

Quality Assurance Project Plan

**Sequim-Dungeness Clean Water District (CWD)
Pollution Identification & Correction (PIC),
Trends and Project Monitoring
(Section 319 Match)**

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This QAPP is available on Clallam Conservation District's website at www.clallamcd.org. Pollution Identification and Correction (PIC) and other water quality monitoring data from this project will be available from Clallam County Health and Human Services, Environmental Health Section (CCEH). Appropriate data will also be uploaded to the Washington State Department of Ecology (Ecology) Environmental Information Management database: www.Ecology.wa.gov/eim/index.htm

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November 2019

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2.0 Abstract

The overall area of focus comprises the boundaries of the Sequim Bay-Dungeness Watershed Clean Water District, a shellfish protection district created by Clallam County in 2001. Work under the Washington State Department of Ecology WQC2020C1CHHS00011 grant will focus investigative work specifically on the upper Matriotti watershed and lower Bell Creek, while pollution correction will continue in the lower Matriotti watershed, Meadowbrook Creek, Meadowbrook Slough, Golden Sands Slough, and Three Crabs Rd. Trends monitoring will continue at existing sites carried over from previous Pollution Identification and Correction Projects Clallam County Environmental Health will be the lead agency, to be assisted by staff and volunteers from Streamkeepers of Clallam County and the Jamestown S'Klallam Tribe.

3.0 Background

This section was adapted from the *Quality Assurance Project Plan for the Clallam Marine Recovery Area (MRA) Septic Solutions Project* (Soule, 2013), and also from *Quality Assurance Project Plan (QAPP) Sequim-Dungeness Clean Water District Pollution Identification & Correction, Trends, and Project Monitoring(PIC)* (Chadd and Bond, 2015).

3.1 Introduction and problem statement

The Clean Water District (CWD) is located in the eastern portion of Clallam County, Washington, on the northeast coast of the Olympic Peninsula, including the City of Sequim (Figure 1). The western edge of the CWD is defined by land draining to Bagley Creek and the eastern edge extends to the area draining to Sequim Bay on the Miller Peninsula. The CWD drains into the marine waters of the Strait of Juan de Fuca, including Dungeness and Sequim bays.

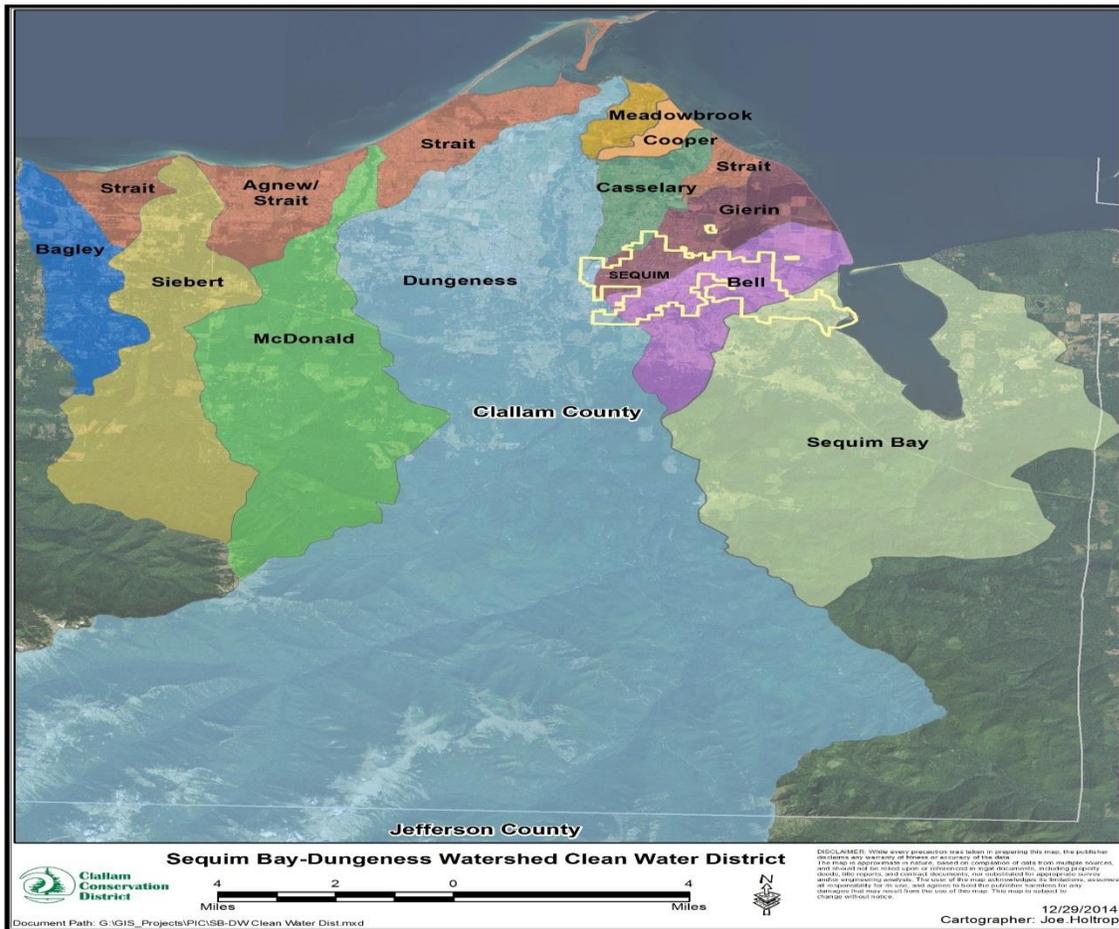


Figure 1: Sequim-Dungeness Clean Water District
Colors denote sub-watersheds within the greater district.

Major Streams within the Clean Water District

Much of the following information was taken from the Elwha-Dungeness Watershed Plan (Elwha-Dungeness Planning Unit 2005).

Tributaries to Sequim Bay:

- Chicken Coop Creek enters the southeast corner of Sequim Bay to the northeast of Jimmycomelately Creek. The mainstem is 3.1 miles in length with an additional 3.1 miles in tributaries.
- No Name Creek, draining to Sequim Bay just south of Chicken Coop Creek, is a generally forested, short, steep creek, relatively undeveloped and minimally impacted by nonpoint sources of pollution.
- Dean Creek is an intermittent stream draining ~3 square miles, flowing ~4 miles from headwaters at an elevation of ~1900' into the southwest corner of Sequim Bay.
- State Park Creek is the largest of several small drainages emptying into the western side of Sequim Bay north of Dean Creek, comprising mixed land uses, including forestry, small farms, and residences.
- Jimmycomelately Creek is the largest stream in the Sequim Bay watershed, draining an extended interior foothill watershed of ~16 square miles, with a vertical drop of 2500' in less than 9 miles, emptying at the south end of Sequim Bay.
- Johnson Creek is the third largest stream within the Sequim Bay watershed (~6.2 square miles), flowing northeast from the foothills of the Olympic Mountains into the west side of Sequim Bay at Pitship Point (near the John Wayne Marina). The total length of Johnson Creek is ~7.4 miles. Five river miles (RM) are attributed to the mainstem, while two miles consist of tributaries. The upper creek flows through a substantial ravine, while the lower two miles are low gradient.
- Bell Creek is a relatively small drainage entering Washington Harbor on the marine shoreline just north of the mouth of Sequim Bay. It is 3.8 miles long and drains a watershed of over 8.9 square miles. Bell Creek has served historically as a conveyance for irrigation water, and much of the creek has been heavily altered by rural and urban development.

