INVENTORY OF STREAM AND RIVER MONITORING EFFORTS IN HOOD CANAL

Prepared for

WRIA 16/14b Planning Unit

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Contents

Introduction

This inventory summarizes surface water quality monitoring efforts carried out by federal, tribal, state and local groups in the Hood Canal watershed since 2000. The purpose in developing such an inventory is to identify monitoring efforts that will best inform the development of a comprehensive, long-term, trend monitoring program for Hood Canal. Consequently, this inventory of monitoring efforts is limited to existing stream and river monitoring efforts. For example, it does not include extensive monitoring performed in marine waters, current groundwater and seepage studies, lake monitoring, or stormwater monitoring. It also does not summarize volunteer monitoring efforts that may be occurring in the watershed. For the purpose of this inventory, the geographic extent of Hood Canal is defined as all watersheds that discharge surface water to Hood Canal as far north as Port Ludlow on the west side, and as far north as Foulweather Bluff on the east side (Figure 1).

This inventory also seeks to identify data gaps in terms of how these efforts fit into an ongoing, comprehensive, long-term evaluation of canal stream water quality. While significant monitoring is occurring in the Hood Canal region, there is no clear assessment of whether or not these various efforts can be combined to form a complete picture of Hood Canal stream water quality.

Information for this survey was gathered by contacting a list of agencies identified by the Water Resource Inventory Area (WRIA) 16/14b Watershed Planning Unit (Planning Unit), initially including the following:

- Skokomish and Port Gamble Tribes
- Mason, Jefferson and Kitsap Counties
- Mason, Jefferson and Kitsap Conservation Districts
- Kitsap Public Utility District
- Kitsap Health District
- Hood Canal Salmon Enhancement Group (HCSEG).

This list was later expanded to include a total of twelve local agencies, three state agencies, and four federal and tribal agencies with jurisdiction within the watershed. Each entity was asked to provide information about stream and river water quality monitoring or flow gauging conducted since 2000. They were also asked about how monitoring is funded, how data is stored, any future monitoring plans, and their views on highest priority monitoring needs for the Canal. Responses varied in level of detail, and some agencies reported studies occurring before 2000 and studies that were not directly related to stream or river monitoring. Although some reported information was not within the scope of this inventory, it has been included in the narrative portion of this report to capture the substance of each group's monitoring efforts.

Table 1 and Figure 2 condense this information by presenting the monitoring efforts most pertinent to the development to a new monitoring plan. Table 1 lists sites where a) regularly scheduled sampling examines a wide range of parameters (e.g., conventional parameters *and*

nutrients *and* fecal coliform bacteria) and has been (or is expected to be) conducted for period longer than a year, or b) regularly scheduled sampling examines only one or two parameters but is expected to continue indefinitely. Figure 2 identifies sites where existing monitoring may be incorporated into a new long-term monitoring program; therefore, it only includes permanent, long-term monitoring sites which are expected to be maintained indefinitely. Figure 3 shows active flow gauging stations that are expected to be maintained indefinitely. The majority of the information was provided via phone contacts and electronic (email) communication. Contact information for each of the people providing information is provided in Table 1.

Monitoring Program Descriptions by Entity

Planning Unit Monitoring

The Planning Unit contracted with EnviroVision to monitor a total of fourteen streams on the south and north shores of lower Hood Canal in 2004. This monitoring was conducted to provide baseline water quality data for small streams draining to Hood Canal to help identify water quality concerns for future management efforts. Each stream was sampled 18 times over a two-year period: five times during the wet season (January-April) and once every three weeks during the dry season (July-September). Field measurements (specific conductance, salinity, pH and temperature) were taken at each site. Physical samples were analyzed for nutrients (total phosphorus, nitrate+nitrite) total suspended solids (TSS), biochemical oxygen demand (BOD), and fecal coliform bacteria. Flow was measured at each site at the same time that samples were collected. All project data was uploaded to the Washington Department of Ecology (Ecology) environmental information management system (EIM). This was a short-term study, although the monitoring was extended by almost two years through the efforts of the Hood Canal Dissolved Oxygen Program (HCDOP), which is described below. Sampling site locations are provided in Table 1.

University of Washington/Hood Canal Dissolved Oxygen Program

The HCDOP began an extensive monitoring effort after the Planning Unit monitoring. This effort was led by the University of Washington but involved collaboration by many groups, including:

- Mason County Public Health (MCPH)
- Mason Conservation District (MCD)
- Skokomish Tribal Nation
- Hood Canal Salmon Enhancement Group
- U.S. Geological Survey (USGS)
- Kitsap County Health District (KCHD)
- Jefferson County Conservation District (JCCD).

The HCDOP study involved two related stream water quality monitoring efforts. The first was a monthly sampling effort that began in spring of 2005 and ended in early 2007. This monitoring

was an extension and expansion of the monitoring program begun by the Planning Unit (as described above), and targeted over 40 streams throughout the basin. Samples were analyzed for nutrients (including nitrate+nitrite, and ammonium nitrogen fractions, as well as silicate, particulate carbon, dissolved organic carbon) and TSS. The second monitoring effort aimed to collect sequential nutrient samples during storms on the Skokomish and Union rivers. There were approximately 10 sampling events between October 2008 and October 2009, with each event consisting of 24 sequential samples collected over 4-day periods. These samples were analyzed for TSS, nutrients (total dissolved nitrogen, total phosphorus, dissolved and particulate carbon, and carbon and nitrogen stable isotope ratios) and dissolved lignin phenols. Flow monitoring to support the HCDOP program was coordinated by HCSEG and performed by multiple agencies.

Both HCDOP sampling efforts had the goals of improving nutrient loading estimates, characterizing land use effects on nutrient concentrations, and providing data to calibrate and validate a watershed biogeochemical scenario analysis model. The monthly sampling program was funded by a U.S. Navy grant, and its annual budget was approximately $75,000. The storm sampling program was funded by University of Washington Puget Sound Regional Synthesis Model funding. Its annual budget was approximately $75,000. Data is primarily stored in spreadsheets and is not immediately available; however, it will be presented in future journal articles. The University of Washington has no plans to continue freshwater monitoring in Hood Canal or to seek funding to continue this monitoring. HCDOP site locations and other summary details are provided in Table 1.

Mason County and Mason County Public Health

Mason County's water quality monitoring program is conducted by MCPH. MCPH has participated in more than 10 different water quality monitoring projects in the Hood Canal watershed area since 2001, including the following:

- Threatened Area Response
- Lower Union River Restoration project
- Hoodsport ambient monitoring
- Mason County ambient monitoring
- BEACHES monitoring
- Hood Canal Dissolved Oxygen Program (HCDOP)
- Skokomish River and Anna's Bay investigative monitoring
- Targeted storm event sampling

- Nutrient and fecal coliform sampling along Mason County's Hood Canal shoreline

- Water quality evaluation of twelve 303 (d) listed streams.

Funding for these projects has been provided by Ecology Centennial Clean Water Fund grants and section 319 Non-point Source Fund grants, Mason County Conservation District Assessment, Emergency Appropriations from the Governor, Department of Health and the US Environmental Protection Agency (EPA). Data from Ecology grant-funded projects is uploaded from spreadsheets to the EIM database, either annually or semiannually. More detailed summaries of the more substantial projects are described below.

MCPH has recently begun evaluating the appropriateness of 303(d) listing on 12 streams that discharge into Hood Canal (Table 1). Beginning in the second quarter of 2010, these 12 streams will be monitored ten times within a consecutive 12 month period. In 2011, a subset of six of the original twelve streams will be monitored for six monitoring events. In 2012, MCPH will monitor the original 12 streams (except streams recommended for removal from the 303(d) list after the first two years of monitoring). MCPH will monitor each stream so as to obtain a total of 10 samples in a 12 month period. This monitoring will include field parameters (temperature, pH, DO, turbidity, conductivity), nutrients (nitrite, nitrate, ammonium, ortho-phosphate and silicic acid), and fecal coliform bacteria. The purpose of this monitoring program is to remove any streams from the 303(d) list that currently meet the water quality standard.

A storm event-focused monitoring effort began in 2009 and includes monitoring of 4 stormwater discharges in Hoodsport and 7 stormwater discharges in Belfair. During the first year, all sites will be monitored during three different events: once during the dry period, and twice during storm events. When the initial monitoring is complete, ten sites will be chosen for continued monitoring. In the beginning of 2011 the number of sites will be further reduced to 5. This project's monitoring will include field parameters (temperature, conductivity, salinity, DO and pH), nutrients (nitrate-nitrate nitrogen, and ortho-phosphorous), metals (copper, lead, nickel, zinc and cadmium), TSS, hardness, fecal coliform bacteria, and a suite of polycyclic aromatic hydrocarbons.

MCPH undertook an extensive program in 2005 to evaluate the many freshwater seeps and discharges that flow into Hood Canal. Over 1,400 sites along the western and southern shorelines of Hood Canal were sampled at least one time between July 2005 and August 2008. Fecal coliform bacteria were evaluated at each site. At 600 of the sites, nutrients (nitrate+nitrite nitrogen, ammonia nitrogen, and ortho-phosphorus) were also measured. Where bacteria concentrations were elevated, sanitary surveys and dye tests were performed to identify pollution sources. Bacterial monitoring will be expanded to include the north and eastern shores of Hood Canal, and monitoring will be conducted between February 2010 through July 2011.

Mason County Ambient Monitoring program in the Hood Canal Watershed was funded through the Conservation District Assessment and the HCDOP. MCPH monitored the following Hood

Canal streams from December 2003 to June 2007 for fecal coliform bacteria. (the number shown in parentheses indicates the number of events sampled)

Skokomish River (28)	Big Mission Creek (19)
Hill Creek (30)	Union River (17)
North Fork of the Skokomish above Lake Cushman (23)	Jorsted Creek (28)
Hamma Hamma River (32)	Potlatch Creek (22)
Dewatto River (30)	Creek at Timber Tides (5)
Tahuya River (28)	Creek at Shady Beach (5)
Stimson Creek (33)	Mulberg Creek (7)
Little Mission Creek (27)	Shoofly Creek (24)
Rensland Creek (14)	Lilliwaup River (20)
Big Bend Creek (6)	Belfair Creek (10)
Finch Creek (20)	Creek at Timber Tides (5)

From 2000 to 2009, MCPH assisted in monitoring fecal coliform bacteria at many sites throughout the Hood Canal Watershed. Site and project information is available from MCPH but is limited in detail. Some of these projects include Threatened Area Response, Lower Union River Restoration project, Hoodsport ambient monitoring, BEACHES monitoring, and Skokomish River and Anna's Bay investigative monitoring

The information in Table 1 representing Mason County's monitoring efforts is limited to the 12 streams currently being monitored to verify 303(d) listings. At the time of publication of this inventory specific site locations for this program had not been finalized, so coordinates are not provided. The other studies listed, while certainly of significant public benefit, do not meet the criteria for inclusion in Table 1 (i.e., they either do not represent stream or river monitoring, do not involve repeated sampling at individual sites over a long period, or do not involve testing of more than one or two parameters.

