runoff	Silver Reef Hotel, Casino & Spa	Automotive wastes, general building wastes	O	Lummi Bay	• Second hotel tower construction started during 2014.
	Other Urban Runoff	Fisherman's Cove (boat storage and launching)	Gasoline, diesel fuel, oil, septage from boat waste disposal areas, automotive wastes, and hydraulic fluid	C	Hale Passage, Lummi Bay	• New marina in planning and permitting stage during 2014.
	Other Urban Runoff	Seafood Buying Facility	Automotive wastes, general building waste	C	Hale Passage	• None
	Other Urban Runoff	Finkbonner Shellfish Inc.	Automotive wastes, general building wastes	C	Hale Passage	• None
	Other Urban Runoff	Native American Shellfish Inc.	Automotive wastes, general building wastes	S	Bellingham Bay	• None
	Other Urban Runoff	Eagle Haven Recreational Vehicle (RV) park	Septage, gasoline, diesel fuel, pesticides, automotive wastes, and household wastes	H	Lummi Bay	• None
	Other Urban Runoff	Barlean's Fisheries, Inc and Barlean's Organic Oil	Automotive wastes, general building wastes, process wastes	P, Q	Onion Bay, Lummi Bay, Lummi River,	• None
	Other Urban	Utilities	PCBs from transformers and capacitors, oils,	C, D, E, F, G, H,	Lummi Bay,	• Potential public health

Table 3.2 Inventory of Potential Nonpoint Source Pollution Sources in Reservation Watersheds

NPS Category	NPS Subcategory	Potential Contaminant Sources	Potential Contaminants[1]	Watershed(s)	Receiving Water Bodies	Comments
	Runoff		solvents, sludges, acid solution, metal plating solutions (chromium, nickel, cadmium)	I, J, K, L, O, P, Q, R, S	Bellingham Bay, Georgia Strait, Hale Passage	hazard
	Highway/Road/Bridge Runoff	Roads	Automotive wastes (e.g., gasoline, antifreeze, transmission fluid, battery acid, engine and radiator flushes, engine and metal degreasers, hydraulic fluids, and motor oil), herbicides along road right-of-ways	A, B, C, D, E, F, G, H, I, J, K, L, O, P, Q, R, S, T	Bellingham Bay, Lummi Bay, Onion Bay, Georgia Strait, Lummi River, Nooksack River, Portage Bay, Hale Passage	• Roads throughout all of the Reservation watersheds including unimproved roads on Portage Island • Similar potential contaminants associated with the Whatcom County Ferry terminal at Gooseberry Point (Watershed C)
Resource Extraction	Surface Mining (sand/gravel)	Crist Gravel Pit	Oils, waste oils, solvents, grease, hydraulic fluids, transmission fluids, antifreeze, acids, and miscellaneous wastes	G	Bellingham Bay	• No longer extracting gravel from this pit • In the process of filling the pit with sediment excavated from construction projects on-Reservation
Land Disposal	On-Site Wastewater Systems	Biosolids application site	Organic matter, nitrates, inorganic salts, coliform and noncoliform bacteria, parasites, and viruses	H	Lummi Bay	• Complies with CWA Section 503 Regulations
	On-Site Wastewater Systems	Wastewater Treatment Plants	Wastewater, biosolids, treatment chemicals (e.g., chlorine), automotive wastes, general building wastes	C, K, L, R, S	Hale Passage, Lummi River, Lummi Bay, Georgia Strait, Nooksack River, Bellingham Bay	• Lummi Nation built a Membrane Bioreactor Plant in 2004 • Plans to replace the Sandy Point Wastewater Treatment Plant • Gooseberry Point Wastewater Treatment Plant installed ultra violet disinfection system in 2011
	On-Site Wastewater Systems	Abandoned landfills	Leachate, organic and inorganic chemical contaminants, wastes from households and businesses, nitrates, oils, metals	I, J, S	Lummi Bay, Bellingham Bay	• Types and quantities of contaminants unknown • Hazardous nature of

Table 3.2 Inventory of Potential Nonpoint Source Pollution Sources in Reservation Watersheds

NPS Category	NPS Subcategory	Potential Contaminant Sources	Potential Contaminants[1]	Watershed(s)	Receiving Water Bodies	Comments
						contaminants unknown • Study to assess hazardous waste leachate in the former Chief Martin Landfill completed in 2011 – found no significant or imminent health risks.
Marinas and Recreational Boating		Sandy Point Marina	Gasoline, diesel fuel, oil, septage from boat waste disposal areas, and automotive wastes	R	Georgia Strait	• Installed new docks in 2010
	Creosote Pilings	Lummi Shellfish and Finfish Hatcheries	Polycyclic aromatic hydrocarbons (PAHs), phenols, and cresols	Not applicable	Lummi Bay, Bellingham Bay, Lummi Aquiculture Facility	• Removed approximately 30 creosote pilings during 2009
Atmospheric Deposition		Phillips 66 Refining and Marketing (petroleum oil refinery)	Criteria Pollutants: Volatile Organic Compounds (VOCs), fine particulate matter, oxides of nitrogen, carbon monoxide, oxides of sulfur Toxic Pollutants: benzene, butanes, cyclohexane, ethylbenzene, pentanes, toluene, trimethylbenzene, xylene, and other toxins in quantities less than 5,000 lbs per year	All 18 watersheds	Bellingham Bay, Lummi Bay, Onion Bay, Georgia Strait, Lummi River, Nooksack River, Portage Bay, Hale Passage	• Large number of potential contaminants • Potential hazard of contaminants • Lummi Nation Spill Prevention and Response Plan Assess risk
		Alcoa-Intalco (aluminum plant)	Criteria Pollutants: VOCs, fine particulate matter, oxides of nitrogen, carbon monoxide, oxides of sulfur Toxic Pollutants: gaseous fluoride	All 18 watersheds	Bellingham Bay, Lummi Bay, Onion Bay, Georgia Strait, Lummi River, Nooksack River, Portage Bay, Hale Passage	• Large number of potential contaminants • Potential hazard of contaminants
		British Petroleum, Inc (petroleum oil refinery)	Criteria Pollutants: VOCs, fine particulate matter, oxides of nitrogen, carbon monoxide, oxides of sulfur Toxic Pollutants: benzene, cyclohexane, ethylbenzene, sulfuric acid, toluene, trimethylbenzene, xylene, and other toxins in quantities less than 5,000 lbs per year	All 18 watersheds	Bellingham Bay, Lummi Bay, Onion Bay, Georgia Strait, Lummi River, Nooksack River, Portage Bay, Hale Passage	• Large number of potential contaminants • Potential hazard of contaminants
		Puget Sound Refinery (Shell Products US)	Criteria Pollutants: VOCs, fine particulate matter, oxides of nitrogen, carbon monoxide, oxides of sulfur	All 18 watersheds	Bellingham Bay, Lummi Bay, Onion Bay,	• Large number of potential contaminants • Potential hazard of

Table 3.2 Inventory of Potential Nonpoint Source Pollution Sources in Reservation Watersheds

NPS Category	NPS Subcategory	Potential Contaminant Sources	Potential Contaminants[1]	Watershed(s)	Receiving Water Bodies	Comments
			Toxic Pollutants: benzene, cyclohexane, ethylbenzene, sulfuric acid, toluene, trimethylbenzene, xylene, and other toxins in quantities less than 5,000 lbs per year		Georgia Strait, Lummi River, Nooksack River, Portage Bay, Hale Passage	contaminants
		Tesoro Northwest Company (petroleum oil refinery)	Criteria Pollutants: VOCs, fine particulate matter, oxides of nitrogen, carbon monoxide, oxides of sulfur Toxic Pollutants: benzene, cyclohexane, ethylbenzene, sulfuric acid, toluene, trimethylbenzene, xylene, and other toxins in quantities less than 5,000 lbs per year	All 18 watersheds	Bellingham Bay, Lummi Bay, Onion Bay, Georgia Strait, Lummi River, Nooksack River, Portage Bay, Hale Passage	• Large number of potential contaminants • Potential hazard of contaminants
		GN Plywood, Inc. (plywood manufacturer)	Criteria Pollutants: VOCs, fine particulate matter, oxides of nitrogen, carbon monoxide Toxic Pollutants: acetaldehyde, acetone, barium, benzene, chlorine, formaldehyde, manganese, naphthalene	All 18 watersheds	Bellingham Bay, Lummi Bay, Onion Bay, Georgia Strait, Lummi River, Nooksack River, Portage Bay, Hale Passage	• Large number of potential contaminants • Potential hazard of contaminants
		Encogen NW Cogeneration Plant	Criteria Pollutants: VOCs, fine particulate matter, oxides of nitrogen, carbon monoxide, oxides of sulfur Toxic Pollutants: ammonia, formaldehyde	All 18 watersheds	Bellingham Bay, Lummi Bay, Onion Bay, Georgia Strait, Lummi River, Nooksack River, Portage Bay, Hale Passage	• Large number of potential contaminants • Potential hazard of contaminants
		Tenaska Washington Partners Cogeneration Station	Criteria Pollutants: VOCs, fine particulate matter, oxides of nitrogen, carbon monoxide, oxides of sulfur Toxic Pollutants: ammonia, benzene, cyclohexane, ethylbenzene, formaldehyde, sulfuric acid, toluene, trimethylbenzene, xylene, and other toxins in quantities less	All 18 watersheds	Bellingham Bay, Lummi Bay, Onion Bay, Georgia Strait, Lummi River, Nooksack River, Portage Bay, Hale Passage	• Large number of potential contaminants • Potential hazard of contaminants
Waste Storage/ Storage Tanks		Sewer lines and sewer pump stations break or	Sewage, coliform and noncoliform bacteria, viruses, nitrates, heavy metals, synthetic detergents, cooking and motor oils, bleach,	C, D, E, F, G, H, I, J, K, L, O, P, Q, R, S, T	Lummi Bay, Bellingham Bay, Georgia Strait,	• Potential public health hazard • Installed automated pumps

Table 3.2 Inventory of Potential Nonpoint Source Pollution Sources in Reservation Watersheds

NPS Category	NPS Subcategory	Potential Contaminant Sources	Potential Contaminants[1]	Watershed(s)	Receiving Water Bodies	Comments
		malfunction)	pesticides, paints, paint thinner, photographic chemicals		Hale Passage	with backup generators in all pump stations along Lummi Shore Road and other pump station sites • Sewer lines were installed in previously unserved areas of the Sandy Point development and septic systems removed during 2014.
		DO Construction	Oils, waste oils, solvents, grease, hydraulic fluids, transmission fluids, antifreeze, acids, paints, miscellaneous cutting oils, and miscellaneous wastes	G	Bellingham Bay	• None
		Fisherman's Cove Marina (retail grocer and gas station)	Automotive wastes, gasoline (underground storage tanks) general building wastes	C	Hale Passage	• New marina in planning and permitting stage during 2014.
		Warrior Construction	Oils, waste oils, solvents, grease, hydraulic fluids, transmission fluids, antifreeze, acids, paints, miscellaneous cutting oils, and miscellaneous wastes	Q	Lummi Bay, Onion Bay	• Former business closed following the passing of the company owner.
Recreation Activities		Stommish Grounds	Automotive wastes, general building wastes	C	Hale Passage	• Seasonal high use during summer months when precipitation events are rare
	Golf	Golf Courses	Lawn and garden maintenance chemicals, automotive wastes	O, S	Lummi Bay, Bellingham Bay	• None

[1] Potential contaminant listings based on literature (EPA 1993b) and 2010 emission inventory information provided by the Northwest Air Pollution Authority. Other than emission inventories, site specific inventories of potential contaminants at each location were not conducted.

3.3. Climate

Pacific Northwest (PNW) climate and ecology are largely shaped by the interactions that occur between seasonally varying water patterns and the region's mountain ranges. Approximately 75 percent of the region's precipitation occurs in just half the year (October – April) when the PNW is on the receiving end of the Pacific storm track. Based on climate data collected at Bellingham International Airport, the average annual precipitation on the Reservation is approximately 36 inches. On average, November, December, and January are the wettest months; June, July, and August are the driest months.

Temperature on the Reservation is relatively mild year round. Temperature data collected at the Bellingham Airport from 1949 – 2005 indicate that the warmest months are July and August. During these months the average maximum daily temperature is approximately 71 degrees Fahrenheit (^{o}F). December and January are the coldest months with the average minimum daily temperature are about 32^{o}F. The growing season is "the portion of the year when soil temperature (measured 20 inches below the surface) is above biological zero (5°Celsius [C] or 41°F). May through September is the approximate growing season for agricultural crops in the area (Gillies 1998).

Evapotranspiration has not been measured on the Reservation but has been estimated. Phillips (1966) estimated the average annual actual evapotranspiration for a 6-inch water holding capacity soil at the Marietta 3 NNW station to be approximately 18.8 inches. This estimate represents about 52 percent of the mean annual precipitation. Evapotranspiration was calculated from meteorological variables measured on the Reservation from 1997 though 2001 as part of the Lummi Peninsula ground water investigation (Aspect Consulting 2003). Evaportranspiration is the combined loss of water to the atmosphere through evaporation from the soil surface, evaporation of intercepted water, and plant transpiration. Evaportranspiration was computed using the Penman Monteith method with a grass reference crop for a representative evapotranspiration from the land cover of the Lummi Peninsula (Aspect Consulting 2003). The computed average reference evapotranspiration for the Lummi Indian Reservation from 1997 through 2001was approximately 21.1 inches. The average annual precipitation during this same period for a representative watershed on the Lummi Peninsula was 32.8 inches, indicating that approximately 64 percent of the average annual precipitation is lost to evapotranspiration. A review of evapotranspiration estimates from 27 studies conducted in the Puget Sound Lowland (Bauer and Mastin 1997) suggests an average evapotranspiration rate around 17.3 inches. On average, the estimated mean annual evapotranspiration from the 27 studies compiled by Bauer and Mastin (1997) was about 46 percent of the mean annual precipitation.

Wind data for Bellingham indicate that the prevailing wind direction on the Reservation is from the south and southeast with gusts upward of 80 miles per hour. Winds from the west are not as common and generally not as strong (U.S. Army Corps of Engineers 1997). Wind roses developed from meteorological data collected at two locations on the Reservation as part of a wind energy development feasibility assessment over the January 2011 through January 2012 period (DNV KEMA 2012) indicate that the wind direction is from the south-southeast or south about 50 percent of the time and from the north or northeast about 15 percent of the time.

The Reservation experiences a variety of infrequent weather patterns. A typical but infrequent weather pattern is generated from the northeast by cold air masses moving down the Fraser River valley. Strong winds from this pattern, blowing across the Fraser and Nooksack river basins, have caused damage to the residents and businesses of the Reservation (USDA 1992). Another typical but infrequent weather pattern involves continental air masses from the east that bring unusually dry weather that can last a few days or weeks (USDA 1992). During the summer, these air masses bring unusually warm temperatures (mid to upper 90s Fahrenheit). During the winter, these air masses usually bring cold temperatures (0°F and colder).

Because most of the precipitation occurs during the winter months when evapotranspiration demand is low, most of the ground water recharge and storm water runoff also occurs during this season. After the rainy season and during the summer months when evapotranspiration demand is high and vegetation slows the movement of storm water, the amount of water available for ground water recharge or surface water runoff is small. Despite the lush summer vegetation, infrequent cloud bursts and the relatively impervious soils common to the Reservation can combine to produce storm water runoff during the summer months. Because of the accumulation of debris between the infrequent summer storms, resultant pollutant loading in storm water can be higher during the summer months relative to the rainy season runoff (LWRD and Salix Environmental Services 2006).

There are numerous intermittent streams, roadside drainage ditches, and agricultural drainage ditches on the Reservation. These channels convey storm water either directly to the surrounding marine waters or indirectly via the floodplains of the Lummi and Nooksack rivers. Surface water runoff was measured from 1997 through 2001 as part of a Lummi Peninsula ground water investigation (Aspect Consulting 2003). Total runoff volumes are a function of precipitation for a given year. The greatest runoff occurred during the wet water year 1998/1999, with runoff ranging from 6 to 14 inches with most of the basins measured in the study having between 10 and 14 inches of runoff (Aspect Consulting 2003). The least runoff occurred in the relatively drier water year 2000/2001, with runoff ranging from 2 to 8 inches with most basins between 3 and 5 inches (Aspect Consulting 2003). The runoff hydrographs for the study indicated both "flashy" storm water runoff and relatively steady wet season base flow components. The storm runoff response is rapid, with abrupt runoff peaks occurring at the time of the precipitation event and declining sharply after the end of precipitation. The seasonal baseflow component of flow is relative steady, building and declining slowly over the wet season. Continuous runoff commonly begins occurring by mid-November. The end of continuous runoff ranged from the first week of May in 1998 to late June in 2000. The cessation of runoff is a function of April through June precipitation, with runoff persisting into June during the relatively wetter springs.

3.4. Soil Characteristics

The United States Department of Agriculture (USDA) – Natural Resource Conservation Service (NRCS) has identified and described forty different soil types on the Reservation from the general soil units (Figure 3.4) (USDA 1992). The eight general soil units are:

Mt. Vernon-Puyallup: Very deep, moderately well drained, nearly level soils; located on river terraces and floodplains covered with shrubs or conifers.

Eliza-Tacoma: Very deep, very poorly drained, level soils that generally have been artificially drained; located on floodplains, deltas, and tidal flats lower than 20 feet of elevation.

Kickerville-Barneston-Everett: Very deep, well drained and somewhat excessively drained, level to very steep soils; located on outwash terraces and glacial moraines.

Lynden-Hale-Tromp: Very deep, well drained to somewhat poorly drained, level to generally sloping soils; located on outwash terraces at 50 to 300 hundred feet in elevation.

Whatcom-Labounty: Very deep, moderately well drained and poorly drained, level to very steep soils; located dominantly on glaciomarine drift.

Birchbay-Whitehorn: Very deep, moderately well drained and poorly drained, level to gently sloping soils; located on glaciomarine drift plains.

Estuarine Unit: Very deep, poorly drained, level soils, located on tidal flats.

Unstable Soil Unit: Moderately deep to very deep, well drained soils, very steep slopes, located on mountainsides, canyonsides, and ridges.

As part of the USDA-NRCS characterization, each soil type was assigned to one of four hydrologic soil groups based on their runoff producing characteristics (USDA 1992). The hydrologic soil group, along with the cover type, drainage area, channel length, and land slope, can be used in the USDA Curve Number Method (USDA 1970) to estimate runoff volumes, peak discharge, and hydrographs for specified storms. The primary consideration in assigning a soil to a hydrologic soil group is the inherent infiltration capacity of the soil with no vegetation (USDA 1992). The hydrologic soil groups, which are labeled A, B, C, or D are described in Table 3.2. In essence, Group A soils have a low runoff potential and a high infiltration potential whereas Group D soils have a high runoff potential and a low infiltration potential. Group B and Group C soils have runoff and infiltration potentials between Group A and Group D soils.

As shown in Figure 3.5 and Table 3.3, most of the northern and southern upland areas of the Reservation watersheds (on-and off-Reservation) have a moderately high or high runoff potential. About 9.5 percent of the soils within the Reservation watersheds have a low or moderately low runoff potential (Group A or Group B). The remaining 90.5 percent of the soils within the Reservation watersheds have a moderately high or high runoff potential (Group C or Group D). These soil characteristics suggest that less than 10 percent of the watershed uplands have a good aquifer recharge potential. The Nooksack River watershed upstream of the Reservation boundary was not included in this analysis.

As shown in Figure 3.5, the Group A and Group B soils are generally found along some of the low lying coastal areas and the glacial outwash terraces of the Reservation. These Group A and Group B soils are concentrated along Haxton Way south of Balch Road, along Lummi View Drive near the Stommish Grounds, on Portage Island, and near Fish Point. There is an isolated area of Group B soils along the west side of Chief Martin Road near the abandoned landfill. The Group C and Group D soils are found along the glaciomarine drift plains in the upland areas and the floodplains of the Lummi and Nooksack rivers. Off-Reservation Group A and Group B soils are mostly found in Watershed P along the east side of Lake Terrell Road. Most of the northern and southern upland areas in the watersheds (on-and off-Reservation) have a moderately high or high runoff potential. The Nooksack River watershed upstream of the Reservation boundary was not included in this analysis.

Table 3.3 Descriptions of Hydrologic Soil Groups within the Reservation Watersheds[1]

Hydrologic Soil Group	Description[2]	Percent of Watershed Soils[1]
A	Soils having high infiltration rates even when thoroughly wetted; consisting chiefly of deep (3 to 6+ ft), well to excessively drained sands (loamy sands, sandy loam, and sands) and/or gravel. These soils have a high rate of water transmission and a low runoff potential.	2.0
B	Soils having moderate infiltration rates when thoroughly wetted; consisting chiefly of moderately deep (20+ inches) and moderately well to well drained soils with moderately fine to moderately coarse textures (loam, silt loam). These soils have a moderate rate of water transmission and a moderately low runoff potential.	7.5
C	Soils having slow infiltration rates when thoroughly wetted; consisting chiefly of: 1) soils with a layer that impedes the downward movement of water, and 2) soils with moderately fine to fine texture (sandy clay loam) and slow infiltration rates. These soils have a slow rate of water transmission and a moderately high runoff potential.	45.3
D	Soils having slow infiltration rates when thoroughly wetted; consisting chiefly of: 1) clay soils with high swelling potential, 2) soils with a high permanent water table, 3) soils with clay pan or clay layer at or near the surface, and 4) shallow soils over nearly impervious materials. These soils have a very slow rate of water transmission and a high runoff potential.	45.2

[1] Does not include the Nooksack River Watershed off-Reservation or tribal tidelands
[2] USDA 1992

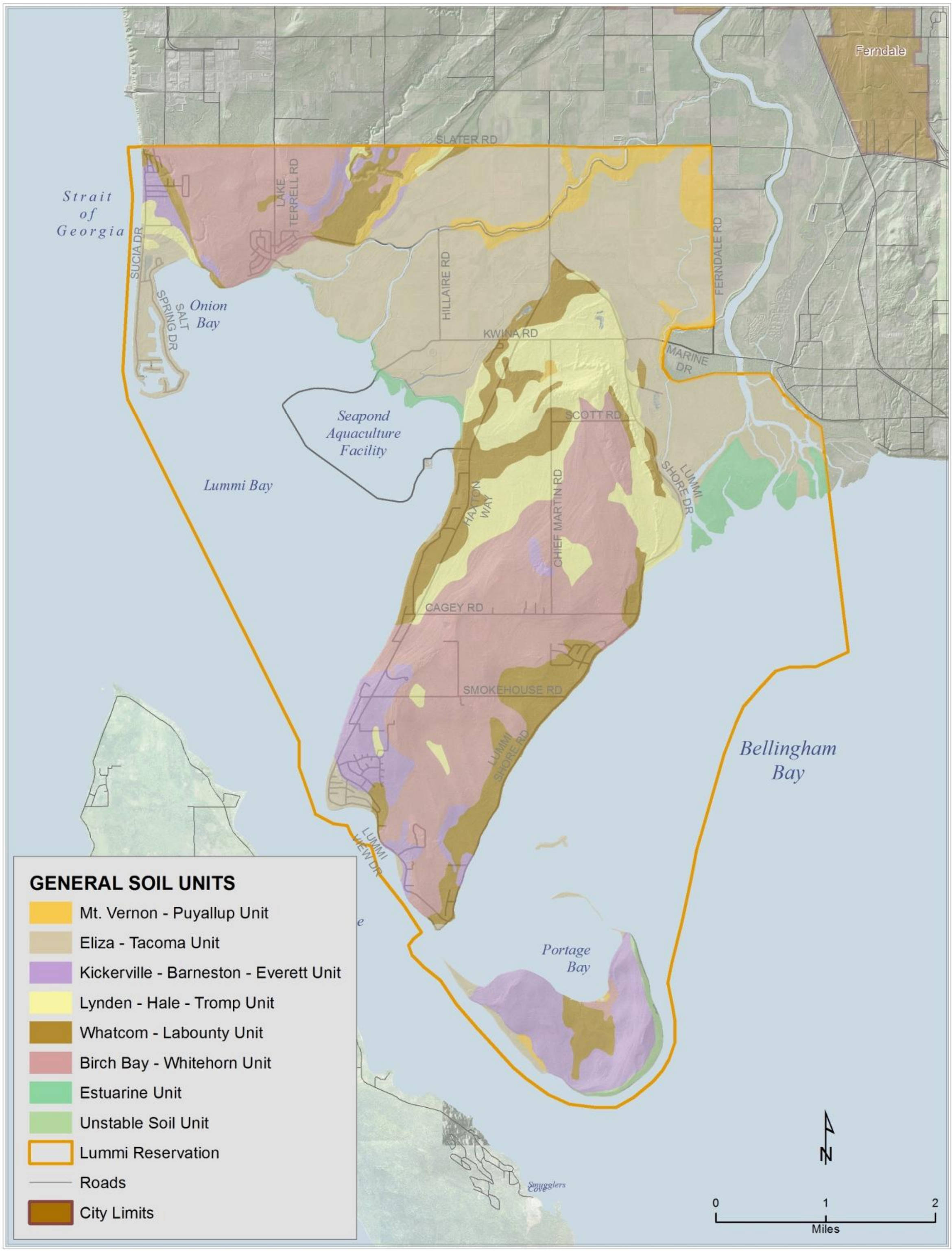

Figure 3.4 General Soil Units of the Lummi Indian Reservation

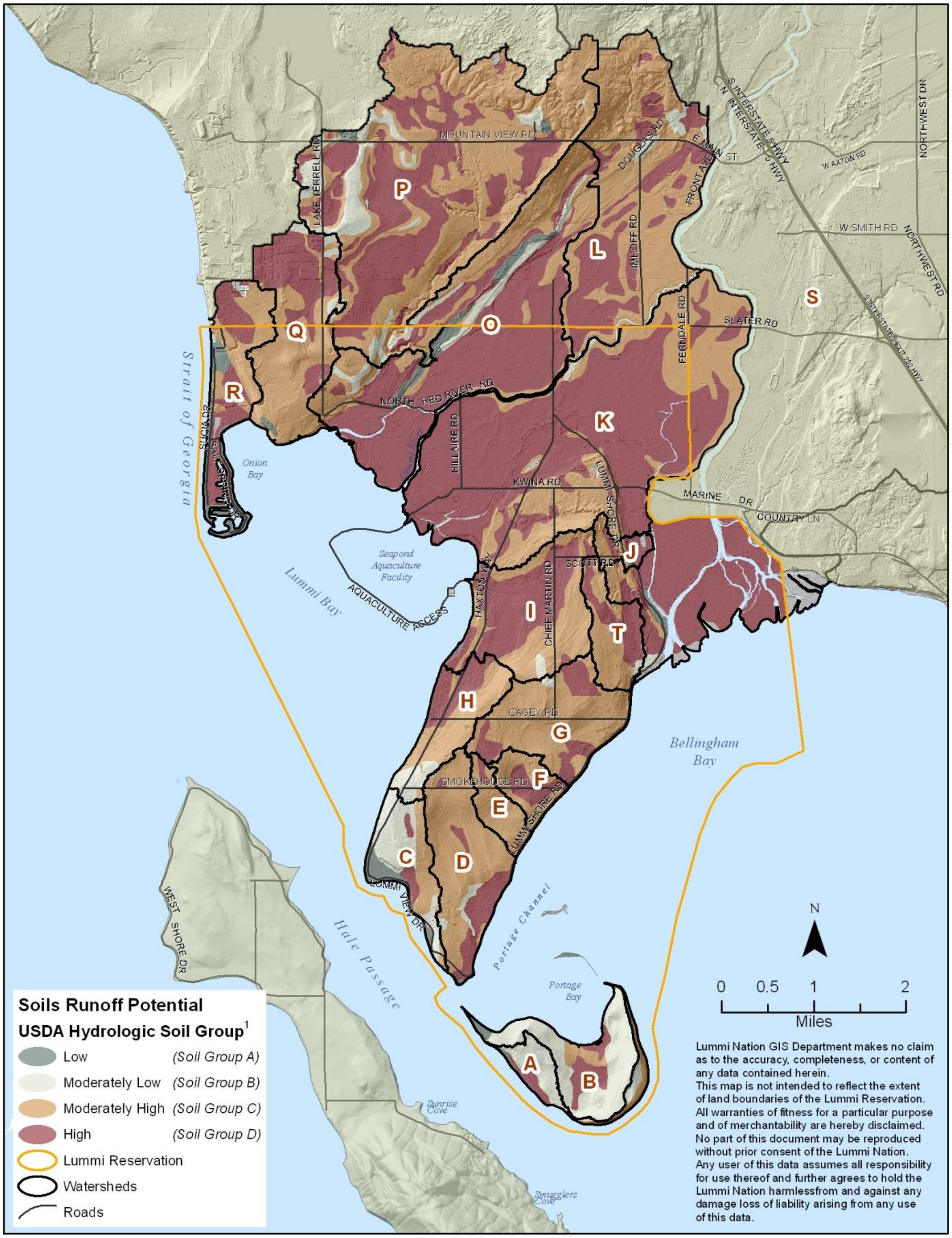

Figure 3.5 Soil Runoff Potential of the Reservation Watersheds
[1] USDA 1992

3.5. Land Use and Socioeconomic Conditions

Like most places, land use changes on the Reservation have generally been associated with changes in vegetation types, decreases in the areas covered by vegetation, changes in natural drainage patterns, and increases in impervious surfaces. After their arrival, Euro-Americans logged, cleared, and drained forested land for agricultural, residential, and commercial development. Natural drainage patterns on the Reservation were substantially altered by the road system, agricultural drainage ditches, and dikes.

Historic, current, and projected future land uses in the Reservation watersheds and socioeconomic conditions on the Reservation are described below. Much of the information about historic land uses and socioeconomic conditions comes from the *Lummi Nation Comprehensive Environmental Land Use Plan: Background Document* (LIBC 1996).

3.5.1. Historic Land Use

Before the arrival of Euro-Americans, the Lummi people were a fishing, hunting, and gathering society. Based on the accounts of Lummi Elders, early European explorers, and early photographs of the region, before 1850 old-growth forests of massive Douglas fir, western hemlock, spruce, and western red cedar dominated what was to become the Lummi Reservation. Deciduous trees such as western big leaf maple, black cottonwood, red alder, and western paper birch were also likely present along the rivers, streams, and open areas. Understory vegetation probably included vine maple, Oregon grape, several different willows, ocean spray, salmon berry, thimbleberry, soapberry, and many others. Wetlands, streams, and rivers supported a unique array of plants adapted to wet environments. The marine shoreline was also a unique environment, where only plants adapted to a saltwater-influenced environment thrived

The forces that shaped vegetation patterns in the Northwest before the arrival of Euro-Americans were forest succession, fires, windstorms, ice storms, floods, and traditional use of natural vegetation by the indigenous peoples. Native American uses of vegetation included the gathering of medicinal plants, the use of willows and other shrubs for fishing, and the extensive use of western red cedar trees for many things, including clothing, baskets, buildings, and canoes. Many plants were also sources of food to complement the traditional diet of fish, shellfish, elk, and deer. Native Americans cultivated some of these plants, such as ferns, camas, and wapato in prairies along the Nooksack River.

Similar to most areas in the lower Nooksack River watershed downstream from Everson, conversion of forestland to agricultural land occurred on the Lummi Reservation following the arrival of Euro-Americans. In 1896, approximately 1,222 acres were reportedly under cultivation on the Reservation. Along with clearing the forested land for agriculture, Euro-Americans constructed ditches, drained wetland areas, cleared logjams, diverted the Nooksack River to drain into Bellingham Bay, built a levee that cut off the Lummi River delta from the Nooksack River, and built a seawall along Lummi Bay. These changes in the natural hydrology of the Lummi Reservation changed the distribution and patterns of watercourses and of wetland and riparian associated plant communities.

Much of the cedar on the Reservation was cut into shingle bolts and shipped to local shingle mills. The old growth trees on Portage Island were cut down to fuel steamboats traveling the Nooksack River. One or more large fires swept through the Reservation area between 1850 and 1900. These fires destroyed nearly all of the remaining old growth forests. Since reforestation was not practiced during the early logging period and did not begin until approximately 1980, pioneer tree species, such as alder, willows, and cottonwoods, soon replaced the conifer forests and dominated the landscape (Leckman 1990).

Historically, the Nooksack River flowed (alternately or simultaneously) to both Lummi Bay and Bellingham Bay (effectively making the Lummi Peninsula an “island”). Before 1860, the Nooksack River discharged primarily into Lummi Bay by way of the present Lummi River channel, with smaller distributaries flowing into Bellingham Bay (WSDC 1960; Deardorff 1992). In 1860 a logjam blocked the Nooksack River near present-day Ferndale and diverted it to a small stream that flowed into Bellingham Bay (WSDC 1960). Since that time, considerable effort has been expended to keep the Nooksack River discharging into Bellingham Bay because of the increased commercial value of the river that resulted from its proximity to sawmills along Bellingham Bay (Deardorff 1992). Until the early 1900s, the Nooksack River was also the primary transportation corridor for Ferndale, Deming, and Lynden residents to travel to Bellingham. The stream remaining in the channel that discharges into Lummi Bay is called the Lummi River or the Red River (WSDC 1960).

In the 1920s, a reclamation project was initiated both to construct a dike/seawall to keep back the sea along the shore of Lummi Bay and to construct a levee along the west side of the Nooksack River (Deardorff 1992). This project, which was started in 1926 and completed in 1934, initially resulted in the nearly complete separation of the Lummi River from the Nooksack River. However, when saltwater intrusion onto the newly reclaimed farmlands and damage to the dam at the head of the Lummi River occurred during flooding, the dam was replaced with a dam and spillway structure (Deardorff 1992). This spillway structure was also damaged over the years during high-flow conditions and was replaced in 1951 by a five-foot-diameter culvert (FEMA 2004) that allowed flow from the Nooksack River into the Lummi River. Currently a four-foot culvert (Deardorff 1992) allows flow to the Lummi River only during relatively high-flow conditions (approximately 10,000 cfs). Levees were also constructed along the Lummi River to prevent saltwater from Lummi Bay from flowing onto adjacent farmlands during higher tides. The dike and levee construction activities were accompanied by agricultural ditching to drain fields and wetland areas. Based on 1887-88 topographic surveys, Bortleson et al. (1980) estimated that wetlands located landward of the general saltwater shoreline in the lower Lummi River watershed decreased from approximately 2.0 square miles to 0.1 square miles (approximately 95 percent) over the 1888-1973 period.

Between 1940 and 1960 several new public roads providing access to Ferndale and Bellingham as well as a toll ferry to Lummi Island contributed to an increase in development on the Reservation. Since 1960 there has been a significant increase in the total population on the Reservation and the number of Tribal members living on the Reservation. This is due to a number of factors including: improved economic conditions within the community, the beginning of tribal self-governance, development of water distribution and wastewater collection and treatment systems, the increased rate of house construction, and a renewed sense of Lummi cultural identity.

3.5.2. Current Land Use

Over the last century, the increase in population, the construction of extensive road networks, development of a waste water collection and treatment systems, the construction of the Sandy Point Marina, and several Tribal housing projects have fostered a trend towards higher density neighborhoods throughout the Reservation. Several distinct residential neighborhoods now exist, mainly along the shores of the Reservation including Sandy Point, Neptune Beach, Sandy Point Heights, and Gooseberry Point. Higher density residential neighborhoods can also be accessed from the numerous spur roads along Haxton Way and Lummi Shore Road, which are the primary roads along the perimeter of the Lummi Peninsula. Although increased residential and commercial development has occurred on the Reservation in the last few decades, the majority of the Reservation remains rural.

The approximation of the current land cover and land use is shown in Figure 3.6. This map was derived from the 2006 NOAA database, Classification of Coastal Washington, which is part of the Coastal Change Analysis Program (C-CAP) of the NOAA Coastal Services Center (NOAA 2006). The map gives an overview of the extent of forest and agricultural lands, residential areas, and wetlands. The estimated distribution of land cover/land use types within the Reservation boundaries is summarized in Table 3.3.

The majority of the forested areas are on the Lummi Peninsula, Portage Island, and the Northwest Uplands. Although there are some conifer groves and Douglas fir plantations, the 2007 inventory of Reservation forests showed that present day forests are largely comprised of deciduous trees, with some mixed deciduous/conifer stands (International Forestry Consultants, Inc. 2007).

The floodplains of the Lummi and Nooksack Rivers are sparsely developed; the most important commercial enterprise in the floodplains is the Silver Reef Hotel, Casino & Spa and the adjacent gas station and mini-mart. This commercial center is located at the intersection of Haxton Way and Slater Road. The floodplains are dominated by agricultural lands and wetlands, both fresh water and estuarine. The tribal center along Kwina Road includes the LIBC offices and the Northwest Indian College (NWIC). The Northwest Indian College and the LIBC offices are undergoing an expansion along the south side of Kwina Road. Figure 3.6 also displays an important feature of the Reservation, the extent of the tidelands which are essential to the way of life of the Lummi people. The seaward border of the Reservation is defined as the extent of the tidelands to -4.5 feet Mean Lower Low Water (ft MLLW).

Based on estimates of land cover in Whatcom County (Whatcom County 2005), land cover/use in the Nooksack River watershed is generally dominated by forested areas upstream from the town of Deming and agricultural lands downstream from Deming. The agricultural lands in the lowlands were largely forested before the arrival of Euro-Americans and had been largely denuded of trees by 1925 (Pierson 1953, as cited in Smelser 1970). Population centers such as Ferndale, Lynden, Everson, and Deming are located adjacent to the Nooksack River.

Table 3.2 Current Land Cover/Land Use Types on the Lummi Reservation

Land Cover/Land Use	Percent of Area
Residential, Commercial, Industrial, and Municipal	10.97
Forest	35.02
Scrub-Shrub	2.35
Wetlands	17.69
Cultivated Land/Grassland	33.96

Does not include the off-Reservation portion of Watershed S (Nooksack River) or tribal tidelands

The 2000 Census found 1,749 housing units on the Reservation. A June 2005 report by the Lummi Nation Statistics Department (Valz 2005) used the Lummi Nation GIS to identify 1,864 buildings classified as residential homes. In 2009, 1,973 addressed structures were identified on the Reservation and of these approximately 1,850 are housing units (Lummi Nation GIS 2010). Approximately 680 homes are occupied by tribal members.

The total population of the Reservation was 4,193 in the 2000 Census, a dramatic increase from 721 in the 1960 census. In the 2000 census, 2,240 people identified themselves as American Indian alone or in combination with other races (53.4 percent of the total Reservation population). Corrected for the estimated rate of undercount (4.74 percent), the estimated actual American Indian population on the Reservation was approximately 2,346 in the year 2000 (Northwest Economic Associates 2003). In 2005, the Reservation population was estimated to have increased to 6,590 including 2,564 enrolled tribal members, 665 people related to enrolled tribal members but not themselves enrolled, and 3,361 nontribal members (Valz 2005). According to the 2010 Census, a total of 4,706 people lived on the Reservation at the time, which is an eleven percent increase from the 2000 census population of 4,193. In the 2010 census, 2,510 people identified themselves as American Indian alone or in combination with other races (53.3 percent of the total Reservation population).

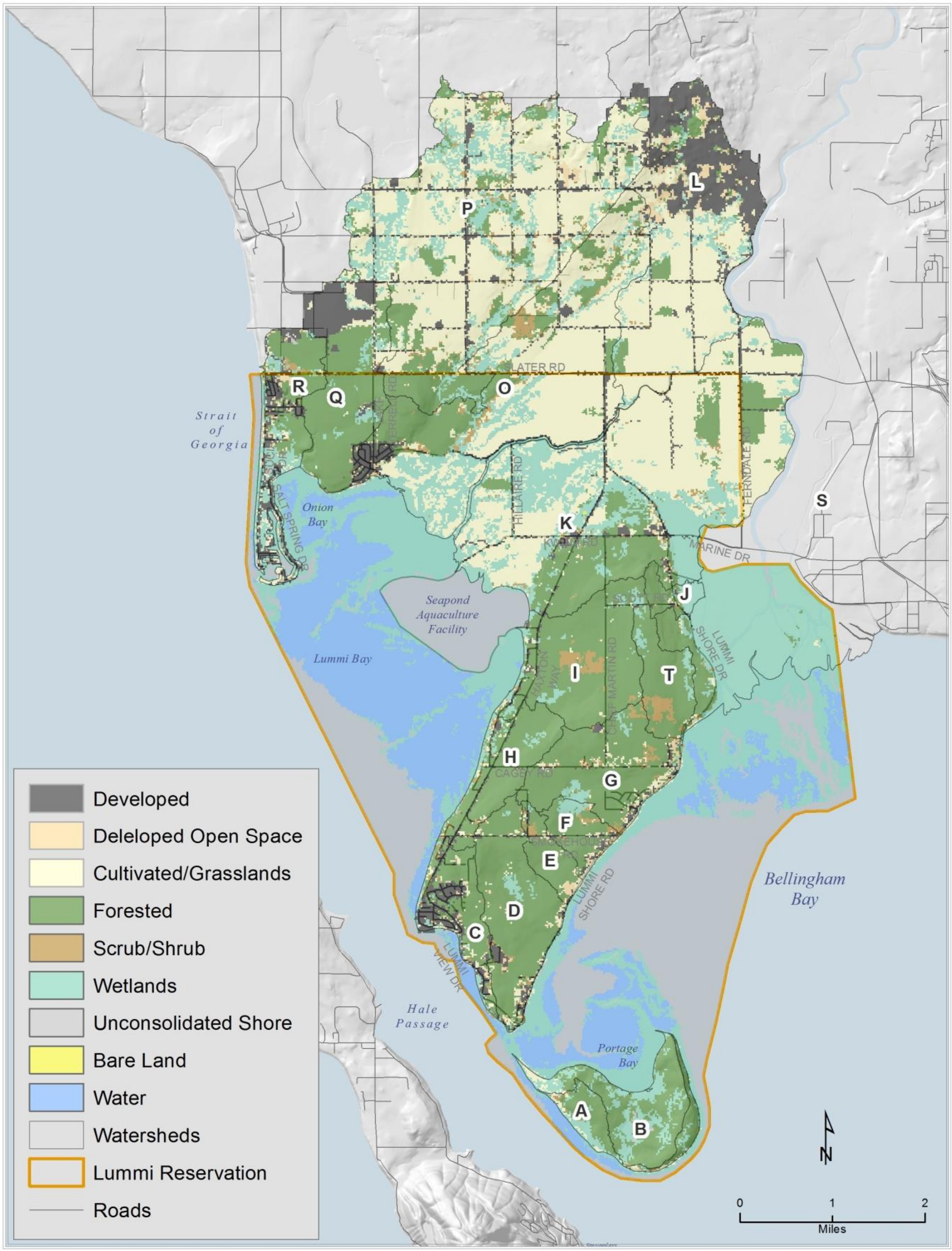

Figure 3.6 Upland Use/Land Cover of the Lummi Indian Reservation Watersheds

3.5.3. Future Land Use

Development on the Reservation is guided by a number of tribal laws and associate regulations including:

- LCL Title 15: Land Use, Development, and Zoning Code
- LCL Title 15A: Flood Damage Prevention Code
- LCL Title 16: Sewer and Water District Code
- LCL Title 17: Water Resources Protection Code
- LCL Title 22: Building Code
- LCL Title 40: Cultural Resources Preservation Code

Figure 3.7 shows the current official zoning map of the Lummi Nation. This zoning map was revised and adopted by the LIBC in 2010 as part of the comprehensive planning effort currently underway by the Planning Department. The zoning update incorporated comments from tribal departments and commissions and from public comments received during four community meetings.

The Lummi Planning Department is developing a Comprehensive Plan for the Lummi Reservation. The plan will show, in general, how land on the Reservation will be used over the next 20 years. The Comprehensive Plan will identify areas that will be developed for residential, commercial, mixed uses, industrial, and agricultural purposes, as well as showing areas that require protection (e.g., Special Flood Hazard Areas, wetlands, and aquifer recharge zones). To date, a technical background document (LIBC 1996) has been developed, public opinion surveys conducted, drafts of the Comprehensive Plan and maps developed, and focused planning workshops and meetings with commissions and community groups have occurred. The Comprehensive Plan is codified LCL Title 15 (Land Use, Development, and Zoning Code). Title 15 also formalizes an environmental review process that was already largely in place pursuant to LIBC resolutions. Key projects in the draft plan include a light industrial park, the recently completed Tribal Government Center, mixed use commercial development at Fisherman's Cove, additional housing and facilities for the NW Indian College, and additional housing for tribal members which may add as many as 900 new units. The draft and the list of projects are undergoing continuing revisions depending on available funds and other issues.

Completion of the Comprehensive Plan in its current form by approximately 2030 will add approximately 1,850 additional homes within the Reservation adding about 5,000 Indian residents to the existing population; develop approximately 1.5 million square feet of commercial buildings for retail, light industrial, warehouse, and office uses with 250 to 400 job opportunities; provide improved tourist and marine activities; and improve the governmental, health, education, recreation, and cultural amenities for the Lummi Nation.

The Comprehensive Plan assumes that no significant additional development by individuals who are not enrolled Lummi tribal members will occur within the Reservation. As cost-effective opportunities arise, the Nation anticipates re-acquiring some of the property parcels

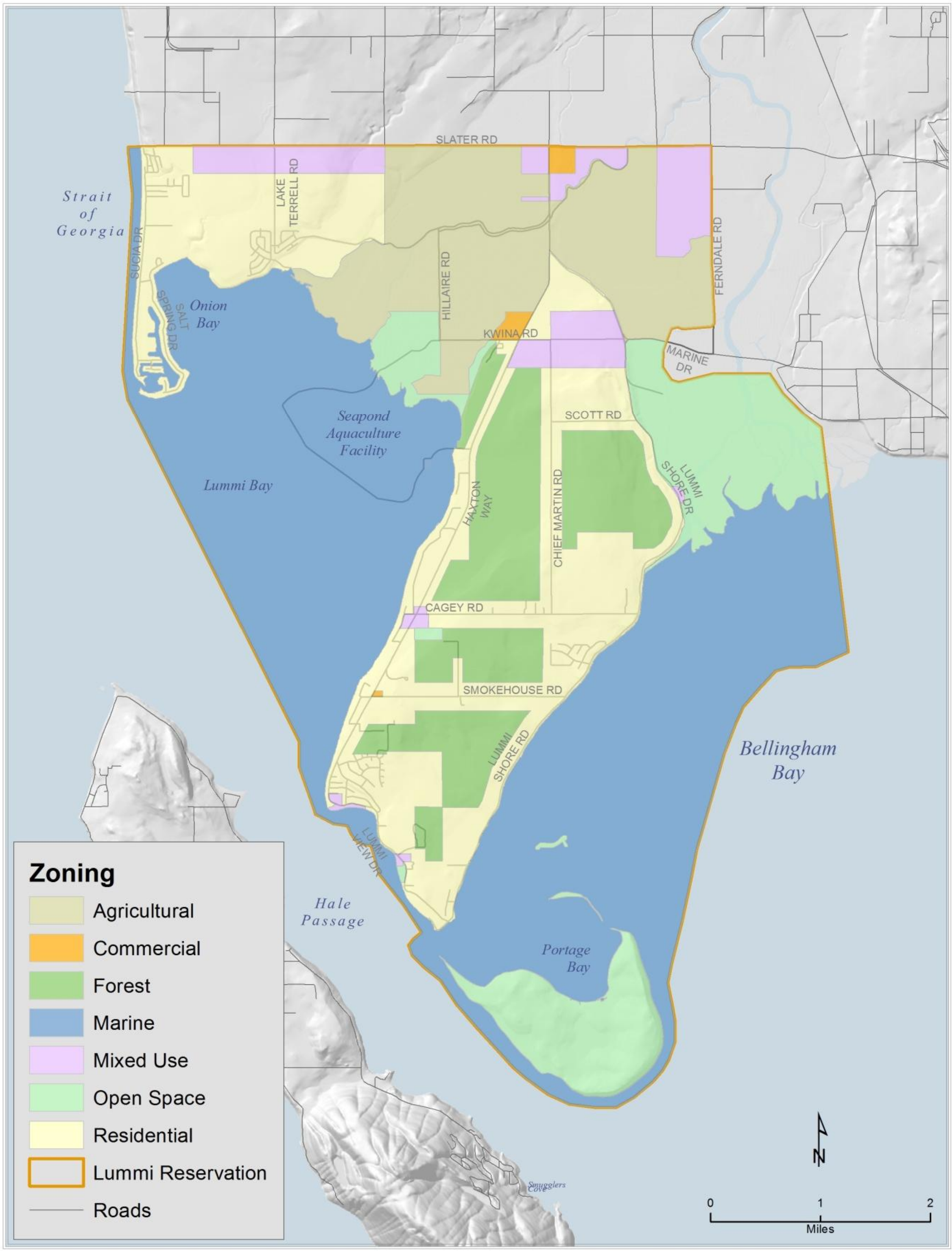

Figure 3.7 Current Land Use Zoning on the Reservation

now owned by non-Lummis. However, the Lummi Nation does expect to cooperate with non-Lummis interested in developing commercial opportunities within the Reservation that are in agreement with the Master Plan and benefit the Lummi Nation. Some of these opportunities may require revisions and/or deviations from the Comprehensive Plan, or adjustments to the scheduled timeframes.