Tributaries to Dungeness Bay:

- The Dungeness River flows north into the outer Dungeness Bay just east of the opening between Graveyard and Cline Spits. The river is 32 miles long and drains 172,517 acres. The upper two-thirds of the watershed are within national forest and national park areas. The river contributes the vast majority of freshwater to the Bay (Soule 2013).
- Matriotti Creek is 9.3 miles long and is the largest low-elevation tributary to the Dungeness River, flowing into it on the left bank at RM 1.9.
- Lotzgesell Creek is a tributary to Matriotti Creek that encompasses similar land uses.
- Hurd Creek is a small, low-elevation tributary approximately one mile long that flows into the Dungeness River on the right bank at RM 2.7.
- Meadowbrook Creek flows north toward Dungeness Bay approximately 0.4 miles east of the Dungeness River mouth. Meadowbrook Slough (also referred to as Dungeness Slough,

by neighbors) is approximately 0.5 miles long and parallels a dike along the lower reaches of the Dungeness River. The points of discharge of the Dungeness River, Meadowbrook Slough, and Meadowbrook Creek are dynamic—occasionally the lesser waterways discharge directly into the bay, while other times they first join the Dungeness River which in turn discharges into the bay.

- Golden Sands Slough discharges into outer Dungeness Bay southeast of Meadowbrook Creek. The slough is a series of constructed channels in an estuarine wetland area. Water in the slough tends to be saline and stagnate (Sargeant 2002).
- Cooper Creek discharges into Dungeness Bay just southeast of Golden Sands Slough. The creek is fed by wetlands, and the upland area is undeveloped. The lower portion of the stream channel has been straightened, and the mouth is controlled by a tide gate.
- Cassalery Creek is approximately 4.2 miles long and discharges to Dungeness Bay just southeast of Cooper Creek.
- Gierin Creek discharges into Dungeness Bay just southeast of Cassalery Creek. It is fed by steep-gradient groundwater discharge from the north slopes of the Olympic Mountains. There are 8.3 miles of streams and tributaries in the 3.1 square-mile watershed.
- An un-named intermittent stream periodically discharges to inner Dungeness Bay at the base of Dungeness Spit. Roadside ditches act as stormwater conveyance and may also be used for occasional flushing of irrigation pipelines under the control of the Cline Irrigation District.

Tributaries to the Strait of Juan de Fuca west of Dungeness Bay:

- McDonald Creek is a significant independent drainage, entering the Strait of Juan de Fuca between the western end of Dungeness Spit and Green Point. Its 13.6 miles drain ~23.0 square miles of the northeast flank of Blue Mountain, with headwaters originating at ~4,700'. The creek flows through a deeply incised coastal upland and marine bluff.
- Agnew Ditch is part of Sequim's irrigation ditch system, originating from the Dungeness River. It is conveyed for several miles via McDonald Creek before irrigating the Agnew area—where it is sometimes known as Agnew Creek—and emptying to the Strait.
- Siebert Creek, 12.4 miles long, drains 19.5 square miles of the northwest flank of Blue Mountain and is a significant independent drainage, entering the Strait at Green Point. The watershed includes 31.2 miles of mainstem stream and tributaries, much of which is well incised, with its upper watershed reaching an elevation of 3,800'. It is the westernmost stream influenced directly by Dungeness area irrigation flows.
- Bagley Creek is a medium-sized independent drainage, entering the Strait ~2 miles west of Green Point. It is the westernmost watershed of the CWD. The drainage has approximately 9.5 miles of streams and tributaries.

In 1997, the Washington State Department of Health (WDOH) reported increasing levels of fecal coliform (FC) bacteria in Dungeness Bay near the mouth of the Dungeness River. Bacteria levels continued to increase in later monitoring activities, with higher levels of bacteria occurring in inner Dungeness Bay. As a result, in 2000 WDOH closed 300 acres near the mouth of the Dungeness River to shellfish harvest. In 2001, 100 more acres were added to the closure area.

Then, in 2003, based on a continuing decline in water quality, 1150 acres from the inner portion of Dungeness Bay were reclassified from Approved to Conditionally Approved and an additional 250 acres from the outer bay were reclassified from Approved to Prohibited. Shellfish harvest is allowed in the Conditionally Approved area from February to October.

Since 2003, WDOH has gradually upgraded the classification of several stations in Dungeness Bay from “Prohibited” to “Conditionally Approved”, meaning that shellfish harvest is open from February through October but closed in the rainy season—from November through January. In 2011, 500 acres in the bay were upgraded from “Prohibited” to “Conditionally Approved.” Four sites that are near or relatively close to the mouth of the River remain closed year round (WDOH 2012). In 2015, 688 acres in the bay were upgraded from “Conditionally Approved” to “Approved”, and 40 acres were upgraded from “Prohibited” to “Conditionally Approved.” Please refer to Figure 2 for a map of WDOH sampling locations and classifications