Mason Conservation District

Mason Conservation District contributed significantly to two intensive Hood Canal monitoring projects. From 2005-2007, MCD was responsible for sampling 15 sites for the HCDOP. From January 2005 through November 2006, MCD partnered with the Skokomish Tribal Nation and Ecology for the Skokomish River Basin Fecal Coliform total maximum daily load (TMDL) monitoring. During this time, MCD measured flow and collected fecal coliform bacteria samples at five sites. The MCD is not currently conducting water quality monitoring in the Hood Canal watershed.

Kitsap County Public Works & Kitsap County Health District

Kitsap County primarily performs National Pollutant Discharge Elimination System (NPDES) monitoring for implementation of their Phase II permit. Therefore, their monitoring efforts are focused on stormwater outfalls, not area streams. However, Kitsap County provides funding via stormwater utility fees to the KCHD to support water quality monitoring associated with their pollutant identification and correction (PIC) program, wellhead protection, and marine sewage programs. Stormwater utility fees have also been used as in-kind match contributions for Ecology grants. This monitoring is also carried out by the Health District.

KCHD has carried out several projects through the PIC program over the past 7 years that focused on collecting fecal coliform bacteria samples and evaluating possible septic system failures along the Hood Canal shoreline. Through this program, all freshwater sources entering the Kitsap County portion of the Hood Canal shore (via bulkhead drains, seeps, streams or other sources) have been sampled at least once. When sampling indicated fecal coliform bacteria were elevated, steps were taken to correct the problem and check effectiveness through follow up sampling. The PIC program can be considered long-term because of its duration; however, monitoring at specific sites generally occurs as single events except where follow up actions are warranted.

EPA funded a project similar to the PIC program which was implemented by KCHD. This program evaluated fecal coliform bacteria as well as nutrient (ammonia, nitrate and phosphorus) inputs from failing septic systems before and after septic system repairs. This monitoring was also not related to evaluating typical stream conditions but instead was focused on short term assessments of site specific problems.

A number of Ecology Centennial grant funded monitoring efforts have been or are being carried out by KCHD. In the upper arm of Hood Canal, KCHD is monitoring fecal coliform in Kinman Creek, Lofall Creek, and Jumpoff Creek. KCHD is also monitoring fecal coliform in the reaches of the Union river that are within Kitsap County.

The KCHD conducts monthly monitoring at 13 permanent sites on streams that flow to Hood Canal. The purpose of this monitoring is to evaluate trends in fecal coliform pollution and therefore related public health threats. The results are also used to inform 303(d) listing decisions. Monitoring of these sites began in 1996 and is conducted on a monthly basis. At the onset of this program, monitoring included some field measurements (i.e., turbidity, DO, pH, temperature and conductivity) but in recent years has been limited to fecal coliform testing. KCHD does not conduct flow monitoring through this program, though some of the monitored streams are gauged by other entities.

The 13 long-term monitoring sites (described above) which KCHD monitors regularly for fecal coliform bacteria have been included in Table 1. These sites are also included in Figure 2, because they are expected to be monitored indefinitely and therefore represent sites that should be considered for a long-term monitoring program.

Kitsap Public Utilities District #1

Public Utility District (PUD) #1 of Kitsap County (KPUD) is presently measuring flow at Gold Creek in the Tahuya River drainage. KPUD monitoring is self-funded, and the number of monitored streams has declined during the last decade as other agencies (e.g., Ecology and HCSEG) established stations. KPUD staff has aggregated stream flow data from different agencies, and the KPUD website provides online hydrographs and daily discharge data for a number of streams in Kitsap County. KPUD does not collect surface water quality data. KPUDs flow monitoring site at Gold Creek is included on Figure 3.

Jefferson County and Jefferson Conservation District

Jefferson County contracts with the Jefferson County Conservation District (JCCD) to carry out water quality monitoring. Beginning in 1986, the Jefferson County Planning Department conducted water quality monitoring in nine Hood Canal drainages, rivers, and tributaries. Only fecal coliform and streamflow were measured in these streams until 1989. After 1989, other parameters were gradually added: temperature, conductivity, pH, dissolved oxygen, turbidity, and total suspended solids. In 1993, monitoring ceased in all of these streams except Tarboo Creek and Donovan Creek, which the Conservation District continues to monitor every 2-4 years for fecal coliform, temperature, pH, dissolved oxygen, conductivity, and turbidity. More recently, Jefferson County Environmental Health has been monitoring streams and fresh water seeps entering the Hood Canal for fecal coliform bacteria. From 2000 to present, the Conservation District has monitored summer temperatures with temperature data loggers on several creeks listed in Table 1. In 2004 only, data loggers were deployed to record summer temperatures in the Little Quilcene River and Leland Creek. Data from all of JCCD's water quality monitoring projects and quality assurance data is maintained in a database at the JCCD office. All monitoring was funded by Ecology and Washington Conservation Commission grants.

Bremerton Public Works and Utilities

Bremerton Public Works and Utilities (BPWU) monitors flow and water quality below the Casad Dam in the headwaters of the Union River. The reservoir is the major source of drinking water for the City of Bremerton. Flow monitoring is required to confirm that minimum stream flows are maintained in the Union River below the dam. Water quality is monitored for turbidity, total organic carbon, fecal coliform, cryptosporidium, and giardia at the water system intake as required by drinking water regulations. Monitoring costs are covered through BPWUs operating budget. Data is available upon request. Since BPWU plans to continue monitoring flow and water quality at the site below Casad dam, it is listed in Table 1 and shown on Figures 2 and 3.

City of Port Townsend Public Works

City of Port Townsend Public Works (PTPW) monitors stream flow and turbidity as part of the City's public water system. Flow is monitored at diversions on the Big and Little Quilcene

Rivers. With financial support from PTPW, USGS maintains a continuous flow station on the Big Quilcene near Tunnel Creek. For the Little Quilcene, USGS provides a rating curve and PTPW makes daily staff readings. Big Quilcene data is available through USGS, and Little Quilcene data may be requested from PTPW. Turbidity is measured at least once daily at both diversions and also the Lords Lake reservoir. Due to the permanent nature of these sites, they are listed in Table 1 and water quality sites are shown in Figure 2.

Hood Canal Salmon Enhancement Group

The Hood Canal Salmon Enhancement Group provides flow monitoring support to a number of entities and projects in the Hood Canal basin. In December 2003, HCSEG continued KPUD's streamflow monitoring of the Union, Big Mission, Little Tahuya, Tahuya, and Dewatto River. In June of 2004, with the start of the HCDOP and the end of the WRIA 16/14b supported watershed monitoring, HCSEG began monitoring streamflow in eight additional streams on the west side of Hood Canal (Table 1). Although there are data gaps in the record caused by storm events and sensor failures, these streams were monitored consistently until a storm in December 2007 destroyed or damaged nearly all the sensors. After the 2007 storm, continuous streamflow monitoring was limited to four streams, (Little Tahuya, Duckabush, Johns and Jorsted) and the remaining streams were measured using a Swoffer meter. All sensors were removed by the end of 2009 following the conclusion of the HCDOP.

Washington State Department of Ecology

Ecology monitors flow or water quality at 17 sites within the Hood Canal drainage (Figures 2 and 3). The flow monitoring network consists of eight sites located near Hood Canal tributary mouths Four are located from Big Quilcene River to Thorndyke Creek (southern portion of WRIA 17), one at the mouth of the Dosewallips River, and three on the east side near Big Beef Creek (WRIA 15) (figure 3). These last three are part of an Intensively Monitored Watershed (IMW) project. Some flow monitoring stations were installed as early as 1998, and others as recently as 2007.

Flow, air and water temperature data is collected and recorded at fifteen minute intervals at all active, Ecology maintained flow gauging stations in the Hood Canal area. Data is transmitted via telemetry every three hours to the Department of Ecology website. Flow data are stored in a Hydstra database, and all procedures follow specific Ecology standard operating procedure (SOP) and quality assurance project plan (QAPP) guidelines.

The water quality monitoring network consists of 10 sites in the Hood Canal area (figure 2). There are two continually monitored "long-term" sites, one located on the South Fork Skokomish River and the other on the Duckabush River. These have been monitored continuously at monthly intervals since 1984 and 1994, respectively. The remaining eight sites are also long-term monitoring sites, but are monitored monthly for only one year out of every five.

At all water quality monitoring sites, field parameters are measured (DO, pH, temperature, conductivity, and turbidity) and samples are collected for nutrient (ammonia, nitrate+nitrite, total nitrogen, soluble and total phosphorous) TSS, and fecal coliform bacteria measurements. Data are processed according to QAPP guidelines and entered into the EIM database. Locations of current Ecology monitoring sites are shown in Figure 3. Previous and current monitoring sites and information about the period of record for these sites can be found in Table 1.

Hood Canal is included within the Puget Sound region of Ecology's Status and Trends Monitoring Program. Every five years, 30 sites within this region are randomly selected for extensive physical, biological and chemical data collection. Sampling occurs between July and October, and each site is visited only once. Because the site selection process is random, each time the region is sampled, a new set of sites is chosen. The Hood Canal watershed represents only a small portion of the Puget Sound region, so only a small number of sampling sites may be within the Hood Canal watershed. For example, when Status and Trends monitoring was conducted in 2009, only one site (Big Beef Creek) was within the Hood Canal watershed and the other 29 were in other watersheds.

Washington Department of Fish and Wildlife

Washington Department of Fish and Wildlife (WDFW) is a partner agency in the IMW project area on Hood Canal. The project area encompasses Stavis, Seabeck, Big Beef, and Little Anderson Creeks on the east side of the upper arm of Hood Canal. WDFW is monitoring between 8 and 25 reaches on each creek for large woody debris, channel cross section, and streambed substrate following EPA's Environmental monitoring & Assessment Program (EMAP) protocols. The program was initiated in 2004 and is scheduled to continue until 2015, with each reach evaluated annually. No water quality data is collected. Collection of crest and temperature data at multiple sites was terminated after one year due to lack of useful information.