3.5.4. Reservation Land Ownership

Land ownership on the Reservation is divided into five categories: Individual Native Trust, Individual Native Fee, Tribal Fee, Tribal Trust, and Fee (Figure 3.8). Table 3.4 summarizes the area of uplands in each of these categories. The approximately 7,000 acres of tidelands on the Reservation are in Tribal Trust status. Ownership of a parcel determines the property tax (if any) applicable to the property and determines what types of land use can occur on the parcel.

Table 3.4 Lummi Indian Reservation Land Ownership Status

Category	Acres	Percent of Reservation Area
Individual Native Trust	6,840	53
Non-Tribal Fee	3,090	24
Tribal Trust	1,536	12
In Process of Becoming Trust Land	990	7.7
Tribal Fee	230	2
Individual Native Fee	164	1

Tribal Trust

Tribal Trust status refers to lands where the land title is held in trust and protected by the federal government for the exclusive use of the Lummi tribal government. Because of the extension of treaties, all land within the defined boundaries of Indian reservations and some of those owned by tribes or individuals off of the reservation were initially held in "trust status." This means that the administration and disposition of an individual or tribe's land base is supervised by the Bureau of Indian Affairs through federal law. Thus, even though a tribal government or an individual Indian may own a parcel of land, he/she cannot lease, sell, or mortgage his/her land without Bureau of Indian Affairs acknowledgment and permission.

Individual Native Trust

Under the Treaty of Point Elliot, the federal government had the authority to assign specific parcels of land to the heads of tribal families for use by that family and their descendents subject to restrictions on sale imposed by the federal government. Much of the land on the Reservation is now held in undivided ownership by descendents of the original assignees, subject to those restrictions. This land has the same status as "tribal trust land" under the law. These lands are shown on the mapping as Individual Native Trust lands.

Fee Land

Fee land is the most basic form of ownership. The owner holds title and control of the property and may make decisions about the most common land use or sale without government oversight. In Indian country, however, whether the owner of fee simple land is

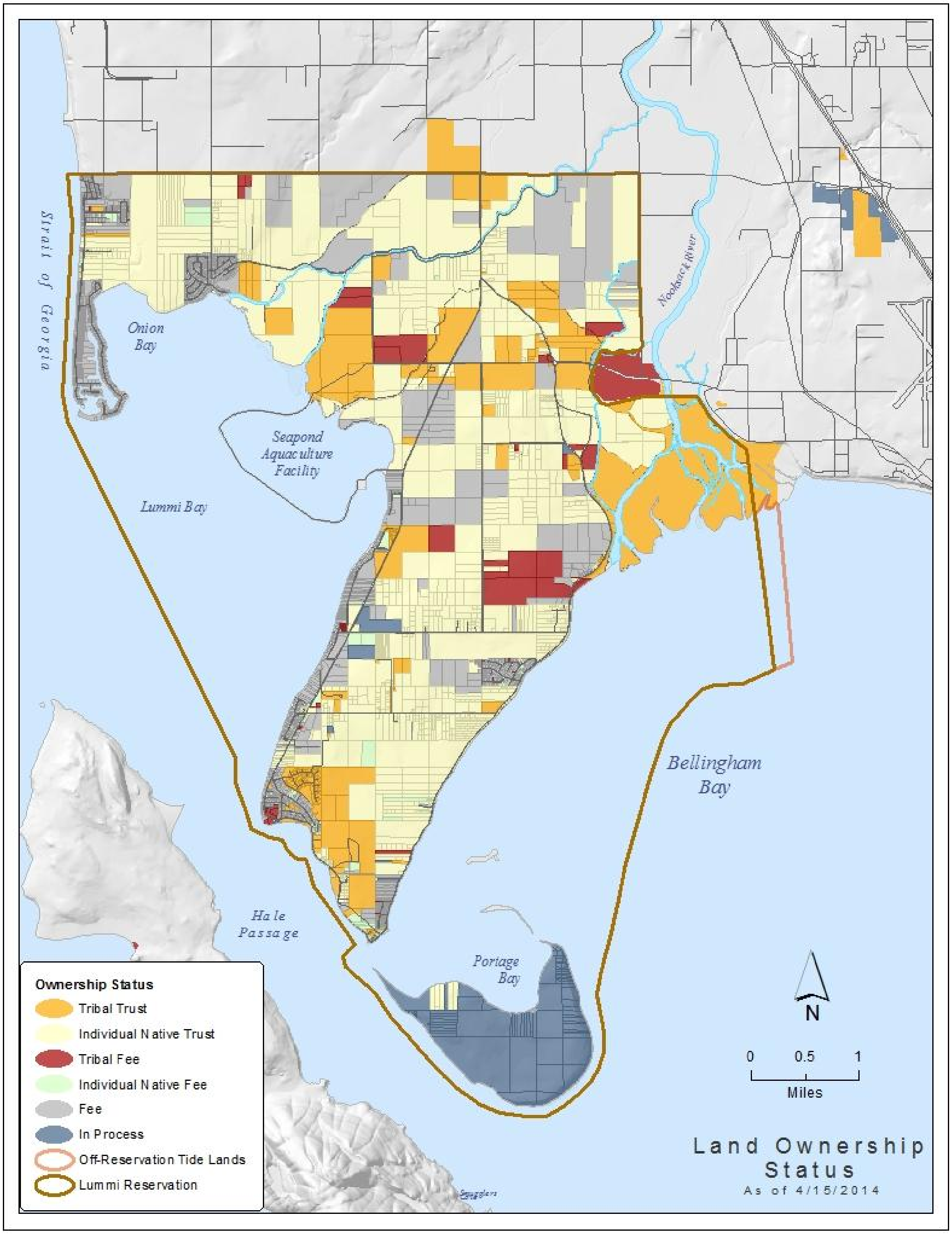

Figure 3.8 Lummi Indian Reservation Ownership Status

Indian or non-Indian is a factor in deciding who has jurisdiction over the land. Due to the checker boarding of Indian reservations, different governing authorities (i.e. county, state, federal, and tribal governments) may claim the authority to regulate, tax, or perform various activities within reservation borders based on whether a piece of land is Indian or non-Indian owned. These different claims to jurisdictional authority often conflict. The case law relevant to jurisdiction on these lands is complex and on some points inconsistent and unsettled.

3.5.5. Socioeconomic Conditions

Fishing, logging, farming, and other natural resource work have historically provided most of the jobs for Lummi tribal members. Until the 1974 Boldt Decision, Lummi tribal members were systematically precluded from the profitable salmon fishery in Puget Sound. Once the treaty fishing right was upheld by the U. S. Supreme Court, commercial fishing and fish processing began to expand on the Reservation resulting in increasing numbers of fishermen, fish processing, and increased overall tribal revenue from salmon fisheries.

The Lummi Nation is the largest fishing tribe in the Puget Sound in terms of pounds of fish landed and number of species fished (NWIFC 2012). However, the recent declines in salmon stocks have dramatically altered the tribal reliance on salmon fishing as an economic mainstay. In 1985, the average Lummi fisherman made $22,796 ($49,000 in 2011 dollars). In 1993, the average income from fishing was only $5,555 ($8,500 in 2011 dollars). During this period, about 30 percent of the tribal work force relied on fishing for their sole source of income (LIBC 1996). In the 10-year period between 1995 and 2005, on average there were 592 fishing registrations and 126 crabbing registrations each year. During the 2012-2013 harvest management year (July 1 – June 30) there were 404 vessels registered with the Lummi Nation.

Over the last ten years, the crab fishery has provided the largest percentage of the yearly fishery revenue followed by sockeye salmon and manila clams. Since 1993, further reductions in salmon stocks have resulted in closure of some fisheries and a further reduction in tribal fishery incomes (LIBC 1996). During 1999, 2007, 2009, and 2013 the sockeye salmon fishery was closed entirely due to low fish runs. The loss or reduction of a fishery increases the importance of the other fisheries to the Lummi economy. Although there are annual variations, 2001 is representative of the most recent 10 years. In 1985, the Lummi Fishing Fleet landed about 15.3 million pounds of finfish and shellfish. In 2001, the combined harvest was about 3.9 million pounds of finfish and shellfish.

In addition to catching fish and harvesting shellfish, the Lummi Nation owns and operates three salmon hatchery facilities. These facilities produce millions of young salmon each year and help offset the decline of fish stocks due to loss of natural habitat and historic over-fishing. The tribe also owns an on-Reservation shellfish hatchery, producing over one billion oyster and clam seeds annually. The tribe owns 7,000 acres of tidelands, much of which is suitable for productive shellfish beds (LIBC 1996). All of these tidelands are held in trust by the United States for the exclusive use of the Lummi Nation.

The tribal commercial shellfish enterprise and the commercial, subsistence, and ceremonial harvest of shellfish by the Lummi Nation and individual tribal members was severely impacted by the closure of 60 acres of tidelands in 1996 and 120 additional acres in 1997. These closures occurred in Portage Bay and were largely attributed to poor dairy waste management practices in the Nooksack River watershed (DOH 1997). Not considering the multiplier effects on the economy, the lost value of the shellfish products alone was estimated to be approximately $825,000 per year. In response to the 1996 closure, the EPA conducted compliance enforcement inspections of dairy operations in the Nooksack River watershed starting in 1997, the State of Washington passed the 1998 Dairy Nutrient Management Act (RCW 90.64), and dairy farmers developed and implemented nutrient management plans (a.k.a. farm plans). As a result of these reactions and additional compliance inspections by the Washington State Department of Ecology (Ecology), water quality in the Nooksack River improved. In November 2003, approximately 75 percent of the previously closed shellfish beds in Portage Bay were reopened to commercial harvest. In May 2006, the remaining closed shellfish growing areas were reclassified as “approved” for harvest.

The Lummi Casino project began in 1983 in an effort to diversify the Reservation economy. The casino operation was upgraded significantly in 1994 with the opening of the Lummi Casino at Fisherman’s Cove. The casino flourished initially, employing approximately 400 people, 65 percent of whom were Native American (LIBC 1996). However, competition and changing economic conditions resulted in the closure of the casino on August 26, 1997. With 238 workers losing their jobs, the Lummi unemployment rate grew to approximately 50 percent.

A new casino opened in April 2002 at a new location (the corner of Haxton Way and Slater Road) closer to the Interstate 5 highway. The new casino (the Silver Reef Casino) initially was 28,000 square feet and employed approximately 200 people. The casino was expanded in 2004 (Phase II) to a total of 55,000 square feet with the addition of additional gaming space, a restaurant, and a 400 seat pavilion. The casino was expanded again in 2006 (Phase III) to 135,000 square feet with the addition of restaurant, additional gaming space, a spa and fitness room, and a six floor, 109 room hotel (NEI 2005). Following this expansion, the Silver Reef Casino was renamed the Silver Reef Hotel, Casino & Spa. A smaller expansion (Phase IV) of approximately 9,000 square feet occurred in 2008 to add gaming space and an additional restaurant. The Phase V expansion was additional parking only. The most recent expansion was completed in 2013 (Phase VI) and included the addition of 50,000 square feet of additional gaming area, a new restaurant, theater, and event center. In 2005, after the first expansion, the casino employed 382 workers of which 274 were full-time employees and 108 were part-time employees (NEI 2005). In 2007, after the addition of the hotel and spa, the casino employed 500 people (Werner 2007). By 2010, the Silver Reef Hotel, Casino & Spa employed 550 people; following the opening of the Phase VI expansion in 2013 there are 675 employees. Construction of a second hotel tower began during 2014. The LIBC operates a gas station and mini-mart adjacent to the Silver Reef Hotel, Casino & Spa.

Other employment opportunities for Reservation residents exist at the two oil refineries and the aluminum smelter just north of the Reservation and nearby in the communities of Ferndale and Bellingham. In 2004, 40.8 percent (131) of the 321 businesses licensed to operate on the Reservation were owned by enrolled tribal members (NEI 2005). These businesses included fireworks sales, food preparation and retail, wholesale, and trade businesses. In 2009, 249 businesses were licensed to operate on the Reservation according to the LIBC Accounting Department. These businesses range from large employers (Silver Reef) to long established fish buying and processing enterprises, trades, native arts, and food catering.

In 2011, the LIBC was the 10th largest employer in Whatcom County and the Silver Reef Casino was the 13th largest employer (WWU 2011). Most of the LIBC and Northwest Indian College (NWIC) employees are tribal members. In 2003, native employees made up 70 percent of LIBC staff (55 percent enrolled Lummi) and 61 percent of NWIC staff (33 percent enrolled Lummi) (Valz 2003). The LIBC provides community, administrative, education, and health services to the tribal population in order to help achieve the tribal economic and social development goals. These goals include job creation for tribal members, income generation to fund community development programs, and diversification and stabilization of the local economy by creating alternatives to fishing. Revenue generation is needed in order for the Lummi Nation to develop economic self-sufficiency.

In 1993, 56 percent of the 2,500 working-age Lummi tribal members were unemployed, under employed, full time students, or no longer seeking work (LIBC 1996). Since 1993, the combined effect of the decline in the fishery and the closure of the original casino have had a substantial negative impact on the Lummi economy. The BIA reported that the unemployment rate on the Reservation in 1999 was 21 percent (BIA 1999). Table 3.5 presents the results of a survey of 2,054, over the age of 18, enrolled tribal members conducted by the LIBC in 2003 (LIBC 2003). This survey indicates that 28 percent of adult tribal members are unemployed and up to 14 percent may be underemployed (part-time plus seasonally employed). In 2004, 74.6 percent of enrolled Lummi tribal members in Whatcom County ages 18 through 64 were employed and 15.9 percent were unemployed (NEI 2005).

Table 3.5 Employment Status of Lummi Tribal Members, 2003[1]

Employment Status	Number in Status	Percentage of Survey Individuals
Employed full-time	825	40.2
Employed part-time	156	7.6
Employed seasonally	133	6.5
Self-employed	84	4.1
Retired	127	6.2
Unemployed	567	28.0
Not available for employment	153	7.4

[1]2003 Lummi Tribal Survey, LIBC Statistics Office

4. SURFACE AND GROUND WATER RESOURCES

4.1. Surface Water Resources

The Lummi Nation is the largest fishing tribe in the Puget Sound in terms of pounds of fish landed and number of species fished (NWIFC 2012), and has relied on their water resources since time immemorial for ceremonial, subsistence, and commercial purposes. Surface waters in the study area include the Nooksack River, the Lummi River, sloughs, small streams, roadside and agricultural ditches, springs, wetlands, estuaries, and marine waters. The watersheds on the Lummi Indian Reservation are within HUC 171100040506 and HUC 171100020203. There are approximately 38 miles of marine shoreline surrounding the Reservation (except along portions of the east boundary and the northern boundary). The associated tidelands extend from the Georgia Strait, to Lummi Bay, Hale Passage, Portage Bay, and Bellingham Bay. In addition to marine waters, there are approximately 24.4 miles of rivers, streams, sloughs, and drainages on the Reservation including the multiple distributary channels of the Nooksack River Delta (Figure 4.1). There are no lakes on the Reservation, but there are approximately 13 ponds. Large numbers and a large variety of finfish and/or shellfish spawn, incubate, and grow within and adjacent to Lummi Nation Waters (LNR 2010a).

4.1.1. Rivers, Sloughs, Streams, and Ditches

There are eleven defined rivers, streams, sloughs, and drainages in the Lummi Bay and Bellingham Bay watersheds (Figure 4.1). Streams on the Reservation are classified as either Category 1 or Category 2 streams (LCL Title 17.06.080). Category 1 streams are all streams that flow year-round during years of normal rainfall or are used by juvenile or adult salmonids. Category 2 streams are all streams that are intermittent or ephemeral during years of normal rainfall and are not used by juvenile or adult salmonids. Of the eleven defined rivers, streams, sloughs and drainages, there are six Category 1 streams and five Category 2 streams on the Reservation. All other agricultural ditches and unnamed drainages are classified as Category 2 streams. As shown in Table 2.2, there are approximately 24.4 miles of streams, rivers, sloughs, and drainages on the Reservation. Jordan Creek, Lummi River, Smuggler’s Slough, Slater Slough, Schell Creek, Onion Creek, and Seapond Creek are included in the Lummi Bay watershed. The Bellingham Bay watershed is comprised of the Nooksack River, Kwina Slough, Lummi Shore Road streams, and Portage Island streams. Five streams, rivers, sloughs, and drainages are completely within the boundaries of the Reservation.

The Nooksack River drains most of western Whatcom County and currently flows through the Reservation close to its mouth and discharges to the marine water of Bellingham Bay near the eastern extent of the Reservation. The Nooksack River reach located on the Reservation is tidally influenced. Streamside levees are in place to protect agricultural lands from flooding and saline water. Several named sloughs, which are the remains of former river channels, have been incorporated into the agricultural drainage network built on the floodplain of the Lummi River and Nooksack River.

The Lummi River currently carries storm water runoff from the Ferndale upland as well as the drainage from a complex network of agricultural ditches in the floodplain. Tidal waters enter the Lummi River from Lummi Bay twice daily and, during the late dry season, saline water extends as far upstream as the northern Reservation boundary along Slater Road. Although Nooksack River water currently flows through a four-foot culvert into the Lummi River channel only during high-flow events (greater than approximately 10,000 cfs), available data indicate that the Lummi River flow was around 200 cfs as recently as June 1955 (WSDC 1964), when a four-foot culvert allowed fresh water to flow from the Nooksack River into the Lummi River channel (Deardorff 1992).

There are several mapped and previously unmapped streams on the Reservation. Most of the previously unmapped streams have poorly defined channels and contain surface flow only during the October through May period (wet season). The approximate locations of these streams were identified as part of the 1997 inventory of storm water facilities (LWRD 1997b). No flow in the streams was observed during a field survey of all Reservation streams in late August 1996.

Table 4.1 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's 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/ 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 the distributary channel lengths in the Nooksack River delta.

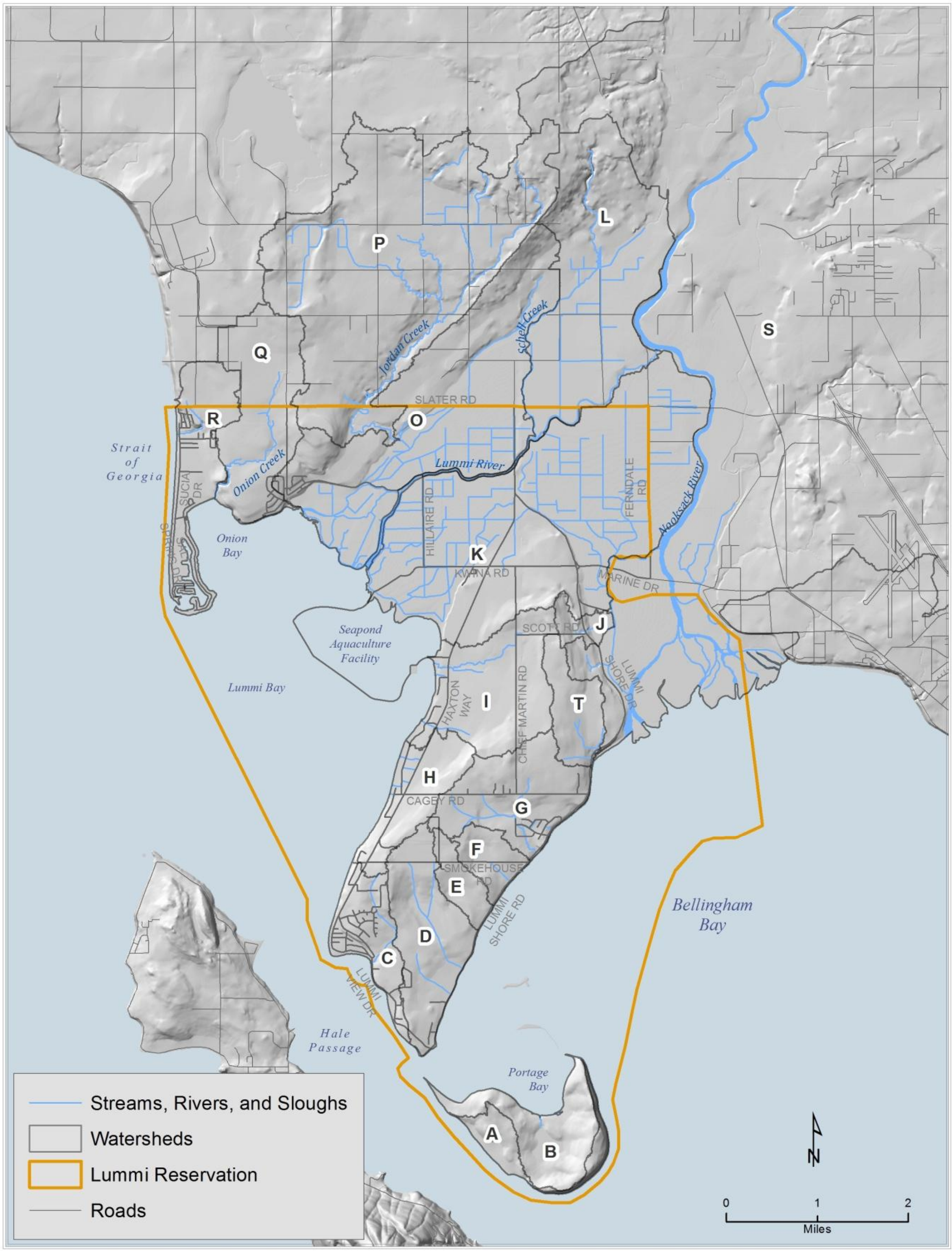

Figure 4.1 Lummi Indian Reservation Streams, Rivers, and Sloughs

4.1.2. Springs and Wetlands

Upland springs are found throughout the Reservation and are commonly ground water discharge zones for shallow, perched aquifers. A seep or spring occurs if the land surface intercepts the aquifer, and wetlands may occur at the seep or spring if conditions are favorable (e.g., clayey soils, shallow slope). In addition to upland springs, springs occur along the shoreline or below the ordinary high water line (vegetation line) at numerous locations on the Reservation.

Historically, springs emerging in the uplands served as a water supply for the Lummi people. In many cases, the springs are part of a wetland system in which the water reinfiltrates along the lower terraces to return to ground water. The springs are important for wildlife habitat and for aquifer recharge and protection. Upland aquifers, which provide the primary Reservation drinking water supply as well as water for salmon egg incubation and rearing in the hatchery program, have experienced depletion and saltwater intrusion. Where it occurs, the infiltration of fresh water above the shorelines provides a buffer against saltwater intrusion.

The 1999 comprehensive inventory of Reservation wetlands (Harper 1999, LWRD 2000) indicated that approximately 43 percent of the Reservation land area is either wetlands or wetland complexes. Wetland complexes are areas where wetlands and uplands form a highly interspersed mosaic. During the wetland inventory, boundaries were drawn around the outer edges of the mosaic of upland and wetland areas and the entire area was labeled as a "wetland complex". Consequently, the estimated total wetland area identified in the inventory represents more wetland area than actually exists. Approximately 60 percent of the floodplain on the Reservation was classified as wetlands or wetland complexes (Lynch 2001). An update to the 1999 wetlands inventory is currently underway. The update includes using Global Positioning System (GPS) technology to refine the locations and extent of all wetlands on the Reservation and collecting additional information on the functions and classifications of these wetlands. To date, approximately 256 wetlands and 3,400 acres of wetland area have been evaluated as part of the 1999 wetland inventory update (LWRD 2014a) (Figure 4.2).

Most of the once extensive floodplain wetlands of the Lummi and Nooksack rivers have been diked, drained, filled, and cultivated since the late 1800s. Low areas near some of the sloughs still reflect the rich and complex wetland habitat that likely covered most of the lower floodplain before human alteration. Small estuarine wetlands lie in sheltered, low energy areas at Onion Bay, Neptune Beach, Portage Island, the Lummi River floodplain, the Nooksack River delta, and adjacent to the Seaponds dike. Road construction and agricultural activity have altered the wetlands that are north of Marine Drive and adjacent to the Nooksack River. South of Marine Drive, many of the wetlands in the Nooksack River delta have been physically altered by the accumulation of sediment deposited by the Nooksack River as it discharged to the marine waters of Bellingham Bay. The Nooksack River delta was identified as the fastest growing delta relative to its basin size in Puget Sound, with a progradation of approximately one mile over the 1888 - 1973 period (Bortleson et al. 1980). Consequently, a large area that was once intertidal is now supratidal and new wetlands have been formed. In addition to the delta progradation, the wetlands of the Nooksack River delta

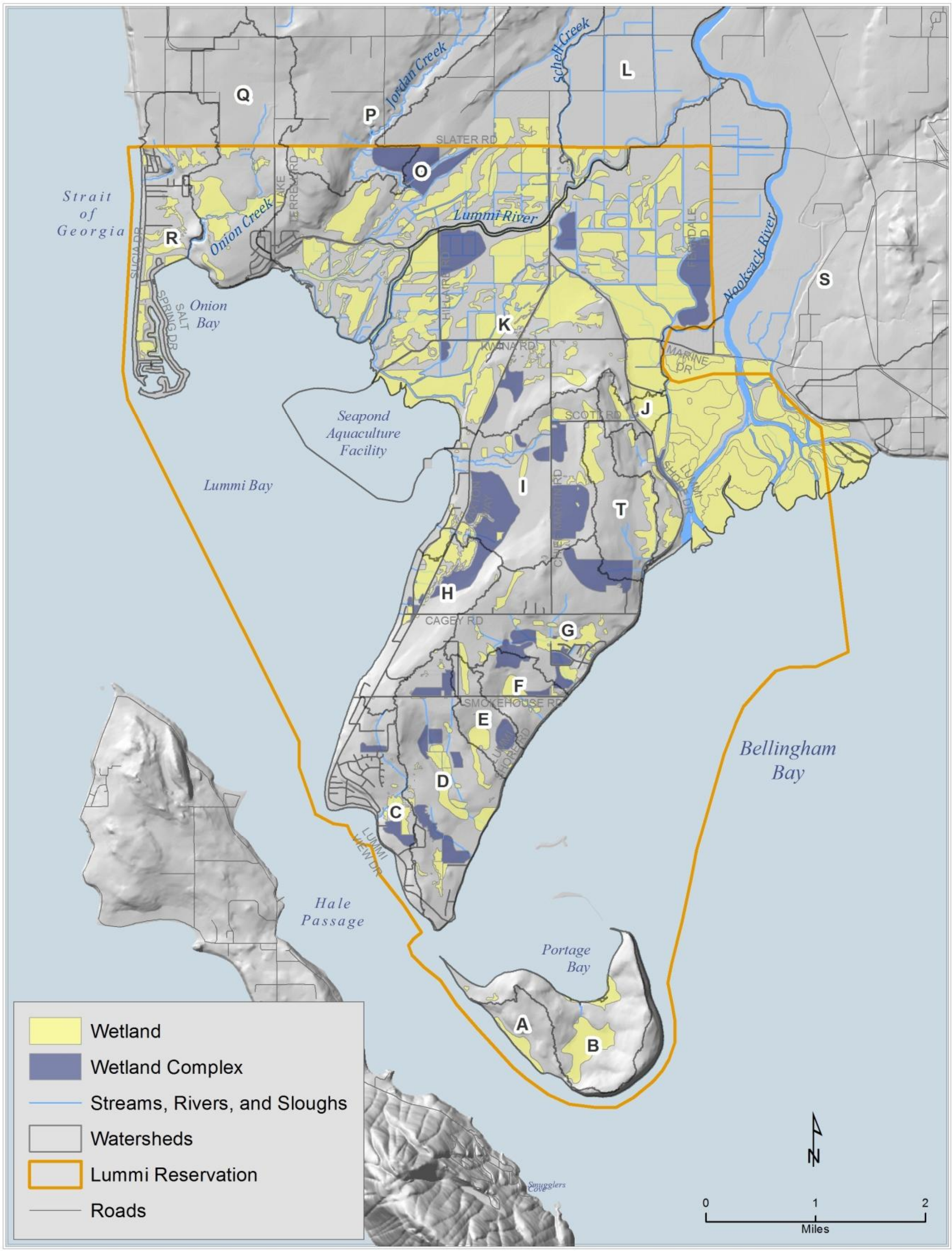

Figure 4.2 Lummi Indian Reservation Wetland Areas

are likely affected by the low instream flows and poor water quality that characterizes the river during some summer months.

The majority of the estuarine wetlands of the Lummi and Nooksack rivers will be protected and functionally improved in the future through the implementation of the Lummi Nation Wetland and Habitat Mitigation Bank. The mitigation bank is being developed in phases. Phase 1A, which encompasses most of the Nooksack River estuary, became operational during July 2012. The area is protected into perpetuity through a conservation easement and enhancement measures like invasive species control and under planting with conifers will improve the ecological functions of the estuary. The mitigation bank is used to mitigate unavoidable impacts to habitat and wetlands on the Reservation and within the mitigation bank service area, which extends off-Reservation (LWRD 2008b).

Remnants of what were once extensive, high-value wetlands are located on the Sandy Point Peninsula between Sucia Drive and the private Sandy Point marina. The private Sandy Point marina and its associated canal system were excavated in the 1960s from uplands that were periodically inundated by marine waters. Road construction, dense residential development and associated shore defense works, and drainage facilities now limit tidal inundation, but wildlife and wetland vegetation is abundant. Plants of traditional cultural significance have been identified in this area. Further north along Sucia Drive, formerly dry and seasonally wet areas are now permanently flooded as a result of road construction that blocked natural drainage.

These palustrine/estuarine emergent wetlands of the lowlands/floodplains are significant for storm water attenuation, floodwater storage, water quality enhancement, fish habitat, wildlife habitat, and for plants with traditional cultural importance. The estuarine wetlands provide critical rearing habitat for migrating salmon, herring, smelt, and other finfish and shellfish. The significance of these wetlands is increasing as wetlands upstream from the Reservation are altered and destroyed. These Reservation wetlands reduce the water quality impacts of off-Reservation land uses on Lummi commercial, ceremonial, and subsistence shellfish beds in Portage and Lummi bays. Protecting and enhancing floodplain and estuarine wetlands is essential to preserving and/or restoring interdependent fish, shellfish, and wildlife habitats in addition to reducing flood damage.

4.1.3. Marine and Estuarine Waters

Brackish estuarine waters grade to marine waters of the Reservation in Lummi Bay, Portage Bay, portions of Bellingham Bay and Hale Passage, and the shoreline along Georgia Strait. Saline water moves across tideflats and into the Lummi and Nooksack river channels twice daily with the tidal cycle. The salt water underlies the less dense fresh water and moves as a wedge upstream. Salt water has been measured upstream as far as Slater Road in the Lummi River and nearly to the fork between the west and east distributaries of the Nooksack River. Tidal effects on the water level (backwater effects) in the Nooksack and Lummi rivers have been observed even further upstream (and possibly occur as far upstream as Ferndale).

Estuarine waters of the Nooksack River and Lummi River deltas form the interface between marine and fresh water. Estuarine waters are important habitat for juvenile and adult salmon as they acclimate to either saline or fresh waters during their seaward and landward migrations, respectively. Estuaries also serve as habitat for juvenile and adult individuals of many other important aquatic species (LNR 2010a).

The complex and rich aquatic resources that provide feeding grounds for fish also attract a large variety of wildlife. The estuaries of the Lummi and Nooksack rivers are a part of a major Pacific Coast flyway for ducks, geese, swans, and shorebirds. These estuaries are also habitat for the peregrine falcon and bald eagle, both formally listed under the Endangered Species Act. Estuarine wetland ecosystems in general, including saltwater marshes, are considered among the most productive (in biomass production per unit area) natural ecosystems on earth. In addition to providing rearing habitat for juvenile salmonids and other species, these ecosystems export a large amount of biomass to estuaries. This biomass can form a large portion, sometimes the majority, of the base of the estuarine food web (Mitsch and Gosselink 1993). Small estuarine marshes in Lummi Bay occur in sheltered fringes of diked areas. As mitigation for wetland filling at the casino site at the Slater Road/Haxton Way intersection, a 17.1-acre saltwater marsh was restored along the waterway adjacent to the Lummi Bay seawall in August 2001.

Lummi Bay tideflats are extensive and rich in resources for tribal commercial, ceremonial, and subsistence purposes and as feeding areas for wildlife. Less extensive tideflats at Gooseberry Point, the Stommish Grounds, and Portage Bay are also important to the tribal economy and culture. A Lummi Intertidal Baseline Inventory (LIBI) was conducted in order to document the existing diversity, abundance, distribution, and habitats of the biological resources that are found on the Reservation tidelands. The LIBI integrates the results from six surveys that were conducted in 2008 and 2009 with compatible pre-existing information. Over 242 separate taxa were documented on the Reservation tidelands during the LIBI (LNR 2010a). In response to the Clean Water Action Plan, the Lummi Natural Resource Department developed and submitted a Unified Watershed Assessment (Appendix A) to the EPA. This large-scale assessment found the Nooksack River and the Georgia Strait watersheds to be Category 1 watersheds in need of restoration. The water quality data and information summarized below support this assessment.

4.2. Ground Water Resources

The hydrogeologic conditions on the Lummi Reservation have been described previously by the USGS and others (Washburn 1957, Cline 1974, Easterbrook 1973, Easterbrook 1976, Aspect Consulting 2003). This section will describe the Reservation geology and aquifers that shape the on-Reservation ground water resources.

4.2.1. Geology

The Reservation is underlain by unconsolidated sediments deposited as glacial outwash, glaciomarine drift, glacial till, and floodplain or delta deposits of Quaternary age (Washburn 1957). The unconsolidated deposits consist of clay, silt, sand, gravel, and boulders. Because the composition of the deposits commonly change laterally over short distances, it is difficult to distinguish between the different stratigraphic units from existing well log data. During the Pleistocene, the sea level rose and fell dramatically as the climate changed and the crust of the earth warped. Inundation by seawater caused the glaciers to float and deposit layers of clay, silt, sand, gravel, and boulders. After the glacier receded, the Nooksack River occupied an old channel formed by the glacial melt water and began depositing material on either side of the Lummi Peninsula (then an island). As the river delta grew, it connected the Lummi Peninsula to the mainland.

The sediment units that occur on the Reservation, as described by Cline (1974) and Easterbrook (1976) in order from youngest to oldest, are summarized below.

- **Alluvium:** The alluvium is derived from sediment carried by the Lummi River and Nooksack River and deposited on the floodplain. It is comprised mostly of clay, silt, sand, and some gravel.
- **Beach Deposits:** The beach deposits are laid by littoral drift processes. The deposits are mostly sand with some gravel and occur mainly at the western part of the Reservation from Neptune Beach to Sandy Point and at Gooseberry Point.
- **Older Alluvium:** The older alluvium was deposited by the Lummi River and Nooksack River when the valley floor was relatively higher than at present. The unit consists mostly of fine sand with some silt and clay located on stream terraces flanking the uplands above the floodplain. These deposits occur along the southeast flank of the Mountain View Upland and the northeast flank of the Lummi Peninsula.
- **Gravel:** A thin unsaturated gravel unit is exposed at the surface at several locations on the Reservation. The unit consists of gravel and sand/gravel. In places, this unit appears to have been reworked by beach processes during post-glacial uplift and overlies glaciomarine drift.
- **Glaciomarine Drift:** The Glaciomarine Drift unit was deposited late in the Fraser Glaciation (from about 20,000 years ago to about 10,000 years ago [Easterbrook 1973]). The drift is comprised of unsorted clay, silt, sand, gravel, and some cobbles and boulders. The deposits include both Kulshan and Bellingham drifts.
- **Glacial Till:** The glacial till from the Vashon Stade of the Fraser Glaciation is comprised of poorly sorted clay, silt, sand, gravel, and some cobbles and boulders. Because the presence of till is noted in only a few well logs and has been observed at only a few locations along the Lummi Peninsula bluffs, the occurrence of till is believed to be limited.
- **Esperance Sand:** The Esperance Sand unit (Easterbrook 1976), formerly named Mountain View Sand and Gravel, is advance outwash comprised of stratified beds of sand and gravel with stratified lenses of sand. The unit overlies the Cherry Point Silt unit and underlies the glaciomarine drift and till; it is the major water-yielding unit beneath the Reservation.
- **Cherry Point Silt:** The Cherry Point Silt unit is the oldest known unconsolidated stratigraphic unit in the northern Puget Sound lowland. The unit is comprised of a thick sequence of blue to brownish gray stratified clay and silt with minor sandy beds.
- **Bedrock:** The Bedrock underlying the Reservation consists mostly of sedimentary rocks such as sandstone, siltstone, shale, and conglomerate. The Bedrock is deeply buried by unconsolidated glacial deposits.

4.2.2. Reservation Aquifers

Ground water in the Reservation aquifers is obtained primarily from outwash deposits of sand and gravel in the unconsolidated glacial sediments, which are generally recharged by local precipitation. Glaciomarine drift is at or near the ground surface over much of the upland areas of the Reservation. The glaciomarine drift overlays the outwash deposits and contains substantial amounts of clay. This clay restricts the recharge to the underlying aquifer and promotes storm water runoff.

Two separate potable ground water systems occur on the Reservation. One system is located in the northern upland area. This northern system flows onto the Reservation from the north and drains to the west, south, and east (Aspect Consulting 2009). The second potable ground water system is located in the southern upland area of the Reservation (Lummi Peninsula) and is completely contained within the Reservation boundaries (LWRD 1997a, Aspect Consulting 2003, LWRD 2011b). The floodplain of the Lummi River and Nooksack River, which contains a surface aquifer that is saline (Cline 1974), separates the two potable water systems. A third potable water system may exist on Portage Island, but information on the water quality and the potential yield of this system is limited and inconclusive. Figure 4.3 summarizes the ground water characteristics of the Lummi Indian Reservation.

In general, both the northern and southern ground water systems contain two aquifer types (Washburn 1957, Easterbrook 1976). The upper aquifer type is comprised primarily of lenses of sand or sand and gravel that are in or above the glaciomarine drift. These relatively permeable lenses are not continuous throughout the area. The lower aquifer layer is comprised of advance outwash sand and gravel. The thickness of the lower aquifer, which appears to be semi-confined in places and unconfined in other places, is variable and generally not known. The pebbly clay in the drift sediments and scattered deposits of till greatly slow the downward percolation of water to the lower aquifer and may act locally as a confining layer.

Because the hydrogeologic conditions on the Reservation vary considerably over short distances, the precise locations of the aquifer recharge zones are not definitively known at this time. It is likely that aquifer recharge areas are distributed over the upland areas. However, given the high runoff potential of the glaciomarine drift that covers much of the Reservation upland, it is also possible that aquifer recharge areas are of limited areal extent and are located primarily in only a few locations around the Reservation. Until more precise information is developed, all of the northern and southern upland areas on the Reservation are assumed to be aquifer recharge zones.

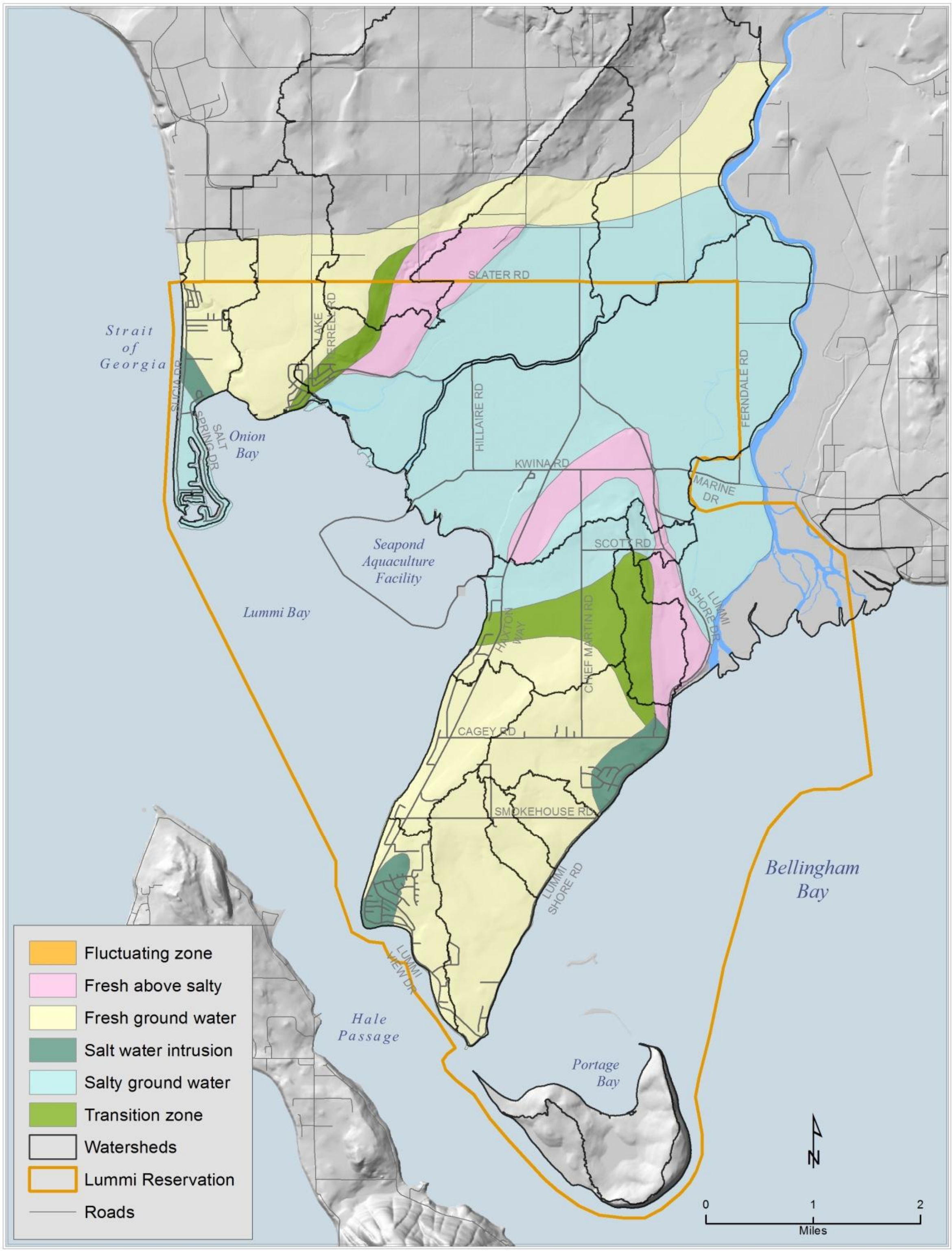

Figure 4.3 Lummi Indian Reservation Ground Water Characteristics

Table 4.2 Watershed Characteristics

			Hydrologic Soil Group						Land Use/Land Cover[3]								
Basin ID	Drainage Area (acres)	Receiving Water Bodies	Group A (%)	Group B (%)	Group C (%)	Group D (%)	Number of Storm Water Facilities[2]	Number of Ground Water Wells	Water (%)	Coniferous and Mixed Forest (%)	Deciduous Forest (%)	Scrub/ Shrub (%)	Grasses and/or Agricultural (%)	Fallow Fields/ Exposed Soils (%)	Urban, Residential, Industrial (%)	Wet land (%)	Other (%)
A	280	Bellingham Bay, Hale Passage	4.9	63.9	20.6	10.6	0	0	0.0	52.4	14.1	2.4	8.5	1.0	0.0	19.0	2.6
B	617	Portage Bay, Hale Passage	2.9	71.5	8.6	17.0	0	1	1.9	59.3	5.3	0.2	3.0	0.8	0.0	29.2	1.1
C	494	Hale Passage, Lummi Bay	13.4	47.8	29.6	9.2	15	39	0.1	32.2	22.0	3.1	6.7	0.7	31.9	4.2	2.2
D	894	Portage Channel, Bellingham Bay	0.4	3.7	75.7	20.2	21	32	0.0	40.6	41.7	2.0	5.6	0.3	6.1	3.1	0.5
E	218	Bellingham Bay	0.0	0.0	90.6	9.4	4	7	0.0	25.9	51.7	5.4	6.7	0.6	8.8	0.8	0.2
F	251	Bellingham Bay	0.0	0.0	64.4	35.7	8	6	0.1	24.8	56.9	7.0	9.0	0.3	9.6	10.1	0.4
G	883	Bellingham Bay	0.0	1.1	79.4	19.5	19	17	0.0	16.9	60.4	5.0	7.5	0.0	5.4	9.0	0.3
H	549	Lummi Bay	0.0	14.7	55.9	29.5	16	27	0.1	15.6	67.8	2.7	3.1	0.0	4.8	4.5	1.4
I	1,059	Lummi Bay	0.4	1.5	45.1	53.0	12	17	0.0	23.3	61.7	5.9	1.3	0.0	2.2	5.5	0.2
J	134	Nooksack River Floodplain	0.0	0.0	56.9	43.0	4	3	0.3	24.0	35.2	1.4	2.0	0.0	3.1	33.5	0.4
K	4,091	Bellingham and Lummi Bays	0.0	0.4	31.4	68.2	65	28	0.0	3.9	17	1.0	48.7	0.1	4.4	24.8	0.1
L	2,306	Lummi River, Lummi Bay	0.0	2.5	67.5	30.0	7	24	0.1	1.7	3.7	0.4	49.2	1.7	37.0	7.7	0.2
O	2,747	Lummi Bay	4.6	5.9	28.0	61.5	29	11	0.0	9.8	9.6	3.9	52.6	0.0	6.0	18.2	0.0
P	4,097	Lummi Bay	0.8	8.5	55.0	35.7	4	61	0.1	4.8	10.6	2.2	57.8	0.0	8.2	16.4	0.0
Q	1,096	Onion and Lummi Bays	1.0	4.0	57.5	37.5	19	22	0.0	21.0	39.0	0.6	8.6	0.0	24.4	5.7	0.2
R	722	Lummi Bay and Georgia Strait	18.9	0.4	40.4	40.3	24	41	1.1	9.2	28.8	2.7	8.8	0.0	28.1	15.5	5.9
S	548,800	Bellingham and Lummi Bays	ND[1]	ND[1]	ND[1]	ND[1]	8	15	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]
T	393	Bellingham Bay	0.0	2.7	57.8	39.5	2	4	0.0	38.8	45.9	10.4	0.8	0.0	0.2	9.0	0.0

[1] ND = Not Determined
[2] Storm water facilities (culverts, catch basins, bridges) inventoried on-Reservation only.
[3] Land uses/land cover types largely estimated from 2006 NOAA database, Classification of Coastal Washington, which is part of the Coastal Change Analysis Program (CCAP of the NOAA Coastal Service Center).