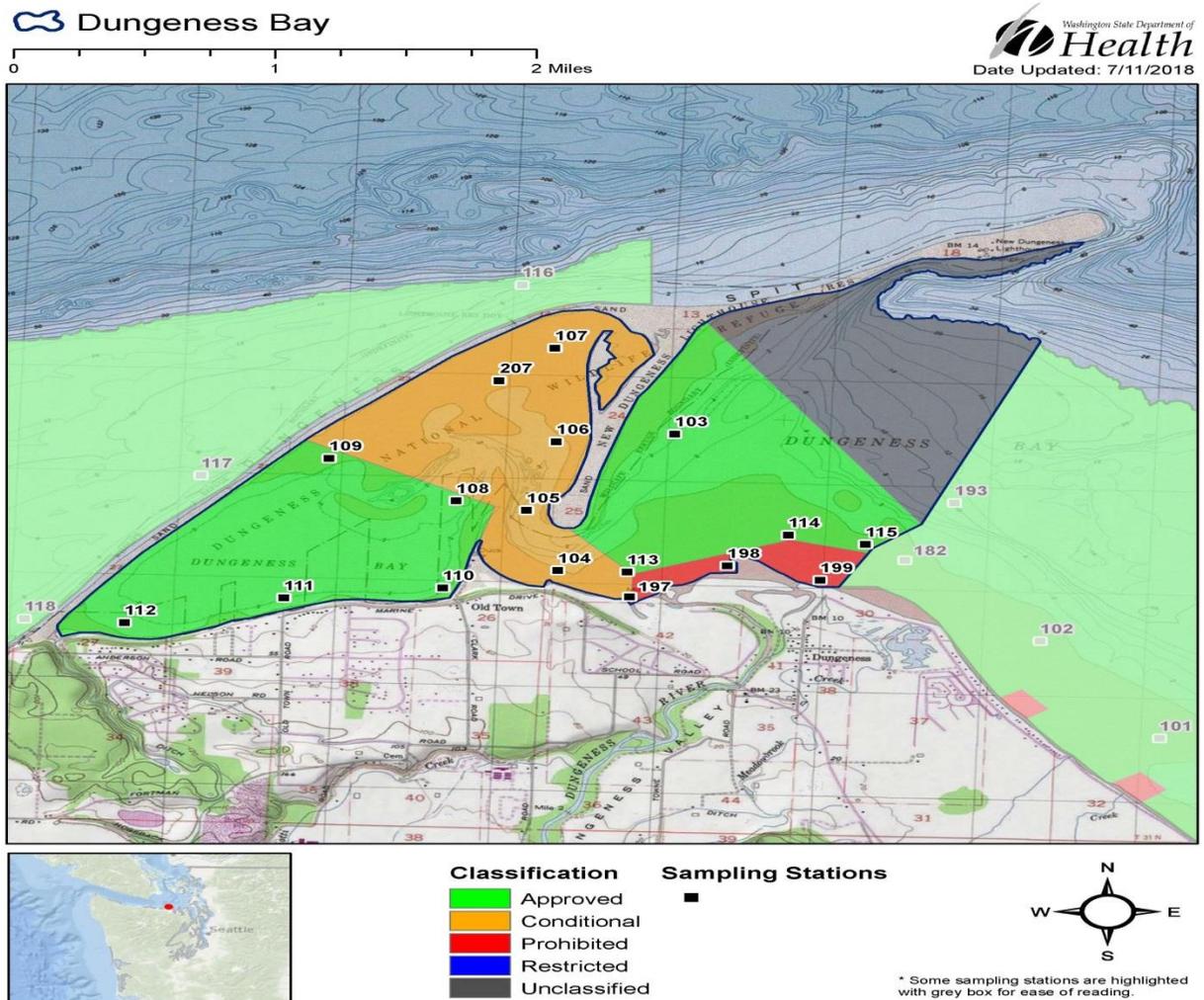


Figure 2: Marine monitoring stations in and around Dungeness Bay with shellfish growing area classification: (Washington State Department of Health, July 11, 2018).

While water quality improvements have been made within the CWD, areas of Dungeness Bay remain closed to shellfish harvesting because of high fecal coliform bacteria levels. The majority

of water quality monitoring that has occurred to date has been project specific and grant funded. This has made the collection and analysis of long-term water quality data extremely difficult.

This PIC project (Ecology grant WQC2020CICHHS00011) will continue the Trends Monitoring Program (Figure 3) on approximately 18 CWD streams to collect data on nutrients, fecal indicator bacteria, and other standard physical and chemical parameters at locations just upstream from marine waters. This data helps guide selection of prioritized waterways for targeted/segmented water quality improvement projects, such as this PIC project.

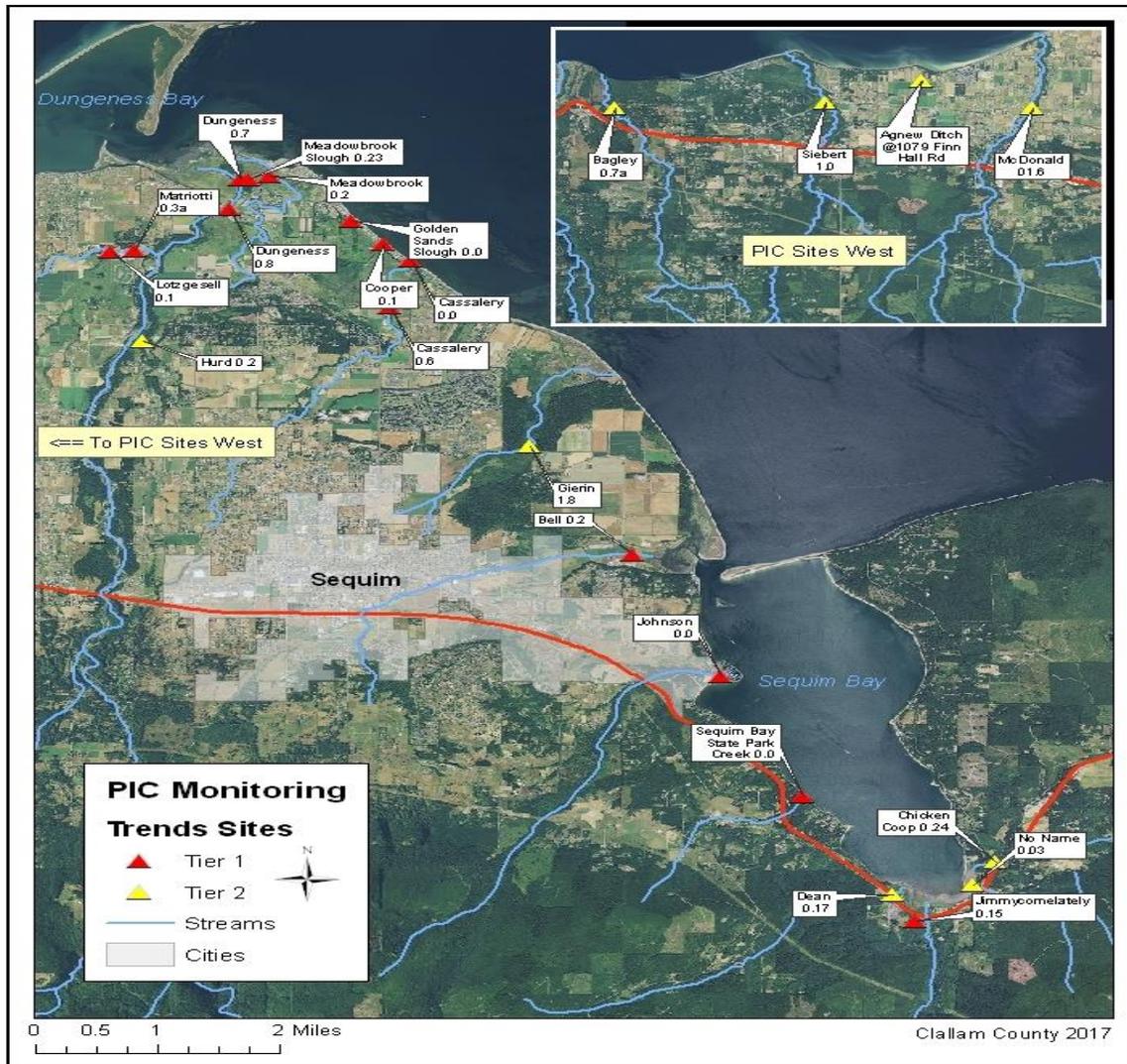


Figure 3: Trends Monitoring Program Sites

Through the planned PIC Project Monitoring Program, segmented sampling will be conducted at 15 sites to identify pollution “hot spots” and sources that can be corrected. Segmented sampling will mainly be conducted in the expanded PIC Project area (upper Matriotti watershed and lower Bell Creek), followed up with correction actions if/when pollution sources are identified. Pollution correction will continue in portions of the Project Area where segmented sampling has generally concluded (Lower Matriotti, Meadowbrook Creek, Meadowbrook Slough, Golden

Sands Slough, and Three Crabs Road). Corrective actions to follow if/when pollution sources are identified.

The goal of these combined tasks is to empower those living within the PIC focus area to make decisions that protect water quality and correct potential pollution sources that increase the quality of the surface water flowing into the bays and ultimately lead to the upgrade of shellfish growing areas.