Skokomish Tribal Nation

The Skokomish Tribal Nation has performed water quality sampling since 1980. Monthly samples are collected at 20 stream stations in the lower Skokomish River. The goal of the program is to establish water quality baseline conditions and assess the effectiveness of restoration efforts, best management practices (BMPs), and the TMDL in the lower Skokomish River.

The current sampling locations were designated in 2004 and are located primarily on tributaries and the main stem of the S. Fork Skokomish River and at several estuarine sites located just north of the mouth of the S. Fork Skokomish. Currently, samples are analyzed for field parameters (DO, pH, conductivity), nutrients (nitrate-nitrogen, total nitrogen, and total phosphorus), and fecal coliform bacteria. Total nitrogen and total phosphorus measurement didn't begin until October 2009. Data is stored in a database which uses the National Park Service (NPS) "NPSTORET" database. The Tribe data is also being uploaded to the ambient

Water Quality Exchange (WQX) database. Funding for ongoing monitoring is provided by EPA section 106 and 319 grants.

The Tribe relies on the flow records from the USGS gauged site near the mouth of the Skokomish for mainstem data. No flow measurements are made at the remaining sites

In addition to this routine monitoring, additional sites are sampled when problems are detected by staff or from community members. Since 1995, the tribe has collected data from 77 additional locations in the watershed due to this type of water quality concern. Coordinates and other summary information for the Skokomish Tribe's permanent water quality monitoring sites are located in Table 1 and Figure 2.

Port Gamble S'Klallam Tribe

The Port Gamble S'Klallam Tribe monitors stream temperature during the summer months on several waterways in the Hood Canal drainage. The Tribe also conducts flow monitoring during selected low flow events following extended rainless periods on Shine Creek, Little Bartan Creek, and Hardy and Thomas Creeks. The Tribe is proposing to install water level logging devices in the upper Quilcene River for flow gauging, but this is pending permission by the NPS and US Forest Service. The seasonal temperature and periodic low flow monitoring conducted by the Port Gamble S'Klallam tribe is not included on the summary table or maps due to the seasonal or unpredictable timing of events. Since the proposed permanent flow gauging stations could support a larger monitoring effort, they are listed in Table 1.

U.S. Geological Survey

The USGS maintains 8 flow monitoring stations in the Hood Canal watershed. Most (5) of the active stations are in the Skokomish drainage; other stations are the Duckabush and Big Quilcene Rivers and Big Beef Creek. USGS also provides support for two other stations on Little Quilcene River (with City of Port Townsend) and Big Quilcene River near Penny Creek. Long-term USGS flow monitoring around Hood Canal began on the Skokomish River between 1914 and 1924. Other sites were added in the 1930s and 1940s for a total of about 30 stations in the region, most of which were abandoned between 1953 and 1979. Between 1994 and 1996, USGS also monitored flow on Devil's Hole Creek, near the U.S. Navy's Bangor submarine base.

The USGS database has the longest time series of flow data available in the project area. Although most stations are no longer active, the data is valuable for evaluation of long-term trends and inter-stream correlations. Funding for this gauging effort is shared: 45% is federally funded (Cooperative Water Program) and 55% by partners (Ecology, Tacoma Power, KPUD, Mason County, Skokomish Tribal Nation, City of Port Townsend, and WDFW). Future plans depend on funding, but it is expected that the current level of effort will be supported. Since USGS flow gauging stations are expected to be maintained indefinitely, their locations and other summary information is included in Table 1 and Figure 3.

Summary and Data Gaps

One of the more significant findings from this inventory effort is the increase in the number of monitoring efforts since a similar inventory was completed in 2003. Since 2003, the number of local, state, tribal and federal entities involved in monitoring in the basin has more than doubled, and the amount of data collected has increased substantially. Most of this effort has focused on fecal coliform bacteria, mainly to identify problems rather than depict overall water quality trends. Most of these efforts, although instrumental to evaluating human health impacts and septic system failures, are not necessarily helpful for establishing long-term trends in overall stream and river condition.

The majority of monitoring implemented in the Hood Canal Watershed over the last decade has been limited to one or two years of monitoring on specific streams. Most of these projects aim to address specific concerns (e.g., 303(d) listings) and the most readily available funding sources (Centennial and 319 grants) are intended for these types of short-term monitoring projects. Unfortunately this approach results in sporadic data records that are difficult to use for evaluating long-term trends in stream conditions. For this purpose, studies which are intended to be long-term from the outset that are accompanied by secure long-term funding sources are required.

There are few studies that evaluate a comprehensive suite of parameters (e.g., nutrients, sediments, metals). As mentioned above, many of the current monitoring efforts are focused specifically on fecal coliform bacteria and related source tracking studies. These efforts are valuable for their intended purpose, but not as helpful for establishing trends in overall stream condition. More efforts that examine overall water quality are needed for a more comprehensive evaluation of watershed health.

Data accessibility and a transparent data management process is another area that needs support. With the exception of Ecology funded projects and Skokomish Tribal Nation monitoring, data is stored in individual spreadsheets at local offices. In this format, data is vulnerable to loss and difficult for third parties to access. If data collected by individual monitoring groups for specific projects are to be combined into a larger, more comprehensive study, it is crucial that data be stored in a common, readily accessible location.

For the purpose of developing a new monitoring strategy, it is beneficial to identify where and how the needs of a comprehensive, long-term monitoring program are already being satisfied. The following is a summary of monitoring that has been or is expected to be long-term, and for which the monitoring occurs with regularity. Figure 2 shows the locations of existing long-term sites within the Hood Canal watershed where water quality monitoring is expected to continue indefinitely, and Figure 3 displays the locations of existing long-term flow monitoring sites. Table 1 summarizes both ongoing and completed monitoring efforts.

Specific ongoing efforts conducted by Ecology, the Skokomish Tribal Nation, USGS, and KCHD may be particularly beneficial to the development of a new long-term monitoring plan.

- Ecology maintains 10 stations throughout the watershed which are monitored for a wide range of water quality constituents. Ecology's stations on the Skokomish and Duckabush rivers are monitored monthly every year and have a period of record of 40 and 14 years, respectively. The remaining 8 Ecology stations are monitored monthly for one out of every five years.

- The Skokomish Tribal Nation monitors 20 stations within the Skokomish watershed for a wide range of water quality parameters as well, and many of these stations also have a nearly 20 year period of record.

- KCHD monitors 11 stations on the Kitsap Peninsula for fecal coliform bacteria on a monthly basis. This program has been in place for 14 years.

- Flow is permanently monitored on 20 Hood Canal Streams by USGS, Ecology, or local public works agencies.

As shown in Figure 2, although there are over 40 long-term water quality monitoring sites in the watershed, half of these are concentrated in one area (the Skokomish), while half of the remaining sites include only bacteria monitoring. When these sites are put in the context of the environmental attributes of area streams such as Category 5 water quality listings, salmon usage and habitat, and future concerns for consumptive water use (Figures 4 and 5), it is apparent current monitoring lacks necessary spatial coverage, especially if considering representation of pollutants other than bacteria. Relative to other watersheds of this size, there are a fair number of flow gauging sites, however these sites are concentrated in the same areas as the water quality monitoring activity.

Given current concerns over consumptive water use, existing temperature problems (Figures 4 and 5), and the potential for global climate change to significantly alter stream flows in the future, more flow monitoring that provides greater spatial coverage and a representation of a more diverse set of stream morphologies is needed. Existing monitoring efforts alone do not fulfill the needs of a comprehensive monitoring program; however, their incorporation into a larger monitoring effort may enhance the efficacy and lower the total cost of such a program. By coordinating and augmenting existing long-term monitoring efforts, and carefully selecting and implementing new sites, a comprehensive and cost effective monitoring plan for Hood Canal can be developed.

Table 1. Inventory of Major Long-Term Surface Water Monitoring Efforts in the Hood Canal Watershed between 2000 and 2010.

Monitoring Group	WRIA	Station ID	Location Description	Dec Latitude	Dec Longitude	Parameters	Period of Record	Data Storage Location	Agency Contact or Website
BPWU	15	N/A	Union River, west branch weirs below Cadas Dam	47.52722222	-122.7880556	Flow	pre-1993-present	Local Database at Bremerton Public Works	Kathleen Cahall Kathleen.Cahall@ci.bremerton.wa.us 360-473-2315
BPWU	15	N/A	Union River at intake facility weir	47.52888889	-122.7855556	primary & secondary drinking water stds, TOC, FC,TURB, cryptosporidium, giardia.	N/A		
Ecology	15	15F150	Big Beef Cr. @ Holly Road	47.59305556	-122.8372222	Flow	Oct 1998-present	Washington Flow Monitoring Network Website	https://fortress.wa.gov/ecy/wrx/wrx/flows/regions/state.asp
Ecology	15	15L050	Seabeck Cr. @ mouth	47.63583333	-122.8383333	Flow (Telemetery),Temp, Tair	June 2004-present		
Ecology	15	15M070	Little Anderson Cr. @ Anderson	47.66	-122.7552778	Flow (Telemetery),Temp, Tair	June 2005-present		
Ecology	16	16D070	Dosewallips River @ Brinnon	47.69	-122.8972222	Flow (Telemetery),Temp, Tair	3/8/2007-present		
Ecology	17	17A060	Big Quilcene R. nr Mouth	47.865	-122.814	Flow (Telemetery),Temp, Tair	Oct 1998-present		
Ecology	17	17D060	Little Quilcene nr Mouth	47.83	-122.8744444	Flow (Telemetery),Temp, Tair	Sept 2002-present		
Ecology	17	17G060	Tarboo Creek nr Mouth	47.862	-122.812	Flow (Telemetery),Temp, Tair	April 2003-present		
Ecology	17	17H060	Thorndyke Creek nr Mouth	47.82361111	-122.7386111	Flow (Telemetery),Temp, Tair	April 2003-present		
Ecology	15	15A070	Dewatto R nr Dewatto	47.469	-123.0266	ALK,EC,FC, HARD, NH3_N, N+N, DO,PH,TSS,TEMP,TP,TN,TURB	1972-1974, 1998, 2008	Ecology EIM Database and River and Stream Water Quality Monitoring Website	http://www.ecy.wa.gov/programs/eap/fw_riv/rv_main.html#4