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5. RESULTS

In response to the Clean Water Action Plan, the Lummi Natural Resources Department developed and submitted a Unified Watershed Assessment (Appendix A) to the EPA. This large scale assessment found the Nooksack River and the Georgia Strait watersheds to be Category 1 watersheds in need of restoration. The water quality data and information summarized below support this assessment.

5.1. Surface Water Quality

Water quality on the Reservation is complex for several reasons. The Reservation consists of approximately 38 miles of marine shoreline and 7,000 acres of tidelands. It is located in the estuaries of the Lummi River and the Nooksack River where marine and fresh water interact; the water column may have varying degrees of salinity based stratification. In addition, water can flow upstream, downstream, or stagnate at many of the water quality sampling sites depending on the tides and weather conditions. Upland sites become saline or dry during the summer months as the dry season progresses. Once the wet season begins during October or November, upland flow increases, diluting many of the saline monitoring sites with fresh water.

Table 5.1 and Table 5.2 present assessments of the 2011 water quality data collected monthly in the Lummi Bay and Bellingham/Portage Bay watersheds. None of the waters in the Lummi Bay watershed and the Bellingham/Portage Bay watershed supported their designated uses during 2011 because of low dissolved oxygen levels, increased temperatures, pH exceedences, increased fecal coliform densities, and/or increased enterococcus densities. The primary source of these impairments in the Lummi Bay watershed is off-Reservation agricultural practices. In the Bellingham/Portage Bay watershed, pH exceedences, fecal coliform bacteria and enterococcous were the most common causes of waters not supporting their designated use. Although fecal coliform levels are elevated for many of the on-Reservation streams that discharge to Bellingham and Portage Bay, these small streams are characterized by seasonal and low volumes of flow that are not capable of changing the salinity or fecal coliform densities of the receiving marine water body. Although fecal coliform levels for the Nooksack River achieved the water quality standards during 2011, these relatively lower levels have not been maintained and more recent water quality data indicate that the fecal coliform standards for the Nooksack River are exceeded. Off-Reservation agricultural land uses are the major source of high fecal coliform densities, particularly the Nooksack River watershed, which drains the majority of the agricultural lands in lower Whatcom County.

The LWRD sampling program results indicate that water quality is generally more degraded at the sample stations further inland, and gradually improves downstream towards the marine waters on the Reservation. The Lummi River watershed (Watersheds K, L and O together) continues to have the poorest water quality of the sites sampled on the Reservation whereas the marine waters of Lummi Bay continues to maintain relatively good water quality. The temperature exceedences in Lummi Bay are due to naturally occurring conditions associated with the tideflats that are de-watered twice daily with the tidal cycle. Sampling of the

Nooksack River (Watershed S) indicated variable water quality with elevated readings during 2011 that remain a cause of concern despite observed improvements compared to the 2003 to 2007 period. During 2011, the achievement of the fecal coliform water quality standards and TMDL goals in the Nooksack River where it flows onto the Reservation and the decreasing levels of fecal coliform bacteria in Bellingham/Portage Bay were interpreted as signs that technical assistance and enforcement actions in the Nooksack River Basin were helping to improve the water quality. However, as described previously, these improving water quality trends were reversed during 2013 and 2014, which led the Lummi Nation to voluntarily close 335 acres of Portage Bay shellfish beds to harvest during September 2014. The water quality in Portage Bay continued to deteriorate through 2014 resulting in additional sampling stations no longer attaining the NSSP standards. In consultation with the Lummi Nation, the Washington Department of Health issued an administrative order on March 19, 2015 that conditionally closed 496 acres of shellfish growing areas. Harvest of shellfish in these growing areas is prohibited from April through June and from October through December.

The continuing poor water quality in the Lummi River and tributaries to Lummi Bay, particularly with respect to increased fecal coliform bacteria contamination, is a major concern due to the potential for new closures of important tribal shellfish beds. The members of the Lummi Nation harvest these shellfish beds for ceremonial, subsistence, and commercial purposes.

The water quality measured on the Reservation during 2011 is summarized below for the geographic areas: Portage/Bellingham Bay and the contributing environs, the marine waters of Lummi Bay and the Sandy Point Marina, the estuarine waters of the Lummi River watershed, and freshwater streams. A more comprehensive discussion of the surface waters of the Reservation and the 2011 surface water sampling data can be found in the 2011 Lummi Nation Water Quality Assessment Report, which can be downloaded from the following website: http://lnnr.lummi-nsn.gov/LummiWebsite/Website.php?PageID=56. Ground water quality and Nooksack River water quality are also discussed in the 2011 Water Quality Assessment Report (LWRD 2014c). Similar annual assessment reports for data collected during 2012, 2013, and 2014 are under preparation. Although the annual assessment reports have not been completed yet, all data collected in the Lummi Surface and Ground Water Quality Monitoring Program is stored in the Water Quality Monitoring Database or the Continuous Data Management System Database and are exported to the EPA's Water Quality Exchange Network (WQX) annually. All water quality data collected through 2014 have been exported to STORET.

5.1.1. Bellingham/Portage Bay and the Contributing Environs

As shown in Table 3.1 and Figure 3.3, the on-Reservation contributing area to Bellingham Bay/Portage Bay is essentially half of the on-Reservation contributing area to Lummi Bay. Approximately 40 percent of the sampling stations in the LWRD Surface Water Quality Monitoring Program are in the vicinity of Bellingham Bay or in areas that contribute water to Bellingham Bay. These locations include the Nooksack River, Kwina Slough, local storm water from Portage Island, the Hermosa Beach area, and marine waters. Water quality monitoring has indicated that contributions of fecal coliform bacteria from the Reservation uplands surrounding Bellingham Bay are not significant (LWRD and Salix Environmental

2006), but that there are nonpoint sources that need to be addressed (e.g., discharges with high fecal coliform counts but low volumes of flow). The Nooksack River water quality (including Kwina Slough, a distributary of the Nooksack River) was generally good during 2011, but there were several occurrences of high densities of fecal coliform bacteria including *Escherichia coli* (*E. coli)*. As noted above, the Nooksack River water quality deteriorated after 2011 and resulted in a closure of 335 acres of Lummi shellfish beds to ceremonial, subsistence, and commercial harvest during September 2014. Water quality in Portage Bay continued to deteriorate through 2014 resulting in additional sampling stations no longer attaining the NSSP standards. In consultation with the Lummi Nation, the Washington Department of Health issued an administrative order on March 19, 2015 that conditionally closed 496 acres of shellfish growing areas. Harvest of shellfish in these growing areas is prohibited from April through June and from October through December.

Table 5.1 Extent Lummi Bay Waters Meet Lummi Water Quality Standards and Designated Uses are Supported During 2011

Location		Dissolved Oxygen (mg/L) Assessment	Temperature (°C) Assessment	pH Assessment	Fecal Coliform Bacteria (cfu/100ml) Assessment	Enterococcus (cfu/100ml) Assessment	Full Support
LUMMI BAY WATERSHED	**Jordan Creek**						**NO**
	SW010	X	X	X	X	X	
	SW011	X	•	X	X	X	
	SW003	X	X	X	X	X	
	SW053	X	X	X	X	X	
	Lummi River						**NO**
	SW009	X	•	•	X	X	
	SW008	X	X	X	X	X	
	SW013	X	X	•	X	X	
	SW051	X	X	X	X	X	
	SW055	X	X	X	X	•	
	SW058	X	•	•	X	X	
	Smuggler's Slough						**NO**
	SW072	X	X	X	•	X	
	SW015	X	X	X	•	X	
	SW059	X	X	X	X	X	
	SW056	X	X	•	X	X	
	Schell Creek						**NO**
	SW012	X	•	X	X	X	
	Onion Creek						**NO**
	SW014	X	X	X	X	X	
	Seapond Creek						**NO**
	SW029	X	•	X	X	X	
	East Reservation Boundary						**NO**
	SW016	X	•	•	X	X	
	SW017	X	X	•	•	•	
	Sandy Point Channel						**NO**
	SW001	•	X	X	•	•	
	SW019	X	X	•	•	X	
	Lummi Bay						**NO**
	SW002	•	X	•	•	•	
	SW022	X	X	X	•	•	
	SW052	•	X	X	•	•	
	DH038	•	X	•	•	N/A	
	DH039	•	X	•	•	N/A	
	DH040	•	X	•	•	N/A	
	DH041	•	X	•	•	N/A	
	DH042	•	X	•	•	N/A	
	DH043	•	X	•	•	N/A	
	DH044	•	X	•	•	N/A	
	DH045	•	X	X	•	N/A	
	DH285	•	X	•	•	N/A	
	DH286	•	X	X	•	N/A	
	DH287	•	X	•	•	N/A	
	DH288	•	X	X	•	N/A	

X **= standard not achieved**; • **= standard achieved**; N/A **= Not determined**

Table 5.2 Extent Bellingham/Portage Bay Waters Meet Lummi Water Quality Standards and Designated Uses are Supported During 2011

	Location	Dissolved Oxygen (mg/L) Assessment	Temperature (°C) Assessment	pH Assessment	Fecal Coliform Bacteria (cfu/100ml) Assessment	Enterococcus (cfu/100ml) Assessment	Full Support
BELLINGHAM BAY WATERSHED	**Nooksack River**						**NO**
	SW118	**X**	•	**X**	•	**X**	
	Kwina Slough						**NO**
	SW007	**X**	•	**X**	•	**X**	
	Lummi Shore Road Watersheds						**NO**
	SW031	•	•	**X**	•	**X**	
	SW032	•	**X**	**X**	**X**	•	
	SW033	**X**	•	**X**	**X**	**X**	
	SW034	•	**X**	**X**	**X**	•	
	SW035	**X**	•	**X**	**X**	**X**	
	SW036	•	**X**	**X**	**X**	**X**	
	SW037	**X**	•	•	**X**	**X**	
	SW038	•	**X**	**X**	**X**	**X**	
	SW039	•	**X**	**X**	•	•	
	Portage Island						**NO**
	SW026	**X**	•	•	**X**	**X**	
	SW027	**X**	•	•	**X**	**X**	
	SW028	**X**	**X**	•	**X**	**X**	
	Portage Bay						**NO**
	SW006	•	**X**	**X**	•	•	
	SW023	•	**X**	•	•	•	
	SW030	•	**X**	**X**	**X**	•	
	DH049	**N/A**	•	**N/A**	•	**N/A**	
	DH050	**N/A**	•	**N/A**	•	**N/A**	
	DH051	**N/A**	•	**N/A**	•	**N/A**	
	DH052	**N/A**	•	**N/A**	•	**N/A**	
	DH053	**N/A**	•	**N/A**	•	**N/A**	
	DH054	**N/A**	•	**N/A**	•	**N/A**	
	DH055	**N/A**	•	**N/A**	•	**N/A**	
	DH057	**N/A**	•	**N/A**	•	**N/A**	
	DH058	**N/A**	•	**N/A**	•	**N/A**	
	DH271	**N/A**	•	**N/A**	•	**N/A**	
	DH272	**N/A**	•	**N/A**	**X**	**N/A**	

X = standard not achieved; • = standard achieved; **N/D** = Not determined

Along the Lummi Peninsula nearshore areas of Bellingham Bay, storm water during the onset of the wet season typically contains elevated fecal coliform bacteria levels, but flows are very low. By the time the flows increase, fecal coliform bacteria levels are substantially reduced. Intensive shoreline sampling over the 1998 through 2001 period demonstrated that local sources of fecal coliform bacteria are not a significant source of fecal contamination to Portage Bay (LWRD 1999, LWRD and Salix Environmental 2006). Small fresh water streams on Portage Island contain elevated fecal coliform bacteria levels, but as described above, flows are very low and do not appear to be a significant source of fecal contamination to Bellingham Bay. Approximately 63 head of feral cattle lived on Portage Island as of June 2008. The cattle on Portage Island may have contributed to the fecal coliform bacteria contamination of surface waters on the island discharging into Portage Bay. The LIBC hired a contractor to remove the cattle from Portage Island due to the potential contamination of shellfish beds and decreased water quality. The cattle were largely removed by February 2012.

5.1.2. Lummi Bay and Sandy Point Marina

Water quality in Lummi Bay and the Sandy Point Marina (SW001, SW002, SW0019, SW022, and DOH sites) was relatively good. Fecal coliform densities were low and salinities were high. All water quality sample sites in Lummi Bay met Lummi Water Quality Standards for fecal coliform and enterococcus. None of the sample sites met the water quality standards for water temperature. Most of the exceedances are caused by the naturally occurring condition where the tideflat is exposed to full sunlight in the summer. High dissolved oxygen levels were also found in Lummi Bay and the Sandy Point Channel. In Lummi Bay, air entrapment, primary production, and rapid heating are likely occurring and contributing to elevated dissolved oxygen values. Within the Sandy Point Marina, testing of the water column for selected metals showed that zinc was detectable in the water column and that copper was detectable once.

5.1.3. Estuarine Waters of the Lummi River Watershed

The estuarine waters of the Lummi River watershed (see Table 5.1) are quite variable because of freshwater, marine, and/or tidal influences. The waters can be fresh, saline, stratified, or well mixed; the waters can be flowing downstream, flowing upstream, or slack. However, most of the stations become saline by the end of the summer dry period or became completely dry. The quality of these waters is poor. Land use practices in the Lummi River watershed are likely the primary cause of the elevated bacteria levels, elevated temperatures, and depressed dissolved oxygen levels in the surface waters along the Reservation boundary. Bacteria densities generally decreased after the onset of the rainy season, although several stations (e.g., SW008, SW009, and SW012) had chronically elevated bacteria levels. There appears to be substantial die-off of bacteria between the northern Reservation boundary (along Slater Road) and Lummi Bay. There are too few nutrient samples (SW003, SW009, and SW015) to provide insight into the nutrient dynamics of the area.

Many sites exceed water temperature criteria during the summer months. These exceedences in the Lummi River watershed are likely due to human caused factors such as the removal of riparian shade and/or drainage alterations that decrease the amount of ground water available to moderate surface water temperatures in the summer. The extent to which anthropogenic influences have contributed to elevated water temperatures at the various sample sites has not been established. Similar to temperature, there are places where extremely low dissolved oxygen values could be due to naturally occurring conditions (e.g., an area without shade where the streambed is in the photic zone and flows are generally low to stagnant). At sites where human created or induced changes occurred (e.g., clearing of vegetation, drainage of ground water, increased nutrient loading), the extremes of dissolved oxygen variation have likely been increased due to the human activity setting the stage for increased primary production. Similarly, high bacteria densities, often created by anthropogenic activities, can cause drops in dissolved oxygen concentrations as the bacteria consume oxygen while metabolizing. The extent to which anthropogenic influences have contributed to depressed dissolved oxygen levels at the various sample sites has not been quantified.

5.1.4. Freshwater Streams

Only five sample sites (SW011, SW014, SW016, SW017, and SW029) are located in non-tidally influenced reaches of streams on the Reservation. All of these streams cease flowing during the dry season. Bacteria counts at these sites increase during the onset of surface water flow, and in general, decrease over time as the rainy season progresses. In a few instances elevated bacteria densities were found during the spring and summer. Only Sample Site SW029 met the Lummi Water Quality Standard for temperature during 2011. Sample Site SW029 (Seaponds Creek) watershed drains a forested wetland in a relatively undeveloped portion of the Reservation.

5.1.5. Nooksack River Watershed

Various federal, tribal, state, and local programs monitor water quality in the Nooksack River watershed. In its 1998 and 2008 303(d) list of impaired waters, the Washington State Department of Ecology listed segments of the Nooksack River and/or its tributaries as impaired by fecal coliform bacteria, high temperature, fine sediment, low instream flow, low dissolved oxygen, pH, and/or ammonia (Ecology 2000a, Ecology 2009). All listings were due to failures to meet Washington State Class A water quality standards or other specific criteria.

5.2. Ground Water Quality

Because the Reservation is located in a coastal area and most of the existing water supply wells are within a half-mile of marine waters, saltwater intrusion is a major threat to the ground water resources of the Lummi Nation. Available evidence suggests that the fresh ground water resources underlying the Reservation consist of a lens that overlies salt water (LWRD 1997a, Aspect Consulting 2003, LWRD 2011b). These conditions indicate that protection is required for both vertical and lateral migration of seawater. Several public water supply wells in the Gooseberry Point area have been closed because of progressive saltwater intrusion induced by overpumping of nearshore wells.

The Lummi Tribal Water District wells in the Gooseberry Point water system met all EPA drinking water quality parameters. The Lummi Tribal Water District wells in the Red River Road/Lake Terrell Water System met all but one of the EPA safe drinking water quality parameters. The Lummi Tribal Water District violated the maximum contaminant level for Arsenic (LTSWD 2011b). Arsenic occurs naturally in rocks and soil, water, air, plants, and animals. It can be further released into the environment through natural activities such as volcanic activity, erosion of rocks, forest fires, or through human actions. The Lummi Tribal Water District believes the source of arsenic is from natural deposits in the aquifer. The Lummi Tribal Water District conducted an arsenic study funded by the Indian Health Service to better characterize the type of arsenic involved and the types of treatment that will be cost effective in order for these wells to gain compliance with EPA drinking water quality parameters. Construction of the Arsenic Treatment Plant was completed in 2013. The ground water found in numerous other areas on the Reservation, especially the Nooksack River and Lummi River floodplains, is too saline for most uses.

The primary sources of variability are seasonal changes (i.e., wet season and dry season) and pumping regimes (which are typically related to season). This variability is addressed through frequent sampling (sub-monthly to monthly), performing multiple well water level measurements during sampling at each well, and recording the pumping rate, totalizer values, and pump status of the well at the time of measurement. Water quality is generally stable in the wells.

In summary, Table 5.3 lists the categories and subcategories of NPSP sources that occur in each of the 18 Reservation watersheds. Consistent with the watershed descriptions given above in Section 4.3, Table 5.3 shows that watersheds C, G, K, L, O, Q, R, and S support the largest amounts of activities that can create NPS pollution.

5.3. Types and Impacts of Nonpoint Source Pollutants

This section describes the main types of NPS pollution and many of the actual and potential impacts on Reservation waters of these pollutants. These impacts may be acute (sudden and/or high intensity) or chronic (long-term and/or low intensity) in nature. In addition, while the individual impacts of each type of pollutant are described below, it is important to note that these pollutants likely have combined impacts on water quality and biotic communities. Although the individual impact of each pollutant may not be significant, the combined and cumulative impacts of all pollutants could, for example, make stream habitats unsuitable for rearing salmonids, make shellfish beds unsuitable for harvest, or make ground water unusable for drinking water.

5.3.1. Bacteria/Pathogens

Fecal coliform bacteria are indicators of the presence of pathogens and therefore of the sanitary quality of water. Human health can be affected by exposure to pathogens through either direct contact or ingestion of contaminated water or shellfish. When fecal coliform levels in the waters over shellfish beds exceed the National Shellfish Sanitation Program (NSSP) criteria, the shellfish growing beds are closed to commercial, ceremonial, and subsistence harvest. Approximately 220 acres of tribal shellfish beds in Portage Bay were closed by the Lummi Nation and the Washington Department of Health from November 1996 to May 2006 due to bacterial contamination that exceeded the NSSP criteria. The fecal coliform contamination was attributed primarily to poor dairy nutrient management practices in the Nooksack River watershed (DOH 1997, Ecology 2000a).

In its 1998 303(d) list of impaired waters, Ecology listed Bellingham Bay, the Nooksack River, and the Lummi River (upstream of the Reservation boundary) as impaired by fecal coliform bacteria (Ecology 2000a). Thirty-nine segments of 16 Nooksack River tributaries were also listed as impaired by bacteria. To address these listings, Ecology prepared a total maximum daily load (TMDL) evaluation for bacteria on the lower Nooksack River. The TMDL required reducing bacterial loads at the mouth of the Nooksack River by 48 percent and in Nooksack River tributaries by up to 98 percent (Ecology 2000a). The Washington State Department of Ecology found that sub-basins with a high density of dairies, animal feeding operations, and manure-sprayed fields delivered significant bacteria loads to the Nooksack River. The Bertrand Creek and Fishtrap Creek watersheds have land uses that are dominated by dairy operations and together accounted for 44 percent of the fecal coliform load in the lower Nooksack River (Ecology 2000a). The DOH identified agricultural wastes in the Nooksack River basin as the only high probability source of fecal coliform bacteria to Portage Bay (DOH 1997). The Portage Bay Closure Response Team identified improper dairy waste management as the largest potential contributor of fecal coliform pollution in the Nooksack River watershed (WCD 1998). Other potential sources of fecal coliform bacteria include on-site septic systems, storm water runoff from residential areas, municipal wastewater treatment effluent, and wildlife (DOH 1997).

Following the initial and subsequent downgrades of tribal shellfish beds in Portage Bay, in addition to the EPA enforcement actions, several federal, tribal, and state agencies and numerous individuals took a variety of steps to address identified pollutant sources (not all of which were related to agricultural activities). The three key actions that led to the improvement of water quality were: (1) technical and financial assistance (in excess of $8 million) to the dairy industry, private land owners, and municipalities that discharge wastes to the Nooksack River; (2) compliance inspections to enforce provisions of the federal Clean Water Act; and (3) water quality monitoring to identify pollution sources and monitor improvements. These three key actions, along with interagency collaboration, resulted in a reclassification of approximately 75 percent of the “Restricted” shellfish growing beds in Portage Bay to “Approved” status in November 2003 and the reclassification of all of the shellfish growing areas in Portage Bay as “Approved” in May 2006 – nearly 10 years after the initial closure.

Unfortunately these three key actions have not continued at the levels that existed prior to 2003 and water quality sampling results indicate that current animal waste management practices are not effectively reducing fecal coliform contamination in the Nooksack River watershed. Water quality sampling results during 2014 initially caused three of the Portage Bay sampling stations to no longer achieve the NSSP standards. As a result, the Lummi Nation voluntarily closed approximately 335 acres of Portage Bay shellfish growing area to ceremonial, subsistence, and commercial harvest during September 2014. However, water quality in Portage Bay continued to deteriorate through 2014 resulting in additional sampling stations no longer attaining the NSSP standards. In consultation with the Lummi Nation, the Washington Department of Health issued an administrative order on March 19, 2015 that conditionally closed 496 acres of shellfish growing areas. Harvest of shellfish in these growing areas is prohibited from April through June and from October through December.

Substantial dairy operations also occur in the Lummi River watershed, including two of the farms cited by the EPA for fecal coliform contamination of surface waters. In its 2008 303(d) list of impaired waters, Ecology listed the Lummi River (upstream of the Reservation boundary) as impaired by fecal coliform bacteria (Ecology 2009). Though its tributaries frequently fail to meet Lummi Water Quality Standards for bacteria, Lummi Bay is not currently impaired by fecal coliform bacteria based on the DOH monitoring under the Shellfish Consent Decree (Order Regarding Shellfish Sanitation, *United States v. Washington [Shellfish]*, Civil Number 9213, Subproceeding 89-3, Western District of Washington, 1994). Under this decree, the DOH is responsible to the federal Food and Drug Administration [FDA] to ensure that the NSSP standards for certification of shellfish growing waters are met on the Reservation. However, elevated fecal coliform bacteria levels in both the Portage Bay and Lummi Bay tributaries is a major concern. In addition, if the Lummi River is re-established as a distributary of the Nooksack River and the density of fecal coliform bacteria in the Nooksack River is not reduced, the approved status of Lummi Bay for the commercial harvest of shellfish could be downgraded.

5.3.2. Fine Sediment

Increased loads of fine sediment in streams can result in decreased growth and survival of fish through reduced feeding efficiency, diminished food sources, smothering of eggs, and reduced habitat availability and complexity. Reduced survival-to-emergence for salmonids due to the deposition of fine sediments in streambeds is of particular concern because it is a source of density-independent mortality that can have very significant negative effects on salmon populations (CRITFC 1994). Increased concentrations of fine sediment also increase the amount of treatment necessary for drinking water because of the color and texture of the water as well as the ability of pollutants (e.g., bacteria, metals, pesticides, nutrients, and petroleum hydrocarbons) to attach (adsorb) to sediments.

Sections of the North Fork and the South Fork of the Nooksack River, as well as two Nooksack River tributaries, Racehorse Creek and Anderson Creek, are listed as impaired by fine sediment on the 2008 Washington State 303(d) list (Ecology 2009). All fine sediment impaired waterbodies are located in the upper reaches of the Nooksack River watershed. Given the probability of undocumented impairment of other streams in the watershed, fine sediments are likely one of the factors limiting salmon production in the Nooksack River watershed (NMFS 1996; CRITFC 1994).

The Nooksack River watershed hosts nine species of salmonids, including three listed under the Endangered Species Act (ESA): chinook, steelhead, and bull trout. The Nooksack populations also appear to provide critical genetic diversity to the Puget Sound, where Nooksack chinook populations are one of only five geographic areas considered essential for recovery of the Puget Sound evolutionarily significant unit (ESU). Unfortunately, many of the Nooksack populations have declined substantially from historic levels and only 3 of 25 salmonid stocks identified in WRIA 1 by Washington State Salmonid Stock Inventories are currently considered healthy. Habitat degradation is considered the leading cause for the decline of WRIA 1 salmonid populations with current habitat conditions substantially less productive than historic conditions.

In addition, the large sediment load carried by the Nooksack River and the circulation patterns in Bellingham Bay have altered estuarine habitat by producing rapid growth of the Nooksack delta. Increased sedimentation is also a potential problem for the Lummi River and Lummi Bay, especially if Nooksack River flow is re-established in the Lummi River. In addition to natural riverine processes, sources of sediments in the Nooksack River watershed include forestry practices, agricultural practices, construction, and urban runoff.

5.3.3. Habitat Alteration

Habitat alteration is a change in the characteristics of a habitat, which generally produces a change in the biotic community. When the source of an adverse alteration is anthropogenic, the results are considered NPS pollution. These changes can interfere with designated uses such as reproduction and growth of salmonids and shellfish. The pollutants described above can have direct and indirect effects on aquatic habitats. However, in the context of this assessment report, consideration of habitat alteration as an NPS "pollutant" will be limited to adverse alterations resulting directly from activities associated with the source categories of NPS pollution (as opposed to alterations produced via the other pollutants). Examples of such activities include the alteration of small creeks into agricultural or roadside drainage ditches, the channelization of streams, the draining or filling of wetlands, the depletion of stream flow due to out-of-stream water uses, and the disruption of aquatic habitats by construction activities.

Aquatic habitat alterations in the Lummi River and the Nooksack River watersheds are typical of those associated with human activities elsewhere. The examples listed above are widespread in these watersheds. Other common habitat alterations occurring in Reservation watersheds include flow modification (e.g., agricultural, industrial, and municipal withdrawals, diversion of the Middle Fork Nooksack River to Lake Whatcom, diversion of the mainstem Nooksack River to Cherry Point, and the Lummi Bay seawall), removal of riparian vegetation, streambank modification, and isolation of the rivers from their floodplains and side channels by levees. These alterations and activities can completely change channel morphology and cause the loss of important habitat components such as the quantity and quality of pools, gravel beds, large woody debris, and off-channel habitat. Habitat alterations in the Lummi River and Nooksack River watersheds are presumably contributing to the reduction of salmonid populations that are native to these stream systems (NMFS 1996; CRITFC 1994).

As noted above, the Nooksack River watershed hosts nine species of salmonids, including three listed under the Endangered Species Act (ESA): chinook, steelhead, and bull trout. The Nooksack populations also appear to provide critical genetic diversity to the Puget Sound, where Nooksack chinook populations are one of only five geographic areas considered essential for recovery of the Puget Sound evolutionarily significant unit (ESU). Unfortunately, many of the Nooksack populations have declined substantially from historic levels and only 3 of 25 salmonid stocks identified in WRIA 1 by Washington State Salmonid Stock Inventories are currently considered healthy. Habitat degradation is considered the leading cause for the decline of WRIA 1 salmonid populations with current habitat conditions substantially less productive than historic conditions.

Aquatic habitat alteration also occurs in the estuarine and shoreline areas of the Reservation. The rapidly growing Nooksack River delta (at least partially a product of sediments that would have been deposited on the floodplain if flood control levees were not present) alters the estuarine habitats of salmonids and shellfish. The Lummi Bay seawall constructed in the mid-1920's and the 750 acres Seaponds Aquaculture Facility constructed in the mid-1970's alter and restrict access to estuarine habitats. Shoreline modification, in particular by bulkheads along the Sandy Point Peninsula shoreline, causes erosion and subsequent change of the shoreline habitat. These changes likely have negative effects on juvenile salmonids and on the prey species on which salmonids depend for survival.

5.3.4. Metals

Metals are persistent and bioaccumulative toxins that generally have a high affinity for fine sediment (e.g., clay). In addition to adversely affecting animals and plants, metals may severely affect the health and welfare of people who consume contaminated terrestrial or aquatic species. Sources of metals include pesticides, wear from automobile tires and brakes, improperly disposed of motor oil, corrosion of copper pipes, paints and stains, lead shot from waterfowl hunting, industrial activities, and antifouling agents for boats.

Zinc and copper have been detected during the period of record (1999 – 2011) within the Sandy Point Marina and at sample Site SW014 (on a small creek where it crosses the northern Reservation boundary, directly south of the Phillips 66 refinery and just west of Lake Terrell Road). Past sampling efforts from the Puget Sound Ambient Monitoring Program and Environmental Monitoring and Assessment Program have also collected toxic compounds in sediment and intertidal invertebrates on and near the Reservations (WDNR 1995, Partridge *et al*. 2005)

Hydrocarbon and polycyclic aromatic hydrocarbons (PAH) in Manila clam tissues and intertidal sediment were assessed as part of the Lummi Intertidal Baseline Inventory to determine baseline condition of compounds associated with petroleum (LNR 2010a). Manila clam tissues and sediment were sampled in Lummi Bay and Portage Bay. The PAH concentrations within the sediment samples were mainly below detection limits except for two PAH compounds at the topmost tidal elevation that was sampled in Lummi Bay. Hydrocarbon concentrations were also below the detection limits within the sediments at both locations. Manila clam tissues did not have detectable PAH concentrations. This effort serves to characterize pre-spill conditions on the Lummi Indian Reservation tidelands and to clarify if these conditions have been influenced by nonpoint pollution sources. Possible other nonpoint sources of metals entering Reservation waters are land disposal, atmospheric deposition, and urban and road runoff.

5.3.5. Nutrients

Phosphorus and nitrogen are the primary nutrients of concern because they are usually the nutrients limiting algal growth. However, elevated phosphorus and nitrogen can result in algae blooms, which can interfere with other aquatic forms (Hem 1989) and can cause a number of environmental and health problems including:

- Aesthetic degradation – water with large algae blooms is murky, has a bad odor, and is generally undesirable for water contact recreation such as swimming, wading, fishing, and boating.
- Aquatic habitat degradation – algae can result in low oxygen levels in the water when the algae decay, which can result in winter and summer fish kills.
- Toxin production – certain species of blue-green algae can produce toxins that can affect people and animals that swim and drink from water with severe algae blooms.
- Drinking water degradation – excessive algae in drinking water supplies can affect the taste and odor of drinking water and increase treatment costs.
- Disrupt fish harvests – excess algae can clog or discolor fishing nets.

Animal and human waste, urban runoff, fertilizers, detergents, and natural sources contribute nutrients to Reservation surface waters and, potentially, ground waters. Nutrient impacts are probable but currently undocumented in the Lummi and Nooksack estuaries. Two Nooksack River tributaries are listed on the Washington State 303(d) list (Ecology 2009) as impaired because of ammonia levels. Agricultural practices and urban runoff are likely the largest sources of nutrients entering Reservation waters.

5.3.6. Oxygen Demanding Substances

Decaying organic matter (e.g., manure, grass clippings, or die-off from algal blooms) can consume the oxygen that is dissolved in the water column. Low dissolved oxygen levels can cause fish and invertebrate mortality, aesthetic impairment, and the release to the water column of metals and other pollutants that were previously attached (adsorbed) to sediments. Sources of oxygen demanding substances (organic enrichment) are widespread – anywhere that decaying organic matter can be carried into a waterbody – and have been found in runoff from urban areas, agricultural lands, forestlands, and marinas.

As shown in Table 5.1 and Table 5.2, the majority of the Reservation water bodies exceed dissolved oxygen (mg/L) water quality standards. Approximately seventy waterbody segments of the Nooksack River and its tributaries are listed as impaired on the Washington State 303(d) list (Ecology 2009) for low dissolved oxygen. Dissolved oxygen levels vary considerably throughout the year, and not always inversely to temperature. At some sites, the deviation of dissolved oxygen and temperature from their equilibrium appears to be due to elevated primary production of oxygen by algae that increases the dissolved oxygen levels concurrent with elevated temperatures. The dissolved oxygen values could range from low to high to low again over a 24-hour period. To explore this phenomenon further, water quality samples should be sampled several times a day over the course of several days at representative sites. Agricultural, urban, and natural activities/processes are probably the main sources of oxygen demanding substances in Reservation waters.

Other causes of high dissolved oxygen levels concurring with elevated water temperatures may be wave entrainment of air or the water heating more rapidly than the rate at which dissolved oxygen maintains equilibrium concentrations in water. There are places where extremely low dissolved oxygen values could be due to naturally occurring conditions (e.g., an area without shade where the streambed is in the photic zone and flows are generally low to stagnant). At sites where human created or induced changes occurred (e.g., clearing of vegetation, drainage of ground water, increased nutrient loading), the extremes of dissolved oxygen variation have likely been increased due to the human activity setting the stage for increased primary production. The extent to which anthropogenic influences have contributed to depressed dissolved oxygen levels at the various sample sites has not been estimated.

5.3.7. Pesticides, Household and Industrial Chemicals, and Oil and Grease

Pesticides, household and industrial chemicals (e.g., antifreeze, solvents, creosote, and cleaning agents), and oil and grease may result in direct mortality or reduction of growth and reproductive capacity in fish, shellfish, wildlife, invertebrates, and aquatic flora (e.g., eelgrass), depending on the intensity and duration of exposure. Some of these substances can accumulate in sediments, increasing the duration and degree of exposure for bottom-dwelling or bottom-feeding organisms. Another important factor is that chemical pollutants that alone are not toxic to aquatic life may become toxic in the presence of other pollutants (i.e., the chemicals have synergistic effects). In addition, chemical concentrations can increase through the food chain by the processes known as bioaccumulation and biomagnification. Bioaccumulation occurs when a substance becomes more concentrated in plant and animal tissue than in the surrounding environment; biomagnification is the progressively (often exponentially) higher chemical concentrations that develop in the tissues of animals at higher trophic levels in the food chain. Through synergistic effects, bioaccumulation, biomagnification, and the persistence of many chemical pollutants and their breakdown products, a relatively low level of chemical pollution can have significant long term effects on individual organisms, populations, or communities. Chemical pollution may directly or indirectly affect human health through direct exposure to contaminated surface waters or consumption of contaminated animals and plants.

Impacts of pesticides, household and industrial chemicals, and oil and grease on Reservation waters are probable, but largely undocumented. A documented case of pesticide impacts on Reservation waters involved the Sandy Point Improvement Company golf course (which lies on non-member owned fee lands on the Reservation, along the north shore of Lummi Bay). In April 1995, ducks were found dead on the golf course. At the request of the Lummi Nation, the EPA investigated and found that improper use of the pesticide Diazinon caused the death of the ducks. The golf course is in close proximity to shellfish beds and a salmon rearing facility. In addition, raptors, which prey on ducks, use the areas surrounding the golf course for foraging. Both wildlife and fishery uses were potentially impaired. The Lummi Natural Resources Department temporarily closed nearby subsistence and commercial shellfish beds to avoid potential health effects on harvesters and consumers.

A second documented case was the over application of the aquatic herbicide Fluridone by the Sandy Point Improvement Company during 2004. In response to concerns expressed by neighbors, samples were collected from Agate Lake on the Sandy Point Peninsula and levels of Fluridone were found to exceed allowable concentrations.

Creosote pilings remain in Lummi Bay, Hale Passage, Bellingham Bay, and within Seaponds (a tribal aquaculture facility located in Lummi Bay). These pilings are a nonpoint source of chemicals to these waters and impact fish and shellfish. Creosote has been used as a wood preservative for over a century to treat telephone poles, railroad ties, piers, docks, and floats. Approximately 300 chemicals have been identified in coal-tar creosote, and there may be 10,000 other chemicals present in the mixture. The major chemicals that can cause harmful health effects to organisms are polycyclic aromatic hydrocarbons (PAHs), phenols, and cresols (WDNR 2008). Recent studies have shown that PAHs are detrimental to salmon immune function and development. Other studies have shown that herring eggs exposed to creosote have a high mortality rate and English sole develop liver lesions. Agricultural practices, land disposal, atmospheric deposition, road runoff, pilings, and urban/residential storm water are the main probable nonpoint sources of chemicals entering Reservation waters.

5.3.8. pH

Alteration of pH (acidity) levels can have significant effects on water quality and biotic communities. Changes in pH can degrade water quality by increasing or decreasing the solubility of metals and other polluting chemicals. Since pH controls many biochemical reactions, extreme pH levels can alter the biochemistry and physiology of all organisms. The resulting impacts on reproduction or respiration, for example, can reduce the viability of many species, including fish. With its many possible effects likely acting in combination, pH alteration can have significant impacts on the biotic community, resulting directly and indirectly in reduced survival of salmonids and other species important to the ecosystem.

Approximately two-thirds of the sample sites did not achieve the Lummi water quality standards for pH during 2011. Fourteen waterbody segments of Nooksack River tributaries, including the South Fork and mainstem of the Nooksack River are listed on the Washington State 303(d) list (Ecology 2009) as impaired by pH. Agriculture, urban runoff, land disposal, and atmospheric deposition are probably the main sources of pH alteration in Reservation waters.

5.3.9. Saltwater Intrusion

Elevated chloride content in ground water can result in the water being unfit for domestic and other purposes. Most wells on the Reservation are located near the shoreline, which makes them particularly vulnerable to saltwater intrusion that would render them unusable. Several public water supply wells, primarily in the Gooseberry Point area, have been closed because of progressive saltwater intrusion induced by overpumping of nearshore wells. Since future residential development will likely produce an increase in the demand for ground water, the potential for future saltwater intrusion is high.

5.3.10. Temperature

Increased water temperatures affect water quality and biotic communities in several ways. As water temperature increases, saturation concentrations for dissolved gases decrease. The reduced dissolved oxygen available in warmer water can be a potential source of respiratory stress for fish and invertebrates. In addition, warmer water diminishes the efficiency of enzymes in cold water species and increases metabolic rates and demands. Higher water temperature also increases the solubility of most metals and chemicals and reduces their adsorption to sediment particles. Increases in water temperature can therefore be expected to increase pollutant concentrations in the water column. When combined, these changes in temperature and water quality alter the habitat and species composition of the biotic community, resulting directly and indirectly in reduced survival of salmonids and other species.

Thirty-eight waterbody segments in the Nooksack River watershed, including the Middle Fork and South Fork of the Nooksack River, are listed on the Washington State 303(d) list (Ecology 2009) as impaired by high water temperature. None of the contributing waterbodies to Portage Bay and Lummi Bay met the Lummi Nation Water Quality Standards for water temperature criteria, except Seaponds Creek (SW029), which drains a forested, undeveloped portion of the Reservation. Low flow and/or shallow water that has flowed over sun-warmed sediments or tideflats likely produced many of these violations. Reduced shading, altered channel structure (e.g., wide, shallow streams), and loss of contributions from ground water, all three of which are due to agricultural practices, forestry, and land development, are likely the primary causes of increased water temperatures in the Nooksack River watershed and on the Reservation.

5.4. Impairment of Reservation Water Bodies

Table 5.3 lists the NPS pollutant types, the source categories for each type (EPA 1997a), and the degree of impairment due to each pollutant for each of the primary water bodies (the Nooksack River, the Lummi River, Portage and Bellingham Bays, and Lummi Bay) and the ground water on the Reservation. The listed degree of impairment reflects documented impacts and/or a literature-based assessment of potential but undocumented impacts.

It is noted that the EPA does not identify aquaculture as a specific source category or subcategory. Because confined-animal feeding operations are a subcategory for the NPS category agriculture, and because some aquaculture facilities can be defined as confined animal feeding operations, aquaculture is being considered as subcategory for the Agriculture NPS category.

In summary, the on-Reservation segments of both the Nooksack River and Lummi River show high impairments from bacteria/pathogens, fine sediment, oxygen demanding substances, temperature, and habitat alteration. Portage and Bellingham Bays show high impairment from bacteria/pathogens. Lummi Bay and the Reservation ground water do not show high levels of impairment from the evaluated pollutant types.

Table 5.3 Degree of Impairment of Reservation Waterbodies by Pollutant Type and NPS Pollution Category

Waterbody	Pollutant Type	Source Category (Subcategory)	Degree of Impairment	Comments
Nooksack River and its tributaries	Bacteria/ Pathogens	▪ Agriculture (pasture grazing, confined animal feeding operations, manure lagoons) ▪ Urban Runoff ▪ Land Disposal (on-site wastewater systems) ▪ Waste storage or storage tank leaks ▪ Natural Sources	High	• 303(d) list (South Fork Nooksack River, 2 segments in 1 tributary) • Lummi Water Quality Standard Violations • Portage Bay Shellfish Closure • Potential Lummi Bay Shellfish Closure
	Fine Sediment	▪ Agriculture (crop production [all types], pasture grazing, confined animal feeding operations) ▪ Silviculture (harvesting, road construction and maintenance) ▪ Construction (highway/road/ bridge, land development) ▪ Urban Runoff ▪ Resource Extraction (surface mining of sand and gravel) ▪ Hydromodification/Habitat Modification (channelization, flow modification, removal of riparian vegetation, streambank destabilization, draining/filling of wetlands) ▪ Atmospheric Deposition ▪ Highway Maintenance and Runoff ▪ Natural Sources	High	• 303(d) list (mainstem, North Fork South Fork, and 2 segments in 2 tributaries) • Salmonid impacts • Shellfish impacts in Portage Bay
	Oxygen Demanding Substances (organic enrichment)	▪ Agriculture (pasture grazing, confined animal feeding operations, manure lagoons) ▪ Urban Runoff ▪ Land Disposal (on-site wastewater systems) ▪ Hydromodification/Habitat Modification (channelization, flow modification, removal of riparian vegetation, streambank destabilization, draining/filling of wetlands) ▪ Waste storage or storage tank leaks ▪ Highway Maintenance and Runoff ▪ Natural Sources	High	• 303(d) list (70 segments Nooksack River tributaries) • Salmonid impact • Lummi Water Quality Standard Violations
	Temperature	▪ Agriculture (crop production [all types], pasture grazing) ▪ Silviculture (harvesting, forest management, road construction) ▪ Construction (highway/road/ bridge, land development) ▪ Urban Runoff ▪ Resource Extraction (surface mining of sand and gravel) ▪ Hydromodification/Habitat Modification (channelization, flow modification, removal of riparian vegetation, streambank modification,	High	• 303(d) list (38 segments of the Nooksack River tributaries) • Salmonid impacts • Lummi Water Quality Standard Violations

Table 5.3 Degree of Impairment of Reservation Waterbodies by Pollutant Type and NPS Pollution Category

Waterbody	Pollutant Type	Source Category (Subcategory)	Degree of Impairment	Comments
		draining/filling of wetlands) ▪ Highway Maintenance and Runoff ▪ Recreation Activities (golf courses) ▪ Ground water Withdrawal		
	pH	▪ Agriculture (crop production [all types], pasture grazing, confined animal feeding operations, manure lagoons, cleaning milking equipment) ▪ Silviculture (harvesting) ▪ Construction (highway/road/ bridge, land development) ▪ Urban Runoff ▪ Resource Extraction (surface mining of sand and gravel) ▪ Land Disposal (landfills, on-site wastewater systems) ▪ Hydromodification/Habitat Modification (removal of riparian vegetation, draining/filling of wetlands) ▪ Atmospheric Deposition ▪ Storage Tank Leaks ▪ Highway Maintenance and Runoff ▪ Spills	High	• 303(d) list (14 segments of Nooksack River tributaries) • Salmonid impact • Lummi Water Quality Standard Violations
	Nutrients	▪ Agriculture (crop production [all types], pasture grazing, confined animal feeding operations, manure lagoons) ▪ Silviculture (restoration, residue management, forest management) ▪ Construction (highway/road/ bridge, land development) ▪ Urban Runoff ▪ Land Disposal (landfills, on-site wastewater systems) ▪ Hydromodification/Habitat Modification (channelization, removal of riparian vegetation, streambank destabilization, draining/filling of wetlands) ▪ Atmospheric Deposition ▪ Waste storage or storage tank leaks ▪ Highway Maintenance and Runoff ▪ Spills ▪ Recreation Activities (golf courses)	Moderate, Potentially High	• 303(d) list (ammonia: 2 segments in 2 tributaries) • Salmonid impacts
	Pesticides, Household and Industrial Chemicals, and Oil and Grease	▪ Agriculture (crop production [all types], pasture grazing, confined animal feeding operations, manure lagoons cleaning milking equipment) ▪ Silviculture (harvesting and restoration, forest management, road construction and maintenance) ▪ Construction (highway/road/ bridge, land development) ▪ Urban Runoff ▪ Resource Extraction (surface mining of sand and gravel)	Moderate, Potentially High	• Potential for high degree of impact from spills, excessive use, and increasing development • Creosote pilings in the Nooksack River Delta • Salmonid impacts

Table 5.3 Degree of Impairment of Reservation Waterbodies by Pollutant Type and NPS Pollution Category

Waterbody	Pollutant Type	Source Category (Subcategory)	Degree of Impairment	Comments
		▪ Land Disposal (landfills, on-site wastewater systems) ▪ Atmospheric Deposition ▪ Storage Tank Leaks ▪ Highway Maintenance and Runoff ▪ Spills ▪ Recreation Activities (golf courses)		• Shellfish impacts in Portage Bay
	Metals	▪ Urban Runoff ▪ Land Disposal (landfills) ▪ Atmospheric Deposition ▪ Highway Maintenance and Runoff	Low	• Salmonid impacts • Shellfish impacts in Portage Bay
	Habitat Alteration	▪ Agriculture (crop production [all types], pasture grazing) ▪ Silviculture (harvesting, road construction) ▪ Construction (highway/road/ bridge, land development) ▪ Urban Runoff ▪ Hydromodification/Habitat Modification (channelization, flow modification, removal of riparian vegetation, streambank modification, draining/filling of wetlands) ▪ Recreation Activities (golf courses)	High	• Salmonid impacts
Lummi River, its tributaries, and Jordan's Creek	Bacteria/ Pathogens	▪ Agriculture (pasture grazing, confined animal feeding operations, manure lagoons) ▪ Urban Runoff ▪ Land Disposal (on-site wastewater systems) ▪ Waste storage or storage tank leaks ▪ Spills ▪ Natural Sources	High	• 303(d) list (Lummi River, up-stream from Reservation) • Lummi Water Quality Standard Violations • Potential shellfish impacts in Lummi Bay
	Fine Sediment	▪ Agriculture (crop production [all types], pasture grazing, confined animal feeding operations) ▪ Silviculture (harvesting, road construction and maintenance) ▪ Construction (highway/road/ bridge, land development) ▪ Urban Runoff ▪ Resource Extraction (surface mining of sand and gravel) ▪ Hydromodification/Habitat Modification (channelization, flow modification, removal of riparian vegetation, streambank destabiliza-tion, draining/filling of wetlands) ▪ Atmospheric Deposition ▪ Highway Maintenance and Runoff ▪ Natural Sources	Moderate, Possibly High	• Salmonid impacts • Potential shellfish impacts in Lummi Bay

Table 5.3 Degree of Impairment of Reservation Waterbodies by Pollutant Type and NPS Pollution Category