3.2 Study area and surroundings

3.2.1 History of study area

The study area is the Sequim Bay-Dungeness Watershed CWD, which is bounded on the west by the Bagley Creek drainage area and on the east by the Sequim Bay drainage.

Dungeness Bay and Sequim Bay have traditionally been rich in littleneck clams. Native people have harvested shellfish here throughout tribal memory. In the 1900s, commercially farmed oysters provided local jobs. Recreational harvest has been popular with residents and tourists, and contributes to the image of Sequim as a beautiful and pristine area (Streeter and Hempleman 2004).

The climate in this region of the Olympic Peninsula is considerably drier than elsewhere in western Washington because it lies in the rain shadow of the Olympic Mountains. Precipitation varies from 15 inches near Sequim to 80 inches in the headwaters of the Dungeness River. Due to the low rainfall, the lower Dungeness valley contains about 170 miles of irrigation water conveyance to support approximately 6,000 acres in agricultural production.

Land use within the study area is mostly rural residential and agricultural. Historically, most of the study area outside of the city of Sequim was farmland. A population increase during the past 20 years has resulted in a significant amount of farmland being converted to residential use. Commercial uses are mostly located within the city of Sequim and the Carlsborg urban growth area (UGA). The city of Sequim and the Carlsborg UGA are both served by sewer systems, while residential and commercial businesses in the rural areas use on-site septic systems (OSS).

Existing data are fairly recent and plentiful for core study sites as well as optional sites. This is thanks to the Washington State Department of Ecology (Ecology) Total Maximum Daily Load (TMDL) studies and efforts of CWD members, especially the Jamestown S'Klallam Tribe (JS'KT), Streamkeepers of Clallam County (SK), and Clallam County Environmental Health (CCEH). This project addresses a need to update water quality conditions in the lower Dungeness.

3.2.2 Summary of previous studies and existing data

Numerous studies on surface and ground water quality have been conducted over the past several decades within the Sequim Bay-Dungeness Watershed CWD, particularly the Dungeness Bay drainage. Background information presented in this QAPP is based on the following documents:

1. Dungeness River and Matriotti Creek fecal coliform TMDL (Sargeant 2002) and post-TMDL data review (Sargeant 2004b).
2. Dungeness Bay fecal coliform TMDL (Sargeant 2004a).
3. An initial shellfish closure response plan, a.k.a, Detailed Implementation Plan, was integrated with Water Cleanup Plans associated with both TMDLs into a “Clean Water Strategy” (Streeter and Hempleman 2004). This Strategy has guided the activities of the Dungeness Clean Water Work Group (CWWG) since it was prepared. Status reports on its implementation are submitted annually by Clallam County to the WDOH.
4. Microbial source tracking (MST) found evidence that many animal groups, including humans, contribute to bacterial contamination in Dungeness watershed and Bay (Woodruff et al. 2009a).
5. Effectiveness monitoring, including monthly sampling at dozens of sites over a two-year period for both FC and nutrients (Woodruff et al. 2009b).
6. Ecology conducted a FC TMDL effectiveness monitoring project (Brown 2009, Cadmus Group 2010).

TMDL studies were conducted for both the lower Dungeness River watershed (Sargeant 2002) and Dungeness Bay (Sargeant 2004a). The main objective for both studies was to determine load reductions for FC bacteria. This was done by estimating pollutant loads and concentrations for tributaries to the bay, modeling an acceptable loading capacity, and recommending load allocations.

The *Dungeness River and Matriotti Creek Fecal Coliform Bacteria Total Maximum Daily Load Study* (Sargeant 2002) measured FC concentrations in several freshwater tributaries to Dungeness Bay in 1999 and 2000. The purpose of the study was to determine the freshwater sources of FC that discharge into the bay. The study area included the lower Dungeness River, Hurd Creek, Matriotti Creek, Meadowbrook Creek, and Meadowbrook Slough. The results of the study set target reductions for FC concentrations in these and other tributaries to the Bay.

Rensel Associates conducted bacteria sampling in Dungeness Bay and ditches discharging into the Bay from October 2001 to 2002. A circulation and bathymetry study was also conducted and documented in an April 2003 final technical report (Rensel 2003). The Rensel study was summarized and used as the basis for the *Dungeness Bay Fecal Coliform Bacteria Total Maximum Daily Load Study* (Sargeant 2004a). The TMDL addressed FC bacteria in inner and outer Dungeness Bay, irrigation ditches to the inner Dungeness Bay, and the Dungeness River. Target reductions for FC concentrations were set for the Dungeness River and irrigation ditches discharging to inner Dungeness Bay.

TMDL study findings included:

- *Elevated FC levels are found in several freshwater tributaries flowing into the bay. More stringent load reductions are needed in several upstream tributaries to meet the marine FC criterion in Dungeness Bay, including the Dungeness River (mouth to RM 0.3), Matriotti Creek, Hurd Creek, Meadowbrook Creek, Meadowbrook Slough, Golden Sands Slough, and Cooper Creek.*

- *There are no permitted point source discharges in the study area.*
- *FC pollution is attributed to nonpoint sources, including on-site septic systems, pet and livestock waste, stormwater runoff, and wildlife.*

The critical period for inner Dungeness Bay is November through February, and the critical period for the outer Dungeness Bay near the mouth of the Dungeness River is March through July.

3.2.3 Parameters of interest and potential sources

The parameters of interest for this project are nutrients, bacteria, temperature, pH, salinity, dissolved oxygen, and conductivity.

OSS failures can contribute to elevated FC levels in freshwater tributaries to the bays. Citizen education about proper OSS operation and maintenance, regular OSS inspections, and system repairs continue to reduce OSS sources of pollution. Within the past decade, the Clallam County Department of Community Development (DCD), CCEH and JSKT decommissioned eight on-site systems from the mouth to RM 1.0 for river restoration purposes. Clallam Conservation District (CCD) offers a cost-sharing program to assist with the repair of failing OSSs that are suspected of impacting water quality.

Other potential sources of FC include livestock, pets, and wildlife.

Projects conducted by the CCD and the Sequim-Dungeness Water Users Association have resulted in the piping of many miles of open irrigation ditches. These projects reduce the amount of water diverted from the Dungeness River, help prevent pollutants from entering the irrigation system, and when totally enclosed, eliminate tail-water discharges to marine and fresh waters.

3.2.4 Regulatory criteria or standards

Chapter 173-201A of the Washington Administrative Code (WAC) establishes water quality standards for surface waters of the state “consistent with public health and public enjoyment of the waters and the propagation and protection of fish, shellfish, and wildlife.” These waters are “protected by numeric and narrative criteria, designated uses, and an antidegradation policy.”

All tributaries in the project area are identified in Table 602 of this WAC with the varying criterion for the project’s parameters of interest.

3.3 Water quality impairment studies

FC concentrations in Matriotti Creek were found to exceed water quality standards in 1991. Matriotti Creek was placed on Washington’s 303(d) list of impaired waters in 1996. Dungeness Bay continued to meet water quality standards through 1996.

Like small streams, the network of irrigation ditches was found to be an additional conduit for fecal coliform to enter Dungeness Bay and its tributaries. Agricultural best management practice implementation and the piping of open ditches have reduced FC inputs to the irrigation system.