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Monitoring Group	WRIA	Station ID	Location Description	Dec Latitude	Dec Longitude	Parameters	Period of Record	Data Storage Location	Agency Contact or Website
Ecology	15	15D070	Tahuya R @ Tahuya River Rd	47.4076	-123.0068	ALK,EC,FC, HARD, NH3_N, N+N, DO,PH,TSS,TEMP,TP,TN,TURB	2008	Ecology EIM Database and River and Stream Water Quality Monitoring Website	http://www.ecy.wa.gov/programs/eap/fw_riv/rv_main.html#4
Ecology	15	15F050	Big Beef Cr @ Mouth	47.6504	-122.7835	ALK,EC,FC, HARD, NH3_N, N+N, DO,PH,TSS,TEMP,TP,TN,TURB	2005-2010		
Ecology	15	15L050	Seabeck Cr. @ mouth	47.635	-122.8352	ALK,EC,FC, HARD, NH3_N, N+N, DO,PH,TSS,TEMP,TP,TN,TURB	2005-2010		
Ecology	15	15M070	Llt Anderson Cr. @ Anderson Hill Rd	47.6604	-122.7554	ALK,EC,FC, HARD, NH3_N, N+N, DO,PH,TSS,TEMP,TP,TN,TURB	2005-2010		
Ecology	15	15N070	Stavis Cr. nr Mouth	47.6245	-122.8749	ALK,EC,FC, HARD, NH3_N, N+N, DO,PH,TSS,TEMP,TP,TN,TURB	2005-2010		
Ecology	16	16A070	Skokomish R nr Potlatch	47.3098	-123.1771	ALK,EC,FC, HARD, NH3_N, N+N, DO,PH,TSS,TEMP,TP,TN,TURB	1960-2010 (except 1968,1971,1976,1977, 1981-1983)		
Ecology	16	16C090	Duckabush R nr Brinnon	47.684	-123.0116	ALK,EC,FC, HARD, NH3_N, N+N, DO,PH,TSS,TEMP,TP,TN,TURB	1972-1974, 1994-2010		
Ecology	17	17A060	Big Quilcene R nr mouth	47.8182	-122.8753	ALK,EC,FC, HARD, NH3_N, N+N, DO,PH,TSS,TEMP,TP,TN,TURB	2000,2001, 2010		

Table 1. Inventory of Major Long-Term Surface Water Monitoring Efforts in the Hood Canal Watershed between 2000 and 2010.

Monitoring Group	WRIA	Station ID	Location Description	Dec Latitude	Dec Longitude	Parameters	Period of Record	Data Storage Location	Agency Contact or Website
Ecology	17	17G060	Tarboo Cr. nr mouth	47.8687	-122.8171	ALK,EC,FC, HARD, NH3_N, N+N, DO,PH,TSS,TEMP,TP,TN,TURB	2007	Ecology EIM Database and River and Stream Water Quality Monitoring Website	http://www.ecy.wa.gov/programs/eap/fw_riv/rv_main.html#4
HCDOP	16	SKOK101	Skokomish at Hwy 101	47.31013049	-123.1755463	DO, DOC, TN, TP, Ortho P, NO3-N, NO2-N, SIO2, TSS	2005-2007	Stored in Individual spreadsheets at University of Washington	Dan Hannafious dan@hcseg.org 360-275-2011
HCDOP	16	KOKA	Lake Kokanee	47.39618698	-123.1992073	DO, DOC, TN, TP, Ortho P, NO3-N, NO2-N, SIO2, TSS	2005-2007		
HCDOP	16	HAMA	Hamma Hamma River	47.54569323	-123.0413553	DO, DOC, TN, TP, Ortho P, NO3-N, NO2-N, SIO2, TSS	2005-2007		
HCDOP	15	DEWA	Dewatto River	47.45598648	-123.0307912	DO, DOC, TN, TP, Ortho P, NO3-N, NO2-N, SIO2, TSS	2005-2007		
HCDOP	16	ENATD	Enati Creek (down)	47.35555983	-123.159066	DO, DOC, TN, TP, Ortho P, NO3-N, NO2-N, SIO2, TSS	2005-2007		
HCDOP	16	ENATU	Enati Creek (up)	47.35552195	-123.1604165	DO, DOC, TN, TP, Ortho P, NO3-N, NO2-N, SIO2, TSS	2005-2007		
HCDOP	16	SKAB	Skabob Creek	47.323916	-123.1501312	DO, DOC, TN, TP, Ortho P, NO3-N, NO2-N, SIO2, TSS	2005-2007		
HCDOP	16	SKOK106	Skokomish at Hwy 106	47.31959351	-123.1384614	DO, DOC, TN, TP, Ortho P, NO3-N, NO2-N, SIO2, TSS	2005-2007		
HCDOP	14B	ALDE	Alderbrook Creek	47.34816407	-123.0670306	DO, DOC, TN, TP, Ortho P, NO3-N, NO2-N, SIO2, TSS	2005-2007		
HCDOP	15	BAND	Big Anderson Creek	47.56698479	-122.9662722	DO, DOC, TN, TP, Ortho P, NO3-N, NO2-N, SIO2, TSS	2005-2007		
HCDOP	15	BBEE	Big Beef Creek	47.65278365	-122.7818821	DO, DOC, TN, TP, Ortho P, NO3-N, NO2-N, SIO2, TSS	2005-2007		
HCDOP	14B	BBEN	Big Bend Creek	47.34832207	-123.0735049	DO, DOC, TN, TP, Ortho P, NO3-N, NO2-N, SIO2, TSS	2005-2007		

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Monitoring Group	WRIA	Station ID	Location Description	Dec Latitude	Dec Longitude	Parameters	Period of Record	Data Storage Location	Agency Contact or Website
HCDOP	17	BQUI	Big Quilcene River	47.81922066	-122.8701276	DO, DOC, TN, TP, Ortho P, NO3-N, NO2-N, SIO2, TSS	2005-2007	Stored in Individual spreadsheets at University of Washington	Dan Hannafious dan@hcseg.org 360-275-2011
HCDOP	14B	DEVE	Deveraux Creek	47.43003702	-122.8470214	DO, DOC, TN, TP, Ortho P, NO3-N, NO2-N, SIO2, TSS	2005-2007		
HCDOP	16	DOSE	Dosewallips River	47.69155838	-122.9019874	DO, DOC, TN, TP, Ortho P, NO3-N, NO2-N, SIO2, TSS	2005-2007		
HCDOP	16	DUCK	Duckabush River	47.65071519	-122.9368841	DO, DOC, TN, TP, Ortho P, NO3-N, NO2-N, SIO2, TSS	2005-2007		
HCDOP	16	EAGL	Eagle Creek	47.48513657	-123.0768015	DO, DOC, TN, TP, Ortho P, NO3-N, NO2-N, SIO2, TSS	2005-2007		
HCDOP	16	FINC	Finch Creek	47.40693811	-123.1394191	DO, DOC, TN, TP, Ortho P, NO3-N, NO2-N, SIO2, TSS	2005-2007		
HCDOP	16	FINU	Finch Creek Upstream	47.40768784	-123.1580035	DO, DOC, TN, TP, Ortho P, NO3-N, NO2-N, SIO2, TSS	2005-2007		
HCDOP	16	FULT	Fulton Creek	47.62263902	-122.9762976	DO, DOC, TN, TP, Ortho P, NO3-N, NO2-N, SIO2, TSS	2005-2007		
HCDOP	14B	HAPP	Happy Hollow Creek	47.38814896	-122.9146611	DO, DOC, TN, TP, Ortho P, NO3-N, NO2-N, SIO2, TSS	2005-2007		
HCDOP	16	HILL	Hill Creek	47.39418205	-123.1439968	DO, DOC, TN, TP, Ortho P, NO3-N, NO2-N, SIO2, TSS	2005-2007		
HCDOP	14B	HOLY	Holyoke Creek	47.40537153	-122.8840042	DO, DOC, TN, TP, Ortho P, NO3-N, NO2-N, SIO2, TSS	2005-2007		
HCDOP	16	JORS	Jorsted Creek	47.52408415	-123.0534661	DO, DOC, TN, TP, Ortho P, NO3-N, NO2-N, SIO2, TSS	2005-2007		
HCDOP	16	LILL	Lilliwaup River	47.46896311	-123.1140258	DO, DOC, TN, TP, Ortho P, NO3-N, NO2-N, SIO2, TSS	2005-2007		

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Monitoring Group	WRIA	Station ID	Location Description	Dec Latitude	Dec Longitude	Parameters	Period of Record	Data Storage Location	Agency Contact or Website
HCDOP	15	LMIS	Little Mission Creek	47.43007922	-122.8828361	DO, DOC, TN, TP, Ortho P, NO3-N, NO2-N, SIO2, TSS	2005-2007	Stored in Individual spreadsheets at University of Washington	Dan Hannafious dan@hcseg.org 360-275-2011
HCDOP	17	LQUI	Little Quilcene River	47.83008434	-122.8734542	DO, DOC, TN, TP, Ortho P, NO3-N, NO2-N, SIO2, TSS	2005-2007		
HCDOP	16	MILL	Miller Creek	47.42975708	-123.1240185	DO, DOC, TN, TP, Ortho P, NO3-N, NO2-N, SIO2, TSS	2005-2007		
HCDOP	15	MISS	Mission Creek	47.4321131	-122.8746234	DO, DOC, TN, TP, Ortho P, NO3-N, NO2-N, SIO2, TSS	2005-2007		
HCDOP	14B	MULB	Mulberg Creek	47.3873546	-122.9238573	DO, DOC, TN, TP, Ortho P, NO3-N, NO2-N, SIO2, TSS	2005-2007		
HCDOP	16	NFSK	North Fork Skokomish River	47.51458107	-123.3292256	DO, DOC, TN, TP, Ortho P, NO3-N, NO2-N, SIO2, TSS	2005-2007		
HCDOP	15	SEAB	Seabeck Creek	47.63505703	-122.8352023	DO, DOC, TN, TP, Ortho P, NO3-N, NO2-N, SIO2, TSS	2005-2007		
HCDOP	15	STAV	Stavis Creek	47.62483715	-122.8716878	DO, DOC, TN, TP, Ortho P, NO3-N, NO2-N, SIO2, TSS	2005-2007		
HCDOP	15	STIM	Stimson Creek	47.41733287	-122.9068058	DO, DOC, TN, TP, Ortho P, NO3-N, NO2-N, SIO2, TSS	2005-2007		
HCDOP	15	TAHU	Tahuya River	47.37404527	-123.0435919	DO, DOC, TN, TP, Ortho P, NO3-N, NO2-N, SIO2, TSS	2005-2007		
HCDOP	17	TARB	Tarboo Creek	47.86965063	-122.8167694	DO, DOC, TN, TP, Ortho P, NO3-N, NO2-N, SIO2, TSS	2005-2007		
HCDOP	17	THOR	Thorndyke Creek	47.82391784	-122.7384682	DO, DOC, TN, TP, Ortho P, NO3-N, NO2-N, SIO2, TSS	2005-2007		
HCDOP	14B	TRAI	Trails End Road	47.39441116	-122.9026987	DO, DOC, TN, TP, Ortho P, NO3-N, NO2-N, SIO2, TSS	2005-2007		