Waterbody	Pollutant Type	Source Category (Subcategory)	Degree of Impairment	Comments
	Oxygen Demanding Substances (organic enrichment)	▪ Agriculture (pasture grazing, confined animal feeding operations, manure lagoons) ▪ Urban Runoff ▪ Land Disposal (on-site wastewater systems) ▪ Hydromodification/Habitat Modification (channelization, flow modification, removal of riparian vegetation, streambank destabiliza-tion, draining/filling of wetlands) ▪ Waste storage or storage tank leaks ▪ Highway Maintenance and Runoff ▪ Natural Sources	High	• Salmonid impacts • Lummi Water Quality Standard Violations • Salmonid impact
	Temperature	▪ Agriculture (crop production [all types], pasture grazing) ▪ Silviculture (harvesting, forest management) ▪ Construction (highway/road/ bridge, land development) ▪ Urban Runoff ▪ Resource Extraction (surface mining of sand and gravel) ▪ Hydromodification/Habitat Modification (channelization, flow modification, removal of riparian vegetation, streambank modifica-tion, draining/filling of wetlands) ▪ Highway Maintenance and Runoff ▪ Recreation Activities (golf courses) ▪ Ground water Withdrawal	High	• Lummi Water Quality Standard Violations • Salmonid impacts
	pH	▪ Agriculture (crop production [all types], pasture grazing, confined animal feeding operations, manure lagoons, cleaning milking equipment) ▪ Silviculture (harvesting) ▪ Construction (highway/road/ bridge, land development) ▪ Urban Runoff ▪ Resource Extraction (surface mining of sand and gravel) ▪ Land Disposal (landfills, on-site wastewater systems) ▪ Hydromodification/Habitat Modification (removal of riparian vegetation, draining/filling of wetlands) ▪ Atmospheric Deposition ▪ Storage Tank Leaks ▪ Highway Maintenance and Runoff ▪ Spills	High	• 303(d) list (14 segments of Nooksack River tributaries) • Salmonid impact • Lummi Water Quality Standard Violations
	Nutrients	▪ Agriculture (crop production [all types], pasture grazing, confined animal feeding operations, manure lagoons) ▪ Silviculture (restoration, residue management, forest management) ▪ Construction (highway/road/ bridge, land development)	Moderate, Possibly High	• Salmonid impacts

Table 5.3 Degree of Impairment of Reservation Waterbodies by Pollutant Type and NPS Pollution Category

Waterbody	Pollutant Type	Source Category (Subcategory)	Degree of Impairment	Comments
		▪ Urban Runoff ▪ Land Disposal (landfills, on-site wastewater systems) ▪ Hydromodification/Habitat Modification (channelization, removal of riparian vegetation, streambank destabilization, draining/filling of wetlands) ▪ Atmospheric Deposition ▪ Waste storage or storage tank leaks ▪ Highway Maintenance and Runoff ▪ Spills ▪ Recreation Activities (golf courses)		
	Pesticides, Household and Industrial Chemicals, and Oil and Grease	▪ Agriculture (crop production [all types], pasture grazing, confined animal feeding operations, aquaculture) ▪ Silviculture (harvesting and restoration, forest management, road construction and maintenance) ▪ Construction (highway/road/ bridge, land development) ▪ Urban Runoff ▪ Resource Extraction (surface mining of sand and gravel) ▪ Land Disposal (landfills, on-site wastewater systems) ▪ Atmospheric Deposition ▪ Storage Tank Leaks ▪ Highway Maintenance and Runoff ▪ Spills ▪ Recreation Activities (golf courses)	Moderate, Potentially High	• Potential for high degree of impact from spills, excessive use, and increasing development • Creosote pilings in the Lummi River delta • Salmonid impacts • Shellfish impacts
	Metals	▪ Agriculture (aquaculture) ▪ Urban Runoff ▪ Land Disposal (landfills) ▪ Atmospheric Deposition ▪ Highway Maintenance and Runoff	Low	• Creosote pilings in Lummi Bay and within Seaponds Dike • Salmonid impacts • Shellfish impacts
	Habitat Alteration	▪ Agriculture (crop production [all types], pasture grazing) ▪ Construction (highway/road/ bridge, land development) ▪ Urban Runoff ▪ Hydromodification/Habitat Modification (channelization, flow modification [levee/seawall], removal of riparian vegetation, streambank modification, draining/filling of wetlands) ▪ Recreation Activities (golf courses)	High	• Salmonid impacts • Shellfish impacts

Table 5.3 Degree of Impairment of Reservation Waterbodies by Pollutant Type and NPS Pollution Category

Waterbody	Pollutant Type	Source Category (Subcategory)	Degree of Impairment	Comments
Bellingham/ Portage Bay	Bacteria/ Pathogens	▪ Agriculture (pasture grazing, confined animal feeding operations, manure lagoons, aquaculture) ▪ Urban Runoff ▪ Land Disposal (on-site wastewater systems) ▪ Waste storage or storage tank leaks ▪ Spills ▪ Natural Sources	High	• Closure of 220 acres to ceremonial, subsistence, and commercial harvest of shellfish from 1996 through 2006 • 2014 Portage Bay Shellfish Bed closure to ceremonial, subsistence, and commercial harvest of shellfish • Lummi Water Quality Standard Violations
	Nutrients	▪ Agriculture (crop production [all types], pasture grazing, confined animal feeding operations, manure lagoons) ▪ Silviculture (restoration, residue management, forest management) ▪ Construction (highway/road/ bridge, land development) ▪ Urban Runoff ▪ Land Disposal (landfills, on-site wastewater systems) ▪ Hydromodification/Habitat Modification (channelization, removal of riparian vegetation, streambank destabilization, draining/filling of wetlands) ▪ Atmospheric Deposition ▪ Waste storage or storage tank leaks ▪ Highway Maintenance and Runoff ▪ Spills ▪ Recreation Activities (golf courses)	Low	• Salmonid impacts
	Pesticides, Household and Industrial Chemicals, and Oil and Grease	▪ Agriculture (crop production [all types], pasture grazing, confined animal feeding operations) ▪ Silviculture (harvesting and restoration, forest management, road construction and maintenance) ▪ Construction (highway/road/ bridge, land development) ▪ Urban Runoff ▪ Resource Extraction (surface mining of sand and gravel) ▪ Land Disposal (landfills, on-site wastewater systems) ▪ Atmospheric Deposition ▪ Storage Tank Leaks ▪ Highway Maintenance and Runoff ▪ Spills	Low, Potentially High	• Potential for high degree of impact from spills, excessive use, and increasing development • Creosote Pilings in the Nooksack River delta • Salmonid impacts • Shellfish impacts

Table 5.3 Degree of Impairment of Reservation Waterbodies by Pollutant Type and NPS Pollution Category

Waterbody	Pollutant Type	Source Category (Subcategory)	Degree of Impairment	Comments
		▪ Recreation Activities (golf courses)		
	Metals	▪ Urban Runoff ▪ Land Disposal (landfills) ▪ Atmospheric Deposition ▪ Highway Maintenance and Runoff	Low	• Salmonid impacts • Shellfish impacts
	Habitat Alteration	▪ Hydromodification/Habitat Modification (channelization, flow modification, removal of riparian vegetation, streambank modification, draining/filling of wetlands)	Moderate	• Salmonid impacts • Shellfish impacts
Lummi Bay (and Strait of Georgia, Hale Passage)	Bacteria/ Pathogens	▪ Agriculture (pasture grazing, confined animal feeding operations, manure lagoons) ▪ Urban Runoff ▪ Land Disposal (on-site wastewater systems) ▪ Marinas and Recreational Boating ▪ Waste storage or storage tank leaks ▪ Spills ▪ Natural Sources	Low, Potentially Higher	• Potential flow from Nooksack River • Potential shellfish impacts
	Nutrients	▪ Agriculture (crop production [all types], pasture grazing, confined animal feeding operations, manure lagoons) ▪ Silviculture (restoration, residue management, forest management) ▪ Construction (highway/road/ bridge, land development) ▪ Urban Runoff ▪ Land Disposal (landfills, on-site wastewater systems) ▪ Hydromodification/Habitat Modification (channelization, removal of riparian vegetation, streambank destabilization, draining/filling of wetlands) ▪ Atmospheric Deposition ▪ Waste storage or storage tank leaks ▪ Highway Runoff ▪ Spills ▪ Recreation Activities (golf courses)	Low	• Salmonid impacts
	Pesticides, Household and Industrial Chemicals, and Oil and Grease	▪ Agriculture (crop production [all types], pasture grazing, confined animal feeding operations, aquaculture) ▪ Silviculture (harvesting and restoration, forest management, road construction and maintenance) ▪ Construction (highway/road/ bridge, land development) ▪ Urban Runoff ▪ Resource Extraction (surface mining of sand and gravel)	Moderate, Potentially High	• Potential for high degree of impact from spills, excessive use, and increasing development • Creosote pilings in Lummi Bay and within Seaponds Dike

Table 5.3 Degree of Impairment of Reservation Waterbodies by Pollutant Type and NPS Pollution Category

Waterbody	Pollutant Type	Source Category (Subcategory)	Degree of Impairment	Comments
		▪ Land Disposal (landfills, on-site wastewater systems) ▪ Marinas and Recreational Boating ▪ Atmospheric Deposition ▪ Storage Tank Leaks ▪ Highway Maintenance and Runoff ▪ Spills ▪ Recreation Activities (golf courses)		• Salmonid impacts • Shellfish impacts • Herring impacts
	Metals	▪ Agriculture (aquaculture) ▪ Urban Runoff ▪ Land Disposal (landfills) ▪ Marinas and Recreational Boating ▪ Atmospheric Deposition ▪ Highway Maintenance and Runoff	Low	• Creosote pilings in Lummi Bay and within Seaponds Dike • Salmonid impacts • Shellfish impacts • Herring impacts
	Habitat Alteration	▪ Hydromodification/Habitat Modification (channelization, flow modification, removal of riparian vegetation, streambank modification, draining/filling of wetlands)	Moderate	• Salmonid impacts • Shellfish impacts
Ground water	Bacteria/ Pathogens	▪ Agriculture (pasture grazing, con-fined animal feeding operations) ▪ Urban Runoff ▪ Land Disposal (on-site wastewater systems) ▪ Waste storage or storage tank leaks ▪ Spills ▪ Natural Sources	Low	• Potential public health risk
	Nutrients	▪ Agriculture (crop production [all types], pasture grazing, confined animal feeding operations) ▪ Construction (highway/road/ bridge, land development) ▪ Urban Runoff ▪ Land Disposal (landfills, on-site wastewater systems) ▪ Atmospheric Deposition ▪ Waste storage or storage tank leaks ▪ Highway Runoff ▪ Spills	Low	• Potential public health risk
	Pesticides, Household and Industrial Chemicals, and Oil and Grease	▪ Agriculture (crop production [all types], pasture grazing, confined animal feeding operations) ▪ Silviculture (harvesting and restoration, forest management, road construction and maintenance) ▪ Construction (highway/road/ bridge, land development) ▪ Urban Runoff	Moderate, Potentially Higher	• Potential for high degree of impact from spills, excessive use, and increasing development • Potential public health risk

Table 5.3 Degree of Impairment of Reservation Waterbodies by Pollutant Type and NPS Pollution Category

Waterbody	Pollutant Type	Source Category (Subcategory)	Degree of Impairment	Comments
		▪ Resource Extraction (surface mining of sand and gravel) ▪ Land Disposal (landfills, on-site wastewater systems) ▪ Atmospheric Deposition ▪ Storage Tank Leaks ▪ Highway Maintenance and Runoff ▪ Spills		
	Saltwater Intrusion	▪ Silviculture (harvesting, road construction and maintenance) ▪ Construction (highway/road/ bridge, land development) ▪ Urban Runoff ▪ Hydromodification/Habitat Modification (channelization, removal of riparian vegetation, draining/filling of wetlands) ▪ Ground water Withdrawal	Moderate (Locally and Potentially High)	• Gooseberry Point wells closed • Documented potential along Bellingham Bay and the Sandy Point Peninsula

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6. DISCUSSION

6.1. Primary Impairments of Major Water Bodies

The information in Table 5.3 demonstrates that the four major water bodies and the ground water on the Reservation are currently and/or potentially impaired by NPS pollution. The three current impairments of greatest concern to the Lummi Nation are the degradation of salmonid habitat in the Nooksack River watershed and estuary; restrictions on ceremonial, subsistence, and commercial shellfish harvests in Portage Bay; and saltwater intrusion into or contamination of the Reservation aquifers. The potential impairment of most concern is the threat of a ceremonial, subsistence, and commercial shellfish harvest closures in Lummi Bay. These waters require NPS pollution control measures to restore or maintain designated water uses and to meet or maintain water quality standards.

6.2. Nonpoint Source Pollution Categories Responsible for Impairment

In order to rank the NPS pollution categories affecting surface and ground water on or flowing onto the Reservation, the level of impact due to each contributed pollutant type was estimated (see Table 6.1) for each source category listed previously in Table 3.2. The source categories in Table 6.1 descend from the category producing the greatest estimated overall impairment of Reservation water resources to the category producing the least estimated impairment. The following criteria were used to estimate the levels of impact:

(1) The number of waterbody segments listed on the Washington 303(d) list or having violations of the Lummi Water Quality Standards;

(2) Approximate proportion of land area represented by the source category (both on- and off-Reservation);

(3) Current and potential impacts on salmonids;

(4) Current and potential impacts on shellfish;

(5) Literature-based assessment of the amount of pollution produced by each source; and

(6) Literature-based assessment of the relative, overall impact of each pollutant on water resources (both on- and off-Reservation).

Based on the information summarized in Table 5.3 and Table 6.1, the NPS pollution categories primarily responsible for the current and potential impairments of Reservation water resources are agriculture, silviculture, urban runoff, and hydromodification/habitat modification. Although not indicated by Table 6.1, ground water withdrawals are also a primary category of concern because of the Reservation's reliance on its limited ground water supply and the high risk of saltwater intrusion. Construction, atmospheric deposition, highway maintenance and runoff, and land disposal may be significant contributors to the impairment of Reservation water resources. However, these four sources and the remaining source categories listed in Table 6.1 do not appear to be major sources at this time. Control of each NPS pollution category should contribute to the improvement and the preservation

Table 6.1 Estimated Impacts of Pollutants by Nonpoint Source Pollution Category

Pollution Source Category	Nonpoint Source Pollution Type									
	Bacteria/ Pathogens	Fine Sediment	Habitat Alteration	Metals	Nutrients	Oxygen Demanding Substances	Pesticides, Oil, Grease, and Other Chemicals	pH	Saltwater Intrusion	Temperature
Agriculture	H	M/H	M/H	M	M/H	H	M	M	L	H
Silviculture	L	H	M	L	L	L	L	L	L	H
Urban Runoff	L/M	L/M	L/M	L/M	L/M	L/M	M/H	L	L	L/M
Construction	L	L/M	L/M	L	L	L	L/M	L/M	L/M	L/M
Atmospheric Deposition	X	L	X	L/M	L/M	L	L/M	L/M	X	X
Highway Maintenance and Runoff	X	L/M	L	L	L	L/M	L/M	L	X	L
Land Disposal	L/M	L	X	L, ~H	L/M	L	L, ~H	L	X	X
Hydromodification/ Habitat Modification	M/H	H	H	L	L/M	M	L	L	L/M	M/H
Ground Water Withdrawal	L	X	X	L	L	L	L	X	L/M, ~H	L/M
Resource Extraction (sand/gravel mining)	L	L, ~M	L, ~M	L	X	L	L	L	L	L
Spills	L, ~H	X	L	L	L, ~H	L	L, ~H	L, ~H	X	X
Waste Storage or Storage Tank Leaks	L	X	L	L	L	L	L, ~H	L	X	X
Recreation Activities (golf courses)	L	X	L	L	L	L	L, ~H	L	L	L
Marinas and Recreational Boating	L, ~H	L	L	L, ~H	L	L	L	L	X	L

L = Low Impact; M = Moderate; H = High; L/M = Low to Moderate; M/H = Moderate to High; ~ = Potentially, X = no, or insignificant, impact of water quality and aquatic habitats both on and off the Reservation. The following discussion describes how the major and potentially significant NPS categories contribute to the impairment of Reservation water resources. These primary sources of impairment are the high priority targets for NPS pollution management on the Lummi Indian Reservation.

6.2.1. Agriculture

Agriculture is a significant source of all the types of pollutants that are responsible for salmonid and shellfish impacts in the Nooksack River and Lummi River watersheds and estuaries. Agricultural land uses, especially by dairy operations, were identified as the major source of the fecal coliform bacteria that was responsible for the closure to ceremonial, subsistence, and commercial harvest of Portage Bay shellfish beds from 1996 through 2006 (DOH 1997; WCD 1998; Ecology 2000a) and the potential closure of Lummi Bay shellfish beds. The agricultural activities that allow bacteria to reach surface waters in the Nooksack River and Lummi River watersheds include dairy waste application to fields, leaking or poorly managed manure lagoons, direct animal access to surface water, direct discharge to waterways, inadequate vegetated buffers along water courses, and runoff from pastures, feedlots, and animal holding areas.

In addition, reduced summer flows, removal of shade providing riparian vegetation, and organic enrichment due to animal wastes contribute to low dissolved oxygen levels in Nooksack River and Lummi River tributaries. Land clearing, soil disturbance, and removal of riparian vegetation combine to increase storm water runoff and fine sediment loads to the streams and rivers. Higher peak flows due to increased runoff results in greater streambank erosion. Increased metal and nutrient levels in streams are largely due to input of fertilizers, animal wastes, and crop residues from farm lands. Agricultural chemicals, including insecticides, herbicides, fungicides, and their derivative products, are one of the sources of chemical contamination of surface and ground water in the watersheds. The Nooksack tributaries on the 303(d) list for pH violations all flow through agricultural areas. Removal of temperature moderating riparian vegetation together with reduced summer flows resulting from agricultural land uses, contributes to elevated water temperatures in the streams of the Lummi River and lower Nooksack River watersheds. In addition, the loss of riparian vegetation, alteration of creeks into channeled drainage ditches, and livestock access to streams damage and alter stream habitats (EPA 1997b). Hydromodification in agricultural areas, particularly irrigation and drainage activities, affects the magnitude and timing of the annual hydrograph and instream flow levels during the summer months by removing water from the system. Many of these agricultural effects on water quality are combined with the effects arising from other NPS pollutant sources, which are described in the following subsections.

Agricultural activities in the Reservation watersheds occurs largely on the floodplain of the Nooksack River and Lummi River. The floodplain is a sensitive area because it is periodically inundated by flood waters and the soil, which may contain accumulated contaminants, can be eroded and transported to areas with important aquatic resources. There is little opportunity for retention of pollutants during flooding because of the proximity of farm lands to surface waters and the lack of riparian vegetation. In addition, ground water under the floodplain is generally in hydraulic continuity with adjacent streams, providing another potential route for pollutants to reach surface waters.

Since some agricultural activity presumably occurs in the recharge zones that have been generally identified for Reservation aquifers (LWRD 1997a, Aspect Consulting 2003, Aspect Consulting 2009, LWRD 2011b), the potential exists for impacts on the Reservation aquifers. Crop production or over-grazing by livestock could reduce ground water recharge by increasing surface runoff. This would increase the probability and magnitude of saltwater intrusion. The use of fertilizers and agricultural chemicals generally contributes to ground water contamination. These impacts, however, are probably not significant in the Reservation aquifers because of the limited extent of agriculture in the recharge zones.

Aquaculture is being treated as a subcategory of the Agriculture NPS category. Creosote pilings used as part of the Seaponds and Lummi Bay aquacultural activities can leach polyaromatic hydrocarbons (PAHs), phenols, and cresols (WDNR 2008). Recent studies have shown that PAHs are detrimental to salmon immune function and development. Other studies have shown that herring eggs exposed to creosote have a high mortality rate and English sole develop liver lesions (Casillas et al 1998a, 1998b, Vines et al. 2000, Myers et al. 2003, Meador et al. 2006).

6.2.2. Silviculture

Forestry activity is probably the primary source of impairment to salmonids in the upper Nooksack River watershed (i.e., along the North, Middle, and South Forks of the Nooksack River and their tributaries) and is a contributing source of NPS pollutants affecting, or potentially affecting, shellfish in Portage Bay and Lummi Bay. The primary direct impacts to streams are increased sediment and elevated water temperature. Lesser and/or indirect impacts result from habitat alteration, the input of nutrients, metals, and pesticides, and the increased access to forest lands that can result in increased recreational uses of former wilderness areas. Timber harvesting, road construction, and road use and maintenance are the activities that generate sediment contributions to streams. Mass wasting events from roads and harvested areas are the primary source of sediment from silvicultural sites (Rice et. al. 1972, Rice and Lewis 1991). The harvest of trees along riparian areas results in elevated stream temperatures during summer months and colder water temperatures during the winter months. The removal of potential large woody debris during harvests and bridge construction both alter stream habitats. Fertilizers used during reforestation and leaching of nutrients from soils exposed by harvest activity can result in nutrient inputs to streams. Silvicultural chemicals, including pesticides and their degradation products, are also carried to streams by runoff and by leaching into the ground water that feeds streams (EPA 1997b).

Since much of the Reservation uplands are forested, future harvesting of these forests may have impacts on ground water. Harvest induced alteration of forest hydrology could reduce ground water recharge by increasing surface runoff during storm events. This could increase the probability and magnitude of saltwater intrusion, depending on whether the land was retained in forestry or converted to another use. The use of fertilizers and silvicultural chemicals during reforestation and forest management activities could contribute to surface and ground water contamination.

6.2.3. Urban Runoff

Urban runoff is a source of all the types of pollutants (bacteria, fine sediment, habitat alteration, metals, nutrients, oxygen demanding substances, pesticides and other chemicals, pH, and temperature) that are responsible for salmonid and shellfish impacts in the Lummi River and Nooksack River watersheds and estuaries including the on-Reservation shellfish beds. Oxygen demanding substances, such as pet waste, oil, grease, detergents, waxes, and other household chemicals, and reduced streamflow due to hydrologic alterations likely contribute to low dissolved oxygen levels in Nooksack River and Lummi River tributaries. The increase of impervious surfaces (e.g., driveways, roads, parking lots, and roofs) associated with development can significantly increase storm water runoff and fine sediment loads to the streams and rivers in the watersheds. Higher instream flows due to the increased storm runoff result in greater streambank erosion. Creeks channelized into roadside ditches and streambed scouring due to storm water runoff result in habitat alterations. In addition, pollutants that accumulate on surfaces and in the atmosphere between precipitation events can produce high pollutant levels in the initial runoff from a storm. These runoff pollutants include the nutrients derived from fertilizers, automotive wastes, failing septic systems, and other sources. Also included are the significant levels of heavy metals, petroleum hydrocarbons, and various other chemicals, including pesticides and their derivative products, that result from automotive wastes and various residential, commercial, and industrial sources (EPA 1997b, Ecology 2005). Many of these sources (e.g., leaking batteries, concrete) can alter the pH in watershed streams. The loss of riparian vegetation and reduced streamflow due to hydrologic alterations contribute to elevated stream temperatures in the Lummi River and lower Nooksack River watersheds.

Streams and storm water runoff transport some of the pollutants described above, especially metals, pesticides, and other chemicals, from urban areas to the resource rich tideland habitats along the Reservation shorelines. With the highest housing density on the Reservation occurring along the shorelines, contaminated storm water can flow directly onto the resource rich tidelands. Because freshwater will generally “float” over denser seawater before gradually mixing with the seawater, species that reproduce, live, or feed in the intertidal zone or in the upper portion of the water column are particularly vulnerable to contaminated freshwater input. These species include juvenile salmon, herring, other small forage fish, shellfish, great blue herons, and bald eagles. This marine exposure pathway also exists for pollutants that enter surface waters from other source categories (e.g., agriculture, silviculture, atmospheric deposition, and highway runoff).

Although much lower than agriculture, urban runoff was a contributing source of fecal coliform bacteria responsible for the closure of Portage Bay shellfish beds from 1996 through 2006 (Ecology 2000a) and the potential closure of Lummi Bay shellfish beds. Exposure of pet waste, illegal solid waste dumpsites that contain items like used diapers, and failing septic systems to surface runoff of storm water are the routes through which bacteria reach surface waters in the Reservation watersheds. The pathway described above acts to expose the shellfish in the tidelands of Bellingham, Portage, and Lummi bays to bacterial contamination with the ebb and flow of each tide.

Since urban runoff occurs in the generally identified recharge zones for Reservation aquifers, the potential exists for impacts to the ground water where surface waters contribute to aquifer recharge. The nutrients, metals, and chemicals present in urban runoff can contribute to ground water contamination. In addition, increased storm water runoff due to impervious surfaces results in reduced ground water recharge, which could potentially increase the probability and magnitude of saltwater intrusion.

6.2.4. Hydromodification/Habitat Modification

Hydromodification, including aquatic and riparian habitat modification, is a significant source of salmonid and shellfish impairment in the lower Nooksack River and Lummi River watersheds and estuaries. Hydromodifications impact habitat and water quality in streams through direct alteration of channel morphology and salmonid habitat, isolation of streams from floodplains and side channels, input of fine sediment, drainage activities that reduce the amount of water available to support instream flows during the low flow season (July – October), and elevated water temperatures. Other impacts include reduction of dissolved oxygen, increased nutrient levels, and pH alterations. In Lummi Bay, the main impacts of hydromodification on habitat and water quality in estuarine habitats are due to the sea wall that physically separates nutrient sources in upland areas from the estuary and that results in a decrease in salt marsh habitat. The Lummi Bay and Bellingham Bay estuaries can also be affected by increased input of fine sediment resulting from hydromodification.

Hydromodification can be a less obvious source of NPS pollution relative to other sources because some of its effects are generated indirectly. For example, several forms of hydromodification indirectly affect dissolved oxygen levels: channelization often reduces the turbulence that mixes oxygen into the water column; reduced flow due to flow modification also reduces turbulence as well as the dilution of oxygen-depleting substances; removal of riparian vegetation produces elevated water temperatures that in turn reduce dissolved gas saturation concentrations; loss of riparian vegetation and streambank destabilization also result in increased loading of sediment and other oxygen depleting substances in runoff; and the draining/filling of wetlands can result in reduced streamflow and less removal of oxygen demanding substances from runoff.

Other significant impacts of hydromodification include the effect of increased streambank erosion due to channelization, removal of riparian vegetation, and streambank destabilization. The draining/filling of wetlands and isolation of streams from their floodplains due to channelization reduces opportunities for fine sediments to be deposited outside of the streambed. In addition to the effects of riparian vegetation removal, reduced streamflow due to flow modification and draining/filling of wetlands also results in higher water temperatures in streams. All of these processes have smaller effects on the nutrient and pH levels in streams (EPA 1997b).

6.2.5. Ground Water Withdrawals

Saltwater intrusion due to excessive pumping of ground water is a current threat to Reservation aquifers. Most of the active water supply wells on the Reservation are located within a half mile of marine waters. Progressive saltwater intrusion has already led to the closure of several public and private water supply wells. Since future residential development would both increase the demand for ground water and potentially decrease the area available for ground water recharge, the potential for further saltwater intrusion is high. Increased pumping due to future economic and population growth could further threaten the ground water resources of the Lummi Nation if such activities are not managed effectively.

6.2.6. Construction

Land development and associated construction activities directly or indirectly contribute possibly significant sources of all nine types of pollutants (bacterial/pathogens, fine sediment, habitat alteration, metals, nutrients, oxygen demanding substances, pesticides and other chemicals, pH, and temperature) that are responsible for salmonid and shellfish impacts in the Lummi River and Nooksack River watersheds, other Reservation watersheds, and in the marine waters on or adjacent to the Reservation. The impacts of land development and construction activities are very similar to those of urban runoff. These impacts are those that occur during the development and construction of buildings and roads; once construction is completed, the land area becomes a source of urban or highway runoff. The contaminants associated with construction are also similar to those of urban runoff. Construction chemicals such as paints, acids, cleaning solvents, asphalt products, soil additives, concrete curing compounds, and pollutants in wash water from concrete mixers largely match or replace the various commercial and industrial chemicals found in urban runoff (EPA 1997b, Ecology 2005). Pollution from construction differs from that of urban runoff in that soil erosion is generally greater (Ecology 2005). Control of soil erosion is therefore a high priority at construction sites.

6.2.7. Atmospheric Deposition

Although significant quantities of atmospheric pollutants are generated in (NWAPA 2010) or pass through the region (USGS 1999), the amount of atmospheric deposition within Reservation watersheds is unknown. The levels of impact from atmospheric deposition listed in Table 6.1 are estimated relative to the impacts determined for the other source categories. Pollutants deposited regionally from the atmosphere in significant amounts include nitrogen, mercury and other heavy metals, fine particulate matter, sulfuric and hydrochloric acids, pesticides, and various organic chemicals (NWAPA 2010; USGS 1999). The major sources of atmospheric pollutants are exhaust from combustion of fuels, waste incineration, pesticide applications, commercial and industrial processes, and natural sources such as volcanism. Industrial sources relatively close to the Reservation include four oil refineries, an aluminum smelter, a pulp and paper mill (now closed), and a municipal waste incineration facility (now closed). Since their distribution is widespread, the deposition of atmospheric pollutants can potentially, if not currently, affect salmonids, shellfish, surface water quality, and ground water quality both on and off the Reservation.

6.2.8. Highway Maintenance and Runoff

Storm water runoff from highways and roads is a contributing, possibly significant source of eight of the nine types of pollutants (fine sediment, habitat alteration, metals, nutrients, oxygen demanding substances, pesticides and other chemicals, pH, and temperature) that are responsible for salmonid and shellfish impacts in the Lummi River and Nooksack River watersheds, other Reservation watersheds, and in the marine waters on or adjacent to the

Reservation. Since this category is a component of the urban runoff source category, the impacts of highway runoff on surface and ground water are the same as for urban runoff and described above. The contaminants in highway runoff, however, are limited to those found in atmospheric deposition and in automotive wastes, including rubber worn from tires (oxygen demanding substance), heavy metals, phosphorus, acids, oil, grease, and various other automotive chemicals.

6.2.9. Land Disposal

Nonpoint source pollution due to land disposal of wastes is a contributing, possibly significant source of seven of the nine types of pollutants (bacteria, fine sediment, metals, nutrients, oxygen demanding substances, pesticides and other chemicals, and pH) that are responsible for salmonid and shellfish impacts in the Lummi River and Nooksack River watersheds, other Reservation watersheds, and in the marine waters on or adjacent to the Reservation. The main sources of these pollutants in Reservation watersheds are failing septic systems and abandoned landfills. Both of these sources may leach organic material, bacteria, nutrients, pesticides, and household chemicals into ground water; landfills may also leach metals, petrochemicals, and various commercial and industrial chemicals, depending on what was placed in the landfill. If ground water from these sites reaches the surface, streams may also become contaminated. For onsite septic systems, this could result in a contribution to bacterial contamination of Portage Bay and Lummi Bay, but on a far smaller scale than that due to agricultural sources (Ecology 2000a).

7. SELECTION OF BEST MANAGEMENT PRACTICES

As part of implementing the 2002 Nonpoint Source Pollution Management Plan (LWRD 2002), the LNR Water Resources Division (LWRD) staff members are responsible for selecting best management practices (BMPs) to control NPS pollution. The BMP selection process is part of the LWRD's mission to protect, restore, and manage the Lummi Nation's water resources, including Reservation shorelines, in accordance with the policies, priorities, and guidelines of the Lummi Nation. The LWRD staff select appropriate BMPs after reviewing pertinent publications on NPS pollution management measures (e.g., MWCOG 1992, EPA 1993a, IDHW 1996, EPA 1996, Ecology 2005, EPA 2007, LWRD 2011a) and consulting, as needed, with other LIBC departments and local NPS pollution management agencies (USDA-NRCS, WSU Cooperative Extension Service, Whatcom Conservation District, Ecology, EPA, U.S. Forest Service, WA Department of Natural Resources). Table 7.1 provides a summary of NPS categories and subcategories, and the key planning and BMP documents utilized by the Lummi Nation to address nonpoint source pollution. Additional BMPs can be found in the nonpoint source pollution prevention and control programs in Section 8 of this document

Because surface and ground water movement does not adhere to private property or political boundaries, and because community participation in developing and implementing the nonpoint source pollution management plan is necessary for a successful program, community involvement will continue to be a key element of the Lummi Nation Nonpoint Source Pollution Management Program. The two elements of the community involvement plan are (1) public education/outreach, and (2) interjurisdictional coordination and cooperation for activities off-Reservation that affect on-Reservation resources. Agency and public involvement in this process will be openly solicited as required by the EPA and the Lummi Indian Business Council and as specified in 40 CFR 25 and the Lummi Nation's Water Resources Protection Code (LCL Title 17). Since a large portion of the NPS pollution within the Reservation is addressed in the Storm Water Management Program, the public participation process of the Nonpoint Source Management Program will be integrated with that of the Storm Water Management Program.

The Lummi Nation Nonpoint Source Pollution Management Program will emphasize continued involvement in NPS pollution issues off the Reservation and implementation of BMPs and other actions identified in the Comprehensive Water Resources Management Program for nonpoint sources on the Reservation. The activities and programs described in this report should result in the maintenance or improvement of surface and ground water quality on the Reservation.

Table 7.1 Best Management Practices to Address NPS Pollution Categories

NPS Category	NPS Subcategory	Key Planning and BMP Documents
Agriculture	Non-Irrigated Crop Production	Whatcom County Conservation District Best Management Practices; Whatcom County Critical Areas Ordinance; NRCS Conservation Practice Standards; Washington State University Extension
	Irrigated Crop Production	
	Specialty Crop Production	
	Pasture Grazing	
	Confined Animal Feeding Operations	
Silviculture	Harvesting, Restoration, Residue Management	Lummi Nation Forestry Management Plan; Lummi Code of Laws Title 10, Federal Forest Plan; USFS Watershed Analysis, WDR HCP, WA Forest Practices
	Forest Management	
	Road Construction/Maintenance	
Construction	Highway/Road/Bridge	Lummi Nation Storm Water Technical Background Document, Lummi Code of Laws Title 17 and Title 15 and associated regulations, DOE Storm Water Management for Western Washington, Whatcom County codes and ordinances
	Land Development	
Urban Runoff/ Storm Sewers	Non-Industrial Permitted	
	Industrial Permitted	
	Other Urban Runoff	
	Highway/Road/Bridge Runoff	
	Erosion and Sedimentation	
Resource Extraction	Surface Mining (sand/gravel)	Lummi Code of Laws Title 17 and Title 15, EPA Industrial Storm Water Fact Sheet for Sector J: Mineral Mining and Processing Facilities, Best Management Practices for Reclaiming Surface Mines in Washington and Oregon, DOE Storm Water Management for Western Washington,
Land Disposal	Landfills	Lummi Code of Laws Title 18, Lummi Nation Integrated Solid Waste Management Plan, EPA Municipal Solid Waste Landfill Criteria-Technical Manual, EPA Safer Disposal for Solid Waste: The Federal Regulations for Landfills
	On-Site Wastewater Systems	Lummi Code of Laws Title 16, A Plain English Guide to the EPA Part 503 Biosolids Rule, EPA On-site Wastewater Treatment Systems Manual, EPA Handbook for Managing On-site and Clustered Wastewater Treatment Systems, EPA Tribal Management of Onsite Wastewater Treatment Systems, DOH On-Site Sewage System Management Plan Guidance, Whatcom County codes and ordinances
Hydromodification/ Habitat Modification	Channelization	Lummi Code of Laws Title 17, EPA Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, EPA National Management Measures to Control Nonpoint Source Pollution from
	Flow Modification	
	Removal of Riparian Vegetation	

Table 7.1 Best Management Practices to Address NPS Pollution Categories

NPS Category	NPS Subcategory	Key Planning and BMP Documents
	Streambank Modification or Destabilization	Hydromodification, NRCS Stream Corridor Restoration: Principles, Processes, and Practices, DOE Storm Water Management for Western Washington,
	Draining/Filling of Wetlands	Lummi Code of Laws Title 17, Lummi Nation Wetland Management Program, Army Corps of Engineers, Washington Department of Ecology, Whatcom County Critical Areas Ordinance
Marinas and Recreational Boating	Creosote Pilings	Lummi Code of Laws Title 17, EPA National Management Measures to Control Nonpoint Source Pollution from Marinas and Recreational Boating, Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, Whatcom County Shoreline Management Program
Atmospheric Deposition		Lummi Code of Laws Title 10 and Title 18, Lummi Forestry Management Plan, Federal Air Rules for Reservations, Northwest Clean Air Agency
Waste Storage/ Storage Tank Leaks		Lummi Code of Laws Title 16,
Highway Maintenance and Runoff		Lummi Nation Storm Water Technical Background Document, Lummi Code of Laws Title 17 and Title 15 and associated regulations, EPA Best Management Practices for Environmental Issues Related to Highway and Street Maintenance, DOE Storm Water Management for Western Washington, Whatcom County codes and ordinances
Spills		Lummi Nation Oil Spill Prevention and Response Plan, Geographic Response Plan for North Puget Sound, DOE Spills Program
Natural Sources		Lummi Code of Laws Title 16 and Title 17, Lummi Wellhead Protection Program
Recreation Activities	Golf Courses	Lummi Code of Laws Title 17, Best Management Practices for Golf Course Maintenance Departments (Florida Department of Environmental Protection)
Ground Water Withdrawal		Lummi Code of Laws Title 16 and Title 17, Lummi Nation Wellhead Protection Program, Lummi Water Conservation Plan, Lummi Tribal Sewer and Water District Water Facilities Plan,

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8. PREVENTION AND CONTROL PROGRAMS

In this section, NPS pollution control programs are listed and the existing Lummi Indian Business Council (LIBC) environmental programs directed toward managing NPS pollution on the Reservation and contributing watersheds are identified and described. Following this description, a summary of how the various programs address the three primary NPS pollution issues on the Reservation (salmonid habitat impairment in the Nooksack River watershed and estuary; restrictions on shellfish harvests for ceremonial, subsistence, and commercial purposes in Portage Bay and Lummi Bay; and saltwater intrusion into and contamination of the reservation aquifers) is presented.

8.1. Nonpoint Source Pollution Control Programs

All available programs for NPS pollution control are listed in this section in Table 8.1 by NPS pollution category. Programs that apply to Reservation lands are listed under "On-Reservation" although some of these programs (e.g., Federal programs) may apply off-Reservation as well. Programs that do not apply to Reservation lands but do apply to the watersheds that discharge to the Reservation are listed under "Off-Reservation". Responsible agencies are identified in parentheses. Most of these NPS pollution control programs are described elsewhere (Ecology 1989; CTCR 1992; FPAST 1993; EPA 1997c; Ecology 2000b; LWRD 2000).

Table 8.1 NPS Pollution Control Programs On- and Off-Reservation

Program	Primary NPS Pollution Categories								Potential NPS Pollution Categories									
	Agriculture		**Silviculture**		**Hydro-modification**		**Urban Runoff**		**Construc-tion**		**Atmo-spheric Deposition**		**Highway Maint. and Runoff**		**Land Disposal**		**Ground Water Withdrawal**	
	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off
Lummi Surface Water Quality Monitoring Program (LWRD)	X		X		X		X		X				X				X	
Lummi Ground Water Monitoring Program (LWRD)	X		X		X		X		X		X		X		X		X	
Lummi Comprehensive Water Resources Management Program (LWRD)	X		X		X		X		X		X		X		X		X	
Lummi Water Resources Protection Code [LCL Title 17] (LWRD)	X		X		X		X		X		X		X		X		X	
Lummi General Land Use Plan (Lummi Planning Department)	X		X		X		X		X		X		X		X		X	
Lummi Technical Review Committee (Lummi Planning Department)	X		X		X		X		X				X		X		X	
Lummi Sewer and Water Code (Lummi Tribal Sewer and Water District)							X		X						X		X	
Tribal Habitat Restoration Projects (Lummi Nation and Nooksack Tribe)	X	X	X	X	X	X												
Portage Bay Shellfish Protection District (Whatcom County)		X		X		X		X		X		X		X		X		X
National Shellfish Sanitation Program (Washington Department of Health)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Clean Water Action Plan (various federal departments and agencies)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Clean Water Act Section 319 Grants (EPA)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	x
Clean Water Act 106 Grants (EPA)	X		X		X		X		X		X		X		X		X	
Clean Water Act Section 404 Permit Process (Army Corps Engineers and EPA)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Clean Water Act Section 401 Certification Process (LNR or Washington Department of Ecology)					X	X	X	X	X	X			X	X				
Clean Water Act Section 402 Permit Process (EPA or Ecology)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
EPA General Assistance Program	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
ESA Section 4(d) Rules for Nooksack Chinook Salmon (National Marine Fisheries Service)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		

Table 8.1 NPS Pollution Control Programs On- and Off-Reservation

Program	Primary NPS Pollution Categories								Potential NPS Pollution Categories									
	Agriculture		**Silviculture**		**Hydro-modification**		**Urban Runoff**		**Construc-tion**		**Atmo-spheric Deposition**		**Highway Maint. and Runoff**		**Land Disposal**		**Ground Water Withdrawal**	
	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off
ESA Section 7 or Section 10 Consultation (National Marine Fisheries Service and US Fish and Wildlife Service)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
National Environmental Policy Act (Project-Dependent Lead Agency)					X	X	X	X	X	X	X	X	X	X	X	X		
Consolidated Pesticide Compliance Monitoring Program (EPA)	X	X	X	X			X	X					X	X				
National Water Quality Assessment Program (USGS)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Bureau of Indian Affairs Water Resources Grant Programs	X		X		X		X		X		X		X	X	X		X	
Nonpoint Watershed Action Plans for Kamm, Tenmile, and Silver creeks (Ecology)		X		X		X		X		X		X		X		X		
Centennial Clean Water Act Grant Program (Washington Department of Ecology)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
WRIA 1 Salmon Recovery Plan (Lummi Nation, Nooksack Tribe, WDFW, Whatcom County)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Puget Sound Partnership (multiple federal, tribal, state agencies)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Local Planning and Management of Nonpoint Source Pollution (Ecology)		X		X		X		X		X		X		X		X		X
Local Wellhead Protection Programs (Whatcom County, DOH)		X		X		X		X		X		X		X		X		X
WRIA 1 Watershed Management Project (initiating governments)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Clean Water Act Section 303 (d) Process (LNR, Ecology and EPA)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Comprehensive Plan (Whatcom County)		X		X		X		X		X		X		X		X		X
Critical Areas Ordinance (Whatcom County)		X		X		X		X		X		X		X		X		X
Shoreline Master Program (Whatcom County and Ecology)		X		X		X		X		X		X		X		X		X
Washington State Growth Management Act (local governments)		X		X		X		X		X		X		X		X		X

Table 8.1 NPS Pollution Control Programs On- and Off-Reservation

	Primary NPS Pollution Categories								Potential NPS Pollution Categories									
Program	**Agriculture**		**Silviculture**		**Hydro-modification**		**Urban Runoff**		**Construc-tion**		**Atmo-spheric Deposition**		**Highway Maint. and Runoff**		**Land Disposal**		**Ground Water Withdrawal**	
	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off
Puget Sound Water Quality Management Program (Ecology)		X		X		X		X		X		X		X		X		X
State Revolving Loan Fund (DOH)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Washington State Water Pollution Control Act (Ecology)		X		X		X		X		X		X		X		X		X
Washington State Ground Water Management Program (Ecology)		X		X				X		X		X		X		X		X
Federal and State Wetland Mitigation Banks Rule (Corps, EPA, Ecology)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Habitat Conservation Programs (NMFS, USFWS)	X	X	X	X	X	X	X	X	X	X			X	X	X	X		
SEPA review of proposed projects (Whatcom County, Ecology, Local Governments)		X		X		X		X		X		X		X		X		
Nooksack Salmon Enhancement Association	X	X	X	X	X	X	X	X										
Whatcom County Land Trust	X	X	X	X	X	X	X	X					X	X				
Whatcom Watershed Information Network (WSU, Whatcom County)	X	X			X	X	X	X	X	X	X	X	X	X	X	X		
Cooperative Extension Service	X	X																
Natural Resources Conservation Service (USDA)	X	X																
Environmental Quality Initiative Program (USDA)	X	X																
Conservation Reserve Enhancement Program (USDA)	X	X																
Wildlife Habitat Incentive Program (USDA)	X	X																
Public Law 566 Small Watershed Protection and Flood Prevention Act (USDA)	X	X																
Conservation Technical Assistance Program (USDA)	X	X																
Emergency Conservation Program (USDA Farm Agency)	X	X																
Rural Clean Water Act Program (USDA)	X	X																

Table 8.1 NPS Pollution Control Programs On- and Off-Reservation

	Primary NPS Pollution Categories								Potential NPS Pollution Categories									
Program	**Agriculture**		**Silviculture**		**Hydro-modification**		**Urban Runoff**		**Construc-tion**		**Atmo-spheric Deposition**		**Highway Maint. and Runoff**		**Land Disposal**		**Ground Water Withdrawal**	
	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off
Farmer's Home Administration (USDA)	X	X																
Rural Development Administration (USDA)	X	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sustainable Agriculture Research and Education (USDA)	X	X																
Agriculture in Concert with the Environment Program (USDA and EPA)	X	X																
Whatcom County Manure Ordinance		X																
Whatcom County Conservation District	X	X																
Washington Sate Dairy Nutrient Management Act (Washington State Department of Agriculture)		X																
Natural Resources Ordinance, LCL Title 10 (LNR)			X															
Lummi Nation Forestry Management Plan (LNR)			X															
BIA Forest Management Program (BIA)			X															
State Forest Practices Rules and Regulations including the Forest and Fish Report/Plan (DNR)				X														
State Forest Land Management Program (DNR)				X														
1987 Timber, Fish, and Wildlife Agreement (Washington State, Indian Tribes, Timber Industry)				X														
Watershed Analysis (DNR)				X														
Watershed Restoration Initiative Forest Roads (state agencies, Indian Tribes, conservation groups)				X														
Northwest Forest Plan (USFS)				X														
Nooksack Estuary Recovery Project					X													
Lummi Nation Wetland and Habitat Mitigation Bank (LNR)	X		X		X	X			X	X			X	X				
Lummi Coastal Zone Management Plan (Lummi Planning Department)					X													

Table 8.1 NPS Pollution Control Programs On- and Off-Reservation

	Primary NPS Pollution Categories								Potential NPS Pollution Categories									
Program	**Agriculture**		**Silviculture**		**Hydro-modification**		**Urban Runoff**		**Construc-tion**		**Atmo-spheric Deposition**		**Highway Maint. and Runoff**		**Land Disposal**		**Ground Water Withdrawal**	
	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off
Tidelands Code, LCL Title 13 (Lummi Planning Department)					X													
Flood Damage Prevention Code, LCL Title 15A (Lummi Planning Department)					X													
Flood Damage Reduction Plan (Lummi Planning Department)					X													
FEMA Unified Hazard Mitigation Assistance Program (FEMA)					X	X												
Wetlands Protection Development Grants (EPA)					X	X												
US Fish and Wildlife Service Grants (U.S. Department of the Interior)					X	X												
Whatcom County Comprehensive Flood Hazard Management Plan (Whatcom County)						X												
Hydraulic Project Approval Program (WDFW)						X												
Washington Conservation Corps (Ecology)						X												
Environmental Justice to Small Community Groups (EPA)							X	X										
Integrated Solid Waste Management Plan (Lummi Planning Department)															X			
Solid Waste Control and Disposal Code, LCL Title 18 (Lummi Planning Department)							X								X			
Resource Conservation and Recovery Act (EPA)							X	X	X	X					X	X		
Municipal Storm Water Management Plans (local governments, Ecology)								X										
Municipal Separate Storm Sewer System Permits (Ecology, EPA)								X										
Disposal of Toxics Program (Whatcom County)								X										
Small Business Hazardous Waste Reduction Program (Ecology, City of Bellingham, Whatcom County)								X										

Table 8.1 NPS Pollution Control Programs On- and Off-Reservation

	Primary NPS Pollution Categories								**Potential NPS Pollution Categories**									
Program	**Agriculture**		**Silviculture**		**Hydro-modification**		**Urban Runoff**		**Construc-tion**		**Atmo-spheric Deposition**		**Highway Maint. and Runoff**		**Land Disposal**		**Ground Water Withdrawal**	
	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off
Community Litter Clean Up Program (Ecology)								X										
Beyond Waste Program (Ecology)								X										
Hazardous Waste Management Program (Ecology)								X										
Sand and Gravel General Permit Program (Ecology)										X								
State Surface Mining Act (DNR)										X								
Air Quality Program (EPA)											X	X						
Northwest Air Pollution Control Authority												X						
Federal Intermodal Surface Transportation Act of 1991																		
Road Maintenance (Whatcom County)											X	X						
Inspection of onsite septic systems (LTSWD)															X			
Inspection of onsite septic systems (Whatcom County)																X		
The settlement negotiated to resolve the federal ground water lawsuit regarding Lummi Peninsula (*United States, Lummi Nation v. Washington State Department of Ecology, et al*, Civ. No. 019047Z W.D. Wash.)																	X	
Washington State Water Right Permit Process (Ecology)						X											X	X

8.2. Lummi Indian Business Council Environmental Programs

Fifteen Lummi Indian Business Council (LIBC) environmental programs on the Reservation directly relate to managing Reservation water quality. Other programs may indirectly protect Reservation water quality (e.g., Public Health and Safety). These environmental programs are part of the LIBC's efforts to protect the political integrity, economic security, health, and welfare of the Lummi Nation and all Reservation residents. The Lummi Natural Resources Department (LNR) administers eight of the programs and the Lummi Planning Department administers seven programs. These fifteen LIBC environmental programs address the current and potential impairments of water quality on the Reservation.