Please refer to section 3.2 for historical information regarding changes to shellfish bed growing classifications to Dungeness and Sequim Bays.

3.4 Effectiveness monitoring studies

Fecal coliform data collection and analysis

Clallam County and JS'KT conducted FC sampling at many of the freshwater TMDL sites from 2001 to 2004. These data, and data collected by Ecology's ambient monitoring program, were compared to the initial TMDL FC data collected in 1999 and 2000. The results of this analysis were presented in the *Dungeness River and Matriotti Creek Post-Total Maximum Daily Load Data Review* (Sargeant 2004b).

The purpose of the 2004 post-TMDL analysis was to determine whether FC bacteria levels were improving in the tributaries to the bay and if the cleanup actions implemented had been effective. The analysis found significant improvement in some areas and seasons. The 2001-2004 data showed that further reductions are necessary even though the trend during certain critical seasons was showing a decrease in FC concentrations. The Matriotti Creek sites showed the greatest decline and may have contributed to a slight decline in FC concentrations in the Dungeness River. Meadowbrook Creek showed a slight increase in FC concentrations (Sargeant 2004a).

In 2005, Clallam County received a Centennial Clean Water Fund grant from Ecology and JS'KT received an Environmental Protection Agency (EPA) Targeted Watershed Grant. Portions of both grant funds were for FC monitoring in the Dungeness watershed (Streeter 2005). The County and Tribe combined efforts to monitor 58 sites monthly in the Dungeness watershed for FC from September 2005 to August 2008. Some of these sites were selected to fill gaps in ambient water quality information. Twenty-two of the TMDL study sites were included to continue evaluating the effectiveness of TMDL implementation. Irrigation ditches included in the *Dungeness Bay TMDL* study were also sampled when water was flowing at those sites. Seven of the 12 TMDL sites targeted for remediation of FC counts were monitored consistently between 1999 and 2009.

Extensive FC data sets resulting from this monitoring have been analyzed and reported in publications by Battelle (Woodruff et al. 2009b) and Cadmus Group (2010). Both reports present multiple diagrams and illustrations of trends by parameter and sub-area; the reader is referred to the online reports to view specific figures of interest:

- Battelle: "Effectiveness Monitoring of Fecal Coliform Bacteria and Nutrients in the Dungeness Watershed, Washington"
- Ecology: "Dungeness Bay and Dungeness River Watershed Fecal Coliform Bacteria Total Maximum Daily Load Water Quality Effectiveness Monitoring Report"
<http://www.Ecology.wa.gov/pubs/1003032.pdf>

The WDOH continues to conduct monthly sampling in Dungeness Bay to monitor FC pollution in shellfish growing areas as part of the National Shellfish Sanitation Program (WDOH 2009). Analyses of WDOH data found evidence of a reduction in FC pollution from 2003-2011 (DOH 2012). Some areas are "Conditionally Approved" (closed Nov-Jan) rather than "Approved"

because water quality in general is consistently poor in winter months. WDOH shoreline surveys conducted in 2007 and 2008 traced elevated FC levels to both Golden Sands Slough and Cassalery Creek. Further evaluation in Golden Sands Slough found problems with OSS systems and direct sewage discharge to the slough. As a result, WDOH prohibited commercial shellfish harvest within 140-meter and 121-meter radii around the mouths of Golden Sands Slough and Cassalery Creek.

From April 2013 to March 2014, CCEH, in partnership with SK and the JS'KT, conducted a water quality monitoring project under an Ecology grant. This project had two objectives (Soule 2013):

1. Assess the current status of FC bacteria and nutrient concentration in the lower Dungeness River and several area streams through ambient monitoring. Fourteen stations were monitored for the ambient study.
2. Study the potential effectiveness of OSS repair in improving surface water quality in adjacent waterways. Unfortunately, no opportunities for septic system repair occurred during the project period, thus system repair effectiveness could not be evaluated.

Data from this project has been recently analyzed and is expected to help with initial prioritization for targeted PIC monitoring (Clallam County, 2014). From January 2015 to present, CCEH, in partnership with SK and the JS'KT have been conducting a PIC Pilot Project under an EPA National Estuary Project (NEP) grant. This project had multiple objectives (Chadd and Bond, 2015):

1. To conduct monthly trends monitoring at 12 sites within the overall project area (MRA), and quarterly trends monitoring at 9 sites. Results showed a continuation of elevated FC at several sample sites, which guided the current project partners to select the focus areas for the 2017-2019 "Phase 2" project area and the proposed 2019-2022 "Phase 3" project areas for the upcoming Ecology grant.
2. To conduct segmented FC sampling within the selected project area (Meadowbrook Slough and Creek, Golden Sands Slough, Cooper Creek). Meadowbrook Slough and Golden Sands slough were (and still are) the focus of this project due to high targeted sampling results. Meadowbrook Creek and Cooper Creek did not show similar high FC results and were monitored through trends sampling, with the occasional targeted sampling on Meadowbrook Creek.
3. To conduct investigative work within specific Meadowbrook Slough and Golden Sands Slough neighborhoods to identify possible pollution sources, mainly in the form of failing OSS systems. Investigation practices included OSS research for each parcel, on-site inspection of operational OSS, and dye testing of certain OSS located directly adjacent to confirmed "hot spots".
4. To perform corrective actions once potential pollution sources are identified, e.g. requiring OSS repair(s), assist agricultural owners with best management practices (BMP), etc. Neither Meadowbrook Slough nor Golden Sands Slough produced a "smoking gun" regarding a direct pollution source. CCEH required all operating OSS to have systems inspected, and all non-conforming waste disposal methods come into

compliance with WACs and Clallam County Codes (CCC). OSS inspection compliance was largely met, and waste disposal compliance is still ongoing, with two conforming systems in the ground in Golden Sands, and several pending.

Nutrient data collection and analysis

There are no water quality criteria for nutrients in streams; however, when nutrients are found at high levels, they can have a negative impact on aquatic systems. Anthropogenic alterations within a watershed generally lead to higher nutrient concentrations.

The chemical speciation of nutrients becomes an important factor both for evaluation of ecological impacts and as a tracer of source contaminants. For example, ammonium (NH₄) is generally found in areas with low oxygen availability (i.e. groundwater) and is rapidly oxidized to nitrate (NO₃) in contact with surface waters. Its presence in surface waters, even at low levels, could indicate close proximity to potential sources such as septic systems or agricultural runoff.

Targeted Watershed Initiative funding from EPA obtained by the JS'KT for 2005-08 sampling included collection of nutrient (nitrogen and phosphorus) data from all sites. These data (over 830 nutrient observations), Battelle (Woodruff et al. 2009b) provide a characterization of nutrients in the watershed, including descriptive statistics and general trends.

For a general reference, nutrient data were compared to historic data (nitrate and phosphate [PO₄]) collected at another location in the upper Dungeness River between 1959 and 1970.