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Monitoring Group	WRIA	Station ID	Location Description	Dec Latitude	Dec Longitude	Parameters	Period of Record	Data Storage Location	Agency Contact or Website
HCDOP	14B	TWAN	Twanoh Creek	47.37863039	-122.9726848	DO, DOC, TN, TP, Ortho P, NO3-N, NO2-N, SIO2, TSS	2005-2007	Stored in Individual spreadsheets at University of Washington	Dan Hannafious dan@hcseg.org 360-275-2011
HCDOP	14B	TFAL	Twanoh Falls Creek	47.38166319	-122.9478836	DO, DOC, TN, TP, Ortho P, NO3-N, NO2-N, SIO2, TSS	2005-2007		
HCDOP	15	UNIO	Union River	47.45189999	-122.8324192	DO, DOC, TN, TP, Ortho P, NO3-N, NO2-N, SIO2, TSS	2005-2007		
HCDOP	14A	UNIS	Union Store Creek	47.35731063	-123.0983983	DO, DOC, TN, TP, Ortho P, NO3-N, NO2-N, SIO2, TSS	2005-2007		
HCDOP	14A	UNNA	Unnamed Drainage	47.35564212	-123.0157967	DO, DOC, TN, TP, Ortho P, NO3-N, NO2-N, SIO2, TSS	2005-2007		
HCDOP	16	WAKE	Wacketickeh Creek	47.55834907	-123.0248431	DO, DOC, TN, TP, Ortho P, NO3-N, NO2-N, SIO2, TSS	2005-2007		
HCSEG	15		Union River	Coordinates Not Provided	Coordinates Not Provided	Flow (sensor), temp (sensor) Dissolved Metals (Cd,Cu,Pb,Zn), TR metal (Hg), TSS, Fecal coliform, Oil/grease, chlorinated herbicide, nit/phos pesticides, Sediment (Cd,Cu,Pb,Zn, Hg, PCBs)	2004 - 2009		Dan Hannafious dan@hcseg.org 360-275-2011
HCSEG	15		Big Mission River	Coordinates Not Provided	Coordinates Not Provided	Flow (sensor), temp (sensor) Dissolved Metals (Cd,Cu,Pb,Zn), TR metal (Hg), TSS, Fecal coliform	2004 - June 06 (transfer to USGS)		
HCSEG	15		Little Tahuya River	Coordinates Not Provided	Coordinates Not Provided	Flow (sensor), temp (sensor)	2004,2007		
HCSEG	15		Tahuya River	Coordinates Not Provided	Coordinates Not Provided	Flow (sensor), temp (sensor)	2004,2007		

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Monitoring Group	WRIA	Station ID	Location Description	Dec Latitude	Dec Longitude	Parameters	Period of Record	Data Storage Location	Agency Contact or Website
HCSEG	15		Dewatto River	Coordinates Not Provided	Coordinates Not Provided	Flow (sensor), temp (sensor)	2004 - June06 (transfer to USGS)		
HCSEG	15		Little Mission Creek	Coordinates Not Provided	Coordinates Not Provided	flow (manual) Dissolved Metals (Cd,Cu,Pb,Zn), TR metal (Hg), TSS, Fecal coliform	Sept 06 - Aug 07		
HCSEG	16		Dosewallips River	Coordinates Not Provided	Coordinates Not Provided	Flow (sensor), temp (sensor)	June 04 - Mar 07 (transfer to Ecology)		
HCSEG	16		Duckabush River	Coordinates Not Provided	Coordinates Not Provided	Flow (sensor), temp (sensor)	June 04 - Sept 08		
HCSEG	16		Fulton Creek	Coordinates Not Provided	Coordinates Not Provided	Flow (sensor), temp (sensor)	June 04 - July 05		Dan Hannafious dan@hcseg.org 360-275-2011
HCSEG	16		Hamma Hamma River	Coordinates Not Provided	Coordinates Not Provided	Flow (sensor), temp (sensor)	June 04 - 09		
HCSEG	16		Johns Creek	Coordinates Not Provided	Coordinates Not Provided	Flow (sensor), temp (sensor)	June 04 - 09		
HCSEG	16		Jorsted Creek	Coordinates Not Provided	Coordinates Not Provided	Flow (sensor), temp (sensor)	Aug 04 - Sept 08		
HCSEG	16		Eagle Creek	Coordinates Not Provided	Coordinates Not Provided	Flow (sensor), temp (sensor)	2007		
Jefferson County Conservation District	17	TB/0.9	Tarboo Cr	47.86945736	-122.8180207	PH, DO, EC, TURB, FC	est. 2009	Access Database at Jefferson Conservation District Office	Glenn Gately gately@jeffersoncd.org

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Monitoring Group	WRIA	Station ID	Location Description	Dec Latitude	Dec Longitude	Parameters	Period of Record	Data Storage Location	Agency Contact or Website
Jefferson County Conservation District	17	TB/2.4	Tarboo Cr	47.89408649	-122.8224604	PH, DO, EC, TURB, FC	est. 2009	Access Database at Jefferson Conservation District Office	Glenn Gately gately@jeffersoncd.org
Jefferson County Conservation District	17	TB/4.0	Tarboo Cr	47.91440521	-122.8258194	PH, DO, EC, TURB, FC	est. 2009		
Jefferson County Conservation District	17	DV/0.1	Donovan Cr	47.82823227	-122.8588016	PH, DO, EC, TURB, FC	est. 2009		
Jefferson County Conservation District	17	DV/0.4	Donovan Cr	47.83185155	-122.8621152	PH, DO, EC, TURB, FC	est. 2009		
Jefferson County Conservation District	17	DV/1.9	Donovan Cr	47.85218225	-122.8586803	PH, DO, EC, TURB, FC	est. 2009		
KCHD	15	BA01	BIG ANDERSON CREEK	47.56678	-122.96761	FC	est. 1995	Database at Local Office	Keith Grellner grellk@health.co.kitsap.wa.us
KCHD	15	BB01	BIG BEEF CREEK	47.65264	-122.78335	FC	est. 1995		
KCHD	15	BY01	BOYCE CREEK	47.60875	-122.91244	FC	est. 1995		
KCHD	15	JJ01	JUMP-OFF JOE CREEK	47.80748	-122.67053	FC	est. 1995		
KCHD	15	KN01	KINMAN CREEK	47.82153	-122.64983	FC	est. 1995		

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Monitoring Group	WRIA	Station ID	Location Description	Dec Latitude	Dec Longitude	Parameters	Period of Record	Data Storage Location	Agency Contact or Website
KCHD	15	LA02	LITTLE ANDERSON CREEK	47.65927	-122.75574	FC	est. 1995		
KCHD	15	LF01	LOFALL CREEK	47.81528	-122.65418	FC	est. 1995		
KCHD	15	MJ01	MARTHA-JOHN CREEK	47.82671	-122.56425	FC	est. 1995		
KCHD	15	PG01	GAMBLE CREEK	47.81087	-122.58025	FC	est. 1995		
KCHD	15	SB01	SEABECK CREEK	47.60912	-122.91215	FC	est. 1995		
KCHD	15	SV01	STAVIS CREEK	47.62485	-122.87301	FC	est. 1995		
KCHD	15	VC01	VINLAND CREEK	47.774849	-122.70066	FC	est. 1995	Database at Local Office	Keith Grellner grellk@health.co.kitsap.wa.us
KCHD	15	TR01	Tahuyeh River	47.5225	-122.8722222	FC	est. 1995		
KCHD	15	UN01	Union River	47.49722222	-122.7994444	FC	est. 1995		
KCHD	15	N/A	Lake Symington	47.59583333	-122.8291667	TEMP, EC, P, DO, pH, SC, chlorophyll, Secchi disc	N/A		
KCHD	15	N/A	Lake Tahuyeh	47.56666667	-122.8375	Temp, EC, P, DO, pH, SC, chlorophyll, Secchi disc	N/A		
KCHD	15	N/A	Mission lake	47.53333333	-122.825	TEMP, EC, TP, DO, pH, SC, chlorophyll, Secchi disc	N/A		
KCHD	15	N/A	Panther lake	47.525	-122.85	TEMP, EC, TP, DO, pH, SC, chlorophyll, Secchi disc	N/A		

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Monitoring Group	WRIA	Station ID	Location Description	Dec Latitude	Dec Longitude	Parameters	Period of Record	Data Storage Location	Agency Contact or Website
KCHD	15	N/A	Tiger lake	47.51666667	-122.8333333	TEMP, EC, TP, DO, pH, SC, chlorophyll, Secchi disc	N/A	Database at Local Office	Keith Grellner grellk@health.co.kitsap.wa.us
KPUD	15	GO	GOLD CREEK	47.55611111	-122.825	Flow (Regular Download)	2/2000-present	Local Database	Jim LeCuyer jlecuyer@kpud.org 360-626-7710
MCPH	16		Lilliwaup Creek	Coordinates Not Provided	Coordinates Not Provided	NO2_N,NO3_N, NH4_N, SRP, Silicic Acid, FC	To Be conducted 2010-2012	Data Will Be Stored in EIM	Amy Georgeson AmyG@co.mason.wa.us (360)427-9670 ext. 544
MCPH	16		Big Bend Creek	Coordinates Not Provided	Coordinates Not Provided	NO2_N,NO3_N, NH4_N, SRP, Silicic Acid, FC	To Be conducted 2010-2012		
MCPH	16		Twanoh Creek	Coordinates Not Provided	Coordinates Not Provided	NO2_N,NO3_N, NH4_N, SRP, Silicic Acid, FC	To Be conducted 2010-2012		
MCPH	16		Twanoh Falls Creek	Coordinates Not Provided	Coordinates Not Provided	NO2_N,NO3_N, NH4_N, SRP, Silicic Acid, FC	To Be conducted 2010-2012		
MCPH	16		Mulburg Creek	Coordinates Not Provided	Coordinates Not Provided	NO2_N,NO3_N, NH4_N, SRP, Silicic Acid, FC	To Be conducted 2010-2012		
MCPH	16		Happy Hollow Creek	Coordinates Not Provided	Coordinates Not Provided	NO2_N,NO3_N, NH4_N, SRP, Silicic Acid, FC	To Be conducted 2010-2012		
MCPH	16		Holyoke Creek	Coordinates Not Provided	Coordinates Not Provided	NO2_N,NO3_N, NH4_N, SRP, Silicic Acid, FC	To Be conducted 2010-2012		
MCPH	16		Trails End Creek	Coordinates Not Provided	Coordinates Not Provided	NO2_N,NO3_N, NH4_N, SRP, Silicic Acid, FC	To Be conducted 2010-2012		