The LNR administers the following environmental programs pursuant to its authority delegated by the LIBC through the Natural Resources Code (Lummi Code of Laws [LCL] Title 10) and the Water Resources Protection Code (LCL Title 17):

- Surface Water Quality Monitoring Program
- Ground Water Monitoring Program
- Comprehensive Water Resources Management Program
    - Storm Water Management Program
    - Wellhead Protection Program
    - Wetland Management Program
    - Non-Point Source Pollution Management Program
    - Water Quality Standards Program
- Case-Specific Investigations of Water Quality Problems
- Nooksack Estuary Recovery Project
- Natural Resources Management
- Spill Prevention and Response Plan
- Multi-Hazard Mitigation Plan

The Lummi Planning Department administers the following programs pursuant to its authority delegated by the LIBC through the Tidelands Ordinance (LCL Title 13), Land Use, Zoning and Development Code (LCL Title 15), Flood Damage Reduction Code (LCL Title 15A), Sewer and Water District Code (LCL Title 16), and the Solid Waste Control and Disposal Code (LCL Title 18):

- General Land Use Plan
- Land Use Permitting/Technical Review Committee
- Lummi Tribal Sewer and Water District
- Integrated Solid Waste Management Plan
- Flood Damage Reduction Plan
- Coastal Zone Management Plan
- Tidelands Management

8.2.1. Surface Water Quality Monitoring Program

The Lummi Nation Surface Water Quality Monitoring Program was started in 1993 and currently includes sampling at 43 sample stations (sites) on and around the Reservation. The Program has grown significantly in the number of sites sampled, the parameters measured, and the ability to manage and analyze collected data. Additional sites were added in the late 1990s to better evaluate the water quality impacts of Nooksack River water on Portage Bay and to better evaluate conditions in the Lummi Bay watershed. The sampling program was modified to reduce sampling frequency and to discontinue sampling at several sites effective October 1, 2013 following a program evaluation (see Appendix D). Figure 2.1 shows the locations of the current water quality sampling sites on the Reservation and the DOH sample sites in Portage Bay. Many of the 43 sample sites are located along the Reservation border, with the majority of the contributing watersheds located off-Reservation. Several intermittent streams and storm water systems are sampled as part of the Program, along with the marine waters of Lummi Bay, Portage Bay, and the Sandy Point Marina.

In consultation with the Lummi Nation and under 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 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. The Lummi Water Resources Division (LWRD) samples the 12 DOH sites in Lummi Bay to provide logistical assistance to the DOH (the sites are only accessible during short duration and limited tidal conditions) and also to assist with the achievement of Program goals. The DOH currently samples 12 sites in Portage Bay six times a year and, following the recent closure, the LWRD has started sampling the 12 sites in Portage Bay on behalf of DOH (LWRD staff collects the samples and DOH pays for the shipment and analysis of the samples at the FDA approved laboratory operated by DOH) during the months that Portage Bay is not sampled by DOH.

For all LWRD sample sites, water temperature, air temperature, water depth, specific conductivity, salinity, dissolved oxygen, pH, turbidity, fecal coliform bacteria, *E. coli*, and enterococci, and are measured and recorded. Secchi disk depth is measured at the marine sites. In accordance with the quality assurance plan for the laboratory, the contracted independent laboratory measures all bacteria from the same sample bottle, and fecal coliform bacteria and *E. coli* are measured from the same culture (LWRD 2014c). On a quarterly basis at selected sites, samples for nutrients, total petroleum hydrocarbons, and metals are collected for analysis at a laboratory certified by Washington State. Due to the costs of analyzing water quality samples for metals and petroleum hydrocarbons, these parameters are only measured quarterly at two of the water quality monitoring sites (one fresh water site downstream from a petroleum oil refinery and one marine water site within a recreational boat marina). Similarly, due to cost considerations, nutrients are measured quarterly at only five of the surface water quality monitoring sites. All measurements are performed and recorded in accordance with a Quality Assurance and Quality Control (QA/QC) plan most recently approved by the EPA in May 2010.

The Surface Water Quality Monitoring Program is intended to collect baseline information about the quality of Reservation surface waters and to identify and locate point and nonpoint source pollution problems. It also supports the implementation of the Lummi Water Quality Standard program. Bacteria data from sample sites along the Reservation boundary are shared with Ecology and Whatcom County to identify and address water quality problems that originate off-Reservation. Information from the Surface Water Quality Monitoring Program has also been used to assist the DOH with shoreline surveys associated with the NSSP.

8.2.2. Ground Water Monitoring Program

The Lummi Nation Ground Water Monitoring Program started in 1993 and included monthly water quality sampling of approximately 28 wells (the number of wells sampled each year varied over time as additional wells became available) until the results of the ambient water quality program review became effective on October 1, 2013 (see Appendix D). Following the review, the sampling frequency of the 28 monitoring wells on the Reservation was reduced to 4 or 5 times per year depending on the type of well (monitoring well or supply well respectively). The number of wells sampled has increased over the years and the parameters measured have changed to include pH and salinity measurements. Wells were added as they were drilled or when access was granted to obtain better spatial resolution of aquifer conditions. Water level, pumping status, temperature, specific conductivity, pH, salinity, and chloride concentration are measured monthly or more frequently at each site. Well production is recorded from existing meters at the Lummi Tribal Water District water supply wells. If a well is not sampled when scheduled, the well is sampled as soon as possible afterwards. All measurements are performed and recorded in accordance with a QA/QC plan (LWRD 2010).

The purpose of the Ground Water Monitoring Program is to collect baseline information about the quality and quantity of Reservation ground water. The chloride concentration, pumping rate and amounts, and water levels of the water supply wells provide critical information about aquifer conditions, pumping regimes, and the need for protective measures as these data indicate whether seawater intrusion is occurring or if the likelihood of seawater intrusion has increased. For wells that are not used for water supply purposes (e.g., inactive wells), water level measurements provide information about aquifer conditions.

8.2.3. Comprehensive Water Resources Management Program

The Lummi Nation Natural Resources Department’s (LNR) Water Resources Division established a Comprehensive Water Resources Management Program in response to Lummi Indian Business Council (LIBC) resolutions 90-88 and 92-43. The purpose of the CWRMP is to ensure that land and water resources on the Lummi Indian Reservation are safeguarded against surface and ground water degradation during planning and development activities. Environmental planning intended to protect the Nation’s water resources has included development of a Wellhead Protection Program (LWRD 1997a, LWRD 2011b), a Storm Water Management Program (LWRD 1998a, LWRD 2011a), a Wetland Management Program (LWRD 2000), a Nonpoint Source Pollution Management Program (LWRD 2001b, LWRD 2002), Water Quality Standards for Reservation surface waters (LWRD 2008a), surface and ground water quality monitoring (LWRD 2010), and spill prevention and response (LWRD 2005). The various Lummi Natural Resources Department programs are complemented by several programs associated with the Lummi land use permitting process. Fact sheets describing the Comprehensive Water Resources Management Program can be downloaded from the following website: http://lnnr.lummi-nsn.gov/LummiWebsite/Website.php?PageID=52.

As part of the Comprehensive Water Resources Management Program, the Water Resources Protection Code (LCL Title 17) was developed to protect, enhance, and restore water quality in the Reservation surface and ground water including the Reservation estuaries and tidelands. Title 17 was adopted by the LIBC in January 2004. The water resources protection code is intended to provide for technically sound, legally defensible, and administratively efficient management of Reservation waters. A copy of LCL Title 17 Water Resources Protection Code can be downloaded from the following website: http://lnnr.lummi-nsn.gov/LummiWebsite/Website.php?PageID=53.

Storm Water Management Program

The purposes of the Lummi Nation Storm Water Management Program are to (1) protect Reservation surface waters, ground water, and tidelands from contamination, and (2) protect downstream property owners from upstream development. The 1998 technical background document, the updated 2011 technical background document, a storm water ordinance, and storm water regulations have been completed. The Lummi Storm Water Management Regulations provides guidance for development of Storm Water Pollution Prevention Plans and was approved by the Lummi Indian Business Council in July 2010. As part of the Storm Water Management Program, and consistent with the Lummi Nation’s 401 certification of the NPDES General Permit for Storm Water Discharges from Construction Activities, the Lummi Water Resources Division staff continue to review Storm Water Pollution Prevention Plans and Site Plans for proposed development and to inspect construction sites to ensure compliance with approved pollution prevention plans. A fact sheet describing the Storm Water Management Program, the storm water regulation, the technical background document, and the technical background update can be downloaded from the following website: http://lnnr.lummi-nsn.gov/LummiWebsite/Website.php?PageID=81.

In general, the Storm Water Management Program helps protect against NPS pollution by (1) identifying receiving waters using maps of storm water facilities and the Reservation stream and ditch network inventoried during 1998 and 2010; (2) identifying and analyzing potential pollutant sources and impacts; and (3) identifying and applying appropriate best management practices and/or other land use permit conditions (e.g., changing a project to avoid an impact) to prevent pollution of Reservation surface waters.

Wellhead Protection Program

The purpose of the Lummi Nation Wellhead Protection Program is to protect the Reservation ground water supplies from contamination. A technical background document (LWRD 1997a, LWRD 2011b), LCL Title 17, and a regulation for well construction standards for wellhead protection have been completed. The Wellhead Protection Program technical background document was updated during 2011 to reflect new information and changing conditions on the Reservation. The Lummi Water Resources Division staff are also implementing the settlement negotiated to resolve the federal ground water lawsuit regarding the Lummi Peninsula Aquifer (*United States, Lummi Nation v. Washington State Department of Ecology, et al*, Civ. No. 019047Z [W.D. Wash.]). A fact sheet describing the Wellhead Protection Program can be downloaded from the following website: http://lnnr.lummi-nsn.gov/LummiWebsite/Website.php?PageID=83.

In general, the Wellhead Protection Program helps protect against NPS pollution through mapping specific wellhead protection areas, identifying potential pollutant sources, decommissioning selected wells, and identifying and applying best management practices to prevent pollution of Reservation ground waters at the scale of both the overall recharge area and the specific wellhead areas.

Wetland Management Program

The goals of the Lummi Nation Wetland Management Program are to (1) protect Reservation ground water supplies; (2) protect surface water resources, including tidelands and estuaries; (3) protect both the functions and values of Reservation wetlands; and (4) accommodate the interests of businesses and property owners by providing defined wetland management standards, requirements, and mitigation alternatives for efficient and effective project planning. A Reservation wetland inventory, a technical background document, LCL Title 17, and Wetland Management Regulations have been completed and the community education component continues. The LWRD staff continue efforts to develop a wetland and habitat mitigation bank on the Reservation to provide compensatory mitigation of unavoidable impacts to Lummi Nation Waters and water of the United States, including wetlands. Phase 1A of the Lummi Nation Wetland and Habitat Mitigation Bank became operational in July 2012. The LWRD staff also continues to improve and update the wetland inventory, review wetland mitigation plans for proposed development, and evaluate land use permit application for potential impacts on Reservation wetlands. A fact sheet describing the Wetland Management Program can be downloaded at the following website: http://lnnr.lummi-nsn.gov/LummiWebsite/Website.php?PageID=84.

In general, the Wetland Management Program helps protect against NPS pollution by (1) identifying receiving waters using maps of wetland locations (LWRD 2014a); (2) identifying wetland functions and values in need of protection; and (3) identifying and applying best management practices and/or other conditions to protect the beneficial functions of wetlands.

Non-Point Source Pollution Management Program

The goal of the Lummi Nation Nonpoint Source (NPS) Pollution Management Program, which is a watershed-based approach that includes this NPS Pollution Assessment Report (NPSPAR) and a NPS Pollution Management Plan, is to effectively and efficiently control nonpoint sources of pollution on the Lummi Indian Reservation (Reservation). The watershed-based approach of the Lummi Nation NPS Pollution Management Program includes coordination with appropriate jurisdictions to control nonpoint sources of pollution in the watersheds that discharge to the Reservation. A NPS Pollution Assessment Report and a NPS Pollution Management Plan were developed during 2001 and 2002 respectively and the management plan has been implemented in conjunction with the other elements of the CWRMP. Specific actions that have been conducted during the plan implementation include advancing the wetland inventory update effort of the wetland management program, decommissioning wells, and participating in watershed management efforts including the South Fork Nooksack River Temperature TMDL and the Whatcom Clean Water Program.

Both the NPS Pollution Assessment Report and the NPS Pollution Management Plan are currently being updated. The objectives of this NPS Pollution Assessment Report are: (1) to determine the current and potential impairments of Reservation water bodies due to NPS pollution, (2) to identify the primary NPS pollution types responsible for these impairments, and (3) to identify the resources available to address NPS pollution. The objectives of the NPS Pollution Management Plan are: (1) to identify management practices that will reduce NPS pollution on the Reservation; (2) to identify and implement on-the-ground projects that protect or restore water quality on the Reservation and in the watersheds that discharge to the Reservation; (3) to encourage public involvement and education directed toward reducing or eliminating NPS pollution sources; and (4) to coordinate with appropriate jurisdictions to reduce off-Reservation NPS pollution that adversely affects Reservation surface and ground water resources.

Water Quality Standards Program

The purpose of the Lummi Nation Water Quality Standards program is to attain fishable and swimmable waters within the Reservation and to adopt and implement rules to protect and enhance public health. The Lummi Nation Water Quality Standards apply to all surface water of the Reservation. The Lummi Nation works in close cooperation with federal, state, and local agencies to address water quality issues. As part of this effort, the Lummi Nation applied to the EPA for eligibility to administer the water quality standards program under Section 518 of the Federal Clean Water Act (CWA). On March 5, 2007 the EPA determined that the Lummi Nation met the requirements of CWA Section 518(e) and EPA regulations from 40 CFR Part 131 and therefore approved the Lummi Nation's application for "treatment in the same manner as a State" (TAS) to administer the water quality standards program under Section 303(c) of the CWA. Pursuant to 40 CFR Section 131.4(c), the Lummi Nation was also found to be eligible to the same extent as a state for the purpose of certification under CWA Section 401 for those waters on the Reservation.

In 1997, the Lummi Nation developed draft Water Quality Standards but did not seek approval pending the EPA eligibility decision. In 2006, the Lummi Nation revised the draft Water Quality Standards to incorporate new scientific information. Following a public hearing and public comment period, the Water Quality Standards for Surface Waters of the Lummi Indian Reservation were adopted by the Lummi Nation in August 2007 and approved by the EPA on September 30, 2008. A fact sheet describing the Water Quality Standards program can be downloaded from the following website: http://lnnr.lummi-nsn.gov/LummiWebsite/Website.php?PageID=82.

In general, the Water Quality Standards and associated anti-degradation policies provide an administrative and legal mechanism to ensure attainment of the water quality needed to support beneficial uses.

8.2.4. Case Specific Investigations of Water Quality Problems

The staff of the Lummi Nation Water Resources Division conduct water quality investigations when specific items or problems are identified that threaten Reservation waters. Sample bottles for metals, nutrients, total petroleum hydrocarbons, and bacteria are maintained specifically for these investigations and arrangements have been made with a contracted, accredited, analytical laboratory to accept samples during holidays and weekends if necessary. These investigations are intended to provide information needed to evaluate identified threats and to determine appropriate responses to address the threat. An example of a case specific investigation is shown in Appendix E, which summarizes the investigation results of the Lummi Auto Recycler facility.

8.2.5. Nooksack Estuary Recovery Project

In response to declining Nooksack River salmon stocks, in 1998 the LIBC passed Resolution No. 98-62, which authorized the Lummi Natural Resources Department to evaluate the Nooksack Estuary Recovery Project. This action led to a public meeting on August 19, 1998 to present the conceptual plan for the project and to solicit input. Over 45 state, federal, tribal, and local government agency representatives and elected officials or their representatives attended the public meeting. Following from this, a Section 22 Planning Study was undertaken by the U.S. Army Corps of Engineers (Corps) and the Lummi Natural Resources Department to evaluate restoration opportunities in the Nooksack River estuary. The Lummi Nation has continued to move forward with the Nooksack Estuary Recovery Project and has completed an estuary habitat assessment, developed a hydraulic model of the estuary, and developed a restoration/mitigation concept for Reservation lands in the floodplain.

Figure 8.1 shows the acquisition and use plan that was authorized by the LIBC through Resolution 2009-094 and illustrates that the Lummi Nation Wetland and Habitat Mitigation Bank is located adjacent to several restoration project sites. The Lummi Nation Wetland and Habitat Mitigation Bank is comprised of three separate sites known as the Nooksack Delta Site, the Blockhouse Site, and the Lummi Delta Site with a total area of approximately 1,945 acres. The location of each of these sites on the Reservation is shown on Figure 8.1.

The anticipated ecological benefits of enhancing the Nooksack Delta Site include reducing invasive species cover and increasing native plant species diversity. Although the Nooksack Delta Site remains in a relatively natural state of primarily forested and scrub-shrub wetlands, substantial habitat improvements could be made that would yield long-term and significant ecological benefits. Index ratings such as habitat suitability for invertebrates, amphibians, and anadromous fish could be improved by removal of invasive species and increasing the ratio of interspersion between vegetation and open water areas. Native plant richness is being improved in the Nooksack Delta Site by underplanting with coniferous trees. When combined, these actions will result in increased habitat diversity and higher ecological function over time. The anticipated ecological benefits of restoring the Lummi Delta Site and the Blockhouse Site include anadromous salmonid habitat improvements and re-establishment and rehabilitation of estuarine scrub-shrub wetlands, inter-tidal emergent wetlands, and forested wetland/shrub wetlands along the wetland/upland transition zone.

In addition to these efforts, the Lummi Natural Resources Department staff have been participating in the development of the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP). The PSNERP is a multi-year partnership between the U.S. Army Corps of Engineers and the Washington Department of Fish and Wildlife (WDFW) to formulate, evaluate, and select an ecosystem restoration plan for sites throughout Puget Sound. The Nooksack River estuary is one of 11 tentatively selected plans of the PSNERP, which should advance efforts to implement the Nooksack Estuary Recovery Project.

8.2.6. Lummi Natural Resources Code

The Lummi Natural Resources Code (LCL Title 10) establishes rules and regulations related to seafood harvesting, hunting, and forestry. The primary portions of Title 10 that apply to Reservation water quality relate to shellfish harvest and forestry activities. Any activity that produces a forest product requires a permit from the Lummi Natural Resources Department before the harvest activity. As part of the permitting process for timber harvests, best management practices intended to protect water quality are required.

8.2.7. Spill Prevention and Response Plan

The Lummi Natural Resources Department has been actively developing spill response capabilities since the mid-1990s and completed the Lummi Nation Spill Prevention and Response Plan in October 2005 (LWRD 2005). This plan identifies measures the Lummi Nation can take to prevent spills of polluting material on the Reservation and actions the Lummi Nation should take in response to spills on- or off-Reservation that threaten Reservation waters. This plan is scheduled to be updated during 2015.

Large amounts of crude oil, petroleum products, and other hazardous materials are transported and stored near the Lummi Indian Reservation. These hazardous materials are transported by ships, pipelines, trucks, and railroad and are used, produced, and/or stored throughout the Reservation area, particularly in the Cherry Points Heavy Impact Industrial Zone immediately north of the Reservation boundary. Spills or releases of petroleum products, chemicals, or other hazardous materials to land or waters can threaten public safety, public health, and destroy some of the most productive and valuable ecosystems in the world. The Lummi Police Department and the Lummi Natural Resources Department, in cooperation with local spill response organizations (e.g., Marine Spill Response Corporation), local refineries, the Whatcom County Division of Emergency Management (in the county Sheriff's Department), and other local fire and police agencies are trained and prepared to respond to minor spills or releases of some hazardous materials. In response to a major spill, experts from the Coast Guard, EPA, National Marine Fisheries Service, U.S. Fish and Wildlife Service, Washington Department of Ecology, Marine Spill Response Corporation, and other local and national contractors would be called in to help control the damage. The Spill Prevention and Response Plan further describe the emergency response capabilities of these agencies.

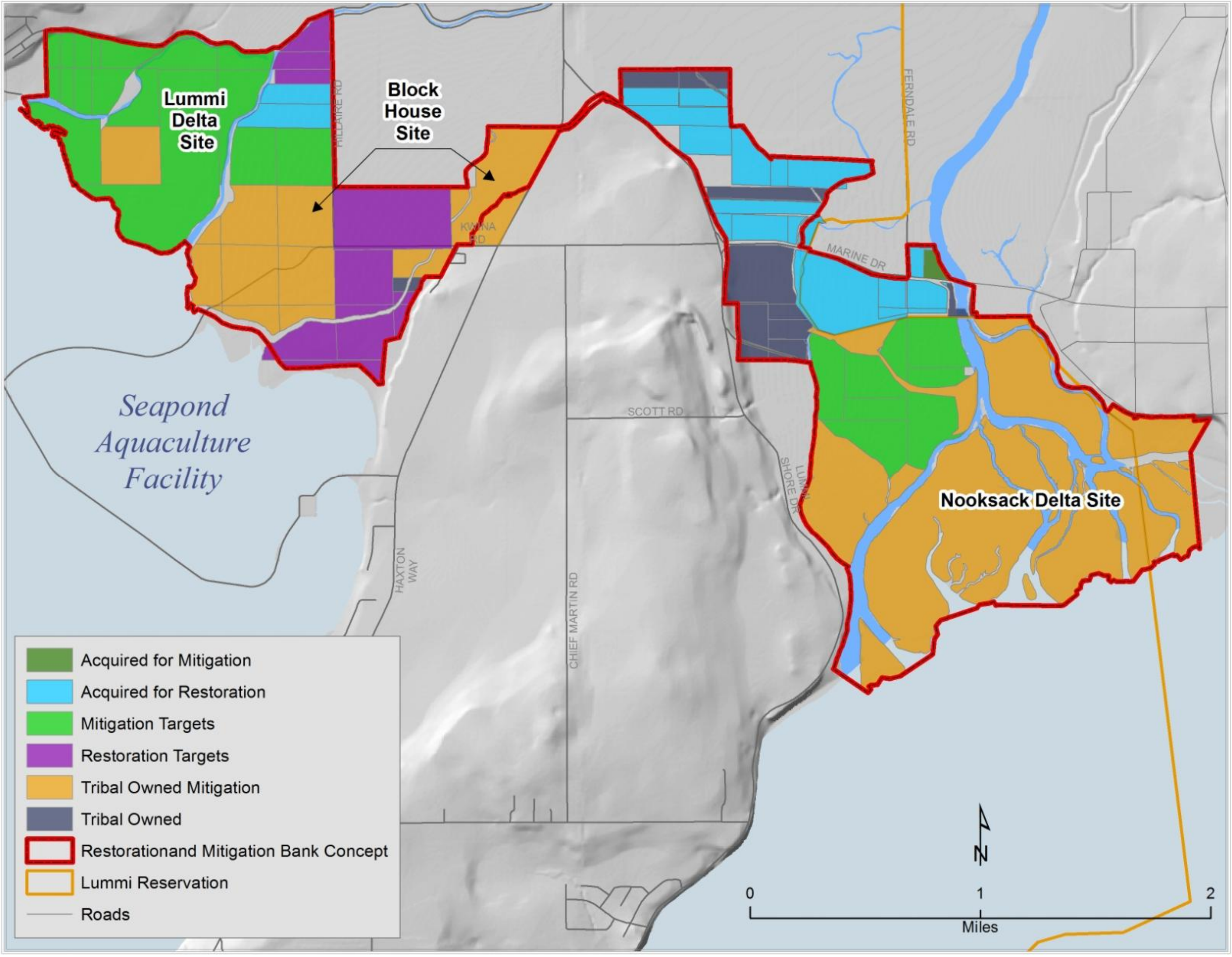

Figure 8.1 Acquisition and Use Plan for Reservation Lands in the Floodplain

The Lummi Natural Resources Department continues efforts to develop spill prevention and response capabilities through staff training, spill response drills, equipment upgrades, planning, research, and public outreach. Spill prevention and response training for staff members is conducted through both dedicated classes and through table-top and boom deployment exercises. The oil spill prevention and response activities are publicized in the community through articles in the Lummi Nation monthly newspaper (*Squol Quol*). The Lummi Natural Resources Department staff also regularly conducts data collection activities and research in support of the oil spill prevention and response capability development by documenting background and ambient conditions. This information will be useful in evaluating the effectiveness of response efforts in the event of an oil spill. These efforts contribute to achieving the Lummi Nation goals of protecting the public health and safety of Reservation residents and protecting treaty rights to hunt, fish and gather throughout all usual accustomed areas and traditional territories.

8.2.8. Multi-Hazard Mitigation Plan

The purpose of the Lummi Nation Multi-Hazard Mitigation Plan (MHMP) is to guide current and future efforts to mitigate the impacts of natural hazards on the Reservation. The MHMP provides an assessment of the vulnerabilities of the Reservation to natural hazards and documented the fact that the Reservation is vulnerable to flooding, earthquakes, severe winter storms, wind storms, coastal erosion, drought, wildfires, landslides, tsunamis, volcano eruptions, and tornadoes. The Lummi Nation determined that these natural hazards on the Reservation have a direct, serious and substantial effect on the political integrity, economic security, health and welfare of the Lummi Nation, its members, and all persons present on the Reservation. The MHMP provides actions to reduce or mitigate future damages from natural hazards. The MHMP was originally developed and approved by the LIBC and FEMA in 2004. Subsequent updates of the plan were developed and approved by both the LIBC and FEMA during 2007 and 2010. The 2010 MHMP can be downloaded from the following website: http://lnnr.lummi-nsn.gov/LummiWebsite/Website.php?PageID=79. The MHMP is scheduled to be updated again during 2015. By reducing natural hazard damage, the actions listed in the MHMP will reduce the transport of NPS pollution to Reservation waters.

8.2.9. General Land Use Plan

The Lummi Planning Department developed a General Land Use Plan for the Lummi Reservation. The plan shows generally how land on the Reservation will be used over the next 20 years. The General Land Use Plan identifies areas that will be developed for residential, commercial, industrial, and agricultural purposes, as well as showing areas that require protection (e.g., wetlands and aquifer recharge zones). To date, a technical background document (LIBC 1996) was developed, public-opinion surveys conducted, a preliminary version of the General Land Use Plan drafted, a second round of maps developed, and focused planning workshops and meetings with commissions and community groups have occurred. The General Land Use Plan was codified in the Lummi Land Use Zoning and Development Code (LCL Title 15). The General Land Use Plan and the LCL Title 15 will prevent NPS pollution by ensuring that land use is compatible with the landscape, that infrastructure is developed in a coordinated fashion, and that development should have the overall effect of minimizing land disturbing activities.

8.2.10. Technical Review Committee

The Technical Review Committee (TRC) was established by the LIBC in 1997 (Resolution No. 97-104) in response to increasing development pressure on the Reservation and the need for coordinated review of Reservation development projects. Resolution No. 97-104 charged the TRC with reviewing proposed land-use activities on the Reservation and implementing tribal and federal laws to protect public and private resources. The TRC consists of representatives from the following LIBC departments or divisions of departments: Cultural Resources Protection, Economic Development, Police, Maintenance, Tribal Employment Rights Office, Natural Resources, Education, Lummi Tribal Sewer and Water District, Housing, Realty, and Planning. The TRC meets weekly to review land use permit applications distributed to committee members before the meeting. At the TRC meeting, comments and conditions are stated and the application is either delayed for further information or a Lummi Land Use Permit is approved, approved with conditions, or denied. The TRC also determines whether a tribal environmental assessment (TEA) is necessary to determine if significant environmental impacts will result from the proposed project or activity.

Land use activities can affect many people. Without careful planning, future opportunities for development may be lost to current land use activities. The TRC is providing for comprehensive and balanced review of proposed land use activities on the Reservation. Participation of the LNR department in the TRC provides for the protection of natural resources as well as an opportunity to provide information to applicants that can help avoid natural resource impacts or otherwise improve their projects.

8.2.11. Integrated Solid Waste Management Plan

The Lummi Planning Office began the solid waste planning process for the Lummi Indian Reservation in the mid-1970s with the preparation of the report titled *Solid Waste Disposal: A Preliminary Survey* (Lummi Planning Department 1978). This report was forwarded to the EPA for review in July 1978, and the Lummi Nation submitted a formal request for technical assistance to the EPA in September 1978. The 1979 Lummi Solid Waste Management Plan (Harper-Owes 1979) was prepared as part of an EPA technical assistance project under the provisions of the 1976 Resource Conservation and Recovery Act (RCRA). The Lummi Solid Waste Management plan was adopted by the LIBC in 1979. An updated Integrated Solid Waste Management Plan (ISWMP) was adopted by the LIBC during March 2014 (LIBC Resolution 2014-077).

The purpose of the Lummi Nation Integrated Solid Waste Management Plan is to guide current and future efforts to effectively and efficiently manage solid waste on the Lummi Reservation over the 2014-2024 period. It also guides efforts to protect and restore environmental trust resources including water resources, shorelines, tidelands, and uplands through proper management and disposal of solid and hazardous waste. The Lummi Indian Business Council, through the Planning Department and the Natural Resource Department, is the solid waste planning and regulatory authority on the Reservation. A designated solid waste management program was initiated in 2002 by the LIBC and operated under the direction of the Vice Chairman's office through 2003. In 2004, the solid waste management program, "Project Clean-Up", was institutionalized within the administrative structure of the LIBC by moving the program from the Office of the Vice Chairman to the Lummi Planning Department. This program was renamed "Lummi Waste Management." The Lummi Solid Waste Management Team was created out of this program consisting of a Waste Management Team Lead, the Water Resources Division Manager, the Land Development Division Manager, and the Lummi Housing Authority Director.

In 2004, the Lummi Nation adopted a Solid Waste Control and Disposal Code (LCL Title 18). Title 18 provides the policy framework and delegation of administrative authority for a coordinated program to address the accumulation, collection, and disposal of solid waste; the resource recovery, recycling, and utilization of recyclable materials; and the creation and operation of disposal sites and transfer stations. One goal of the Lummi ISWMP is to minimize NPS pollution from illegal dumping from entering Lummi Nation waters.

8.2.12. Sewer and Water District Code

The Lummi Tribal Sewer and Water District (LTSWD), which is a quasi-autonomous district governed by a separate Water District Board and a Sewer District Board that are elected is administratively within the Lummi Planning Department. The LTSWD operates a water treatment and distribution system and a comprehensive Reservation-wide sewage collection and treatment system that serves the majority of households on the Reservation. The sewer facilities consist of sewer collectors, sewer interceptors, 25 lift stations, a biosolids application site, and three treatment plants, including a Membrane BioReactor (MBR) Plant completed in 2004. A new sequencing batch reactor wastewater treatment plant is planned for construction during 2015 to replace outdated rotating biological contactor Sandy Point Wastewater Treatment Plant. In addition, during 2014 new sewer lines were installed along Salt Spring Drive and other locations within the Sandy Point Improvement Company housing development to replace on-site septic systems. For residences not on a sewer line, the Sewer and Water District Code (LCL Title 16) regulates sewage disposal for public health and safety and establishes criteria for the design, construction, alteration, and operation of on-site septic systems. The Lummi Tribal Sewer District enforces LCL Title 16 and inspects on-site septic systems. The sewer district and LCL Title 16 serve to minimize NPS pollution by ensuring that appropriate sanitary sewer facilities are used by Reservation residents and that the systems are operated and maintained in a manner that protects public health.

The Lummi Tribal Sewer and Water District also operates the largest potable water system on-Reservation though consolidated management (e.g., pumping, treatment, and distribution of potable water), which reduces the potential for salt water intrusion and allows for the decommissioning of wells. Salt water intrusion represents a NPS pollution threat to both aquifers on the Reservation. In addition, abandoned wells that are not properly decommissioned could lead to direct contamination of ground water through conveyance of pollutants associated with storm water or through other means.

8.2.13. Flood Damage Reduction Plan

The Lummi Natural Resources Department developed a Flood Damage Reduction Plan (FDRP) during 2001 to complement the Flood Damage Prevention Code (LCL Title 15A) that was adopted in 1997 by the LIBC through Resolution No. 97-119. The adoption of Title 15A made the LIBC eligible to participate in the National Flood Insurance Program (NFIP) administered by the Federal Emergency Management Agency. Title 15A established construction requirements for development in flood hazard areas; new construction that meets these requirements can be insured under the NFIP. The large portion of the Reservation that lies in the floodplains of the Lummi and Nooksack rivers and the coastal areas of the Reservation (especially the Sandy Point Peninsula and Gooseberry Point) are vulnerable to flood damage and the resulting transport of NPS pollutants to the Reservation tidelands and estuaries. The 2001 FDRP identified actions that will reduce the vulnerability to flood damage on the Reservation and its waters. The FDRP was incorporated into the 2004 Multi-Hazard Mitigation Plan (MHMP) and was subsequently updated in 2007 and 2010. By reducing flood damage, these actions will reduce the transport of NPS pollution to Reservation waters.

8.2.14. Coastal Zone Management Plan

The purpose of the Lummi Nation's 1979 Coastal Zone Management Program is threefold: to protect and preserve the shoreline areas of the Lummi Nation, to implement the United States Coastal Zone Management Act of 1972, and to cooperate with the state of Washington in the implementation of the Washington State Coastal Zone Management Program and the Washington State Shoreline Management Act. The Lummi Nation Coastal Zone Management Program provides guidelines for reviewing development proposals within the coastal zone according to established environmental principles. The policies were developed around the elements found in the guidelines for the Washington State Environmental Policy Act and the Washington State Shoreline Management Act. The Lummi Nation Coastal Zone Management Program is currently being updated and following a public comment period, will be presented to the LIBC for approval during 2015.

A Coastal Zone Management Permit (a.k.a. coastal zone permit) must be obtained from the Lummi Planning Department for all non-exempt permitted uses and conditional uses before any construction or other activities take place within 200 feet of Reservation shorelines (i.e., the coastal zone). Similarly, the Lummi Coastal Zone Management Plan is used by the Lummi Nation to make Coastal Zone Consistency Determinations for CWA Section 404 and/or Rivers and Harbor Act Section 10 permitting actions by the U.S. Army Corps of Engineers. The Lummi Coastal Zone Management Program minimizes NPS pollution along Reservation shorelines by prohibiting or limiting certain activities in the coastal zone and ensuring the application of best management practices intended to prevent pollution.

8.2.15. Tidelands Management

The Tidelands Code (LCL Title 13) establishes rules and regulations related to uses of tribal tidelands. Tidelands are defined as any lands, including beaches, seaward of the line of natural vegetation or the meander line, whichever be more landward, along all salt water bordering the Reservation, including all such lands east of the Point Francis/Treaty Rock line. The Reservation tidelands extend to the Extreme Lower Low Water line (-4.5 feet mean lower low water). The tidelands code minimizes NPS pollution along Reservation tidelands by prohibiting or limiting certain activities on Reservation tidelands.

A temporary Tideland Access Permit is required for people who are not enrolled members of the Lummi Nation who wish to access certain areas of the Reservation tidelands. Other Reservation tidelands are closed for non-members. An application for a Lummi Nation Temporary Tideland Access Permit and associated restrictions that are intended to control NPS pollution sources can be obtained from the Planning Department (see Appendix F).

8.3. Programs and Activities Addressing Primary NPS Pollution Issues

Each of the three current or potential primary impairments of Reservation waters identified in this assessment report are currently being addressed by LIBC programs and by specific activities that are designed to help prevent or resolve the impairments. This section summarizes how these programs and activities address each impairment.

8.3.1. Shellfish Concerns in Portage Bay and Lummi Bay

The water quality in Portage Bay and Lummi Bay is being addressed by several actions or programs including:

- The Surface Water Quality Monitoring Program was expanded to include 19 sample sites in and around Portage Bay including five sample sites on Portage Island;
- The Surface Water Quality Monitoring Program was expanded to include a total of 20 sample sites in the Lummi Bay watershed, four sites in Lummi Bay, and 12 DOH sample sites;
- The LNR is working with the DOH to conduct and coordinate water quality sampling at 12 sites in Portage Bay and along Lummi Shore Road so that the LNR staff collect samples along Lummi Shore Road and contributing areas (e.g., bacterial levels in the Nooksack River, local uplands, or salinity distributions) at the same time the DOH collects samples in Portage Bay to help isolate NPS sources and to provide context for the DOH sample results;
- The LNR is working with Whatcom County to ensure that water quality in the Nooksack River watershed is sampled the day prior to the LWRD and DOH sampling in Portage Bay;
- The LNR is implementing the Water Resources Protection Code (LCL Title 17), which provides a regulatory mechanism to address Lummi Bay and Portage Bay water quality;
- The Lummi Natural Resources Department and the Lummi Planning Department worked cooperatively to remove feral cattle from Portage Island, which is a minor source of fecal coliform into Portage Bay due to the relatively low loading potential;
- The Lummi Tribal Sewer and Water District have installed updated and automated pump stations and backup generators, which reduces the possibility for a sewage spill during power outages;
- The LNR coordinates with EPA inspectors when potential problems are observed on-Reservation and in the Nooksack River watershed;

- The LNR has participated as a technical advisor to the Portage Bay Shellfish Protection District;
- The LNR coordinates with the Washington Department of Ecology and the Washington Department of Agriculture dairy inspectors when potential problems are observed off-Reservation in the Nooksack River and Lummi River watersheds; and
- The Lummi Tribal Sewer and Water District installed new sewer lines along the Sandy Point Peninsula during 2014 which removed approximately 40 homes from on-site septic systems and thereby reduced the potential for bacteria contamination in Lummi Bay;
- In cooperation with LNR, the Washington State Department of Natural Resources removed creosote pilings within Lummi Bay;
- The LNR participates in the Whatcom Clean Water Program, which was established in 2012 to help implement the Washington Governor's Shellfish Initiative and resulted in additional compliance enforcement actions by the Washington State Department of Ecology and the Whatcom County Health Department;
- The LNR is conducting restoration projects to improve estuarine connection from the Lummi River delta to the Nooksack River delta through the Smuggler's Slough watershed and flood control project;
- The LNR continues to develop a wetland and habitat mitigation bank in the Nooksack River and Lummi River deltas, which will treat contaminated runoff from the watershed through created or enhanced wetlands;
- The LNR is participating in the development and evaluation of the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP), which should improve nearshore areas including shellfish growing areas;
- The LNR completed a Lummi Intertidal Baseline Inventory (LNR 2010) to characterize the biota found along Reservation shorelines.

8.3.2. Salmonid Impairment in the Nooksack River Watershed

Salmonid impairment in the Nooksack River watershed and estuary is being addressed by several actions or programs including:

- As a salmon co-manager, the LNR is a co-lead in the development and implementation of the WRIA1 Salmon Recovery Plan and an active participant in the Puget Sound Partnership;
- The LNR is participating as an initiating government in the WRIA 1 Watershed Management Project;
- The LNR Restoration Division implements projects (e.g., engineered log jams, riparian plantings) throughout the Nooksack River watershed as part of the WRIA1 Salmon Recovery Plan implementation;
- The LNR Forest and Fish Division reviews Timber Harvest Plans and ensures that best management practices associated with silviculture activities are followed;

- The LNR Water Resources Division is monitoring and protecting estuarine water quality habitat via the Water Resources Protection Code (LCL Title 17);
- The LNR Water Resources Division conducts case specific investigations of water quality problems;
- The LNR is evaluating the improvement of estuarine habitat as part of the Nooksack Estuary Recovery Project and PSNERP;
- The LNR Restoration Division conducts restoration projects to improve estuarine salmonid habitat in along Smuggler's Slough;
- The LNR conducts research and monitors populations of salmonids in the Nooksack River watershed using a smolt trap and surveys of spawner grounds;
- The LNR has participated in instream flow negotiations for the Nooksack River;
- The LNR operates its salmon hatcheries pursuant to Hatchery Genetic Management Plans and the Multi-Sector General National Pollutant Discharge Elimination System Permits for salmon hatcheries; and
- As part of the Technical Review committee responsibilities, LWRD staff select appropriate BMPs to control NPS pollution.

8.3.3. Saltwater Intrusion and Aquifer Contamination

Saltwater intrusion and other sources of aquifer contamination are being addressed in several ways, some of which are beyond the scope of existing environmental programs (i.e., through implementation of a negotiated settlement of litigation over ground water rights on the Lummi Peninsula part of the Reservation). The programs and activities that are intended to protect ground water quality include:

- The Lummi Indian Business Council (LIBC) purchased and retired the wells of one water system that had experienced saltwater intrusion;
- The LIBC has shut down or curtailed production from tribal water supply wells when conditions that could lead to saltwater intrusion are observed (based in part on the Ground Water Monitoring Program);
- The LIBC offered to take over the operation of the private water systems on the Reservation and connect them to the Lummi Tribal Water District, which would allow individual wells to be shut down if saltwater intrusion occurred or was imminent, while still providing water to customers (only one private system became part of the Lummi Water District);
- The Ground Water Monitoring Program provides information for effective management of ground water resources;
- The LWRD implements the Water Resources Protection Code (LCL Title 17) and associated administrative regulations to protect aquifers from saltwater intrusion and other contaminant sources;
- The LIBC is implementing the settlement negotiated to resolve the federal ground water lawsuit regarding the Lummi Peninsula Aquifer (*United States, Lummi Nation v. Washington State Department of Ecology, et al,* Civ. No. 019047Z [W.D. Wash.]);

- The LNR and Lummi Tribal Sewer and Water District are decommissioning wells no longer in use to protect aquifers from contamination;
- The LNR and Planning Departments are supporting solid waste removal and implementation of the Integrated Solid Waste Management Plan;
- The LNR completed a study of the Northwestern Lummi Aquifer to delineate its geographic extent;
- The LNR conducts case-specific investigations of water quality problems;
- The LNR works with the EPA to address the on-Reservation sources of pollution;
- The Lummi Planning Department administers the General Land Use Plan and the Technical Review Committee, which protect ground water quality by ensuring that land use and development occur with minimal impacts; and
- The Lummi Code of Laws Title 17 establishes Wellhead Protection Areas on the Reservation and Sanitary Control Areas surrounding domestic and public supply wells, which protect ground water quality by limiting the type of development that can occur in these areas.

9. CONCLUSION

This update of the 2001 Nonpoint Source Assessment Report (LWRD 2001b) includes the following primary changes to the earlier version:

- Revised watershed delineation based on higher resolution topography data;
- Updated inventory of potential NPS pollution sources in the Reservation watersheds;
- Updated descriptions of the Lummi Surface and Ground Water Quality Monitoring Program;
- Updated Lummi Surface Water Quality data;
- Updated list of impairments of Reservation water bodies;
- Updated descriptions of NPS pollution prevention and control programs; and
- Updated listing of BMPs for NPS pollution types.

This analysis of available water quality data and potential sources of NPS pollution shows that surface waters on and flowing onto the Reservation are currently or potentially affected by all classes of NPS pollutants. These NPS pollutants include bacteria/pathogens, fine sediment, nutrients, oxygen demanding substances (low dissolved oxygen), pH, temperature, metals, pesticides, household and industrial chemicals, and oil and grease. The four major water bodies (Nooksack River, Portage Bay/Bellingham Bay, Lummi River, and Lummi Bay/Georgia Strait) and the ground water on the Reservation are currently and/or potentially impaired by NPS pollution. The Lummi Nation is focused on addressing the three current impairments of greatest concern: loss of salmonid habitat in the Nooksack River watershed and estuary; restrictions to ceremonial, subsistence, and commercial shellfish harvests in Portage Bay; and salt water intrusion or other contamination of the Reservation aquifers. Also identified in this NPSPAR is the potential impairment of Lummi Nation Waters that would result in restrictions to ceremonial, subsistence, and commercial shellfish harvests in Lummi Bay. These waters require NPS pollution control measures to restore or maintain desired water uses and to meet or maintain the Lummi Water Quality Standards.

The NPS pollution categories primarily responsible for the current and potential impairments of surface and ground water in the Reservation watersheds are agriculture, silviculture, hydromodification/habitat modification, urban runoff, and ground water withdrawal. Although construction, atmospheric deposition, highway/road runoff, and land disposal may be significant contributors to the impairment of Reservation waters, these four sources and the remaining source categories listed in Table 6.1 do not appear to be major sources at this time. However, control of each NPS category should contribute to the improvement and the preservation of water quality and aquatic habitats both on- and off- Reservation. The primary and potentially significant sources of impairment should be the high priority targets for NPS pollution management.

To reduce the impacts of NPS pollution on surface and ground water and achieve the NPS pollution management goals, appropriate BMPs must be effectively applied. Effective use of

BMPs, coupled with land use zoning, should minimize the effects of NPS pollution on the Reservation. Fifteen LIBC environmental programs, as well as specific LNR activities aimed at the three current impairments and one potential impairment, already address or will address NPS pollution on the Reservation. The Nonpoint Source Pollution Management Program will support and complement these current programs and activities. Because the Lummi Nation is a federally recognized tribe with TAS approval in accordance with the CWA 518(e), it will continue to apply for CWA Section 319 grant funds to address current and potential NPS pollution sources.