Study findings include:

- For the most part, recent nutrient levels in the lower Dungeness watershed were not very different than historic values, although a direct site comparison could not be made. There were, however, several trends in the data that warrant further investigation.
- NH₄ concentrations were slightly higher in all Dungeness River tributaries and Bell Creek compared to those detected in the River or Johnson Creek.
 - In addition, ammonium levels were an order of magnitude higher at Golden Sands Slough, another freshwater station close to the Bay.
 - There were minimal seasonal changes noted in NH₄ concentrations, another possible indication of septic system influence since septic system input generally varies less by season than other anthropogenic nutrient sources that get incorporated into seasonal runoff.
- Total inorganic nitrogen (TIN) was higher in Matriotti Creek, Bell Creek, Golden Sands Slough, and the irrigation ditches compared to other water bodies and stations.
 - TIN is an indicator of a number of possible anthropogenic inputs.
 - Overall, the TIN values were higher during the wet season compared to the dry season.
- PO₄ and total phosphorus (TP) concentrations showed a similar trend of elevated concentrations in Bell Creek, Golden Sands Slough and the irrigation ditches, with higher concentrations during the wet seasons compared to the dry season.
- There was no significant correlation between nutrients (those mentioned above, plus NO₃ and nitrite [NO₂]), freshwater FC concentrations, and daily rainfall determined for the days of sample collection. The lack of a statistically significant correlation may be indicative of

varying sources of FC and nutrients; however, analysis of rainfall patterns over a longer duration might demonstrate a correlation.

4.0 Project Description

4.1 Project goals

Three main tasks guide this PIC Project. Work will be focused in the PIC project area highlighted in Figure 4. They include public outreach and education; water quality monitoring and analysis; and technical assistance, correction, and compliance.

The ultimate goal of the project is the upgrade of shellfish growing beds in Dungeness and Sequim Bays. Water quality monitoring and analysis help evaluate this progress and a significant part of the project work is conducted through a three-pronged approach, each described below.

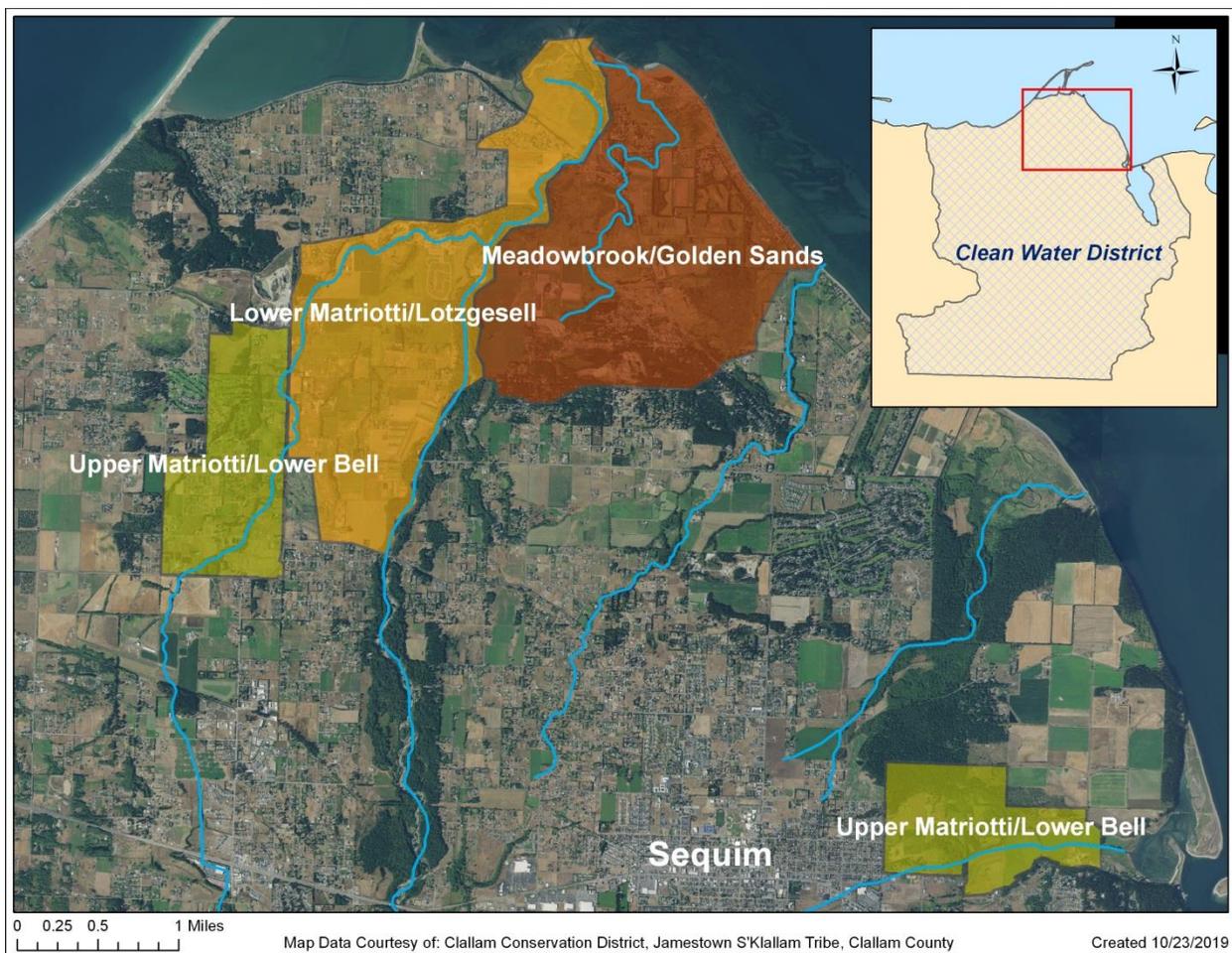


Figure 4: PIC Project Area 2015-2022

Brown: PIC Phase 1/Implementation; Orange: Phase 2; Green: Phase 3

4.2 Project Objectives

This monitoring project has three objectives:

Trends Monitoring Program

- A. Identify water quality trends for FC and nutrient pollution within the CWD.
- B. Identify waterways that are being impacted by FC and nutrient pollution.
- C. Prioritize waterways for PIC Project implementation.

PIC Targeted Monitoring Program

- A. Identify sources of bacterial pollution through segmented sampling.
- B. Implement correction efforts, e.g. septic system violation abatement, agriculture BMPs, etc.
- C. Evaluate effectiveness of pollution correction efforts with follow up water quality sampling.

PIC Project

- A. Apply the PIC plan in priority sub-watersheds within the CWD.
- B. Identify sources of bacterial pollution through segmented sampling in priority sub-watersheds within the CWD, including Matriotti Creek, Lotzgesell Creek, Meadowbrook Creek, Meadowbrook Slough, and Golden Sands Slough. Other investigative tools include property/OSS evaluation by CCEH field staff, creek “walks”, beach “walks”, and when practical, dye testing.
- C. Use available means to correct suspected sources of pollution within the project area. Examples include public education and outreach, enforcement of State and County Codes, CCEH technical assistance for OSS, and CCD technical assistance for poor agricultural practices.

4.3 Information needed and sources

In addition to the studies reviewed in prior sections, this monitoring plan depends on collaboration between the members of the Sequim Bay-Dungeness CWWG. A subcommittee of CWWG members (consisting of both the signatories and recipients of this plan) has consulted extensively in devising this plan.