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Monitoring Group	WRIA	Station ID	Location Description	Dec Latitude	Dec Longitude	Parameters	Period of Record	Data Storage Location	Agency Contact or Website
MCPH	16		Deveraux Creek	Coordinates Not Provided	Coordinates Not Provided	NO2_N,NO3_N, NH4_N, SRP, Silicic Acid, FC	To Be conducted 2010-2012	Data Will Be Stored in EIM	Amy Georgeson AmyG@co.mason.wa.us (360)427-9670 ext. 544
MCPH	16		Little Mission Creek	Coordinates Not Provided	Coordinates Not Provided	NO2_N,NO3_N, NH4_N, SRP, Silicic Acid, FC	To Be conducted 2010-2012		
MCPH	16		Stimpson Creek	Coordinates Not Provided	Coordinates Not Provided	NO2_N,NO3_N, NH4_N, SRP, Silicic Acid, FC	To Be conducted 2010-2012		
MCPH	16		Shoofly Creek	Coordinates Not Provided	Coordinates Not Provided	NO2_N,NO3_N, NH4_N, SRP, Silicic Acid, FC	To Be conducted 2010-2012		
Planning Unit	14B	N/A	Big Bend Creek	47.34832207	-123.0735049	TP, N+N, TSS, FC, BOD	2004	EIM Database	www.ecy.gov/eim
Planning Unit	14B	N/A	Alderbrook Creek	47.34816407	-123.0670306	TP, N+N, TSS, FC, BOD	2004		
Planning Unit	14B	N/A	Unnamed Creek	47.3553552	-123.0169366	TP, N+N, TSS, FC, BOD	2004		
Planning Unit	14B	N/A	Shady Beach Creek	47.372938	-122.9877056	TP, N+N, TSS, FC, BOD	2004		
Planning Unit	14B	N/A	Twanoh Creek	47.37863039	-122.9726848	TP, N+N, TSS, FC, BOD	2004		
Planning Unit	14B	N/A	Twanoh Falls Creek	47.38166319	-122.9478836	TP, N+N, TSS, FC, BOD	2004		
Planning Unit	14B	N/A	Mulberg Creek	47.3873546	-122.9238573	TP, N+N, TSS, FC, BOD	2004		
Planning Unit	14B	N/A	Happy Hollow Creek	47.38814896	-122.9146611	TP, N+N, TSS, FC, BOD	2004		

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Monitoring Group	WRIA	Station ID	Location Description	Dec Latitude	Dec Longitude	Parameters	Period of Record	Data Storage Location	Agency Contact or Website
Planning Unit	14B	N/A	Holyoke Creek	47.40537153	-122.8840042	TP, N+N, TSS, FC, BOD	2004	EIM Database	www.ecy.gov/eim
Planning Unit	14B	N/A	Deveraux Creek	47.43003702	-122.8470214	TP, N+N, TSS, FC, BOD	2004		
Planning Unit	15	N/A	Mission Creek	47.4321131	-122.8746234	TP, N+N, TSS, FC, BOD	2004		
Planning Unit	15	N/A	Stimson Creek	47.41733287	-122.9068058	TP, N+N, TSS, FC, BOD	2004		
Planning Unit	15	N/A	Shoofly Creek	47.3897426	-122.986367	TP, N+N, TSS, FC, BOD	2004		
Planning Unit	15	N/A	Tahuya River	47.3783396	-123.0335029	TP, N+N, TSS, FC, BOD	2004		
Port Gamble Tribe	17	N/A	Upper Quilcene River	N/A	N/A	Pending Approval	Proposed installation	N/A	Hans Dobbinberger hans@pgst.nsn.us (360)297-6289
PTPW	17	N/A	Lords Lake	47.87916667	-122.9333333	TURB	N/A	National Water Information System	http://waterwatch.usgs.gov/
PTPW/USGS	17	12051900	LITTLE QUILCENE RIVER BELOW DIV NR QUILCENE, WA	47.87481306	-122.9596127	Flow (Manual Measurment)	1/21/1994-present		
Skokomish Tribal Nation	16	SWQM-1	Skokomish R at Hwy 106 Bridge	47.319256	-123.139811	PH, DO, NO3_N, TEMP, TP_P ,TN_N, FC	est. 1980	NPS-STORET Database	Ron Figlar Barnes rbarnes@skokomish.org (360) 877-2110 ex. 1
Skokomish Tribal Nation	16	SWQM-11	10 Acre Cr. Vly . Rd.	47.304936	-123.185744	PH, DO, NO3_N, TEMP, TP_P ,TN_N, FC	est. 1995		
Skokomish Tribal Nation	16	SWQM-13	Middle Skobob Cr.	47.323625	-123.147908	PH, DO, NO3_N, TEMP, TP_P ,TN_N, FC	est. 1992		

Table 1. Inventory of Major Long-Term Surface Water Monitoring Efforts in the Hood Canal Watershed between 2000 and 2010.

Monitoring Group	WRIA	Station ID	Location Description	Dec Latitude	Dec Longitude	Parameters	Period of Record	Data Storage Location	Agency Contact or Website
Skokomish Tribal Nation	16	SWQM-2	Skokomish R. @ Rocky Beach	47.316571	-123.200793	PH, DO, NO3_N, TEMP, TP_P ,TN_N, FC	est. 1992	NPS-STORET Database	Ron Figlar Barnes rbarnes@skokomish.org (360) 877-2110 ex. 1
Skokomish Tribal Nation	16	SWQM-20	Skobob Wetlands Boundary	47.314578	-123.143361	PH, DO, NO3_N, TEMP, TP_P ,TN_N, FC	est. 1996		
Skokomish Tribal Nation	16	SWQM-21	Weaver Cr. Lower Br.	47.304786	-123.165853	PH, DO, NO3_N, TEMP, TP_P ,TN_N, FC	est. 1995		
Skokomish Tribal Nation	16	SWQM-3	Skokomish R. @ Chico's Eddy	47.314567	-123.142664	PH, DO, NO3_N, TEMP, TP_P ,TN_N, FC	est. 1995		
Skokomish Tribal Nation	16	SWQM-33	Potlach Creek nr Mouth	47.363042	-123.156433	PH, DO, NO3_N, TEMP, TP_P ,TN_N, FC	est. 1996		
Skokomish Tribal Nation	16	SWQM-6	Vance Cr. Lower Br.	47.317028	-123.253697	PH, DO, NO3_N, TEMP, TP_P ,TN_N, FC	est. 1995		
Skokomish Tribal Nation	16	SWQM-7	Purdy Cr. Bour. Br	47.304081	-123.1613	PH, DO, NO3_N, TEMP, TP_P ,TN_N, FC	est. 1995		
Skokomish Tribal Nation	16	SWQM-8	Weaver Cr. Vly. Rd Br	47.308661	-123.185658	PH, DO, NO3_N, TEMP, TP_P ,TN_N, FC	est. 1995		
Skokomish Tribal Nation	16	SWQM-82	Skokomish R. Hwy 101 Br	47.309469	-123.176014	PH, DO, NO3_N, TEMP, TP_P ,TN_N, FC	est. 1992		
Skokomish Tribal Nation	16	SWQM-83	No Name Cr	47.319086	-123.138419	PH, DO, NO3_N, TEMP, TP_P ,TN_N, FC	est. 2002		

Table 1. Inventory of Major Long-Term Surface Water Monitoring Efforts in the Hood Canal Watershed between 2000 and 2010.

Monitoring Group	WRIA	Station ID	Location Description	Dec Latitude	Dec Longitude	Parameters	Period of Record	Data Storage Location	Agency Contact or Website
Skokomish Tribal Nation	16	SWQM-9	Purdy Cr nr Mouth	47.306111	-123.154178	PH, DO, NO3_N, TEMP, TP_P ,TN_N, FC	est. 1995	NPS-STORET Database	Ron Figlar Barnes rbarnes@skokomish.org (360) 877-2110 ex. 1
Skokomish Tribal Nation	16	SWQM-90	Upper Potlach Cr.	47.362142	-123.158421	PH, DO, NO3_N, TEMP, TP_P ,TN_N, FC	est. 2004		
Skokomish Tribal Nation	16	SWQM-94	Headwaters Potlach Cr	47.362	-123.160058	PH, DO, NO3_N, TEMP, TP_P ,TN_N, FC	est. 2006		
Skokomish Tribal Nation	16	SWQM-95	Headwaters Potlach Cr. 1	47.362167	-123.160419	PH, DO, NO3_N, TEMP, TP_P ,TN_N, FC	est. 2006		
Skokomish Tribal Nation	16	SWQM-96	Headwaters Potlach Cr. 2	47.362014	-123.160406	PH, DO, NO3_N, TEMP, TP_P ,TN_N, FC	est. 2006		
Skokomish Tribal Nation	16	SWQM-98	10 Acre Cr. George Adams Hatchery	47.301828	-123.181211	PH, DO, NO3_N, TEMP, TP_P ,TN_N, FC	est. 2007		
Skokomish Tribal Nation	16	SWQM-99	Weaver Cr. Hwy 101 Br	47.303056	-123.179847	PH, DO, NO3_N, TEMP, TP_P ,TN_N, FC	est. 2007		
USGS	16	12054000	DUCKABUSH RIVER NEAR BRINNON, WA	47.68398059	-123.011551	Flow (Manual Measurment)	1/1/1939-present	National Water Information System	http://waterwatch.usgs.gov/
USGS	16	12056500	NF SKOKOMISH R BL STAIRCASE RPDS NR HOODSPORT, WA	47.51425666	-123.3298868	Flow (Telemetry)	2/2/1925-present		
USGS	16	12058790	NF SKOKOMISH R NR LWR CUSHMAN DAM NR POTLATCH, WA	47.3964809	-123.2034909	Flow (Manual Measurment)	8/28/1989-present		
USGS	16	12059500	NORTH FORK SKOKOMISH RIVER NEAR POTLATCH, WA	47.32981429	-123.2432128	Flow (Telemetry)	2/7/1945-present		

Table 1. Inventory of Major Long-Term Surface Water Monitoring Efforts in the Hood Canal Watershed between 2000 and 2010.