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11. LIST OF ACRONYMS AND ABBREVIATIONS

Programs and Terms:	
BMP	Best Management Practice
CWA	Clean Water Act
CWRMP	Comprehensive Water Resources Management Program
CZMP	Coastal Zone Management Plan
ESA	Endangered Species Act
GAP	General Assistance Program
GIS	Geographic Information System
GLUP	General Land Use Plan
ISWMP	Integrated Solid Waste Management Plan
MOA	Memorandum of Agreement
NERP	Nooksack Estuary Recovery Project
NPS	Nonpoint Source
NPSPAR	Nonpoint Source Pollution Assessment Report
NSSP	National Shellfish Sanitation Program
PAH	Polycyclic Aromatic Hydrocarbons
PSNERP	Puget Sound Nearshore Ecosystem Restoration Project
QA/QC	Quality Assurance/Quality Control
TMDL	Total Maximum Daily Load
TPH	Total Petroleum Hydrocarbons
TRC	Technical Review Committee
WQS	Water Quality Standards
WRIA	Water Resource Inventory Area

Agencies and Organizations (Parent Organization):	
BIA	Bureau of Indian Affairs
Corps	U.S. Army Corps of Engineers
DOH	Department of Health, Washington State
Ecology	Department of Ecology, Washington State
FDA	Food and Drug Administration
FEMA	Federal Emergency Management Agency
LIBC	Lummi Indian Business Council
LNR	Lummi Natural Resources Department
LTSWD	Lummi Tribal Sewer and Water District
LWRD	Lummi Water Resources Division (LNR)
MWCOG	Metropolitan Washington Council of Governments
NMFS	National Marine Fisheries Service (NOAA)
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service (USDA)
NWAPA	Northwest Air Pollution Authority
NWIC	Northwest Indian College
USDA	US Department of Agriculture
USDI	US Department of the Interior

EPA	US Environmental Protection Agency
USFWS	US Fish and Wildlife Service (USDI)
USGS	US Geological Survey (USDI)
WCD	Whatcom Conservation District
WDFW	Washington State Department of Fish and Wildlife
WSDC	Washington State Department of Conservation
WDNR	Washington State Department of Natural Resources
WSU	Washington State University

APPENDIX A

Unified Watershed Assessment for Watersheds within the Boundaries of the Lummi Nation

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LUMMI INDIAN BUSINESS COUNCIL

2616 KWINA ROAD • BELLINGHAM, WASHINGTON 98226-9298 • (360) 384-1489

DEPARTMENT ______________________ EXT. __________

September 24, 1998

The Unified Watershed Assessment Working Group (4503F)
U.S. Environmental Protection Agency
401 M. Street. S. W.
Washington, D.C. 20460

Subject: Unified Watershed Assessment for the Lummi Indian Nation

Dear Working Group Members,

Enclosed for your use, please find the unified watershed assessment completed for watersheds within the boundaries of the Lummi Nation. Both of the watersheds (HUC 17110002 and 17110004) were classified as Category I watersheds. The classification assigned to these two watersheds by the Lummi Nation is consistent with the watershed classifications assigned by the State of Washington in their parallel process.

Lummi Nation staff has coordinated our efforts with the Washington State Department of Ecology (lead agency for the Clean Water Action Plan in Washington State), the local Natural Resources Conservation Services office, and the Whatcom County Water Resources Manager.

Please do not hesitate to call Leroy Deardorff, Lummi Nation Environmental Protection Program Director (360-384-2272), if you would like additional information regarding the enclosed assessment.

Sincerely,

Merle Jefferson

Merle Jefferson, Executive Director
Lummi Natural Resources Department

cc Christine Hempleman, Department of Ecology
John Gillies. Natural Resources Conservation Service
Sue Blake, Whatcom County Water Resources Manager

Unified Watershed Assessment For
Watersheds Within the Boundaries of the Lummi Nation

Final September 1998

Introduction

The U.S. Environmental Protection Agency (EPA) and the U.S. Department of Agriculture (USDA) issued the Clean Water Action Plan (CWAP) in February 1998. The CWAP calls for tribal and state governments to work with appropriate agencies, governments, and the public to assess the conditions of water resources in their areas and to classify watersheds within their boundaries into one of four categories. The four categories are:

- **Category I.** Category I watersheds are in need of restoration. These watershed do not now meet, or face imminent threat of not meeting, clean water and other natural resource goals.
- **Category II.** Category II watersheds are meeting clean water and other natural resource goals and standards and support healthy aquatic systems. All such watersheds need the continuing implementation of core clean water and natural resource programs to maintain water quality and conserve natural resources.
- **Category III.** Category III watersheds have exceptionally pristine water quality, other sensitive aquatic system conditions, and drinking water sources. These areas include currently designated and potential candidate Wilderness Areas, Outstanding Natural Resource Waters, and Wild and Scenic Rivers.
- **Category IV.** Category IV watersheds lack significant information, critical data elements, or the data density needed to make a reasonable assessment at this time.

Although watersheds can be evaluated at various geographic scales (e.g., lake, wetland, stream, river, small bay), a common scale is needed for the national objectives of the CWAP. As defined in the CWAP, watershed boundaries for the purposes of the CWAP are defined by the U.S. Geological Survey (USGS) 8-digit hydrologic unit code. In western Washington State, tribal lands can be generally characterized as having small reservations and large usual and accustomed (U&A) fishing, hunting, and gathering areas where the tribal governments are co-managers of the natural resources with state and federal governments. Because of the large size of the U&A areas and work load/staffing constraints, the Lummi Nation has focused its natural resources management efforts throughout the Nooksack River watershed and Georgia Strait. A similar limited geographic area approach is being used to conduct the unified watershed assessments called for in the CWAP. The two 8-digit hydrologic unit code watersheds that will be addressed in the Lummi Nation unified watershed assessments are:

- 17110002 (Strait of Georgia - 955 square miles) and
- 17110004 (Nooksack River - 795 square miles).

The remainder of this document will describe the process, participants, rationale, and information used to classify these two watersheds into one of the four categories identified in the CWAP. As will be described further below, both of these watersheds were classified as Category I watersheds.

Classification Process

The selection factors identified in the CWAP were used as the basis for categorizing watersheds 17110002 and 17110004. The selection factors, the criteria associated with each selection factor, and the applicability of each of the criteria to the two subject watersheds are summarized in Table 1. As shown in Table 1, all of the identified selection factors and criteria applied to both of the subject watersheds. Consequently, both watersheds were classified as Category I watersheds in this unified watershed assessment.

Although all of the selection factors and criteria were applicable to both watersheds, it is important to note that the geographic scale of the assessment is large. Consequently, these watersheds have areas that meet clean water and other natural resource goals and, at a smaller scale, would result in a Category II classification for some of the subbasins that comprise the larger watershed. Similarly, each of the watersheds contain areas of pristine lands that would be classified as Category III.

Participants

Due to a lack of available staff time, development of the unified watershed assessment did not begin until early August 1998. This unified watershed assessment for tribal lands was developed primarily by the Water Resources Division of the Lummi Natural Resources Department. Staff and time limitations prevented implementation of a public review process for this assessment by the Lummi Nation.

Although a public review process was not conducted by the Lummi Nation for this unified watershed assessment, the information used to conduct the analysis was derived from scientific reports and other public documents that have included public review processes. The Lummi Water Resources Division has also worked with the Washington State Department of Ecology in the development of the draft Unified Watershed Assessment for Washington State. The two subject watersheds (17110002 and 17110004) were classified as Category I watersheds in the Washington State process. In addition, the Lummi Water Resources Division contacted the local Natural Resources Conservation Service office and the Water Resources Manager for Whatcom County to ensure that development of the unified watershed assessment did not overlap their efforts.

Rationale

The rationale for classifying watersheds 17110002 and 17110004 as Category I watersheds is summarized in Table 1.

Table 1. Classification system used by the Lummi Nation to categorize watersheds for the Clean Water Action Plan

Selection Factor	Criteria	Watershed 17110002	Watershed 17110004
1. Nonattainment of national clean water goals.	a) Watershed with a waterbody on the 1996 303(d) list.	Yes	Yes
	b) Watershed with shellfish beds that are, or continue to be, threatened with downgrade in accordance with National Shellfish Sanitation Program criteria or where shellfish areas are closed to harvesting and a closure response plan is in place.	Yes	Yes
	c) Watersheds with concerns related to nitrates in the drinking water, pesticides, and/or heavy metals.	Yes	Yes
2. Nonattainment of natural resource goals related to aquatic systems, including goals related to habitat, ecosystem health, and living resources.	a) Watershed with a waterbody that does not meet the minimum instream flows established by Washington State in 1986 as part of the Instream Resources Protection Program.	Yes	Yes
3. Other appropriate measures and indicators of degraded aquatic system conditions (e.g., wetland condition and current and historical loss rates, percent impervious surface, and other measures of aquatic habitat).	a) Watershed with a waterbody where loss of wetland areas along streams and rivers and/or in estuaries have been reported.	Yes	Yes
	b) Watershed rated above "3" on the EPA Index of Watershed Indicators	Yes	Yes
4. Decline in the condition of living and natural resources that are part of the aquatic system in the watershed (e.g., decline in the populations of rate and endangered aquatic species, decline in healthy populations of fish and shellfish, etc.)	a) Watershed with a waterbody where there is a proposed listing of spring Chinook salmon as "threatened" under the Endangered Species Act	Yes	Yes

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APPENDIX B

Delineation of Watershed Boundaries from 2005 LiDAR Bare Earth Sample Points

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LUMMI INDIAN BUSINESS COUNCIL

2616 KWINA ROAD · BELLINGHAM, WASHINGTON 98226 · (360)384-1489

MEMORANDUM

DATE: October 8, 2010

TO: Jeremy Freimund, P.H., Water Resources Manager

FROM: Gerald Gabrisch, Geographic Information System Manager

SUBJECT: **Delineation of Watershed Boundaries of the Lummi Indian Reservation from 2005 LiDAR Bare-Earth Sample Points**

Purpose:

This memorandum details the methods and results of a Geographic Information Systems (GIS)-based analysis conducted to delineate watershed boundaries for those lands that contribute to overland flow on the Lummi Indian Reservation (Reservation). This watershed delineation utilized Light Distance and Ranging (LiDAR) bare-earth sample point data collected by Terrapoint USA Inc. (Terrapoint) in 2005. Pursuant to our discussion, the resulting watershed delineations will serve as the 'best available' GIS dataset of watersheds for the Reservation, and replace the 1998 watershed delineations developed through a manual interpretation of United States Geological Survey (USGS) 7.5 minute topographic maps (20-foot contour intervals) coupled with the results of a storm water facilities inventory (LWRD, 1998).

Data:

The data used for this watershed delineation include the following:

- XYZ text files of LiDAR bare-earth sample point data collected by Terrapoint in 2005;
- Lummi Nation GIS data of surface water hydrography including stream channels and agricultural irrigation/drainage ditches;
- On-Reservation storm water facility point locations collected by the Lummi Water Resources Division;
- Off-Reservation storm water facilities point location data collected by the Lummi Water Resources Division and/or Whatcom County; and
- Storm water facilities and catchment boundaries of the City of Ferndale (Ferndale) provided by the Ferndale Public Works Department.

All data were re-projected to the North American Datum of 1983, Washington State Plane North (NAD83WaSPN) coordinate system prior to analysis to conform to the datum, projection, and coordinate system of the LiDAR data. All x and y coordinate values are measured in feet. All elevation values (z coordinates) represent feet above the North American Vertical Datum of 1988 (NAVD 88).

Methods:

Text files containing the x, y, and z values of individual LiDAR bare-earth sample points were used to construct an ESRI ArcGIS terrain data model. The resulting terrain model is a single continuous elevation surface model over the extent of the LiDAR collection area. Because this terrain data model cannot be used for hydraulic modeling, the data were subsequently transformed into ESRI Grid (raster) surface models. A total of eight ESRI Grid surface models were created using five different pixel sizes and two different interpolation methods available in the ArcGIS v 9.3 software package (Table 1). To reduce file sizes and speed computer processing time, each Grid surface model was clipped to only include the Reservation areas upland of the tidal vegetation line.

The areas covered by the catchment boundaries of Ferndale were also excluded from the GIS analysis because the natural flow regime within the Ferndale residential and commercial core area is altered by a network of storm water facilities. Additionally, since an extensive body of data was provided by the City of Ferndale including flow directions of storm sewers, outlet locations, and catchment boundaries, the Ferndale data were considered higher quality than the LiDAR/GIS analysis performed for this study for those areas.

Table 1. Surface model cell resolutions and interpolation methods.

Raster Grid Resolution/Cell Size	Interpolation Method	Used For Watershed Delineation
30-feet	Linear	Yes
30-feet	Natural Neighbors	Yes
6-feet	Linear	No
6-feet	Natural Neighbors	No
3-feet	Linear	Yes
3-feet	Natural Neighbors	Yes
1-foot	Linear	No
0.5-foot	Linear	No

Different raster cell sizes and different interpolation algorithms used to generate the raster surface models resulted in different watershed delineations. To assess the quality of the different surface models listed in Table 1, a root mean square error (RMSE) calculation was preformed on each dataset to determine which raster surface had the highest accuracy and therefore would likely result in the highest quality watershed delineation. The RMSE value determines the standard deviation for the interpolated pixel values of the surface model and the values of known surveyed locations (Equation 1)(Wu et al., 2008). The greater the RMSE, the less accurate the model.

Additionally, the RMSE value was generated for a 10-meter pixel USGS surface model for comparison. The surveyed sample points used for the RMSE included 50 locations where the land surface elevation had been determined using professional field survey techniques by Pacific Survey and Engineering and 13 locations surveyed by TerraPoint. Table 2 shows the RMSE values for each surface model.

Equation 1. Root Means Square Error equation to determine the difference in standard deviations (in feet) between the interpolated cell values and the surveyed point elevation values.

$$\text{RMSE} = \sqrt{\frac{\sum_{i=1}^{n}(x_{1,i} - x_{2,i})^2}{n}}.$$

Where X_1 represents the interpolated pixel value at the location of X_2, X_2 is the surveyed elevation value, and n represents the total count of surveyed locations.

Table 2. Root Mean Square Error values showing the standard deviation in feet between the interpolated pixel value and the value at a surveyed location coincident to the interpolated cell.

Surface Model Resolution	Interpolation Method	RMSE (feet)
USGS 10-meter	Unknown	6.583
30-feet	Linear	1.478
30-feet	Natural Neighbors	1.473
6-feet	Linear	1.393
6-feet	Natural Neighbors	1.388
3-feet	Linear	1.393
3-feet	Natural Neighbors	1.387
1-foot	Linear	1.390
0.5-foot	Linear	1.469

The 3-feet grid, natural neighbors interpolation model was selected for the watershed delineation process based on the RMSE values and the available computer processing capabilities. The 1-foot and the 0.5-foot surface models were excluded from the watershed delineation process because the RMSE was similar to the 3-feet grid surface models and the file sizes were too large to process using available desktop computer processors. The surface models using the 6-feet grid cell size were excluded because the RMSE values were nearly identical to the 3-feet RMSE, which better captures elevation heterogeneity through increased cell resolution. The 30-feet and the 10-meter surface models were not used because the RMSE was larger than the surface models developed using the 3-feet grid cell size.

The LiDAR technology cannot capture the flow path of storm water facilities underneath roads because those flow paths are blocked from the aerial view of the LiDAR collection system. To enforce hydrologic connectivity in those areas traversed by raised road beds, 'culvert burning' was used to establish flow paths through storm water facilities (Duke, 2003). The point data of storm water facility locations collected by the Lummi Nation Water Resources Division and Whatcom County were combined into a single dataset of storm water facilities. A 50-feet buffer polygon around each storm water facility was created to sufficiently span the width of the raised road beds. The resulting storm water facility buffers were converted to a 3-feet raster Grid surface model and assigned an elevation value equal to the minimum value of the entire LiDAR dataset. The pixel values of the storm water facility grid were used to computationally replace the coincident pixels in the surface models, thereby establishing a connective flow path across the "obstruction" created by the raised road beds.

The hydrography vector lines were manually edited to ensure that for each individual line segment the line direction of flow matched the direction of flow detailed in the Lummi Nation Storm Water Facilities Inventory. The ESRI ArcHydro geoprocessor cannot calculate flow directions in a network of looping flow paths, for example braided streams or interconnected drainage ditches(Maidment, 2002). For this reason, some hydrography lines had their uphill node disconnected from the network of flow paths to ensure that no flow lines formed closed loops.

The resulting 'culvert burn' surface model and the non-looping hydrography data set were imported into an ArcGIS/ArcHydro geodatabase. The ArcHydro database allowed the stream network (hydrography) to be 'burned' into the surface models, enforcing flow connectivity based on the configuration of the stream network (Maidment, 2002). The resulting hydrologically corrected surfaces were filled using the ArcGIS *fill* function to remove sinks and obstructions from the surface models that might impede the analysis.

The filled surface models were used to generate flow direction surfaces detailing the flow direction from each cell to one of its eight adjacent neighbors (Figure 1). The flow direction surfaces were then used to generate a flow accumulation surface where the numeric value of each pixel represents the total count of individual cells that flow into that cell (Figure 2). The flow accumulation surfaces were used to generate watershed boundaries where all cells that share a "pour point" are assigned a unique nominal numeric value (Figure 3). The basin output was transformed from its grid format into a polygon data structure.

Upon a manual inspection of the Ferndale storm water facility outfall, all Ferndale catchment polygons that contributed to overland water flow onto the Reservation were added to the polygons of basins.

Finally, the polygon data were manually aggregated into watersheds to mimic those watersheds delineated in 1998 based on the 7.5 minute USGS topographic maps (LWRD, 1998).

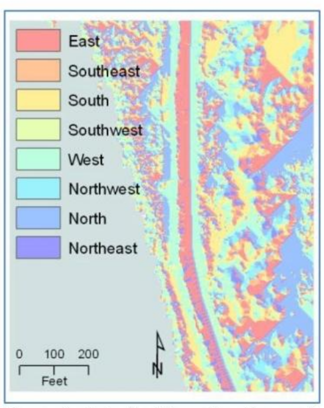

Figure 1. A typical flow direction surface. Each cell stores a numeric value detailing the flow direction in one of eight cardinal directions.

Figure 2. A typical flow accumulation surface; each cell stores the count of cells that pour into that cell. Higher cell counts are displayed as a darker blue. Coloration does not necessarily indicate a perennial or seasonal stream.

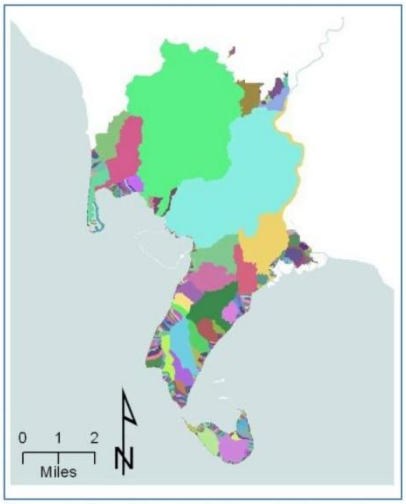

Figure 3. Resulting basin boundaries; each color represents an area that is hydrologically connected. (Catchments are not aggregated into Watersheds and City of Ferndale catchments were not incorporated into this figure.)

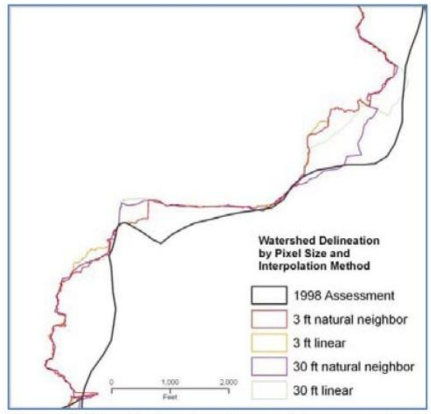

Figure 4. Detail showing the resulting watershed delineations based on different pixel cell sizes and interpolation methods compared with the 1998 topographic map delineation.

Results:

In the coarser surface models, for example in the 30-feet pixel surfaces, the value of the cell is the average value of all LiDAR points that fall within that cell. When the pixel size is larger than the density of the sample points, the RMSE should increase since the surface model is relying more heavily on the interpolation algorithm and therefore more prone to over-estimations and under-estimations(Aguilar, 2006). Because the 3-feet grid, natural neighbor interpolation surface model resulted in the lowest RMSE and provided the highest resolution surface that could be processed with available computers, the 3-feet natural neighbor model was selected as the best available surface from which to generate watershed boundaries. Figure 4 highlights some of the different catchment lines resulting from different pixel sizes and different interpolation algorithms.

Figure 4 demonstrates that given the same elevation sample data, different catchment boundaries will be calculated based on differences in pixel resolution (i.e., cell size). While the 3-feet raster resulted in the highest quality surface model, the catchments generated by this surface model are affected by error introduced in the LiDAR sampling and post processing, the data models, and the assumptions incorporated into the GIS functions and methods. The user of these data should be aware of the inherent abstraction of spatial data when making policy decisions. More extensive field surveys and sampling may be required to confirm/verify the delineated catchment boundaries.

Figure 5 shows the 1998 watershed boundaries developed from the USGS topographic maps compared to the watershed boundaries developed from the LiDAR data. As shown in Figure 5, the boundaries are generally similar with a few notable exceptions.

Table 3 shows a comparison of the 1998 delineation and the 2005 LiDAR-based delineation that resulted from this study. Approximately 933 acres were added to all watersheds that contribute overland flow to the Reservation. Two watersheds from the 1998 delineation (Watershed M and Watershed N) were discontinued. Watershed M was a small isolated island located at the mouth of the Lummi River channel and the Lummi River channel downstream from the Schell Creek confluence and waterward of the levees along the channel. This watershed was combined with Watershed L. Watershed N was combined with Watershed O as the LiDAR delineations did not identify these areas as separate catchments. Watershed T is a newly delineated watershed that isolates a portion of Watershed K from the 1998 delineation. Watershed S includes the entire Nooksack River drainage area, a vast majority of which is not covered by the 2005 LiDAR data. Although most of Watershed S extends off-Reservation and beyond the geographic scope of the LiDAR data, the LiDAR data were used to delineate the western extent of Watershed S on the Reservation. The acreage for Watershed S listed in Table 3 is the acreage total reported by the WRIA 1 Watershed Management Project (www.wria1project.whatcomcounty.org).

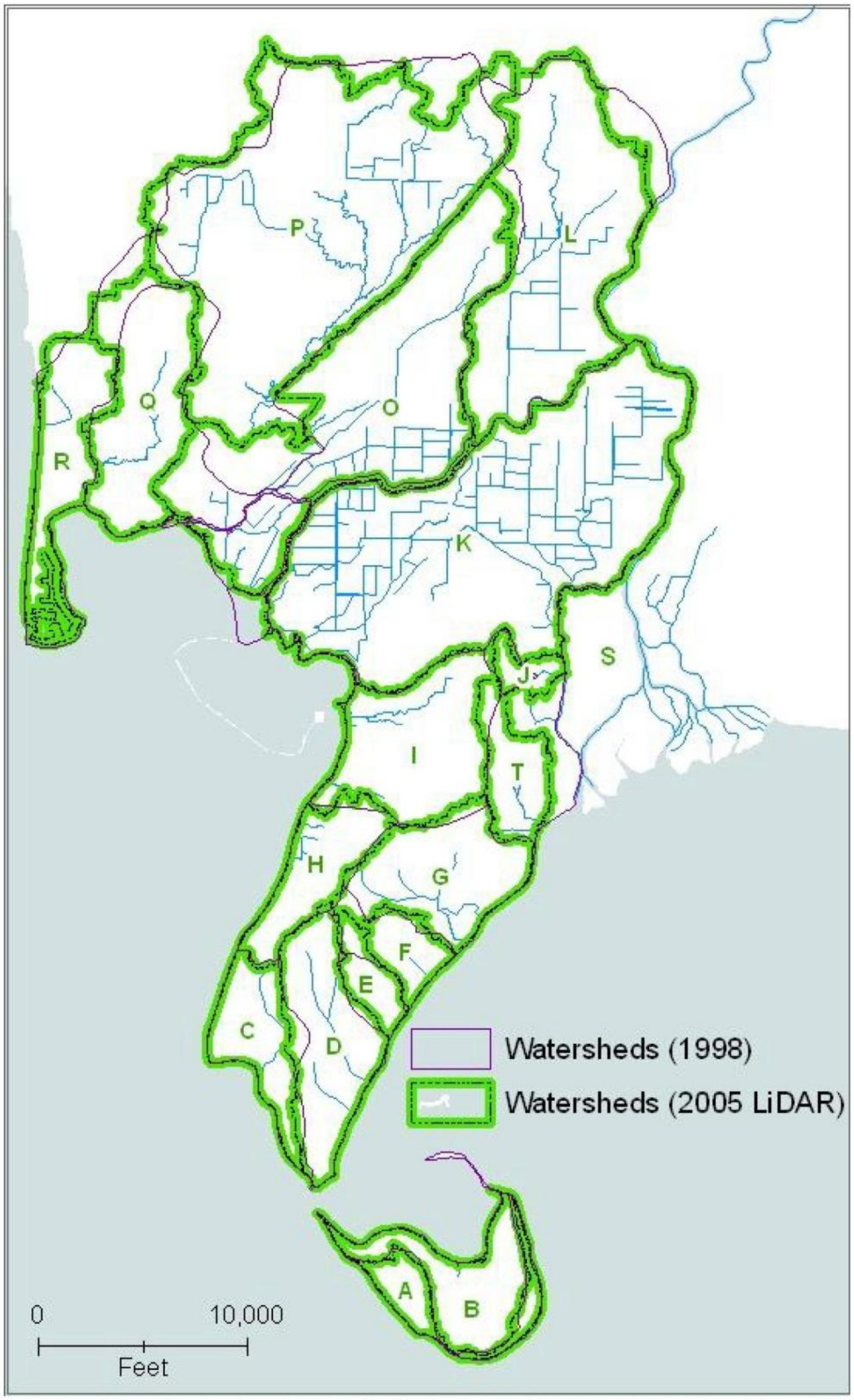

Figure 5. Final watershed delineation based on the 2005 LiDAR data and incorporation the City of Ferndale catchment boundaries.

Table 3. Watershed identifiers and acreage total comparisons between the 1998 delineation and the 3-feet natural neighbors surface model.

Watershed ID	Stream Name	1998 7.5 min Topographic Map Delineations (acres)	2005 LiDAR Delineations (acres)	Difference in Watershed Area (acres)	Difference in Watershed Area (percent difference)
A	Unnamed	306.8	279.7	-27.1	-9.7
B	Unnamed	633.9	616.7	-17.2	-2.8
C	Unnamed	583.3	493.8	-89.5	-18.1
D	unnamed	797.5	894.4	96.9	10.8
E	unnamed	183.2	218.3	35.1	16.1
F	unnamed	326	250.8	-75.2	-30.0
G	unnamed	836.1	883.3	47.2	5.3
H	unnamed	537.3	549	11.7	2.1
I	unnamed	1,142.3	1,058.9	-83.4	-7.9
J	unnamed	86.8	134.2	47.4	35.3
K	Smuggler Slough	4,696.50	4,091.1	-605.4	-14.8
L	Lummi River	2,384.0	2,306.5	-77.5	-3.4
M	unnamed	198.1	combined with Watershed L	n/a	n/a
N	unnamed	333.4	combined with Watershed O	n/a	n/a
O	Schell Creek/Northern Distributary of the Lummi River	1,964.3	2,746.8	782.5	28.5
P	Jordan Creek	4,228.9	4,097.1	-131.8	-3.2
Q	Onion Creek	1,291.7	1,096.4	-195.3	-17.8
R	unnamed	1,023.8	721.8	-302	-41.8
S	Nooksack River	517,718 (WRIA1 area)	south western extent of watershed only	n/a	n/a
T	unnamed	extracted from Watershed K	392.46	n/a	n/a
Total		21,553.9	22,486.7	932.5	4.2

Conclusions:

Using the 2005 Terrapoint LiDAR bare-earth point data, digital terrain models (DTMs) were developed using several grid cell sizes and interpolation methods. A root square mean analysis was used to identify the surface model with elevation values most similar to professionally surveyed control points. A 3-feet natural neighbor interpolation DTM was identified as the surface model with the highest level of precision and that had pixel sizes that were large enough to be manageably analyzed using available computer resources.

The 3-feet natural neighbor DTM was incorporated into an ESRI ArcGIS 9.3 ArcHydro geodatabase along with point data of storm water facilities, and line data of known stream channels and agricultural drainage ditches. The storm water data and surface water hydrography data were used to enforce hydrologic connectivity by computationally breaching LiDAR artifacts such as bridges or culvert passages under roads.

The hydrologically corrected surface model was analyzed using standard GIS procedures including sink filling, identifying flow directions, calculating flow accumulations, and generating basin boundaries to identify the basin boundaries. The final basin boundaries were combined into watershed administrative units based on the watershed units developed as part of the 1998 watershed delineation (LWRD, 1998).

The final watershed boundaries developed from the 2005 LiDAR data resulted in a 584-acre gain (or 4.2 percent increase) in area from the original 1998 delineation. Watershed M from the 1998 delineation was incorporated into Watershed L, Watershed N was incorporated into watershed O, and one new watershed (Watershed T) was added based on the refinement made possible with the 2005 LiDAR data. Watershed S includes those lands that contribute overland-flow to the Nooksack River. Because the 2005 LiDAR coverage does not include the entire Nooksack River basin, only the southwestern extent of Watershed S was determined as part of this analysis. The remainder of the Watershed S boundary was determined as part of the WRIA 1 Watershed Management Project and these results were adopted to estimate the acreage associated with the Nooksack River watershed.

The final dataset was loaded onto the Lummi Nation GIS data server and metadata was created. The final data detailed in this report is available at *Z:\Data\Boundaries\Watersheds\LummiWatershedsBestAvailable.shp*.

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APPENDIX C

May 27, 2010 Letter to the USEPA Regarding Nooksack River Basin Water Quality, Tribal Shellfish Beds, and the Management of Animal Wastes in Washington State

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LUMMI INDIAN BUSINESS COUNCIL

2616 KWINA ROAD · BELLINGHAM, WASHINGTON 98226 · (360)384-1489

DEPARTMENT________________________________DIRECT NO. ____________

May 27, 2010

Mr. Dennis J. McLerran,
Regional Administrator
U.S. EPA Region 10
Office of the Executive
1200 Sixth Avenue
Seattle, WA 98101

SUBJECT: Nooksack River Basin Water Quality, Tribal Shellfish Beds, and the Management of Animal Wastes in Washington State

Dear Administrator McLerran,

I am writing to (1) express my concerns regarding deteriorating water quality in the Nooksack River watershed in northwestern Washington; (2) to provide you a brief history on Nooksack River water quality, impacts of the degraded water quality on tribal shellfish beds in Portage Bay on the Lummi Indian Reservation, and previous actions taken; and (3) to seek further action by the EPA to address these concerns.

Deteriorating Water Quality in the Nooksack River Watershed: Water quality monitoring focused on fecal coliform levels in the Nooksack River watershed has been conducted since at least 1997. Initially, the sampling was conducted by the Washington Department of Ecology (Ecology) as part of the Lower Nooksack River Bacteria TMDL (Ecology 2002). The Whatcom Conservation District used Ecology grant funding to expand this sampling program from 21 stations to 65 stations over the 1998 to 2000 period. Sampling at these 65 stations was continued by the Lummi Natural Resources Department using grant funding from the EPA and Ecology through 2005 as part of the TMDL Implementation Monitoring in WRIA 1[1] Project. The Lummi Nation has also used grant funding from the EPA to sample, analyze, and report on Nooksack River water quality at the location where the river flows onto the Reservation since 1997 as part of our ambient water quality monitoring program.

The collected water quality data indicated that as of February 28, 2004, nine of the ten Lower Nooksack River Bacteria TMDL sample stations achieved their respective TMDL

[1] Washington State has divided the state into 62 Water Resources Inventory Areas (WRIAs). WRIA 1 is the Nooksack River basin and certain adjacent streams including Lake Whatcom.

geometric mean targets. One year later, on February 28, 2005, only three of the ten stations achieved their respective TMDL targets. In September 2004, the Washington Department of Health (DOH) reported that 5 of the 11 sampling stations in Portage Bay were close to exceeding the National Shellfish Sanitation Program (NSSP) standards. Poor water quality over parts of tribal shellfish beds in Portage Bay necessitated a temporary closure of a portion of these beds during January through March of 2005. A review of the EPA files will demonstrate that I sent a letter to one of your predecessors (Ron Kreizenbeck) on June 7, 2005 regarding our concerns at that time.

Unfortunately, the deteriorating water quality trends that we wrote about during 2005 have continued. As shown in Figure 1 through Figure 9, the TMDL targets and/or the applicable water quality criteria for fecal coliform bacteria are not being achieved at the monitoring stations. Figure 1 through Figure 8, which were developed by Ecology staff, show a marked reversal of the previously declining fecal coliform levels in the Nooksack River tributaries starting in 2003 and an increasing trend in fecal coliform levels for all of the tributaries except for Tenmile Creek. As you may know, on July 1, 2003 the Livestock Management Program within the Washington State Department of Ecology was eliminated and the responsibility to implement the Dairy Nutrient Management Act was transferred to the Washington State Department of Agriculture (WSDA). The WSDA only addresses animal wastes from dairy farms – not beef cattle or hobby farms.

In Figures 1 through Figure 8, if the TMDL targets were being achieved, the geometric mean line (black line) would be at or below the last pink circle. If the applicable water quality standards were being achieved, the geometric mean line would be below the solid green line and the dotted black line would be below the dotted green line.

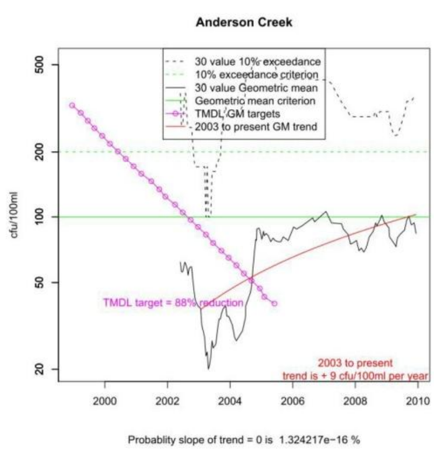

Figure 1. Fecal Coliform Trends in Nooksack River Tributaries: Anderson Creek

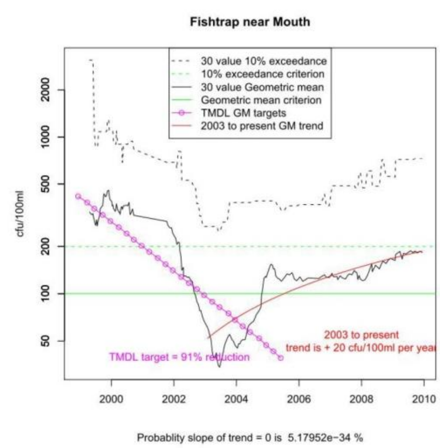

Figure 2. Fecal Coliform Trends in Nooksack River Tributaries: Fishtrap Creek Near Mouth

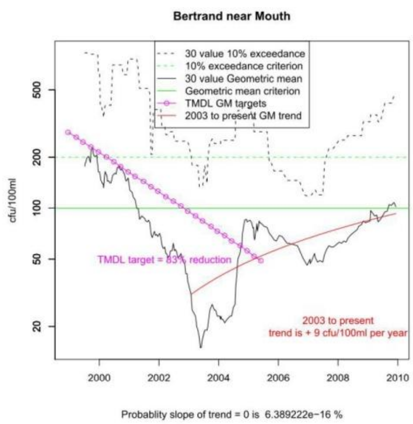

Figure 3. Fecal Coliform Trends in Nooksack River Tributaries: Bertrand Creek Near Mouth

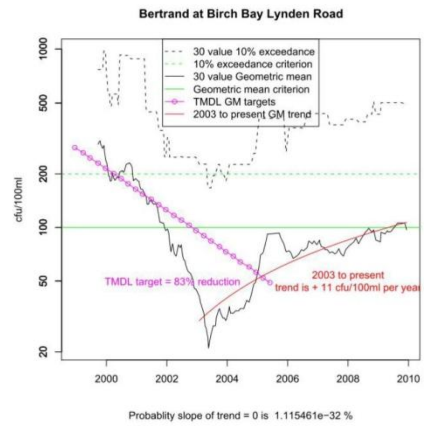

Figure 4. Fecal Coliform Trends in Nooksack River Tributaries: Bertrand Creek At Birch Bay Lynden Road

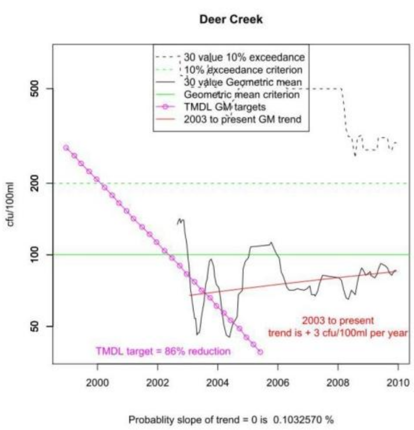

Figure 5. Fecal Coliform Trends in Nooksack River Tributaries: Deer Creek

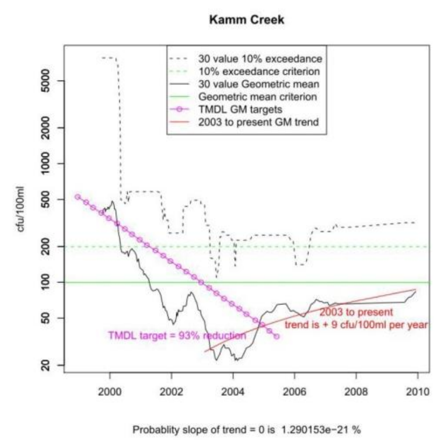

Figure 6. Fecal Coliform Trends in Nooksack River Tributaries: Kamm Creek

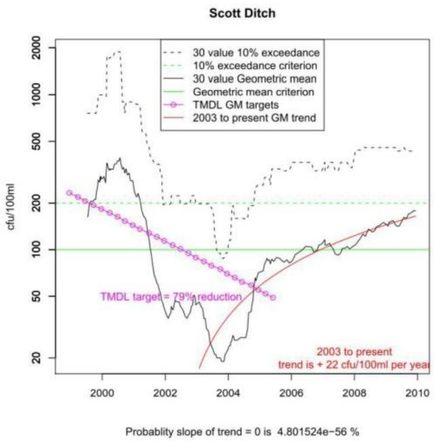

Figure 7. Fecal Coliform Trends in Nooksack River Tributaries: Scott Ditch

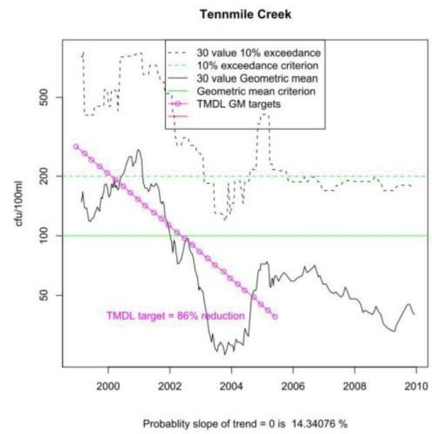

Figure 8. Fecal Coliform Trends in Nooksack River Tributaries: Tenmile Creek

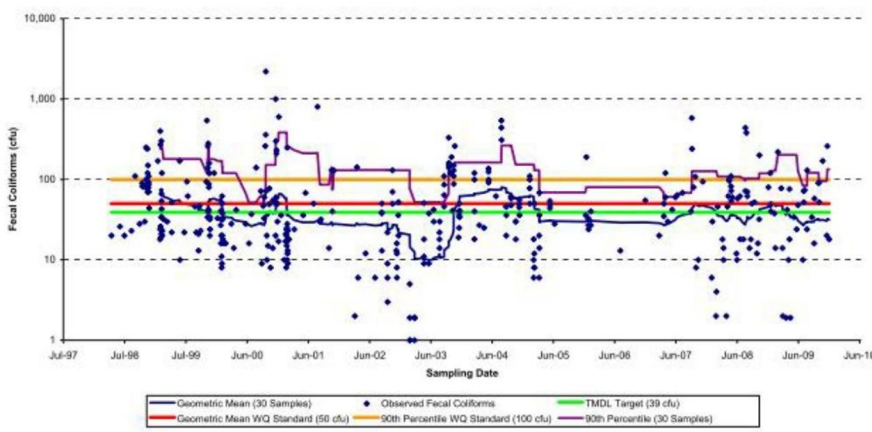

Figure 9. Fecal Coliform Trends in Nooksack River at Marine Drive Bridge

Figure 9 is a summary of the measured fecal coliform levels from the Lummi Natural Resources Department ambient water quality monitoring program at a site where the Nooksack River discharges to the Reservation (Marine Drive). Figure 9 shows that the fecal coliform geometric mean is currently below both the TMDL target and the applicable water quality standards but, since the 90th percentile currently exceeds the applicable water quality standard for fecal coliform, the tribal water quality criteria are not achieved. As can be seen in Figure 9, both the TMDL target and the water quality criteria were exceeded shortly after June 2003.

4

Brief History, Impacts of Degraded Water Quality, and Previous Actions: 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 DOH in consultation with the Lummi Nation is responsible to the federal Food and Drug Administration to ensure that the National Shellfish Sanitation Program (NSSP) standards for certification of shellfish growing waters are met for tribal harvest areas including on-Reservation areas. In consultation with the Washington DOH, the Lummi Nation closed portions of the tribal shellfish beds in Portage Bay in December 1996 (60 acres) and August 1998 (120 additional acres) when the NSSP standards for certification of shellfish growing waters were exceeded. Washington DOH formally reclassified these growing areas from "Approved" to "Restricted" in August 1997 and September 1999 respectively.

These closures directly affected approximately 200 tribal shellfish harvesters and their families. Ceremonial and subsistence uses of these shellfish resources were also impacted, as was the tribal commercial shellfish enterprise. The economic impact of these closures has been estimated to be in excess of $850,000 per year. Although the Lummi Nation and its members did not cause the downgrade of our shellfish beds, we have been the ones who have suffered due to the actions and inactions of others and have received no compensation for our losses.

The sanitary survey conducted by the Washington DOH following the initial downgrade found that farm animal wastes originating in the Nooksack River watershed are an actual, as opposed to a potential, pollution source and represent a high probability of being the principal source of fecal coliform contamination in the Portage Bay shellfish beds. At the request of the Lummi Nation, the EPA conducted compliance and enforcement actions during 1997 and 1998. In our view, these EPA compliance inspections and enforcement actions were the key to initiating the local actions and needed changes to state laws.

Following the initial and subsequent downgrades of tribal shellfish beds in Portage Bay, in addition to the EPA enforcement actions, several federal, tribal, and state agencies and numerous individuals took a variety of steps to address identified pollutant sources (not all of which were related to agricultural activities). I believe that most people would agree that the three key actions were: (1) technical and financial assistance (in excess of $8 million) to the dairy industry, private land owners, and municipalities that discharge wastes to the Nooksack River; (2) compliance inspections to enforce provisions of the federal Clean Water Act; and (3) water quality monitoring to identify pollution sources and monitor improvements. These three key actions, along with interagency collaboration, resulted in a reclassification of approximately 75 percent of the "Restricted" shellfish growing beds in Portage Bay to "Approved" status in November 2003 and the reclassification of all of the shellfish growing areas in Portage Bay as "Approved" in May 2006 – nearly 10 years after the initial closure.

Unfortunately these three key actions have not continued at the levels that existed prior to 2003 and, as a result, whether or not all of the tribal shellfish beds in Portage Bay and Lummi Bay will remain classified as "Approved" in the coming years and decades is an open question. As you may know, first Ecology eliminated their Livestock Management Program and their compliance inspection and enforcement responsibilities were transferred to the WSDA. The effect of this management change was a reduction from two Ecology dairy waste inspectors based in Bellingham and focused on Whatcom and Skagit counties to a single WSDA inspector focused on Whatcom, Skagit, Snohomish, Island, and part of King County. This change has also resulted in regulatory gaps in that the EPA delegated the administration of Section 402 of the Clean Water Act to Ecology (not to the WSDA), the WSDA mandate is to address dairy operations only (not beef cattle operations, hobby farms, or direct animal access to streams), and because the single WSDA position was initially vacant and then has been vacated for various intervals over the years as personnel changes occurred.

Due to budget constraints and programmatic limitations, the TMDL implementation monitoring program was reduced from semi-monthly (two times per month) to monthly sampling during 2004-2005. Funding for this program ended in February 2005 and efforts to obtain state funding during the 2005 legislative session were unsuccessful. Currently, the monitoring program continues at 21 sites at a reduced frequency. I am not certain what has happened to the technical and financial assistance to the agricultural community, but I understand that this too has been reduced. Based on past experience, without continued technical assistance, compliance inspection activities, and water quality monitoring and source identification in the Nooksack River watershed, the likelihood of continued or future downgrades of tribal shellfish beds in Portage Bay is significantly increased. The same is true for the Lummi Bay watershed.

Requested Actions: Another closure of tribal shellfish beds in Portage Bay due to fecal coliform contamination would have a substantial negative impact on the Lummi Nation. The previous Portage Bay shellfish bed closure, which was largely attributed to poor animal waste management in the Nooksack River watershed, lasted nearly 10 years and had an estimated monetary impact of over $8.5 million on Lummi tribal members and their families. The impact to tribal ceremonial and subsistence harvest in this area is not measureable. These losses have never been compensated. We feel that we communicated our concerns about the deteriorating water quality in the Nooksack River watershed and the impacts and threats to our shellfish beds in our June 7, 2005 letter and provided the local agricultural community an opportunity to take local action at that time. As evident from the water quality data presented above, the current animal waste management practices are not effectively reducing fecal coliform contamination. We need to shift from reactive to proactive natural resources management in order to avoid repeating past mistakes and impacts to tribal shellfish beds.

My staff has discussed animal waste management practices with federal and state agency staff members and there seems to be a general consensus that the current Washington State program for managing animal wastes is broken. We have heard a number of ideas of how the current program could be fixed that, in our opinion, have merit and could be expected to reduce the likelihood of future closures to the tribal shellfish beds due to animal waste management practices. These ideas include:

1. All operators that generate, store, and/or land apply animal wastes should be regulated no differently that other industries that generate wastes that are applied to the land (e.g., food processors, apple packers, wastewater treatment plants). That is, they must have a permit from a single state or federal agency with the authority to review and enforce animal waste management plan provisions. The state or federal agency must also have the unfettered ability to conduct routine inspections and initiate meaningful/appropriate enforcement actions for noncompliance.
2. Permit fees must generate sufficient revenue to support the number of inspectors needed to effectively regulate the operators described above.
3. Operators must maintain and effectively implement animal waste management plans designed for their current operation.

In addition to pursuing the ideas described above with the affected parties, we would like your agency to report on the steps taken in response to the actions that we requested in our June 7, 2005 letter. The requested actions were the following:

1. Conduct a review of inspections conducted by the Department of Ecology from July 1998 to June 2003 and by the Department of Agriculture since July 2003 in the Nooksack River watershed to determine the number of inspections conducted each month, what was found, what actions were taken, what were the results of the actions, and evaluate the relative regulatory presence and effectiveness of the two agencies.
2. Conduct a review to determine if any inspections have been conducted by any state or federal agency to evaluate the effectiveness of nutrient management plan (a.k.a. farm plan) implementation. The purpose of this evaluation is to determine if the nutrient management plans are being effectively implemented and updated appropriately as animal units fluctuate, conditions change, and experience dictates modifications such as providing increased manure storage.
3. Based on the experience over the 2004-2005 winter months when many manure lagoons were at capacity by January, advocate to revise the manure lagoon design standards so that the lagoons can store anticipated manure generation (solids and liquids) plus the seasonal rainfall volume expected to be exceeded 10 percent of the time in the area that contributes to the lagoon plus the 24-hour, 25-year rainfall event.
4. Ensure that contingency plans for manure management are incorporated in the farm plans to avoid a repeat of what occurred in January 2005.

5. Conduct an evaluation to identify other potential non-point pollution sources including beef cattle operations and hobby farms. Specifically locating and mapping areas where there is direct animal access to waterways.
6. Conduct additional compliance inspections and take enforcement actions as warranted to ensure a level economic playing field for dairy producers and beef cattle operations.
7. Provide financial support to revive the water quality sampling, analysis, and reporting necessary to identify sources and monitor progress.

In summary, collectively we need to continue compliance inspections and enforcement actions, water quality monitoring to identify sources and track progress, and continue to support the effective implementation of nutrient management plans for the dairy industry and for all other operators that apply animal wastes to the landscape. The last thing anyone wants is to have the shellfish beds closed again in the future. We need the EPA and Washington State to be proactive environmental stewards rather than reactive stewards – history has shown that a reactive management approach leads to closed shellfish beds. The water quality data are indicating that there is a growing threat to our shellfish beds, the adaptive management approach dictates that action is needed before it is too late.

I would like to meet with you and/or your key staff to discuss both the issues in this letter and the degraded water quality in the Lummi Bay watershed, which threatens our shellfish beds in Lummi Bay. Please keep me informed regarding the actions that your agency takes in response to this request and please notify me (360-384-2225 or merlej@lummi-nsn.gov) or my staff if you need any support from my agency.