4.4 Tasks Required

Trends Monitoring Program Tasks

- Tier 1 waterways (13) will be sampled monthly for FC and bimonthly for nutrients or as funding allows.
- Lower priority Tier 2 waterways (11) will be sampled quarterly for FC, as funding allows.
- Tiers and sampling parameters/periodicity may change in response to data (and available funding). For example, a Tier 1 waterway may drop to Tier 2 if State water quality standards are consistently met, and vice versa, per decision of the CWWG. Upon this occurring, which is not expected to occur during this grant period, reclassification would be reflected in the field logs, databases and an amended QAPP.
- Select polluted waterways for PIC implementation projects.
- Submit data to Ecology’s Environmental Information Management (EIM) database (and, in turn, to EPA’s STORage and RETrieval Database [WQX]).

PIC Targeted Monitoring Program Tasks

- Conduct segmented FC sampling on selected waterways to identify sources of bacterial pollution.
- Compile results, assess data, and involve CWWG in preliminary analysis.
- Identify “hot spots” based off of segmented sampling results.
- Implement additional investigative tools such as OSS inspections and dye testing if practical
- Conduct proper corrective actions based on surrounding anthropogenic activity (OSS vs. agriculture).
- Conduct post-remediation activity sampling to evaluate effectiveness.
- Submit all water quality data to Ecology’s EIM (and in turn to EPA’s WQX).

PIC Project Tasks

- Apply PIC Plan to selected project area.
- Compile results, assess data, and involve CWWG in preliminary analysis.
- Use sampling results to direct pollution correction actions within the project area.

4.5 Systematic planning process

The CWWG is tasked with ongoing water quality monitoring and clean-up activities. This group has been meeting regularly to develop the PIC plan, as described above. The PIC plan builds local capacity to adaptively and comprehensively manage pollution by better coordinating water quality monitoring, outreach and clean-up efforts. Figure 5 outlines the PIC Flow Chart.

APPENDIX B - PIC FLOW CHART

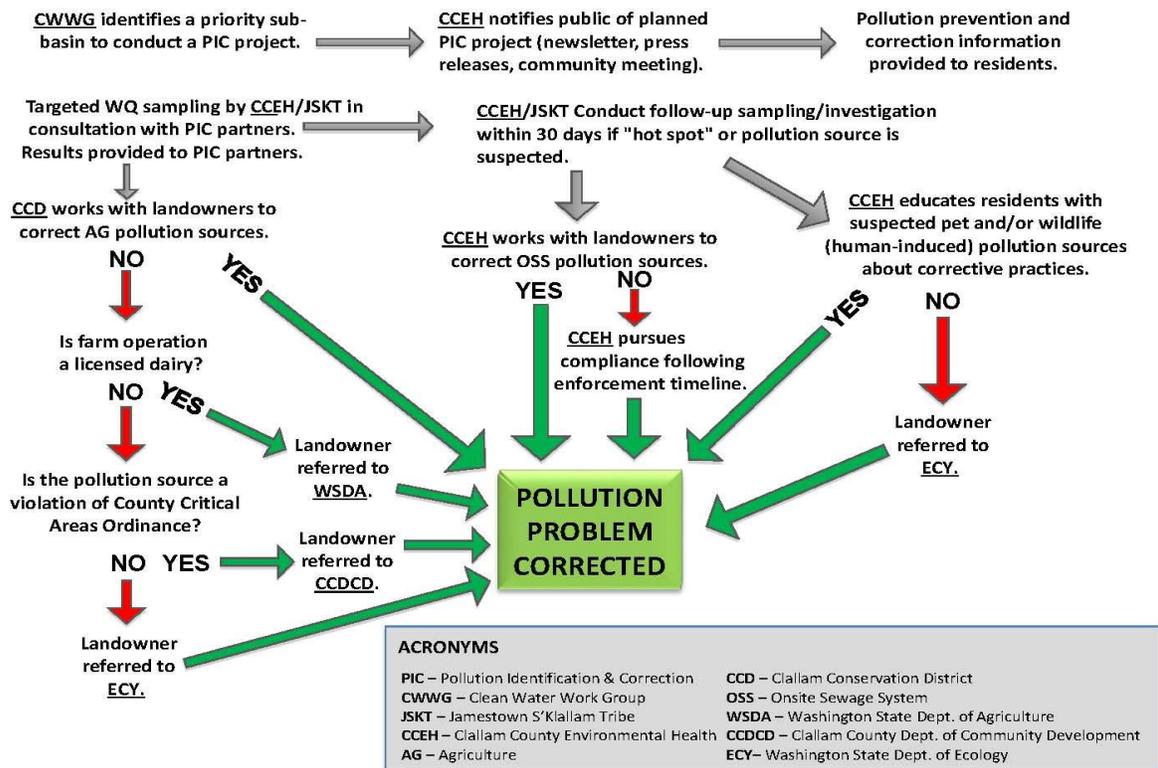


Figure 5: PIC Flow Chart

Trends Monitoring Program – The study design supports project objectives to identify trends for FC and nutrients in the CWD. This data helps project partners gain a broad understanding of the health of District streams and will help prioritize cleanup and protection efforts within the District.

PIC Project Monitoring Program – The selection of PIC Project sampling sites is based on Kitsap County’s PIC Manual (Kitsap County 2014). The primary objective of this monitoring program is to identify sources of pollution. This will occur by strategically selecting sampling stations that lead to pollution source identification. Follow-up sampling will sometimes be necessary to evaluate the effectiveness of corrective actions.

5.0 Organization and Schedule

5.1 Key individuals and their responsibilities

Streamkeepers of Clallam County (SK) is the lead agency responsible for QAPP preparation and supervision of all trends monitoring activities, including quality assurance/quality control (QA/QC) and submittal of trends monitoring FC and nutrient data to EIM. The SK program coordinator is the lead staff person for trends monitoring, assisted as needed by staff of CCEH, JS'KT, and CCD.

- Trends Monitoring: SK will lead, with the fieldwork to be performed primarily by SK volunteers. SK staff or volunteers will be responsible for shipment of nutrient samples to University of Washington (UW) Marine Lab and delivery of FC samples to the CCEH lab. SK staff and volunteers will report on trends monitoring data on a quarterly basis, and, in conjunction with CCEH, will compose an annual report analyzing the data.
- PIC Targeted Monitoring: JS'KT will lead sampling efforts and submit data from this sampling to EIM.
- PIC Project: CCEH will serve as project lead, with segmented sampling to be performed primarily by JS'KT staff members.

We intend to use the following laboratories to analyze water samples for all parameters of interest:

- UW Marine Chemistry Laboratory for nutrient samples (Katherine Kroglund, Sample Coordinator)
- CCEH Water Laboratory for fecal coliform (FC) samples (Sue Waldrip, lab manager)

5.2 Special training and certifications

SK volunteers and members of the JS'KT are thoroughly trained per Streamkeepers' QAPP (Chadd 2016a, Chadd 2016b).

5.3 Organization chart

Not applicable (N/A)

5.4 Proposed project schedule

Regular monthly and quarterly schedules have been established for the two tiers of trends sampling (second Tuesday of the month), with a backup day (third Tuesday of the month) in case the regular day is not an option (though any date within the target month will suffice). FC sampling for Tier 1 sites will occur monthly, while nutrient sampling will occur bi-monthly. Targeted sampling will occur regularly as staff availability permits. See Figure 3 for trends monitoring sample sites.