Monitoring Group	WRIA	Station ID	Location Description	Dec Latitude	Dec Longitude	Parameters	Period of Record	Data Storage Location	Agency Contact or Website
USGS	16	12060500	SOUTH FORK SKOKOMISH RIVER NEAR UNION, WA	47.34036949	-123.2801586	Flow (Telemetry)	2/26/1932-present	National Water Information System	http://waterwatch.usgs.gov/
USGS	16	12061500	SKOKOMISH RIVER NEAR POTLATCH, WA	47.3098151	-123.1770995	Flow (Telemetry)	12/00/1933-present		
USGS	15	12069550	BIG BEEF CREEK NEAR SEABECK, WA	47.64064868	-122.7851527	Flow (Manual Measurment)	12/22/1969-present		
USGS/PTPW	17	12052210	BIG QUILCENE RIVER BELOW DIVERSION NR QUILCENE, WA	47.78453566	-122.97961	Flow (Manual Measurment)	1/21/94 (PTPW) or 2/17/1994 (USGS)-present		
USGS/USFWS	17	12052390	BIG QUILCENE RIVER ABOVE PENNY CR NR QUILCENE, WA	47.8087025	-122.9132204	Flow (Manual Measurment)	1996 or 1997?-present		
WDFW	17	N/A	Penny Creek	47.80888889	-122.9119444	Temp	est. 1980	Data Mainatained at Local Office	Ron Wong USFWS Quilcene Hatchery 360-765-3334 ron_wong@fws.gov
WDFW	17	N/A	Penny Creek	47.80888889	-122.9119444	PH,TURB, TDS, inorganics (metals, major ions), pesticides, VOCs	2008-2010		
WDFW	17	12052390	BIG QUILCENE RIVER ABOVE PENNY CR NR QUILCENE, WA	47.8087025	-122.9132204	PH,TURB, TDS, inorganics (metals, major ions), pesticides, VOCs	2008-2010		

HERRERA ENVIRONMENTAL CONSULTANTS

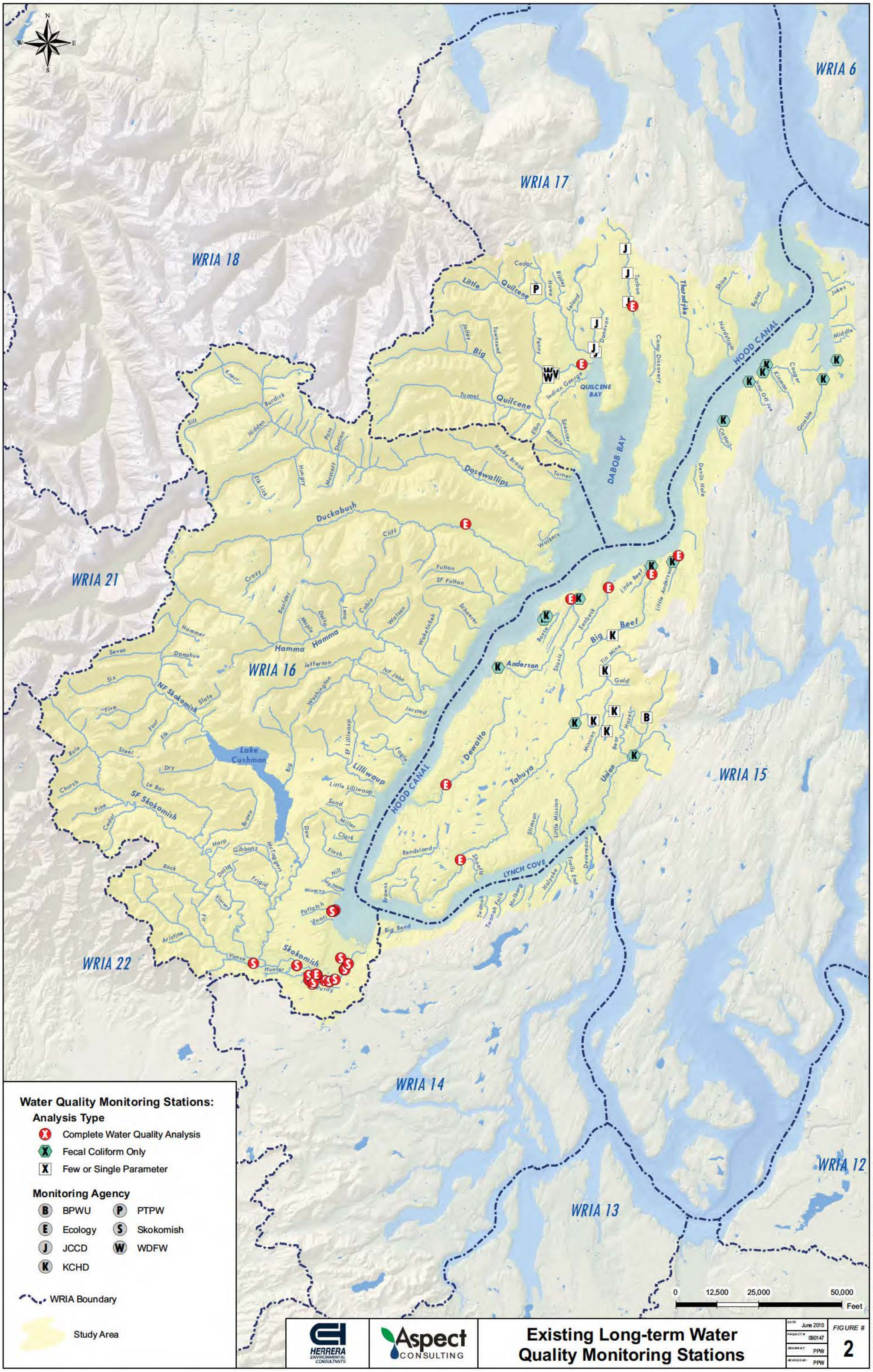
Aspect CONSULTING

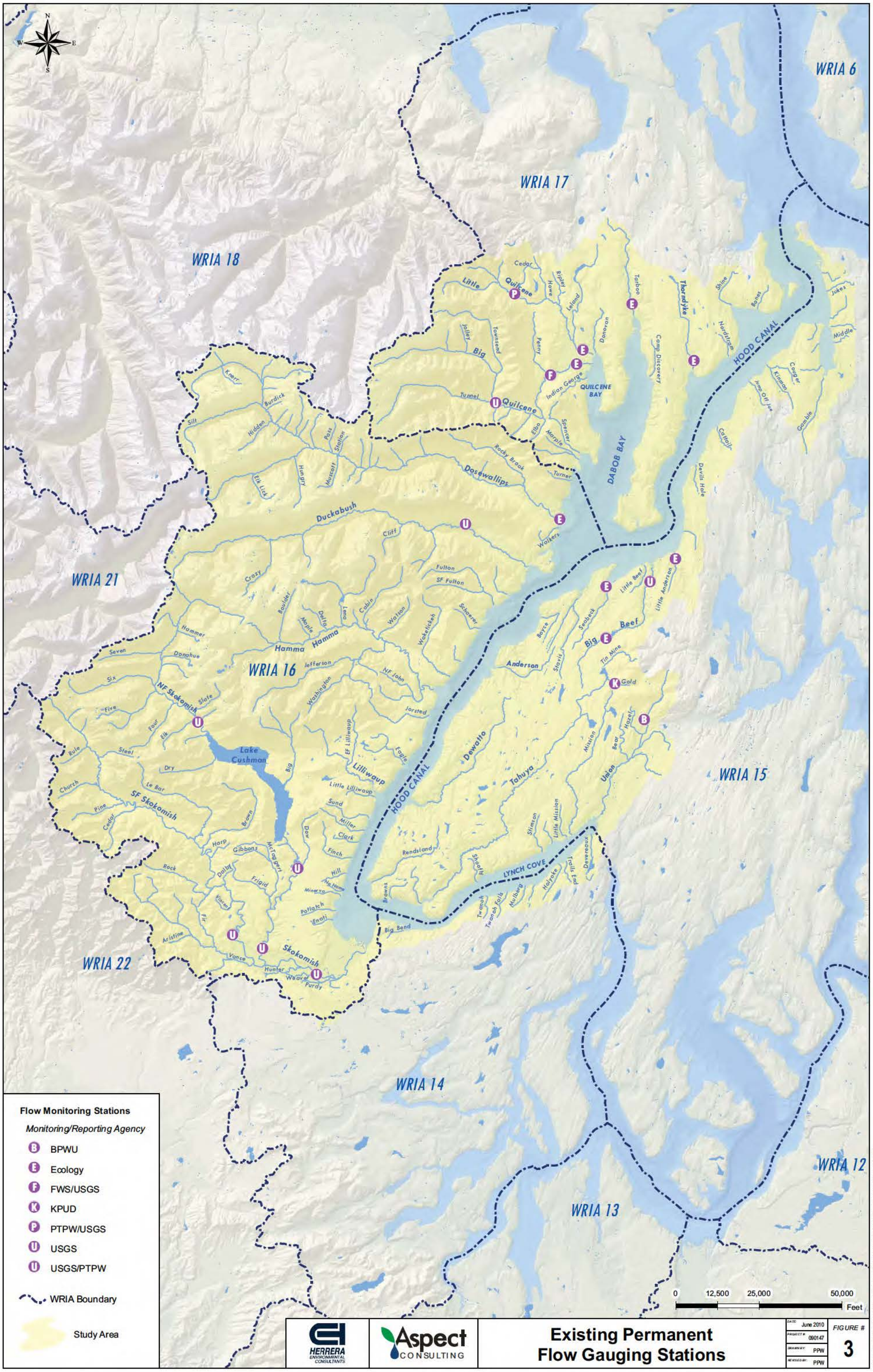
Project Location Map

DATE:	June 2010
PROJECT #:	090147
DRAWN BY:	PPW
REVISED BY:	PPW

FIGURE #
1

T:\projects_8\WRIA16\HoodCanal_SW_Mon_Plan\Deliverables\Inventory Memo\Project_Location_Map.mxd