Sincerely,

Merle Jefferson

Merle Jefferson, Executive Director
Lummi Natural Resources Department

cc Mike Bussell, EPA Office of Water and Watersheds Director
Karma Anderson, EPA Regional Agriculture Advisor
Rick Parkin, EPA Acting Director, Office of Ecosystems, Tribal, and Public Affairs
Tom Eaton, EPA Washington Office
Robin Slate, EPA Tribal Coordinator
Ted Sturdevant, Washington Department of Ecology Director
Dan Newhouse, Washington Department of Agriculture Director
Richard Grout, Washington Department of Ecology Bellingham Field Office
Nora Mena, Washington Department of Agriculture
George Boggs, Whatcom Conservation District
Henry Bierlink, Agricultural Preservation Committee
Jay Gordon, Washington Dairy Federation

APPENDIX D

2013 Lummi Ambient Water Quality Program Review

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LUMMI INDIAN BUSINESS COUNCIL
2665 KWINA ROAD BELLINGHAM, WASHINGTON 98226 (360) 312-2000

MEMORANDUM

DATE: **September 24, 2013**

TO: **Merle Jefferson, LNR Executive Director**
Leroy Deardorff, LNR Environmental Program Director

FROM: **Jeremy Freimund, P.H., Water Resources Manager**

SUBJECT: **Recommendation to Adapt the Ambient Water Quality Monitoring Program**

As you know, on September 9, 2013 the Water Resources Division staff met to review the Ambient Water Quality Monitoring Program. The purpose of this memorandum is to summarize the technical recommendations collectively reached by the Water Resources Division staff and to seek policy approval. Overall, this memorandum outlines recommendations to suspend water quality sampling at select sites and reduce sampling frequency at others in order to maximize the use of limited staff and financial resources. If accepted, the recommendations described in this memorandum will be implemented immediately.

The Water Resources Division has implemented an extensive water quality sampling program on the Lummi Indian Reservation (Reservation) since 1993. Currently, the Water Resources Technician III, with the support of various other LNR staff, is responsible for sampling 51 surface water sites, 27 ground water sites, and downloading 9 temperature loggers on a monthly basis. This is an extensive sampling effort for a relatively small geographic area. The costs of implementing such an intensive water quality monitoring program are substantial due to contracted analytical laboratory services, supplies, and staff resources. These costs are largely supported by an annual EPA grant that has remained essentially stagnant since 2002 even though program costs have increased.

The goals of the Ambient Water Quality Monitoring Program are threefold: (1) to establish baseline conditions of surface and ground waters on and flowing onto the Reservation, (2) to use information to evaluate regulatory compliance of waters flowing onto the Reservation, and (3) to support the development and implementation of the water quality regulatory program on the Reservation. The purposes of the following recommendations are to improve the efficiency of the water quality monitoring program and utilization of the limited resources available to support the program, while ensuring the program’s three goals are met.

Recommendations for Suspending Sample Collection

The Water Resources Division staff recommends that we reduce the costs and increase efficiency of the Ambient Water Quality Program in two ways,: (1) suspend sampling of sites that are no longer essential to achieving the goals of the program, and (2) reduced the sample frequency where the beneficial uses of data collected will continue to be achieved but through reduced efforts. The Water Resources Division staff recommends that water quality sampling is suspended indefinitely at the eight (8) Ambient Water Quality Monitoring Program sample sites identified in Table 1. In addition, pursuant to the recommendations identified in a separate memorandum dated September 10, 2013 (see Attachment 1) and approved by Merle on September 11, 2013, we have also suspended sample collection at the 12 sites in the Nooksack River Delta that were being sampled in an effort to obtain certification under the National Shellfish Sanitation Program (NSSP) for the commercial harvest of varnish/mahogany clams. Figure 1 displays the location of the sample sites affected by the recommendations identified in this memorandum.

Table 1. Ambient Water Quality Sample Sites Where Sampling Should be Suspended:

Site ID:	Site ID:
SW052	SW034
SW030	SW036
SW058	SW038
SW032	SW006 (Nutrients Only)

Justifications for Suspending Sample Collection:

The justification for suspending sampling at the eight Ambient Water Quality Monitoring Program sample sites identified in Table 1 includes the reasoning summarized below.

SW052 – Sample Site SW052 is located within the Lummi Sea Pond Aquaculture Facility near the northern tide gate. Sampling at Site SW052 should be suspended because the Sea Pond is already sampled regularly as part of the Department of Health (DOH) Lummi Bay sampling program, which makes sampling this site as part of our ambient monitoring program redundant.

SW030 – Sample Site SW030 is our northernmost site along Lummi Shore Road and is the closest site accessible by land to the Nooksack Delta. Sampling at Site SW030 should be suspended because it is not in the vicinity of a point of surface water discharge and because it can be time consuming and dangerous to sample at times due to tidal conditions and wave action. Because Sample Site SW118 provides data representative of water discharging from the Nooksack River into Bellingham Bay, and the DOH regularly samples Portage Bay, sampling Site SW030 is redundant and provides no additional information.

SW058 – Sample Site SW058 is located along an agricultural drainage ditch and two pipelines extending from Frank Moser's farmland, under South Red River Road, and into the Lummi River. However, the upper, more visible pipeline is controlled by a valve that is always closed, preventing the flow of water from Moser's farmland to the Lummi River. A dye study conducted in March 1997 by the United States Environmental Protection Agency (EPA) identified a second pipeline beneath the water's surface. Results of that dye study documented that flow from Moser's farmland to the Lummi River occurs in the second pipeline. Although there is some flow that discharges through the second pipeline from Moser's farmland, the Water Resources Division staff recommends that sampling be suspended at Site SW058 because surface flow is rarely visible and large densities of Duck Weed are commonly found on site. This vegetation suggests that the water being sampled is generally stagnant, which is not ideal for meeting the goals of our Ambient Water Quality Monitoring Program. Additionally, access to Site SW058 is hazardous to the staff because of exposed rebar, large and steep rip-wrap, and the frequent illegal dumping of solid waste.

SW032, SW034, SW036, SW038 – Sample Sites SW032, SW034, SW036, SW038 are located in the Hermosa Beach area along Lummi Shore Road, and are the "plume" sample sites associated with points where freshwater discharges into Portage Bay. Sampling at these marine water sites should be suspended because freshwater sample sites are already established at the upstream end of the culverts that discharge to Portage Bay at these locations. These "plume" sites were originally established as part of a three-year study (1998 – 2001) to evaluate the water quality impacts of storm water originating along Lummi Shore Road on shellfish growing areas in Portage Bay. Baseline bacteria densities have been established and the DOH continues to sample Portage Bay regularly. Consequently, although sampling the associated freshwater sampling sites (i.e., SW031, SW033, SW035, and SW037) will continue, it is not necessary to continue the effort to sample the plume sites.

SW006 – Sample Site SW006 is located in the center of Portage Bay and is currently sampled monthly for bacteria and the other water quality parameters that we typically evaluate, and is also sampled quarterly for Nutrients and Total Organic Carbon (TOC). Sampling for Nutrients and TOC should be suspended at this site due to the high analytical laboratory cost for nutrient analysis ($434 per sample) and the fact that saltwater samples have proven very difficult for the lab to process accurately. In addition, many of the sample results indicate low concentrations of nutrients. Nutrient analysis will continue quarterly for SW002 leaving one remaining saltwater nutrient site as part of the Ambient Water Quality Program. Collecting bacteria and general water quality parameters will continue to occur at SW006 as normal.

Recommendations for Reducing Sample Collection

The Water Resources Division staff recommends that water quality sampling is reduced indefinitely at the Ambient Water Quality Monitoring Program sample sites identified in Table 2.

Table 2. Sample Sites where Sample Frequency Should be Reduced:

Run Name:	Run Type:	Existing Frequency	Suggested Frequency
Lummi Shore Road	Surface Water	Once a Month	6 Times/Year
Domestic Wells	Ground Water	Once a Month	5 Times/Year
Supply Wells	Ground Water	Once a Month	5 Times/Year
Monitoring Wells	Ground Water	Once a Month	4 Times/Year
Continuous Temperature Monitoring	Surface Water	Once a Month	4 Times/Year

<u>Justifications for Reducing Sample Collection:</u>

Lummi Shore Road (LSR) – The Lummi Shore Road (LSR) sampling run samples small outflows, primarily from wetlands, discharging into Bellingham Bay and Portage Bay. These sites were originally established as part of a three-year study (1998 to 2001) to evaluate the water quality impacts of storm water originating along Lummi Shore Road on shellfish growing areas in Portage Bay. Baseline bacteria densities have been established in this area and the DOH continues to sample Portage Bay every other month (or six times a year depending upon weather, tide, staffing, or equipment issues). Sampling of these sites along Lummi Shore Road should be reduced from monthly (12 times per year) to six times a year and scheduled to occur on the days DOH is conducting the NSSP compliance monitoring of Portage Bay. This effort will save six days of staff time a year (and associated laboratory analytical costs), while continuing the program's ability to collect status and trends data, and (through data sharing and collaboration with the DOH) allow for the assessment of bacteria density comparisons between freshwater discharge along Lummi Shore Road (and the Nooksack River) and bacteria densities within Portage Bay. Sample Sites SW029 and Site SW007 should no longer be sampled as a part of the LSR sampling run but as part of the Flood Plain East (FPE) sampling run because the purpose of and information collected from these two sites differs from that gathered from the sites along the Hermosa Beach area. Status and trends water quality data will continue to be collected for sample Sites SW029 and SW007 monthly as a component of FPE.

Domestic and Public Supply Wells – Domestic and Public Supply Well sampling runs monitor the Lummi Nation's ground water supply by collecting static water level, chloride, temperature, pH, salinity, specific conductivity, and when appropriate, pump rate and totalizer data. Monitoring the Nation's ground water is important because over 90 percent of the potable water supply on the Reservation comes from ground water. The most "at risk" times of year, or times when the aquifers are most susceptible to salt water intrusion and ground water mining, are during the summer months when water use peaks. Sampling of these wells should be reduced to every other month beginning in April and extending through December and suspended when water levels and aquifer recharge rates are greatest during the January through March period. April is the time of year when water levels are expected to be highest within the aquifer and sampling during April should ensure water level yearly maximums are represented in our status and trends data set. June through October is when the aquifer is most at risk. However, baseline analyses collected over the last 10 years indicate relatively stable water levels and chloride concentrations during this period. Therefore, reducing sampling to every other month during the summer season allows for continued status and trend monitoring while still monitoring frequently enough for early detection of changes to aquifer health. Additionally, once implemented this strategy will save another 14 days of staff time spent in the field each year.

Monitoring Wells – Monitoring Wells are wells that are not currently in use for water supply but allow the aquifer conditions to be evaluated. The Ambient Water Quality Monitoring Program uses these wells to monitor static water levels as evenly distributed across the Reservation as possible. In select wells, a water level monitoring device (i.e., a pressure transducer with an associated data logger) has been deployed to collect water levels every 15 minutes. At this recording interval, the recorder must be downloaded monthly to ensure data are not being over-written by the recorder and lost. Recording measurements every 15 minutes creates large data sets that are difficult to manage. This measuring rate is also more frequent than necessary to allow for an evaluation of aquifer water level characteristics. Reducing the recording interval to once an hour will substantially increase the length of time the recorder can safely store data between downloads, while collecting meaningful data and creating more manageable data sets. It is yet to be tested, but reducing the recording interval to hourly should reduce the need from downloading once a month to four times a year, which is expected to save Water Resources Staff eight days of field time each year.

Continuous Temperature Monitoring – The Lummi Water Resources Division currently has continuous temperature monitoring probes and associated data loggers that measure and record temperature every 15 minutes at nine sites across the Reservation. The data loggers in the probes must be downloaded monthly in order to ensure the logger does not reach capacity and result in the loss of data. The measurement frequency of these probes should be reduced to one reading per hour in order to reduce the need to download as frequently.

Recommendations for Additional Sample Collection

In addition to suspending or reducing sample collection at identified sites, as summarized in Table 3, additional monitoring is recommended for Site SW118, which is located along the Nooksack River. The Nooksack River has been identified as a source of bacterial pollution that has resulted in closures to Lummi shellfish beds in Portage Bay. It is reasonable to believe the Nooksack River may also be contaminated with excess nutrients from farm practices upstream of the Reservation. This additional monitoring will allow for further baseline information and better characterization of potential and actual sources of pollution from the Nooksack River. Due to the cost of analyzing for nutrients it is only practicable to monitor quarterly as identified in our Quality Assurance Project Plan.

Table 3. Summary of additional monitoring to the Lummi Ambient Water Quality Monitoring Program

Site ID	Sample Type	Current Monitoring	Additional Monitoring
SW118	Surface Water	3 Times Monthly: Bacteria, Temperature, pH, Salinity, Specific Conductivity, Dissolved Oxygen	Quarterly: Nutrients and TOC

Summary

The Water Resources Division manages an extensive water quality sampling program that is currently consuming more financial and staff resources than necessary to meet the program goals. The Division technical staff held a meeting to review the program and discuss modifications. The result of this discussion included a number of recommendations to suspend sampling at some locations, reduce sampling frequency at other locations, and to increase the number of parameters sampled at one location. If all recommended program modifications are implemented, the number of days required to conduct the sampling program will be reduced by approximately 28 days per year. Since the field crew is comprised of at least two staff members, if the recommend changes are approved and implemented, approximately 56 work days of staff time will be available for allocation to other priority projects. The program modifications will also reduce laboratory and supply cost associated with implementing the sampling program. If accepted, the recommendations described in this memorandum will be implemented immediately.

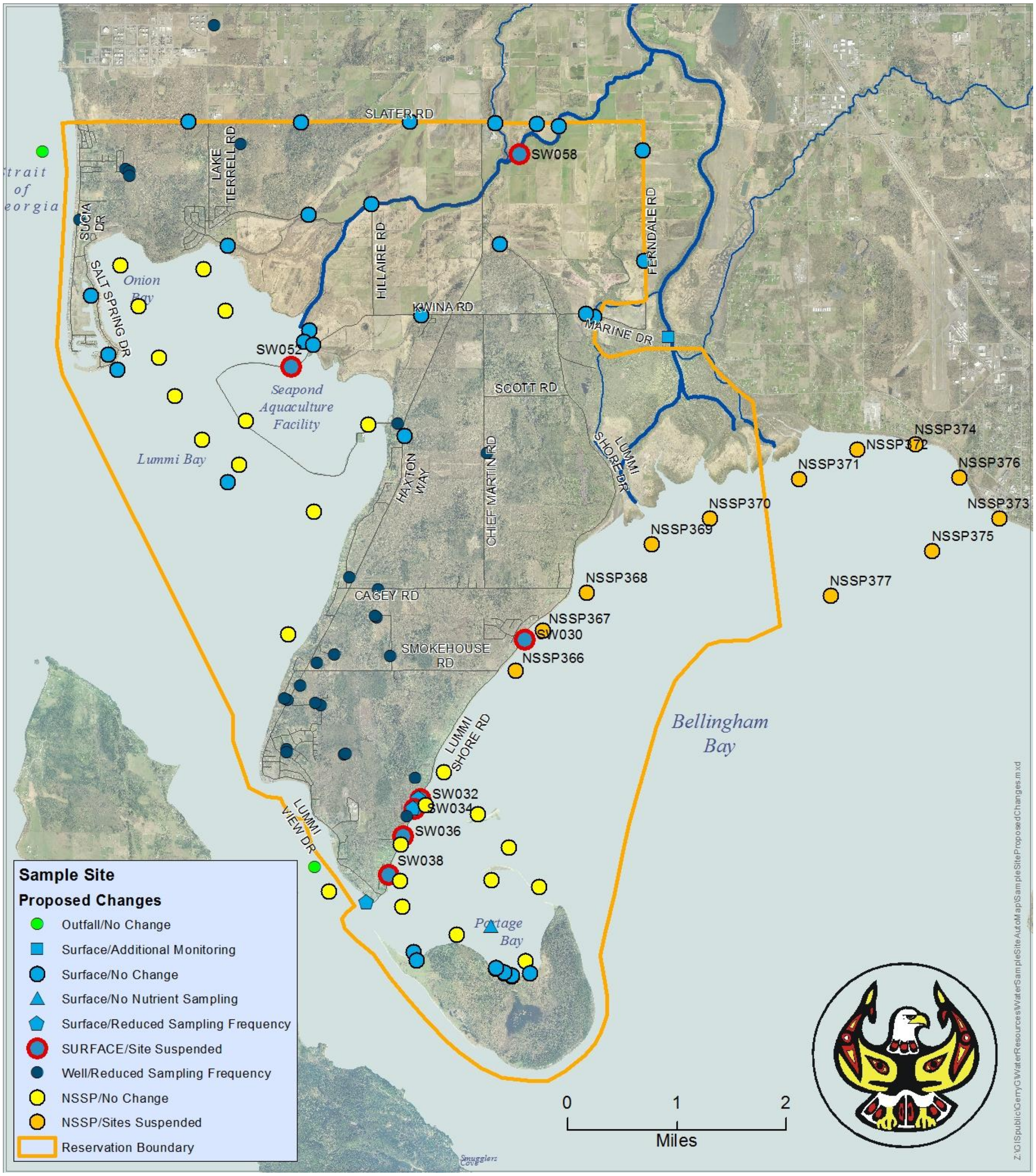

Figure 1. Map displaying sites affected by proposed changes to the Lummi Ambient Water Quality Monitoring Program.

ATTACHMENT 1

Memorandum Dated September 10, 2013 – Recommendation to Suspend Effort to Seek National Shellfish Sanitation Program Certification to Harvest Varnish/Mahogany Clams in the Nooksack Delta

LUMMI INDIAN BUSINESS COUNCIL
2665 KWINA ROAD BELLINGHAM, WASHINGTON 98226 (360) 312-2000

MEMORANDUM

DATE: **September 10, 2013**

TO: **Merle Jefferson, LNR Executive Director**
Leroy Deardorff, LNR Environmental Program Director

FROM: **Jeremy Freimund, P.H., Water Resources Manager**

SUBJECT: **Recommendation to Suspend Effort to Seek National Shellfish Sanitation Program Certification to Harvest Varnish/Mahogany Clams in the Nooksack Delta**

Pursuant to our conversation, the purpose of this memorandum is to outline reasons why I recommend that we suspend the efforts of the Water Resources Division to obtain certification under the National Shellfish Sanitation Program (NSSP) to commercially harvest varnish/mahogany clams from the Nooksack Delta.

Challenges Meeting NSSP Standards

As you know, before shellfish can be harvested and sold commercially the area must meet approved NSSP shellfish growing area standards. The NSSP standards require all the sites in the growing area to have a geometric mean less than 14 colony forming units per 100 milliliters (CFU/100 mL) and a 90^{th} percentile that is less than 43 CFU/mL based on the 30 most recent samples. As shown in Figure 1 and in Table 1, currently there are 12 sites being sampled in the Nooksack Delta as regularly as practicable considering the weather and tidal conditions required for access. At least two sets of samples were rejected by the Department of Health (DOH) laboratory and several scheduled runs were canceled in consultation with me due to weather conditions or staff and/or equipment availability. As a result, to date we have only managed to get a total of 12 samples at these sites during the 26 month period from June 2011 to August 2013. At this sampling rate, we probably won't reach the 30 sample minimum until sometime in 2016. However, current indications suggest that if the statistics were calculated on the data so far, only 2 of the 12 sites would meet the necessary water quality standards to allow the area to be approved. In other words it is very unlikely that the area is going to be approved once we finally reach the 30 sample requirement and we will have to continue sampling until the higher sample results are no longer considered part of the 30 sample data set. In Table 1, the samples with relatively high fecal coliform levels are highlighted in yellow; the statistics that currently do not meet the NSSP standards are highlighted in red.

Figure 1. Locations of Nooksack Delta NSSP Sample Sites

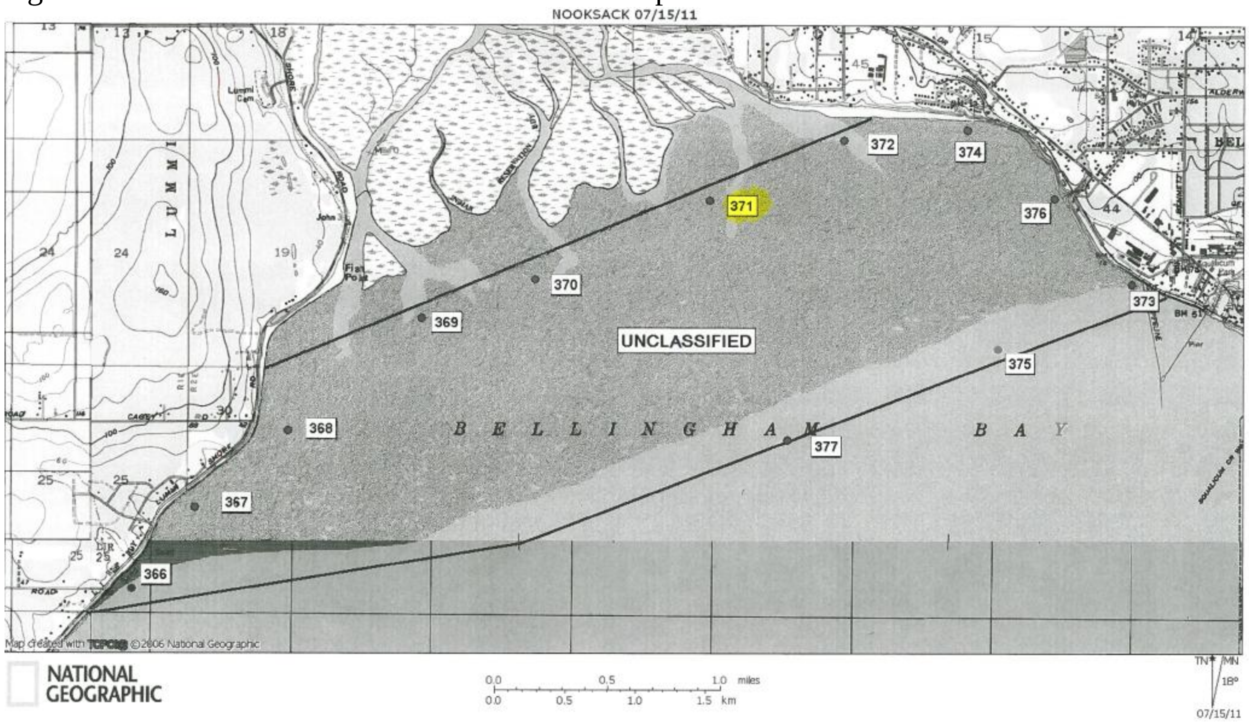

Table 1. Summary of Sample Results for the Nooksack Delta NSSP Sample Sites

Run Date	DH366	DH367	DH368	DH369	DH370	DH371	DH372	DH373	DH374	DH375	DH376	DH377
6/14/2011	1.7	1.7	2	22	7.8	17						
7/12/2011	11	2	4.5	11	2	1.7	4.5	49	110	1.7		1.7
8/8/2011	4.5	1.7	4.5	17	9.3	2	6.8	23	33	1.8	33	2
9/20/2011	4.5	1.7	1.7	13	13	4.5	7.8	4.5	1.7	2	1.7	7.8
10/24/2011	11	17	7.8	13	22	13	79	7.8	33	11	49	1.7
11/16/2011		11	13	49	23	350	49	13	23	13	7.8	1.7
12/20/2011	2	2	17	23	33	540	350	4.5	49	23	33	2
2/6/2012												
4/12/2012	13	13	13	79	14	79	46	49	2	4.5	2	17
6/18/2012	110	49	33	33	130	140	70	79	130	33	70	79
7/2/2012	49	46	14	21	70	49	79	49	79	79	23	9.3
8/2/2012												
9/24/2012	13	13	2	17	6.8	7.8	23	13	13	1.7	13	1.7
11/6/2012	33	21	46	49	23	110	33	49	70	49	79	240
3/6/2013	1.7	2	11	7.8	2	4.5	1.7	1.7	1.7	1.7	2	2
4/2/2013												
5/8/2013												
Geometric Mean (n=12)	9.3	6.7	8.2	22.0	14.5	24.8	26.2	16.7	21.0	7.5	14.2	5.8
90th Percentile (n=12)	47.4	41.0	29.8	49.0	62.6	308.0	79.0	49.0	106.9	47.4	70.0	72.8

Challenges Collecting Samples

Water quality sampling of the Nooksack Delta sites is extremely difficult and potentially dangerous due to the very shallow water and strong winds in the area. Although it is certainly possible, accessing the 12 Nooksack Delta sample sites is time consuming due to shallow water conditions (minimum +7.5 ft MLLW tide is required) and distance. Approximately 4 to 5 hours of on-water time is required to sample the 12 Nooksack Delta sites compared to approximately 3 hours to sample the 12 Lummi Bay sites (DOH currently collects samples from Portage Bay). This sampling time is in addition to the quality assurance, preparation time, boat deployment time, boat recovery time, and transport time to the Greyhound station in Fairhaven for shipment of the collected samples to the DOH laboratory in the Seattle area.

Market/Logistical Challenges

Market/Logistical challenges associated with harvesting varnish clams in the Nooksack Delta include the following:

1. Data collected in recent years suggest that, similar to butter clams, varnish clams retain biotoxins from toxic algal blooms for a prolonged period of time. This characteristic makes it critically important to test shellfish tissue samples before any harvest opportunity can be considered, and then regularly during the harvest period. Given that the only access to the site requires use of a boat, this sampling can be quite difficult to arrange.

2. Varnish clams tend to retain quite a bit of sand inside the mantle cavity, which is a negative characteristic from a marketability viewpoint. In areas where varnish clams are being harvested this problem is usually solved by keeping the clams in bags either on the beach or in seawater tanks for 48 hours immediately after harvest to give them time to spit out the sand. Currently, we do not have any facilities that would be suitable for such use. Any kind of storage facility will need to provide sufficient security to prevent illegally harvested clams from being introduced into the chain of custody, as well as to stop fishers from removing clams that they did not harvest themselves. This also introduces a Hazard Analysis and Critical Control Points (HACCP) regulatory issue as there are temperature control issues that arise if the clams are not sold within a very short period of time after harvest. This requires that the seawater environment be temperature controlled and that records are kept verifying the water temperatures are within acceptable limits. One possibility might be to use the Seapond Aquaculture Facility as a sand depuration facility. However, this introduces the potential to transfer disease causing organisms or toxins from the Delta into the Seapond, and potentially into the wider area of Lummi Bay. Although Craig is not currently aware of any disease organisms on the delta, there is still the potential for adverse impacts on the Shellfish Hatchery and Lummi Bay wild clam harvest that should be considered.

3. Varnish clams also commonly contain the commensal pea crabs (these are also found in the mantle cavity of horse clams). This introduces a food allergy problem for people who are allergic to crustaceans and who inadvertently consume the tiny crab while eating the clams. This is a known marketability issue with varnish clams. Unfortunately, depuration does not appear to have much impact on the rate of pea crab incidence.

4. Nooksack Delta site access for harvesters is difficult and requires a boat.

Other Considerations

Other considerations include the following:

1. There are already (smaller) varnish clam populations in the approved shellfish growing area in Lummi Bay that we could harvest immediately if the Harvest Management division could solve the market issues of sand depuration. Given that this area is much easier for fishers to access and for biotoxin monitoring, and can be harvested immediately, it seems there is not much genuine interest in developing the fishery.

2. The interest in the Nooksack Delta fishery stems from the very high numbers of varnish clams found during the Lummi Intertidal Baseline Inventory (LIBI). The LIBI survey had relatively little sampling intensity on the Nooksack Delta and really is not a great dataset for stock assessment purposes. It would be desirable to have the Harvest Management Division conduct a more targeted stock assessment survey to better quantify the size of the resource. Also, it is not uncommon for invasive species to initially develop very high population densities before the population crashes and reaches equilibrium with the overall ecosystem. Since varnish clams are still recent arrivals, it would be a shame to expend a massive investment of time and effort only to discover that the resource has declined since the LIBI was conducted.

Summary

There are numerous issues that need to be solved before a fishery for varnish clams on the Nooksack Delta can be contemplated. Since the water quality data to date indicates that the Nooksack Delta will not receive an approved growing area status in the near future, and there are significant costs and safety concerns with the extensive sampling effort required to continue sampling the area, I recommend suspending the sampling effort on the delta until such time as the Harvest Management Division has demonstrated an ongoing, successful pilot fishery for varnish clams in Lummi Bay.

APPENDIX E

Summary of Lummi Auto Recycling Water Quality Monitoring Results and Recommendation to Suspend Sample Collection

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LUMMI INDIAN BUSINESS COUNCIL
2665 KWINA ROAD BELLINGHAM, WASHINGTON 98226 (360) 312-2000

MEMORANDUM

DATE: **December 4, 2013**

TO: **Merle Jefferson, LNR Executive Director**
Leroy Deardorff, LNR Environmental Program Director

FROM: **Jeremy Freimund, P.H., Water Resources Manager**

SUBJECT: **Summary of Lummi Auto Recycling Water Quality Monitoring Results and Recommendation to Suspend Sample Collection**

The Lummi Indian Business Council has been aware of and has attempted to address potential pollutant sources and threats to public health and the environment associated with the Lummi Auto Recycler (LAR) facility located at 2544 Cagey Road (formerly operated by Mr. Tony Julius) since the early 1990s. The Lummi Water Resources Division began targeted water quality sampling around the LAR facility in November 2004 to better identify and assess the threats associated with the LAR facility. Between 2004 and 2006, Lummi Water Resources Division staff investigations characterized facility operations, identified soil types, delineated watershed boundaries, located wells, delineated wetlands, and collected water quality samples from road side ditches both upstream and downstream from the LAR facility. A memorandum written by Amy Sattler (former Water Resources Specialist) in 2006 described the water quality results obtained around the LAR facility between 2004 and 2006 (see Attachment 1). Pursuant to recommendations expressed in Sattler's 2006 memorandum, the Water Resources Division has continued to collect water quality samples around the LAR facility at least once a year during the wet season.

Essentially all vehicles were removed from the LAR facility by the end of the first quarter of 2011 (i.e., March 31, 2011). With the removal of the scrap vehicles from the LAR facility, the most concerning source of contaminants and threat to the Lummi Nation's surface water quality has likewise been removed from the site. The purpose of this memorandum is to summarize the results of water quality data collected between November 2004 and November 2012 at the LAR facility, to recommend the suspension of targeted sample collection near the LAR facility, and to seek policy approval of this recommendation.

Lummi Auto Recyclers Water Sampling Background and Site Descriptions

Two water quality monitoring sites (one upstream and one downstream from the LAR facility) were established in the roadside ditch along the north side of Cagey Road during November

2004 to characterize and monitor the quality of storm water discharging from the facility. In January 2006, as part of an effort to more accurately assess potential impacts of the LAR facility on nearby surface waters, a third sample site was established where runoff from the facility enters the ditch along the North side of Cagey Road. From January 2006 to November 2012 samples were collected upstream of LAR (Site SW100), immediately downstream of storm water discharge from LAR (Site SW101), and further downstream from LAR where a culvert diverts flow underneath and to the south side of Cagey Road (Site SW102). Sample Site SW100 was established as a reference site because water quality results from upstream of the LAR facility should be unaffected by the facility activities downstream and represent ambient water quality conditions for the area. Water quality data collected from Site SW101 is representative of the water quality of waters most concentrated with storm water that originates from the LAR facility. Water quality data from Site SW102 characterizes the surface water before it flows into a depressional wetland located to the south of Cagey Road. Concentration comparisons between the three sites indicate the extent to which Lummi Auto Recycler activities affect nearby surface waters and whether or not contaminant concentrations are being diluted as water flows downstream. Table 1 summarizes the sample collection effort associated with the LAR facility.

Table 1. Summary of Water Quality Sampling Associated with the LAR Facility

Sampling Event No.	Sampling Date	SW100	SW101	SW102
1	11/2/2004	X		
2	11/8/2004	X		
3	11/15/2004			X
4	11/24/2004	X		X
5	1/11/2006	X		
6	1/30/2006	X	X	X
7	2/5/2008	X	X	X
8	1/7/2009	X	X	X
9	1/13/2010	X	X	X
10	1/7/2011	X	X	X
11	11/19/2012	X	X	X

Figure 1 shows the subject property over the 1993 to 2001 period. Figure 2 shows the subject property over the 2004 through 2013 period. Figure 3 is an enlarged version of the 2013 image in Figure 2, which is an aerial photograph taken on April 22, 2013. Figure 3 also shows the location of Sites SW100, SW101, and SW102 and illustrates that the scrap vehicles formerly stored on the subject properties have been removed.

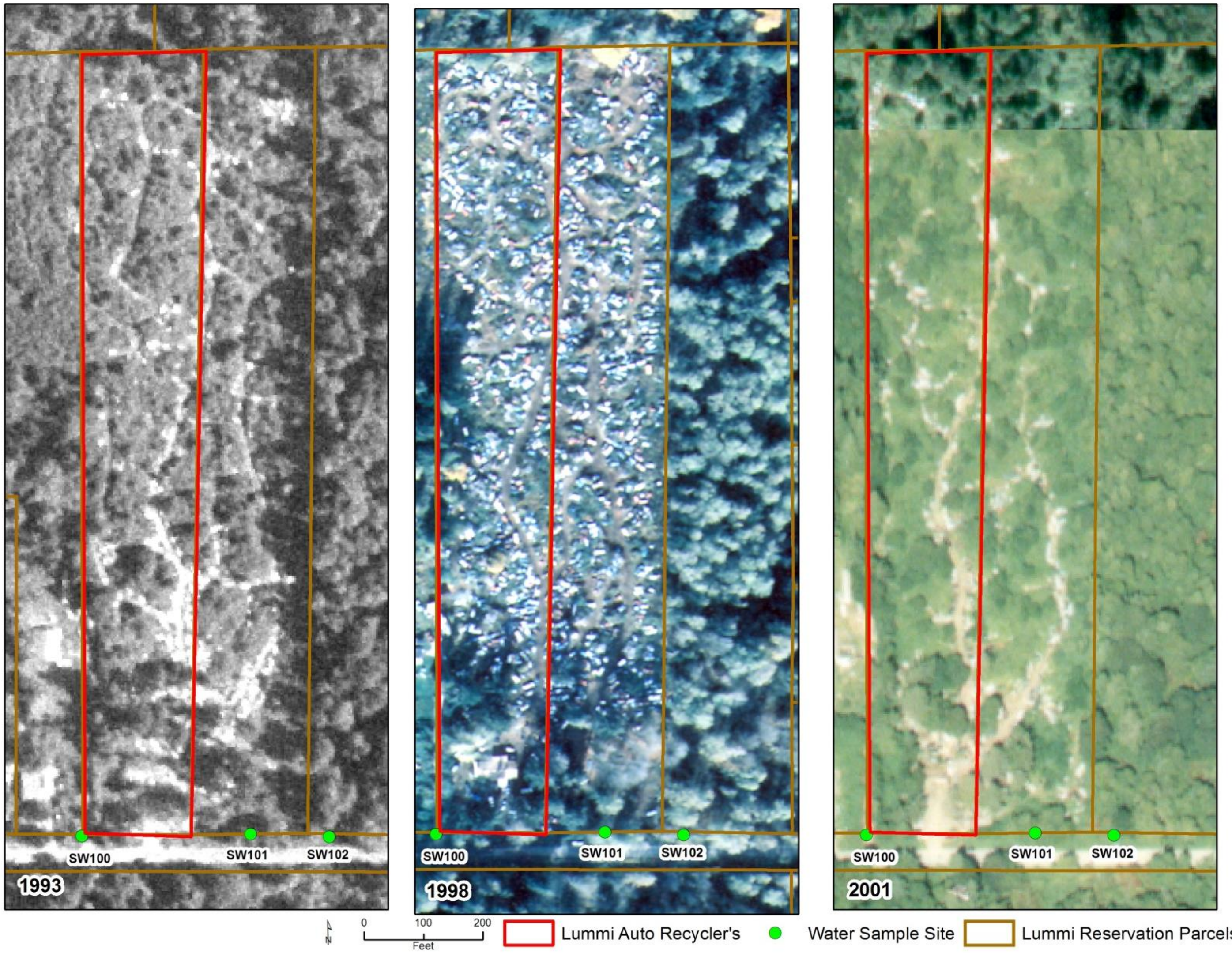

Figure 1. Lummi Auto Recycler Facility 1993 to 2001.

Figure 2. Lummi Auto Recycler Facility 2004 to 2013.

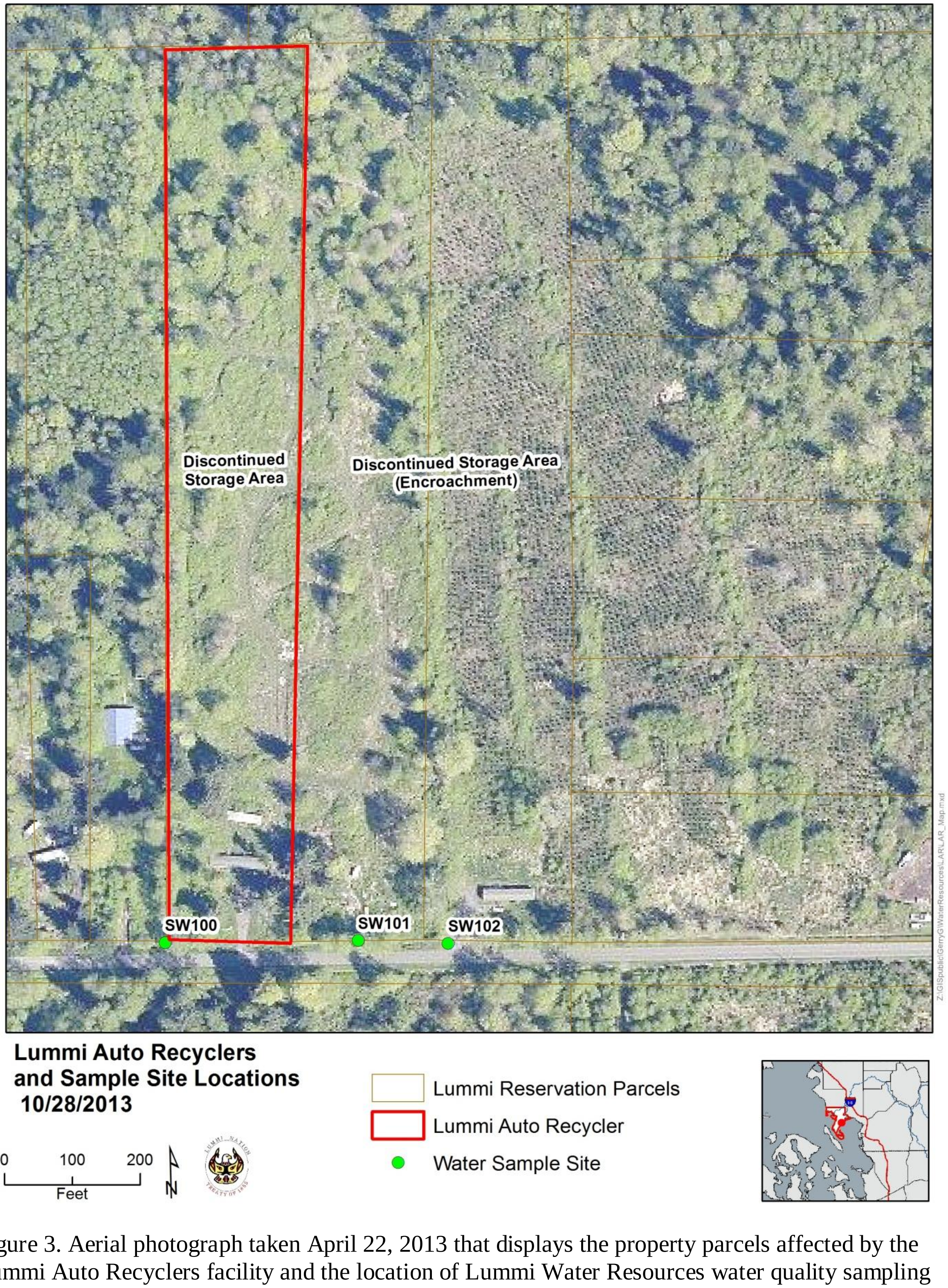

Figure 3. Aerial photograph taken April 22, 2013 that displays the property parcels affected by the Lummi Auto Recyclers facility and the location of Lummi Water Resources water quality sampling Sites SW100, SW101, and SW102.

Baseline Water Quality Results and Analysis

Water quality data from sample sites SW100, SW101, and SW102 were evaluated in three ways, (1) comparing contaminant concentrations upstream, on site, and downstream of the LAR facility; (2) assessing how contaminant concentrations change over time (status and trends data beginning November 2004 and extending through November 2012); and (3) assessing whether contaminant concentrations meet or exceed Water Quality Standards for Surface Waters of the Lummi Indian Reservation ("Lummi Water Quality Standards" Lummi Administrative Regulation 17 LAR 07). Each contaminant may be evaluated differently depending on the nature of the parameter. For example, water quality standards do not exist for some parameters and therefore cannot be evaluated against compliance with Lummi Water Quality Standards. However, long term status and trends analysis may capture how water quality has been affected over time by changing land use practices at the LAR facility.

Special consideration should be taken when evaluating data from the seventh (7th) sampling event on February 5, 2008. As shown on the graphs below, this sampling event captured the highest concentrations of contaminants observed over the sampling period. In addition, the highest values between the three sites were at Site SW101, the point nearest to storm water runoff from the LAR facility. Special consideration is required because field notes from this sampling event noted that water was present at each sample site but water was not flowing from one sample site to the next. This recorded observation indicates that the sample sites were independent of each other at the time of sample collection. These data are useful when considering each discrete sample site and that the contaminants present could only be contributed by localized sources. However, the data are not useful for understanding the influence of contaminant concentrations from an upstream site on a site further downstream. Lummi Water Resources staff additionally noted at Site SW101, "Drainage from Lummi Auto Recyclers entering ditch. Water has a sheen to it. Standing water with trash present in ditch," indicating that Site SW101 was receiving storm water runoff from the LAR facility during sample collection.

In an effort to establish baseline water chemistry for surface waters associated with the LAR facility, a status and trends analysis was used to evaluate how biochemical oxygen demand (BOD), chemical oxygen demand (COD), pH, and total suspended solids (TSS) vary over time and space. All the baseline water chemistry parameters, except pH, are without water quality standards but serve as important indicators of surface water integrity. Table 2 shows which parameters were evaluated as a part of establishing baseline water chemistry near the LAR facility.

Table 2. Baseline Water Chemistry for Lummi Auto Recyclers (November 2004 to November 2012).

Parameter	Units
Biochemical Oxygen Demand (BOD)	mg/l
Chemical Oxygen Demand (COD)	mg/l
pH	pH Units
Total Suspended Solids (TSS)	mg/l

The water quality parameters biochemical oxygen demand (BOD) and chemical oxygen demand (COD) are used as surrogates to measure the amount of organic compounds in water.

High concentrations of BOD and COD are problematic to ecosystem health and indicate the presence of excess organic compounds which can lead to low oxygen levels and sedimentation. The BOD, which is typically lower than COD, of unpolluted waters is typically 2 mg/L or less; BOD is between 2 mg/L and 10 mg/L for moderately polluted waters; treated municipal sewage has a BOD ranging from 20 mg/L to 100 mg/L. The concentration of COD in unpolluted waters is typically 20 mg/L or less; COD can be greater than 200 mg/L for moderately polluted waters. Water quality results for BOD and COD from LAR sampling during November 2004 and extending through November 2012 reflect low concentrations of BOD and COD at nearly every instance and indicate that these surface waters are not consistently contaminated with excess organics. The seventh (7th) set of samples from February 5, 2008 was analyzed for BOD and COD and high concentrations were detected at Site SW101. Concentrations of BOD and COD returned to low levels prior to the eighth (8th) sampling event. The second time when BOD and COD concentrations were elevated was the eleventh (11th) sampling event on November 19, 2012. During this sampling event, concentrations were highest at Site SW100, which is the control site upstream of the LAR facility and cannot be due to practices occurring at the facility unless there had been some vehicles parked or otherwise temporarily stored along the roadway just prior to the sampling event. The biochemical oxygen demand and chemical oxygen demand concentration results for each sampling event and associated LAR sample site are presented in Figure 4 and Figure 5 below.

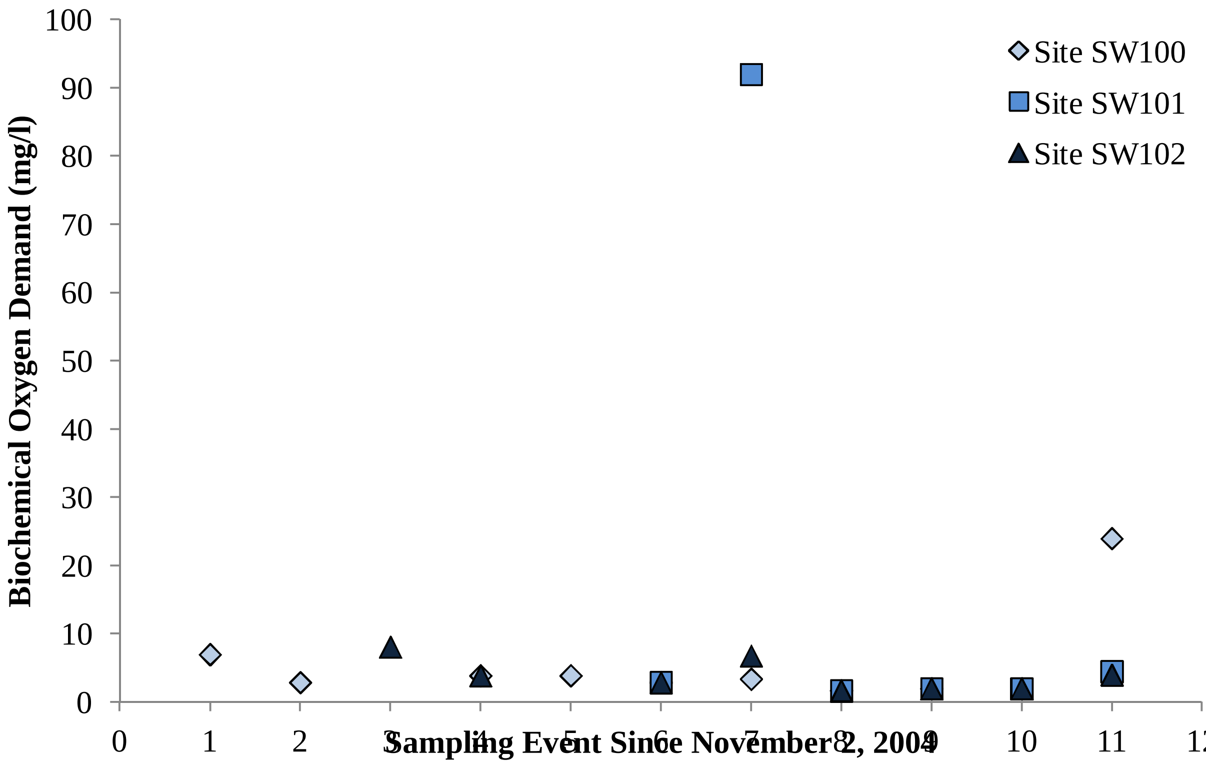

Figure 4. Biochemical oxygen demand (mg/l) at the Lummi Auto Recyclers Facility between November 2, 2004 and November 19, 2012.

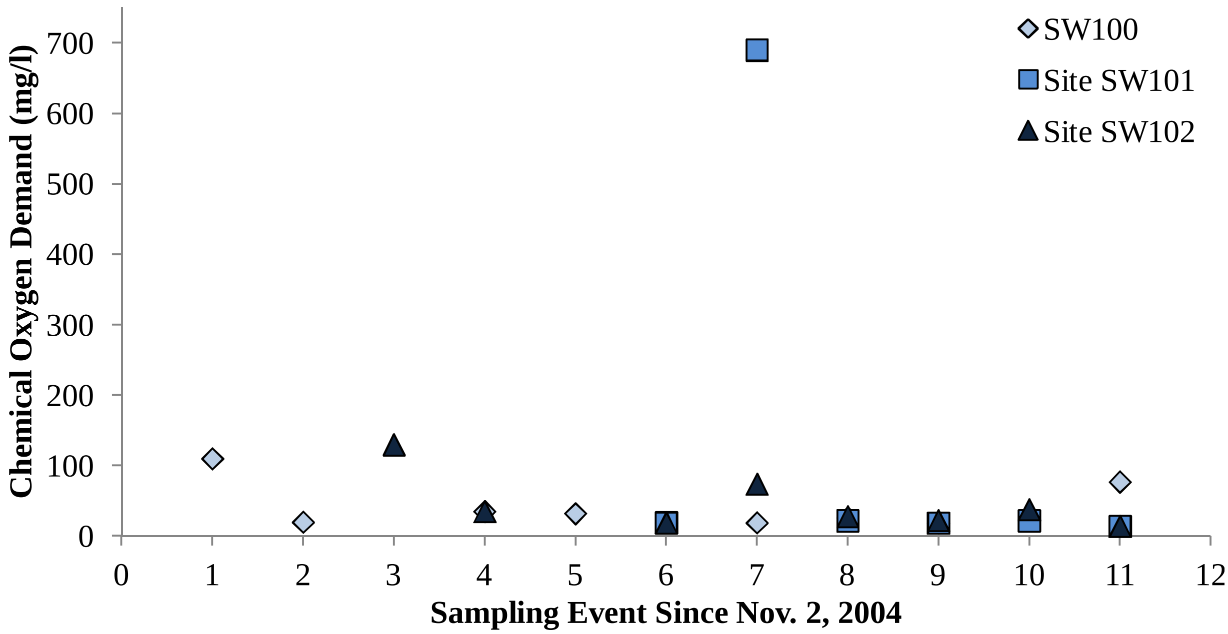

Figure 5. Chemical oxygen demand (mg/l) at the Lummi Auto Recyclers Facility between November 2, 2004 and November 19, 2012

The Lummi Water Quality Standards for pH of Reservation surface waters are that pH must fall within 6.5 and 8.5 pH units. Water quality data near the LAR facility over the November 2004 through November 2012 period indicate that the pH of surface waters in the north ditch along Cagey Road did not meet Lummi Water Quality Standards at Site SW100, Site SW101, or Site SW102 until the final sampling event on November 19, 2012. Results from each sampling event for pH are displayed in Figure 6 and show stable pH results upstream, on site, and downstream of the LAR facility. It is not likely that pH noncompliance with the water quality standards can be solely attributed to the LAR facility as low pH values are also present upstream of LAR.

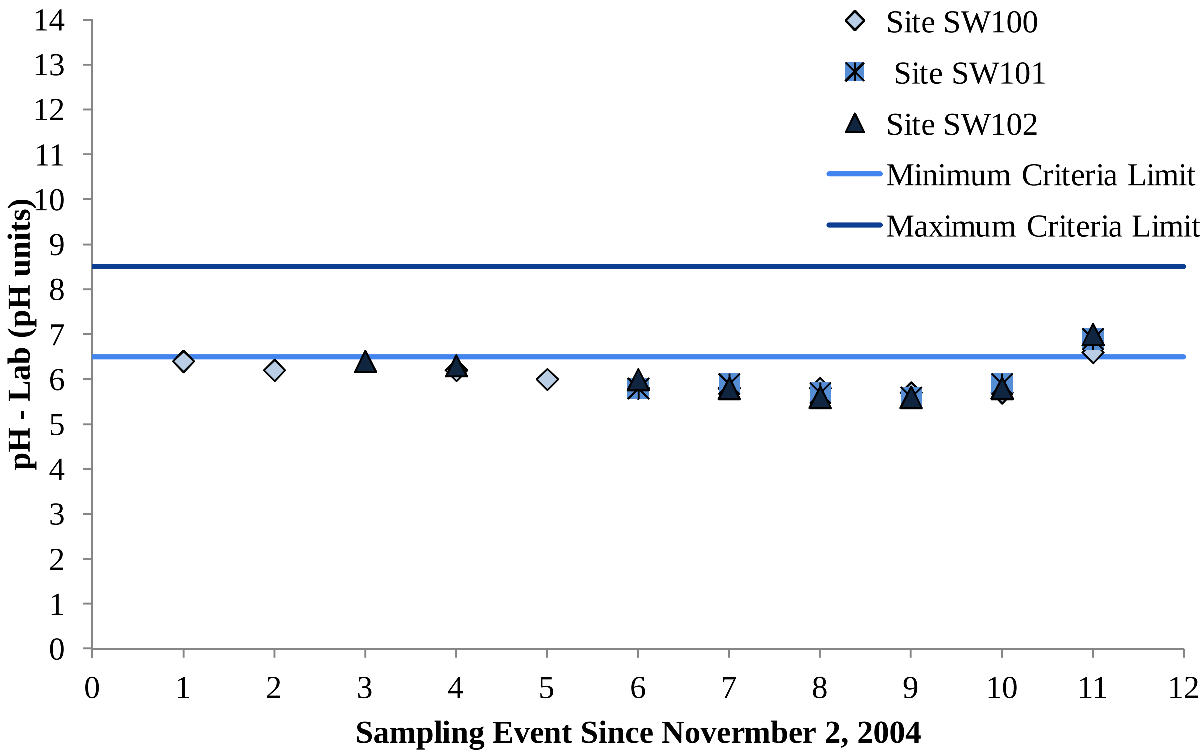

Figure 6. pH (pH units) at the Lummi Auto Recyclers Facility between November 2, 2004 and November 19, 2012.

Measurements of total suspended solids (TSS) near the LAR facility between November 2004 and November 2012 indicate that surface water runoff from the facility is largely free of suspended sediments. On the seventh (7^{th}) sampling event the TSS values are high at Site SW101, the sample site nearest the LAR facility, but concentrations decreased when sampled further downstream at Site SW102 and returned to the low levels that were observed during prior site visits. Sample results for TSS are depicted in Figure 7.

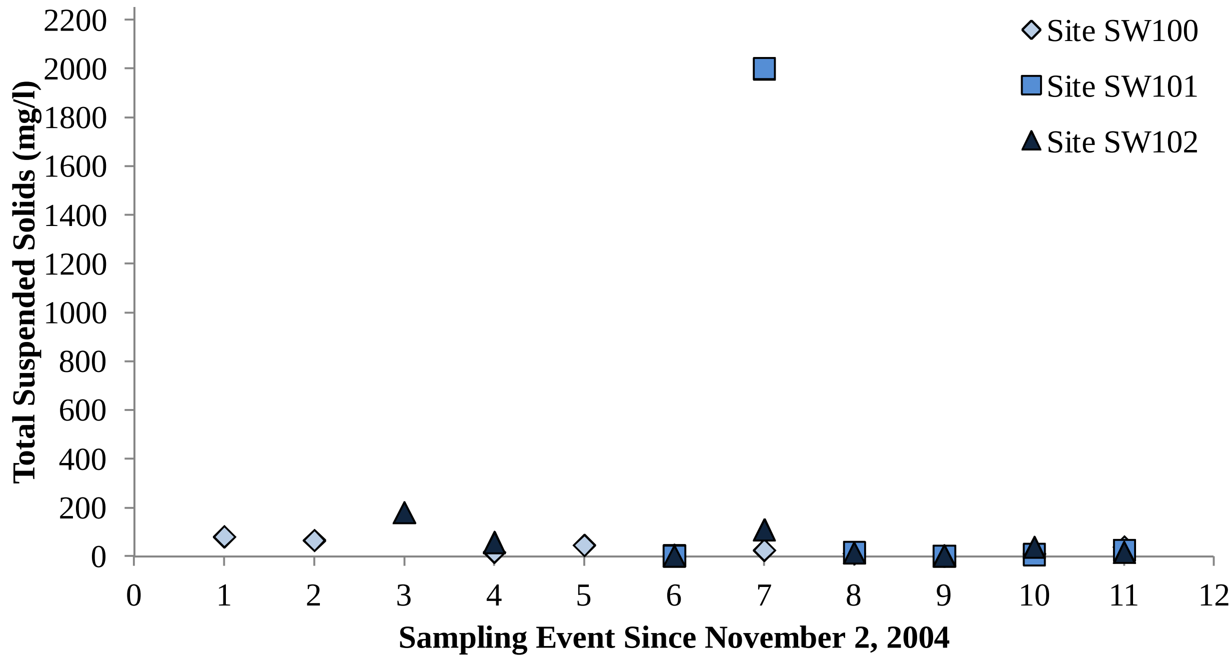

Figure 7. Total suspended solids (mg/l) at the Lummi Auto Recyclers Facility between November 2, 2004 and November 19, 2012

Targeted Water Quality Sampling Results – Metals and Hydrocarbons

Water samples collected in relation to the LAR facility were also analyzed for the metals and hydrocarbons often associated with practices typical of an auto recycling facility and that could be reasonably expected to be found in storm water originating from the facility. Table 3 shows which parameters were selected for targeted sampling and analysis.

Table 3. Targeted Water Chemistry for Lummi Auto Recyclers and Associated Lummi Water Quality Standards (November 2004 to November 2012).

Parameter	Units	Chronic Criteria Limit	Acute Criteria Limit
Oil Range Hydrocarbons	mg/l	N/A	N/A
Chromium	mg/l	0.011	0.016
Copper	mg/l	0.009	0.013
Lead	mg/l	0.0025	0.065
Zinc	mg/l	0.12	0.12

Hydrocarbons are naturally occurring in the environment at varying concentrations; however it is possible that practices associated with the LAR facility could contribute to increased loading of hydrocarbons through storm water runoff. Lummi Water Quality Standards do not exist for hydrocarbons or anti-freeze constituents in surface waters but assessing concentrations across space and time near the LAR facility allows for a determination to be made if the facility is a hydrocarbon pollution source or an anti-freeze pollutant source.

The concentrations of hydrocarbons and anti-freeze constituents in the surface waters sampled near the LAR facility were largely below the detection limit of laboratory analysis.

None of the following hydrocarbons or anti-freeze constituents were detected at the LAR facility sample sites between 2004 and 2012:

- Diesel range hydrocarbons,
- Ethylene glycol (anti-freeze constituent),
- Propylene glycol (anti-freeze constituent), and
- Surfactants.

As shown in Figure 8, oil range hydrocarbons were detected once at Site SW101 but were not present downstream at Site SW102 or during the next sampling event. As noted previously, field notes from the 7th sampling event indicated that water was not flowing between the sample sites at the time of sample collection and that there was a sheen observed in the water at SW101. On the 11th sampling event, the laboratory tested for lube oil range hydrocarbons while all previous results were obtained using a heavy oil range hydrocarbons test. Results were non-detect.

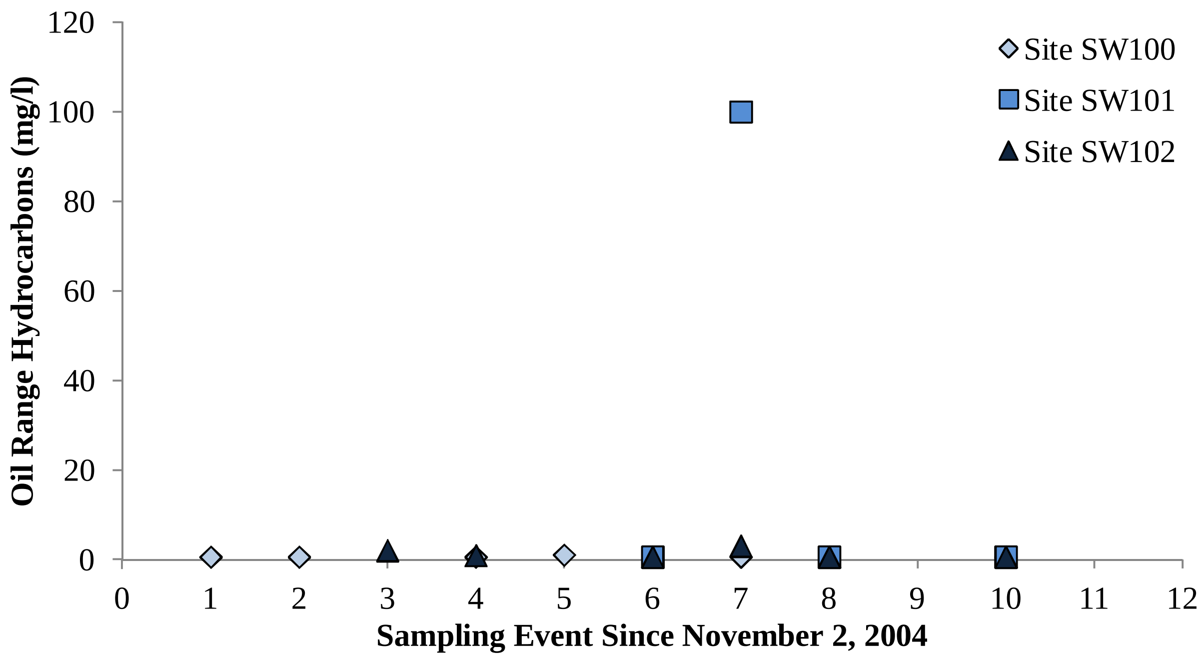

Figure 8. Oil range hydrocarbons (mg/l) at the Lummi Auto Recyclers Facility between November 2, 2004 and November 19, 2012.

Certain metals were also selected for laboratory analysis because they are contaminants commonly associated with auto recycling practices and can be hazardous to human health at low concentrations. Specifically, chromium, copper, lead, and zinc were monitored near the LAR facility between November 2004 and November 2012 and compared with the Lummi Water Quality Standards. Each listed metal was present at concentrations higher than the acute and chronic criteria limits established in the Lummi Water Quality Standards on at least one occasion between 2004 and 2012. All vehicles were removed from the LAR facility by the end of the first quarter of 2011 (i.e., March 31, 2011). Water quality samples were collected on one occasion (November 19, 2012) following the removal of the vehicles from the facility and all associated water quality data were found to be in accordance with the Lummi Water Quality Standards.

Chromium was detected at concentrations exceeding its chronic criteria limit twice and concentrations that exceeded the acute criteria limit once. On each occasion, chromium exceeded water quality standards at one site only. On the third (3rd) sampling event the chronic criteria limit was exceeded at Site SW102 furthest downstream from the LAR facility. When chromium concentrations exceeded the acute criteria limit at sample Site SW101 during the seventh (7th) sampling event, chromium concentrations were below both the acute and chronic water quality standards downstream at Site SW102. However, as noted previously water was not flowing between the sample sites during this sampling event. Other than these two events, as shown in Figure 9 the concentration of chromium in surface waters near the LAR facility were below the acute and chronic criteria limits for the remainder of the sample study.

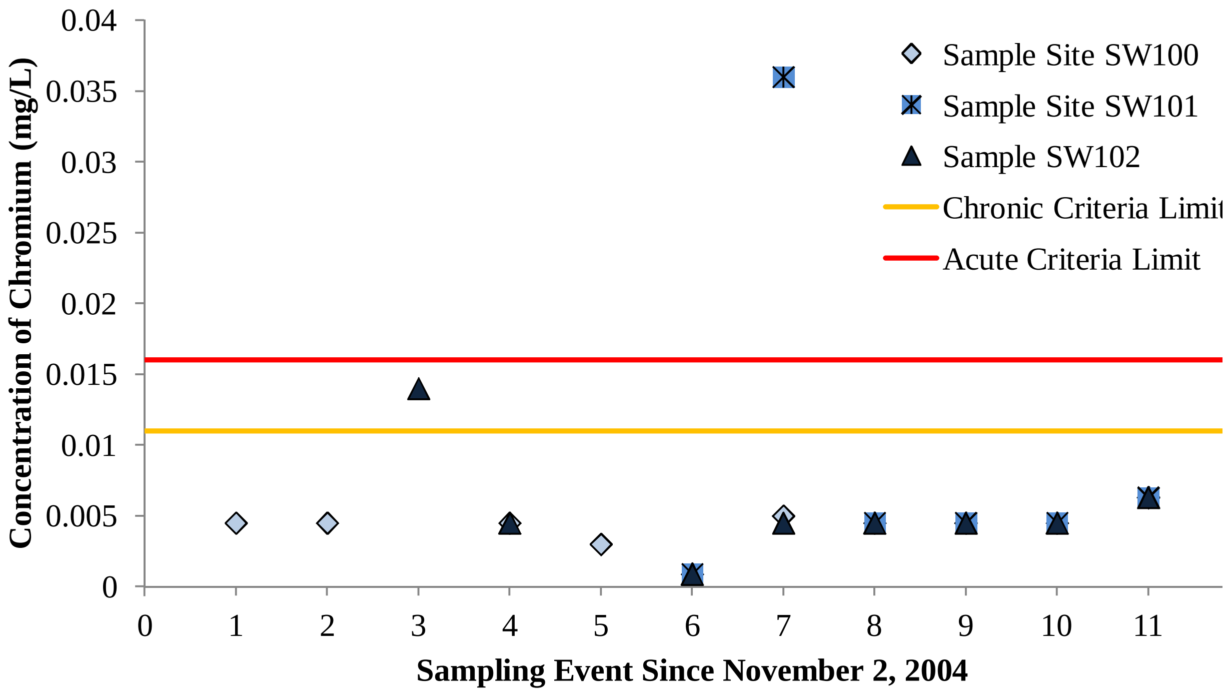

Figure 9. Chromium Concentrations (mg/l) at the Lummi Auto Recyclers Facility between November 2, 2004 and November 19, 2012.

Copper was detected above the applicable Lummi Water Quality Standards on several occasions and at each sample site, including the reference site upstream from the LAR facility. With the exception of the 7th sampling event, when copper was detected above the criteria limit at two of the sample sites, elevated copper concentrations were observed at only one of the three sample sites during the other sampling events. These data indicate, (1) concentrations of copper at particular sites appear independent, and (2) concentrations of copper in the north ditch along Cagey Road regularly exceed Lummi Water Quality Standards. On one occurrence (the 7th sampling event on February 5, 2008), copper concentrations were highest and exceeded both acute and chronic water quality standards at Site SW101 and at Site SW102. As noted previously, water was not flowing between the sample site locations on February 5, 2008. Figure 10 presents water quality results for copper at each of the LAR facility sample sites over time and relative to the acute and chronic limit criterion.

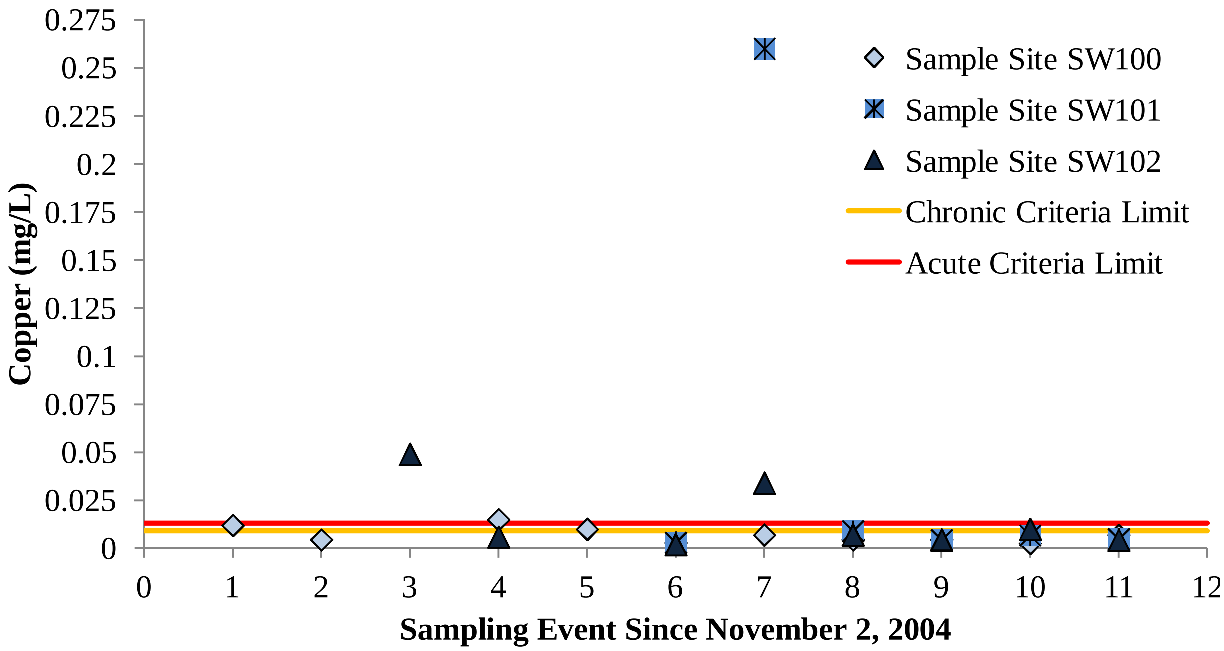

Figure 10. Copper Concentrations (mg/l) at the Lummi Auto Recyclers Facility between November 2, 2004 and November 19, 2012.

As shown in Figure 11, lead was detected above the Lummi Water Quality Standards on several occasions and at each sample site, including the reference site upstream from the LAR facility. On several occasions, lead concentrations in surface water near the LAR facility where higher upstream (at the control Site SW100) or downstream at Site SW102 than at the sample site at the facility (sample Site SW101). These data indicate, (1) concentrations of lead at particular sites appear independent, and (2) concentrations of lead in the north ditch along Cagey Road regularly exceed Lummi Water Quality Standards. Figure 11 shows water quality results for lead at each of the LAR facility sample sites over time and relative to the acute and chronic limit criterion. On the seventh sampling event (February 5, 2008) concentrations of lead exceeded water quality criterion at all three sites. Water quality data from February 5, 2008 and January 7, 2009 are the only records where concentrations of lead were higher at sample Site SW101 than any other site.

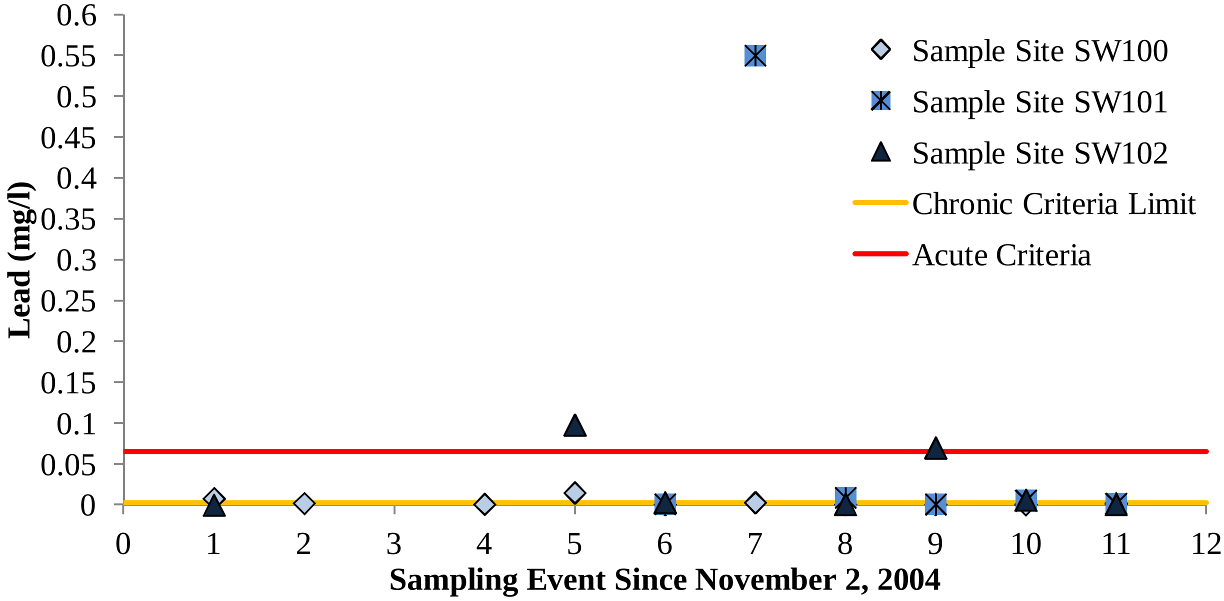

Figure 11. Lead Concentrations (mg/l) at the Lummi Auto Recyclers Facility between November 2, 2004 and November 19, 2012.

Zinc was detected at concentrations greater than the criteria limits established by the Lummi Water Quality Standards on three occasions and at each sample site near the LAR facility. As is shown in Figure 12, water quality at each sample station exceeded the acute and chronic criteria limit for zinc on three different occasions while samples from the other two sample stations, collected during the same sampling event, were in compliance with water quality standards. In every case where a result for a sample site showed zinc concentrations above the acute and chronic criteria limit, the concentration of zinc was in compliance with water quality standards during the next sampling event and remained below the acute and chronic criteria limit for the duration of the investigation.

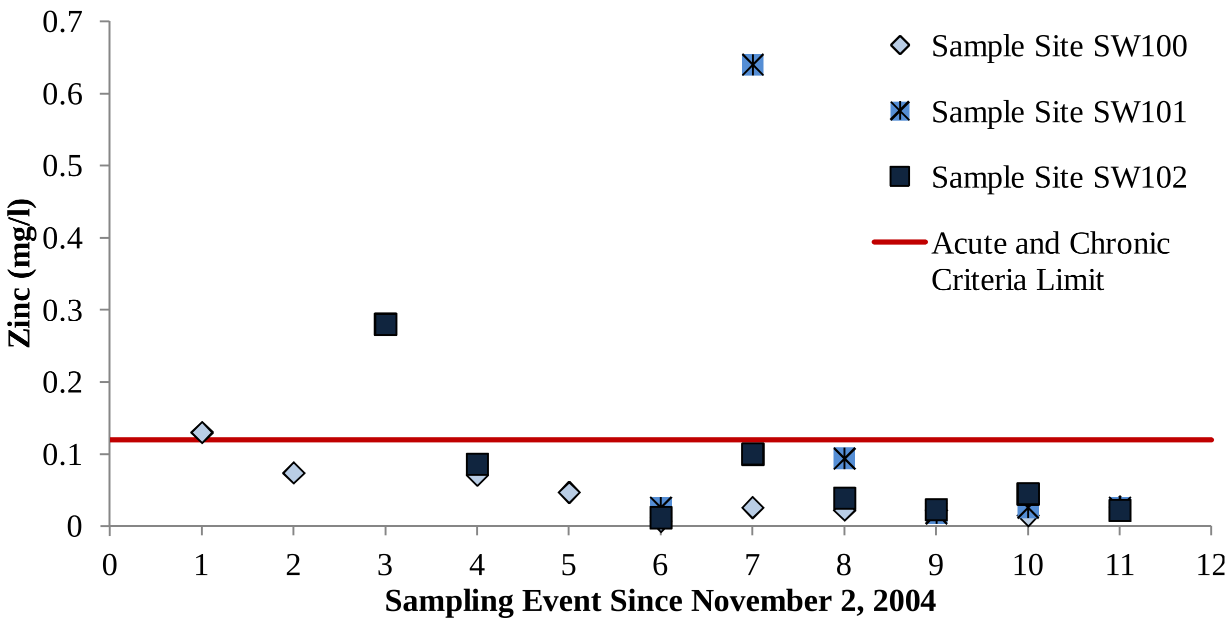

Figure 12. Zinc Concentrations (mg/l) at the Lummi Auto Recyclers Facility between November 2, 2004 and November 19, 2012.

Summary and Recommendations

Targeted water quality sampling occurred at three sample sites relative to the LAR facility (SW100, SW101, and SW102) over the November 2004 through November 2012 period. Water samples were analyzed for baseline water quality parameters, hydrocarbons, anti-freeze constituents, and metals typically associated with automobile recycling operations. Baseline water quality, hydrocarbon, and anti-freeze constituent data indicate that water quality is fairly stable and that the LAR facility did not appear to discharge these contaminants. The presence of chromium, copper, lead, and zinc in the north ditch along Cagey Road often exceeded Lummi Water Quality Standards over the November 2004 through November 2011 period. The source of metal contamination cannot be solely attributed to storm water runoff from the LAR facility because in some cases water quality criteria are exceeded upstream of the facility but the standards are achieved at the site most closely related to the facility. In other instances, concentrations were higher further downstream than existed at the site associated with the facility.

The review of eight years of water quality data (November 2004 to November 2012) collected at the three sites associated with the LAR facility indicates that the facility can be attributed with degrading the water quality of surface water along the north side of Cagey Road. However, the facility was not the only source of contamination near the site as there were occasions when the water quality measured upstream from the facility was more degraded than the water quality at and downstream from the facility. Water quality samples were collected on one occasion (November 19, 2012) after all vehicles were removed from the LAR facility (by March 31, 2011) and all of the Lummi Water Quality Standards were achieved. Since all of the vehicles from the LAR facility have been removed, the threat to Lummi Nation surface water quality represented by the facility has diminished.
With the removal of the scrap vehicles and the cessation of the business at the LAR facility, the Lummi Water Resources Division recommends the suspension of the targeted water quality sampling that was conducted at the facility over the 2004 through 2012 period. If approved, the suspensions of targeted water quality sampling at LAR will be effective immediately.

ATTACHMENT 1

Memorandum Dated May 8, 2006 – Lummi Auto Recycling Water Quality Water Quality Results from samples collected in November 2004 and January 2006

MEMORANDUM

DATE: May 8, 2006

TO: Jeremy Freimund, P.H., Water Resources Manager

CC: Mann Lewis, Water Resources Technician

FROM: Amy Sattler, Water Resources Specialist

SUBJECT: **Lummi Auto Recycling Water Quality Water Quality Results from samples collected in November 2004 and January 2006**

•

The water quality in the ditch along the north side of Cagey Road seemed to be minimally impacted by Lummi Auto Recycling (LAR) when sampled on January 30, 2006, but the impacts appeared more significant when sampled in November of 2004. As illustrated in Figure 1, the samples were taken from the ditch on the north side of Cagey Road just upstream (1), immediately downstream (2), and further downstream (3) of Lummi Auto Recycling. The sample collected further downstream (3) was collected adjacent to the culvert that crosses under Cagey Road, and was only sampled in 2006, not in 2004.

Within this Memorandum, in addition to comparing the water quality between these different sampling locations, the water quality in the ditch was evaluated against either the 2004 National Recommended Water Quality Criteria[1] (Water Quality Criteria), the maximum daily effluent limits for transportation equipment cleaning[2] (Effluent Limits), or the Model Toxics Control Act (MTCA) Cleanup Levels for ground water[3] (Groundwater Cleanup Levels). The MTCA does not apply on the Lummi Reservation but cleanup levels within MTCA were used to evaluate the measured water quality. The reason for evaluating different parameters against different standards is that there are not National Recommended Water Quality Criteria for all the parameters. For Chemical Oxygen Demand (COD), propylene glycol, ethylene glycol, and surfactants, there are also no Effluent Limits or Groundwater Cleanup Levels.

On January 30, 2006, the basic water quality parameters in the ditch adjacent to LAR were mostly normal, the concentrations of metals and hydrocarbons were low, and there was minimal difference in these parameters between the samples (Table 1 and Table 2). For basic water quality parameters, the temperature, biochemical oxygen demand (BOD), chemical oxygen demand (COD), and total suspended solids were all at safe, low levels, but the pH values (5.8-6.0) were lower than the Water Quality Criterion for pH of 6.5-9. However, this low pH is likely not caused by Lummi Auto Recycling because it is also present upstream. The metal concentrations, both upstream and downstream, are lower than the Water Quality Criteria, and mostly lower than concentrations found in November 2004, but do fluctuate slightly between the sampling locations in the ditch just upstream, immediately downstream, and further downstream of Lummi Auto Recycling. Concentrations of both lead and zinc increased slightly between the upstream and immediately downstream sampling locations, suggesting that Lummi Auto Recycling may be contributing lead and zinc to the water in the ditch. However, both of these concentrations decreased between the site immediately downstream and the site further downstream of Lummi Auto Recycling. Additionally, the concentration of iron decreased between upstream and further downstream of Lummi Auto Recycling. Finally, all the hydrocarbon concentrations were low and safe and stable between upstream and further downstream of Lummi Auto Recycling during the time of the January 2006 sampling event.

On November 15, 2004, the water quality in the ditch downstream from LAR exceeded the Water Quality Criteria for all the metals, exceeded the Discharge Limits for total suspended solids (TSS), and exceeded the Groundwater Cleanup Levels for lube oil (Table 3 and Table 4). The other parameters measured met criteria, except pH. The ditch upstream of LAR was dry on November 15, 2004, suggesting that 100% of the discharge in the ditch downstream originated from LAR.

Nine days later, on November 24, 2004, there was flow in the ditch upstream of LAR. This flow was considered a "first flush" flow because it occurred during the initiation of the rainy season that year. Water flow during the "first flush" is often more contaminated than during later in the rainy season since it contains pollutants that have accumulated over the dry season. However, the water in the ditch downstream from LAR was less contaminated on November 24, 2004 than on November 15, 2004, when there was no flow in the ditch upstream from the facility. On November 24, 2004, the water in the ditch both upstream and downstream from the facility met all Water Quality Criteria, except that pH was lower than criteria, and iron was equal to criteria (Table 5 and Table 6). Similarly, the TSS concentration was equal to the Effluent Limit, but all other parameters were in range of the Water Quality Criteria, Effluent Limits, and Groundwater Cleanup Levels. Although the water quality at both upstream and downstream sample locations was within the criteria or limits, the water downstream of LAR was more contaminated than the water upstream from LAR. Specifically, after passing LAR, the water in the ditch had increased concentrations of TSS, lead, zinc, iron, and lube oil, suggesting that these substances originated at LAR.

In summary, during two of three different water quality sampling events of the storm water originating from the Lummi Auto Recycler facility, measured parameters were equal to or lower than water quality standards or criteria. Although criteria were exceeded during one sampling event, nine days later the criteria were not exceeded. However, during all of the sampling events, water quality was reduced when comparing the results obtained from upstream and downstream from the facility. I recommend that we continue to sample the water quality from this facility during periods when there is storm water flowing in the roadside drainage ditch that fronts the facility.

Figure 1. Sampling locations along the ditch adjacent to the Lummi Auto Recycling. The samples were taken from the ditch on the north side of Cagey Road just upstream (1), immediately downstream (2), and further downstream (3) of Lummi Auto Recycling

Table 1. Lummi Auto Recycling (LAR) Samples from January 30, 2006: Basic Water Quality Parameters and Metals

Location relative to LAR	pH	Temp of pH Sample (C)	BOD (mg/L)	TSS (mg/L)	COD (mg/L)	Lead (mg/L)	Chromium (mg/L)	Zinc (mg/L)	Copper (mg/L)	Iron (mg/L)
Just upstream	5.8	21.1	<3.0	6.0	<20	<0.001	<0.001	0.007	0.003	0.25
Immediately downstream	5.8	21.1	<3.0	2.6	<20	0.001	<0.001	0.026	0.003	0.20
Further downstream, @ culvert	6.0	21.1	<3.0	<2.0	<20	<0.001	<0.001	0.012	0.002	0.06
National Recommended Standard (Chronic Toxicity)[1]	6.5-9	NA[4]	NA[4]	NA[4]	NA[4]	0.0025	0.011	0.12	0.009	1
Maximum Daily Limit[2]	NA[4]	NA[4]	61	58	NA[4]	0.14	0.42	8.3	0.1	NA[4]

Table 2. Lummi Auto Recycling (LAR) Samples from January 30, 2006: Hydrocarbons

Location relative to LAR	NWTPH Diesel (mg/L)	NWTPH Lube Oil (mg/L)	NWTPH Gasoline (mg/L)	Ethylene glycol (mg/L)	Propylene glycol (mg/L)	Surfactant (MBAS) (mg/L)
Just upstream	<0.25	<0.63	<0.63	<5	<5	0.03
Immediately downstream	<0.25	<0.63	<0.63	<5	<5	0.03
Further downstream, @ culvert	<0.25	<0.63	<0.63	<5	<5	0.02
MTCA GW Cleanup Levels[3]	1.0	1.0	1.0	NA[4]	NA[4]	NA[4]

[1] National recommended water quality criteria, 2004: U.S. Environmental Protection Agency, Office of Water and Office of Science and Technology (4304T)
[2] Effluent Limitations Guidelines, Pretreatment Standards, and New Source Performance Standards for the Transportation Equipment Cleaning Point Source Category (40 CFR §442)
[3] Model Toxics Control Act (MTCA) Cleanup Levels for ground water
[4] NA = Not Available

Table 3. Lummi Auto Recycling (LAR) Samples from November 15, 2004: Basic Water Quality Parameters and Metals

Location relative to LAR	pH	Temp of pH Sample (C)	BOD (mg/L)	TSS (mg/L)	COD (mg/L)	Lead (mg/L)	Chromium (mg/L)	Zinc (mg/L)	Copper (mg/L)	Iron (mg/L)
Just upstream	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry
Immediately downstream	6.4	20.0	8.1	110	180.0	0.098	0.014	0.280	0.049	1.30
National Recommended Standard (Chronic Toxicity)[1]	6.5-9	NA[4]	NA[4]	NA[4]	NA[4]	0.0025	0.011	0.12	0.009	1
Maximum Daily Limit[2]	NA[4]	NA[4]	61	58	NA[4]	0.14	0.42	8.3	0.1	NA[4]

Table 4. Lummi Auto Recycling (LAR) Samples from November 15, 2004: Hydrocarbons

Location relative to LAR	NWTPH Diesel (mg/L)	NWTPH Lube Oil (mg/L)	NWTPH Gasoline (mg/L)	Ethylene glycol (mg/L)	Propylene glycol (mg/L)	Surfactant (MBAS) (mg/L)
Just upstream	dry	dry	dry	dry	dry	dry
Immediately downstream	<0.63	2.000	<0.25	<10	<10	0.05
MTCA GW Cleanup Levels[3]	1.0	1.0	1.0	NA[4]	NA[4]	NA[4]

[1] National recommended water quality criteria, 2004: U.S. Environmental Protection Agency, Office of Water and Office of Science and Technology (4304T)

[2] Effluent Limitations Guidelines, Pretreatment Standards, and New Source Performance Standards for the Transportation Equipment Cleaning Point Source Category (40 CFR §442)

[3] Model Toxics Control Act (MTCA) Cleanup Levels for ground water

[4] NA = Not Available

Table 5. Lummi Auto Recycling (LAR) Samples from November 24, 2004: Basic Water Quality Parameters and Metals

Location relative to LAR	pH	Temp of pH Sample (C)	BOD (mg/L)	TSS (mg/L)	COD (mg/L)	Lead (mg/L)	Chromium (mg/L)	Zinc (mg/L)	Copper (mg/L)	Iron (mg/L)
Just upstream	6.2	21.0	<4.0	35	18.0	0.001	<0.005	0.071	0.015	0.90
Immediately downstream	6.3	21.0	<4.0	35	58.0	0.003	<0.005	0.086	0.006	1.00
National Recommended Standard (Chronic Toxicity)[1]	6.5-9	NA[4]	NA[4]	NA[4]	NA[4]	0.0025	0.011	0.12	0.009	1
Maximum Daily Limit[2]	NA[4]	NA[4]	61	58	NA[4]	0.14	0.42	8.3	0.1	NA[4]

Table 6. Lummi Auto Recycling (LAR) Samples from November 24, 2004: Hydrocarbons

Location relative to LAR	NWTPH Diesel (mg/L)	NWTPH Lube Oil (mg/L)	NWTPH Gasoline (mg/L)	Ethylene glycol (mg/L)	Propylene glycol (mg/L)	Surfactant (MBAS) (mg/L)
Just upstream	<0.63	<0.63	<0.25	<10	<10	<0.05
Immediately downstream	<0.63	0.900	<0.25	<10	<10	0.05
MTCA GW Cleanup Levels[3]	1.0	1.0	1.0	NA[4]	NA[4]	NA[4]

[1] National recommended water quality criteria, 2004: U.S. Environmental Protection Agency, Office of Water and Office of Science and Technology (4304T)
[2] Effluent Limitations Guidelines, Pretreatment Standards, and New Source Performance Standards for the Transportation Equipment Cleaning Point Source Category (40 CFR §442)
[3] Model Toxics Control Act (MTCA) Cleanup Levels for ground water
[4] NA = Not Available

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APPENDIX F

Tideland Use Permit Brochure

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Fee Schedule

Permit Type	Applies To	Cost	Where to Obtain
Day	Non-tribal members over 12 years. Each permit allows up to 5 children under 12. Groups of more than 10 children requires Special Purpose Permit.	$3.00	Mini-Mart, Cove Store, Tribal Center (Accounts Payable). See map.
Month	Non-tribal members over 12 years. Each permit allows up to 5 children under 12. Groups of more than 10 children requires Special Purpose Permit.	$30.00	Mini-Mart, Cove Store, Tribal Center (Accounts Payable)
Annual	Non-tribal member property owners only over 12 years of age. Covers up to 5 family members. Cards are issued to each family member by name.	$250.00 plus $50 for each family member over 5 years of age.	Lummi Planning Department
Special Use	Non-tribal groups including educational, scientific, and groups of more than 10 children.	$10.00	Submit application to Planning Department, pay at Tribal Center Accounts Pay-

All permits are good from dawn to dusk.

Permitted Activities: Jogging, running, walking; dog walking (all wastes removed); sun bathing and swimming; launching of non-motorized water craft; picnicking; bird watching, artistic, and photographic pursuits.

Prohibited Activities: Hunting, trapping, fishing, and/or harvesting of shellfish, invertebrates, or seaweed; collecting or removing artifacts, driftwood, souvenirs, shells, sand, or gravel; littering; campfires or fires of any kind; overnight camping; operation or parking of any motorized vehicle; construction or placement of boat ramps, docks, or raft on tidelands; entering closed areas; intoxicated or disorderly behavior; possession, transportation or use of firearms or drugs; all uses set forth in Title 13.02.020; any other activity which has been communicated to permit holder by the Lummi Planning Department to satisfy Title 13.02.080(a).

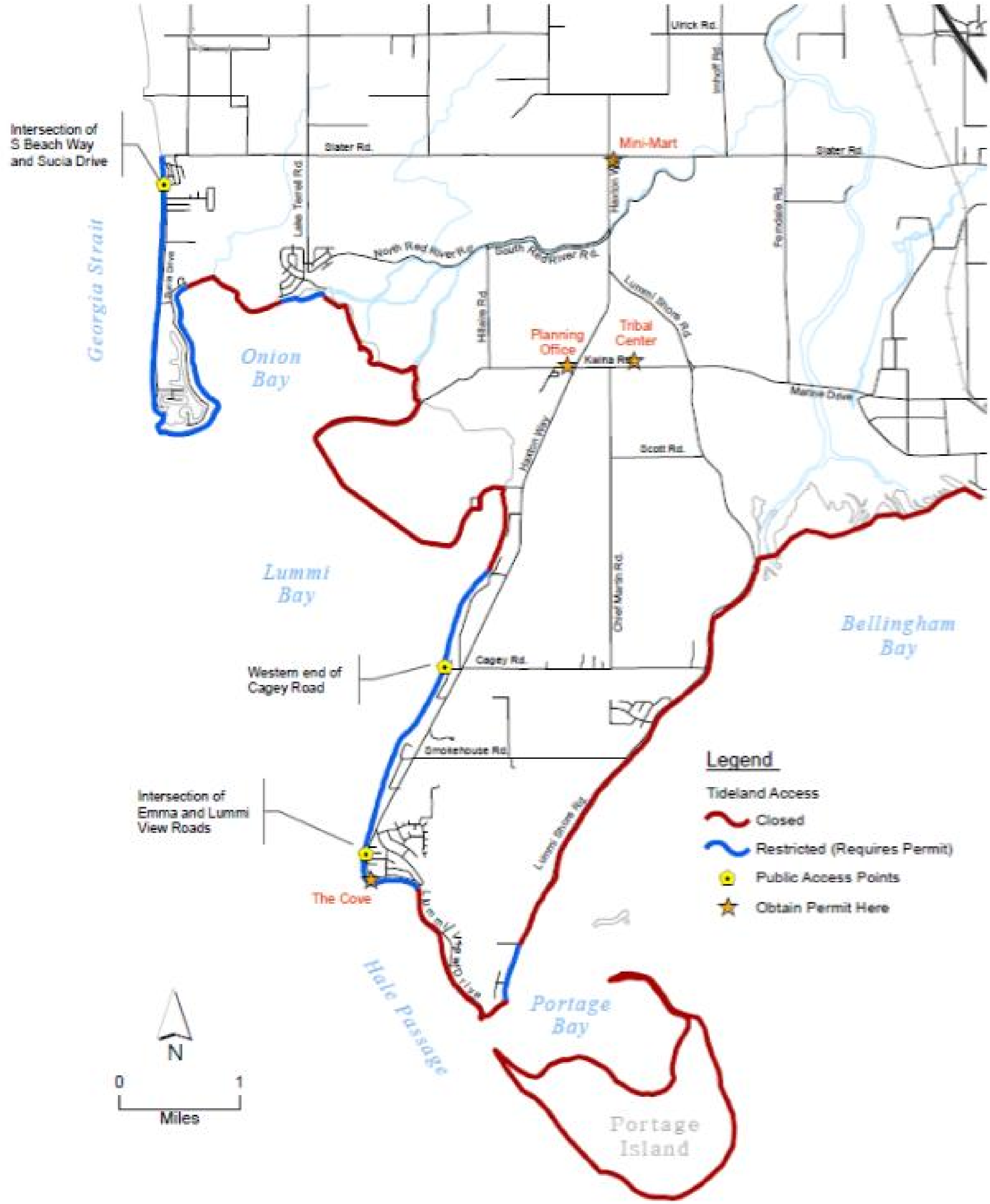
Enforcement: Failure to comply with the provisions of Title 13 Tidelands Ordinance of the Lummi Code of Laws is subject to a fine of $500 for a first offense and $1,000 for second and further offenses. Any object involved in the violation is subject to confiscation and forfeiture following a hearing in Lummi Tribal Court. The Lummi Indian Business Council shall be held harmless for liability resulting from injury or property loss while engaging in permitted activities.

LUMMI NATION

TIDELANDS ACCESS PERMIT

Teeming with life, the tidelands of the Lummi Reservation are essential to the Lummi culture, economy, and environmental health. In 1855, the U.S. Government ratified the Treaty of Point Elliott which granted ownership of these tidelands to the Lummi Nation. Tribal tidelands are defined as "land over which the tides flow[ed]." In an effort to be a good neighbor while properly managing and administering the activities which occur on the tidelands, the Lummi Nation has developed and implemented a permit system which will monitor public use of this fragile environment.

The purpose of permitting access to the tidelands is to ensure the resource is protected while allowing low impact, conscientious use. With your cooperation and consideration, negative impacts will be minimized. Thus the tidelands can be enjoyed by future generations for many years come.



Intersection of S Beach Way and Sucia Drive
Georgia Strait
Onion Bay
Lummi Bay
Bellingham Bay
Hale Passage
Portage Bay
Portage Island
Western end of Cagey Road
Intersection of Emma and Lummi View Roads
The Cove
Mini-Mart
Planning Office
Tribal Center
Slater Rd.
Ulrick Rd.
Imhoff Rd.
Lake Terrell Rd.
North Red River Rd.
South Red River Rd.
Haxton Way
Lummi Shore Rd.
Ferndale Rd.
Hillaire Rd.
Kwina Rd.
Marine Drive
Scott Rd.
Chief Martin Rd.
Cagey Rd.
Smokehouse Rd.
Lummi View Drive
Legend
Tideland Access
Closed
Restricted (Requires Permit)
Public Access Points
Obtain Permit Here
N
0
1
Miles