WRIA 6
WRIA 17
WRIA 18
WRIA 21
WRIA 16
WRIA 15
WRIA 22
WRIA 14
WRIA 13
WRIA 12
HOOD CANAL
DABOB BAY
QUILCENE BAY
LYNCH COVE
Little Quilcene
Big Quilcene
Tunnel
Dosewallips
Duckabush
Hamma Hamma
Lake Cushman
NF Skokomish
SF Skokomish
Skokomish
Lilliwaup
Dewatto
Tahuya
Anderson
Big Beef
Thorndyke
Camp Discovery
Indian George
Cedar
Ripley
Howe
Leland
Tarboo
Penny
Donovan
Jolley
Townsend
Knarr
Burdick
Silt
Hidden
Pass
Station
Muscott
Hungry
Elk Lick
Rocky Brook
Turner
Elbo
Marple
Spencer
Cliff
Walkers
Crazy
Boulder
Maple
Delta
Lend
Cabin
Watson
Wakefield
Schaerer
Fulton
SF Fulton
Hammer
Seven
Donahue
Six
Five
Four
Elk
Slate
Rule
Steel
Dry
Church
Le Bar
Pine
Cedar
Brown
Harp
Gibbons
McTaggert
Rock
Dalby
Frigid
Aristine
Vance
Hunter
Jefferson
Washington
NF John
Jorsted
EF Lilliwaup
Eagle
Big
Little Lilliwaup
Sund
Miller
Clark
Finch
Hill
No Name
Minerva
Potlatch
Enatai
Big Bend
Browns
Rendsland
Shoofly
Twanoh
Twanoh Falls
Mulberg
Holyoke
Trails End
Devereaux
Stimson
Little Mission
Mission
Bear
Hazel
Union
Boyce
Seabeck
Stavis
Tin Mine
Gold
Little Beef
Little Anderson
Shine
Bones
Jukes
Middle
Nordstrom
Cougar
Kinman
Jump Off Joe
Gamble
Cattail
Devils Hole
Water Quality Monitoring Stations:
Analysis Type
Complete Water Quality Analysis
Fecal Coliform Only
Few or Single Parameter
Monitoring Agency
BPWU
Ecology
JCCD
KCHD
PTPW
Skokomish
WDFW
WRIA Boundary
Study Area
0
12,500
25,000
50,000
Feet
HERRERA ENVIRONMENTAL CONSULTANTS
Aspect CONSULTING
Existing Long-term Water Quality Monitoring Stations
DATE: June 2010
PROJECT #: 090147
DRAWN BY: PPW
REVISED BY: PPW
FIGURE # 2
T:\projects_8\WRIA16\HoodCanal_SW_Mon_Plan\Delivered\Inventory Memo\WQ_Stations_ALL.mxd


WRIA 6
WRIA 17
WRIA 18
WRIA 21
WRIA 16
WRIA 15
WRIA 22
WRIA 14
WRIA 13
WRIA 12
HOOD CANAL
DABOB BAY
QUILCENE BAY
LYNCH COVE
Cedar
Little Quilcene
Ripley
Howe
Leland
Tarboo
Thorndyke
Shine
Bones
Jukes
Middle
Penny
Donovan
Camp Discovery
Nordstrom
Jolley
Townsend
Big Quilcene
Tunnel
Indian George
Elba
Marple
Spencer
Rocky Brook
Turner
Dosewallips
Duckabush
Cliff
Walkers
Crazy
Boulder
Maple
Delta
Lena
Cabin
Watson
Wakefield
Schaerer
Fulton
SF Fulton
Little Beef
Little Anderson
Big Beef
Seabeck
Boyce
Anderson
Stavis
Tin Mine
Gold
Hazel
Bear
Union
Mission
Dewatto
Tahuya
Stimson
Little Mission
Devereaux
Trails End
Holyoke
Mulberg
Twanoh
Twanoh Falls
Shoofly
Browns
Rendsland
Big Bend
Hammer
Seven
Donahue
Six
NF Skokomish
Slate
Five
Four
Elk
Rule
Steel
Dry
Church
Le Bar
Pine
Cedar
SF Skokomish
Brown
Harp
Gibbons
McTaggert
Rock
Dalby
Frigid
Vincent
Fir
Aristine
Vance
Skokomish
Hunter
Weaver
Purdy
Hamma Hamma
Jefferson
Washington
NF John
Jorsted
EF Lilliwaup
Eagle
Lilliwaup
Little Lilliwaup
Sund
Miller
Clark
Finch
Hill
No Name
Minerva
Potlatch
Enati
Dow
Big
Lake Cushman
Kneff
Burdick
Silt
Hidden
Pass
Station
Muscott
Hungry
Elk Lick
Cougar
Kinman
Jump Off Joe
Gamble
Cattail
Devils Hole
Flow Monitoring Stations
Monitoring/Reporting Agency
B BPWU
E Ecology
F FWS/USGS
K KPUD
P PTPW/USGS
U USGS
U USGS/PTPW
WRIA Boundary
Study Area
0 12,500 25,000 50,000
Feet
HERRERA ENVIRONMENTAL CONSULTANTS
Aspect CONSULTING
Existing Permanent Flow Gauging Stations
DATE: June 2010
PROJECT #: 090147
DRAWN BY: PPW
REVISED BY: PPW
FIGURE # 3
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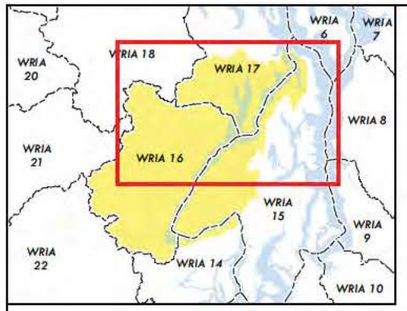

LELAND LAKE
Total Phosphorus

TARBOO CREEK
Temperature

HOWE CREEK
Temperature

RIPLEY CREEK
Temperature

LELAND CREEK
pH, Temp, and DO

TARBOO CREEK, E.F.
Temperature

DONOVAN CREEK
Temperature

LITTLE QUILCENE RIVER
Temperature

BIG QUILCENE RIVER
Temperature

KINMAN CREEK
Dissolved Oxygen

MARTHA-JOHN CREEK
Dissolved Oxygen

GAMBLE CREEK
Dissolved Oxygen

JUMPOFF JOE CREEK
Dissolved Oxygen

GAMBLE CREEK
Temperature

MARPLE CREEK
Temperature

DUCKABUSH RIVER
Temperature

DOSEWALLIPS RIVER
Temperature

SEABECK CREEK
Dissolved Oxygen

BIG BEEF CREEK
Dissolved Oxygen

STAVIS CREEK
Fecal Coliform &
Dissolved Oxygen

BIG BEEF CREEK
Temperature

FULTON CREEK
Temperature

BOYCE CREEK
Fecal Coliform &
Dissolved Oxygen

BIG BEEF CREEK
Temperature

BIG ANDERSON CREEK
Fecal Coliform & pH

Dabob Bay

Hood Canal

Hood Canal

Hood Canal

Water Quality Monitoring Stations:

Monitoring Agency:

- (B) BPWU
- (E) Ecology
- (J) JCCD
- (K) KCHD
- (P) PTPW
- (S) Skokomish
- (W) WDFW

Analysis Type:

- (X) Complete WQ Analysis
- (X) Fecal Coliform Only
- [X] Few/Single Parameter

WATER COUSE/BODY NAME
Listed Parameter(s)

Category 5 Listed Waters

PNW Hydro Framework 12th-level Hydrologic Unit Boundaries

Relative Rating of Potential Impact for Consumptive Water Use and Habitat Condition

- not rated/no data
- low potential
- moderate potential
- high potential

Salmonid/Bull Trout Distribution (WDFW SaSI)

SPECIES:

- Bull Trout
- Other Salmonids

Habitat Condition Rating (WSCC Salmonid Limiting Factors, modified)

- Good
- Fair
- Poor

N W E S

0 7,500 15,000 30,000 Feet

1:180,000

HERRERA ENVIRONMENTAL CONSULTANTS

Aspect CONSULTING

Existing Long-term Water Quality Stations and Environmental Attributes Northern Hood Canal Watershed

DATE: June 2010
PROJECT #: 090147
DRAWN BY: PPW
REVISED BY: PPW

FIGURE # 4

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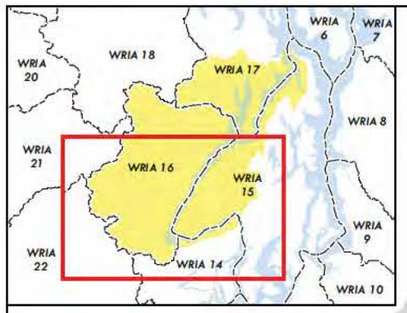

Existing Long-term Water Quality Stations and Environmental Attributes Southern Hood Canal Watershed

Water Quality Monitoring Stations:

Monitoring Agency: (B) BPWU; (E) Ecology; (J) JCCD; (K) KCHD; (P) PTPW; (S) Skokomish; (W) WDFW

Analysis Type: (X) Complete WQ Analysis; (X) Fecal Coliform Only; [X] Few/Single Parameter

WATER COUSE/BODY NAME
Listed Parameter(s)

Category 5 Listed Waters

PNW Hydro Framework 12th-level Hydrologic Unit Boundaries

Salmonid/Bull Trout Distribution (WDFW SaSI)
SPECIES:
Bull Trout
Other Salmonids

Habitat Condition Rating (WSCC Salmonid Limiting Factors, modified)
Good
Fair
Poor

Relative Rating of Potential Impact for Consumptive Water Use and Habitat Condition
not rated/no data
low potential
moderate potential
high potential

0 7,500 15,000 30,000 Feet
1:180,000

HERRERA ENVIRONMENTAL CONSULTANTS
Aspect CONSULTING

DATE: June 2010
PROJECT #: 090147
DRAWN BY: PPW
REVISED BY: PPW

FIGURE # 5

T:\projects_8\WRIA18\HoodCanal_SW_Mon_Plan\Delivered\Inventory Memo\WQ_Bio_South.mxd