5.5 Budget and funding

Long-term sustainable funding for this sampling plan is not yet secured. The project activities described in this QAPP are being funded under a grant provided by Ecology for three years. This funding will be used as follows:

- QAPP development and submittal
- Long-term water quality trend monitoring to assess the influence of 20 streams in the CWD on marine water quality. This monitoring will collect data for nutrients, bacteria, temperature, pH, salinity, conductivity, dissolved oxygen, and conductivity.
- CCEH will reach out to landowners within the Matriotti Creek and Bell Creek focus areas to request access to stream segments to conduct water quality sampling. CCEH and JS'KT will monitor for bacteria, temperature, and salinity at 15 sites (approximately 360 samples). A segmented sampling site location map will be produced.
- SK, CCEH, and JS'KT will submit all monitoring data into EIM, which will subsequently be submitted to WQX.
- CCEH, with support from SK and JS'KT, will submit an annual water quality monitoring reports for a variety of entities and a final report to be approved by Ecology.
- CCEH will participate in professional development trainings relevant to the project goals.

PIC Ecology 2020	Task 3
<i>Description of Deliverable</i>	Monitoring/ Investigation
Personnel	\$26,910
Fringe Benefits	\$10,764
Contract (UW Lab, Ozark Lab, Mailing Service)	\$8,520
Subaward (JSKT, Cons. Dist., SK, WSU)	\$18,333
Other (Lincoln Street, Postage, County Water Lab)	\$19,870
Indirect/Overhead	\$8,073
Total	\$92,470

6.0 Quality Objectives

6.1 Data quality objectives

The main data quality objective (DQO) for this project is to collect an adequate number of samples to accurately characterize possible sources of bacteria and nutrients in the project area. The samples will be analyzed using EPA methods.

6.2 Measurement quality objectives

Field sampling procedures and laboratory analyses inherently have associated error. Measurement quality objectives (MQOs) establish the allowable error for a project. Precision and bias provide measures of data quality and are used to assess agreement with MQOs. The MQOs for this project are outlined in Table 1 and in further detail below.

Parameter	Bias	Field Precision	Lab Precision	Sensitivity	Expected Range of Results
	Deviation from NIST standard or spiked blank	Field measures = Per-pair variation Lab analyses = Annual median RSD	Relative Standard Deviation (RSD)	= Range, Lab Analyses = Method Detection Limit	
FIELD MEASUREMENTS—other parameters may be measured following the Streamkeepers QAPP in force at the time (e.g., Chadd 2016a)					
Temperature (thermistor)	0.2 °C (two-point)	0.2 °C	n/a	-5 - 50 °C	0 - 30 °C
Temperature (liquid thermometer)	1 °C (two-point)	0.5 °C			
Salinity	5% RPD	0.02 PSS ⁶ or 5% RSD		0 - 70 PSS	
LABORATORY ANALYSES					
Fecal coliform	n/a	See footnote ¹	40% ¹	1 cfu/100 mL	<MDL - 2000 cfu/100 mL
NO ₃ - N	15% ²	10% RSD ³	20% ⁴	0.0134 mg/L	<MDL - 10,000 µg/L
NO ₂ - N	20% ²			0.0010 mg/L	<MDL - 100 µg/L

NH ₄ - N		15% RSD ³		0.0049 mg/L	<MDL - 2000 µg/L
PO ₄ - P		10% RSD ³		0.0005 mg/L	<MDL - 1000 µg/L
SiO ₄ - Si ⁷	15% ²			0.0093 mg/L	<MDL - 50,000 µg/L
Total Persulfate N	10% ²			0.0276 mg/L	<MDL - 15,000 µg/L
Total Persulfate P				0.0011 mg/L	<MDL - 1,500 µg/L

Table 1: MQOs

- ¹. Duplicate pairs with means <20 cfu/100 mL are excluded from these QC tests: 50% of duplicate pairs <20% RSD; 90% of duplicate pairs <50% RSD; all duplicate pairs <85% RSD (Mathieu 2006).
- ². University of Washington Marine Chemistry Lab will deal with these tests internally.
- ³. Duplicate pairs with means less than 5x the reporting limit are excluded. (Mathieu 2006). Nutrient reporting limits are not reported by the lab but are calculated synthetically—see text.
- ⁴. Lab duplicates are not required, but they may be requested if field replicates exceed QC limits.
- ⁵. Detection limits for nutrients parameters are determined annually by the UW Lab per EPA methods described in 40 CFR 136, Appendix B.
- ⁶. Practical Salinity Scale
- ⁷. This analyte is not a parameter of interest for this project and is only included because it is batched in the UW lab analyses with parameters of interest.

6.2.1 Targets for Precision, Bias, and Sensitivity

6.2.1.1 Precision

Precision measures the reproducibility of repetitive measurements and is defined as the agreement among independent measurements produced by applying the same process under similar conditions. Precision assessment measures the variability in the results of replicated measurements due to procedural inconsistency, variable environmental conditions, or unknown error. Precision for replicates will be expressed as percent relative standard deviation (%RSD, which for a pair of values equals $\text{SQRT}(2) * \text{difference/sum} * 100\%$) and assessed following the MQOs outlined in Table 1. Replicate samples will be collected at a minimum 5% of sampling sites, and at least one set of replicate samples will be taken by each field team each day.

6.2.1.2 Bias

Bias is a measure of the systematic error (difference) between the population mean (or an estimated value) and true value of the parameter being measured. Field and laboratory QC procedures, such as blanks, check standards, and spiked samples, provide a measure of any bias affecting measurement procedures. Bias from the true value is very difficult to determine for the set of parameters measured in this project; however, staff will minimize bias in field

measurements and samples by strictly following measurement, sampling, and handling protocols, including:

- Avoidance of skin products; use of gloves.
- Field-grab bottles which contain no potentially-confounding compounds.
- A thorough grab-bottle and syringe acid-wash procedure.
- Regular cleaning and rotation of purified-water bottles taken into the field.
- Bottle transfers made under cover, usually in the cargo area of a vehicle, on a clean surface.
- Avoidance of cleaning products containing quaternary ammonia compounds.

Project staff will assess bias in field samples by submitting field blanks. Field staff will prepare blanks in the field by filling the bottles directly with deionized water, and handling and transporting the samples to the labs in the same manner that the rest of the samples are processed.

For field measurements, project staff will minimize bias by calibrating and/or checking equipment using NIST-traceable standards before and after each run. More detailed information is found in Section 10 on Quality Control Procedures. Staff will assess any potential bias from instrument drift in probe measurements using criteria expressed in Table 7.

6.2.1.3 Sensitivity

Sensitivity is defined as the smallest quantity of an analyte that can be detected by a given method, and an instrument's range represents the span of values that it can measure. Both are presented in Table 1.

6.2.2 Targets for Comparability, Representativeness, and Completeness

6.2.2.1 Comparability

It is important for results from this project to be comparable to results generated by previous projects in the Dungeness watershed. To help ensure comparability, standardized sampling techniques and methods, and analysis and data reduction, are being used. In addition, laboratories for analysis were chosen to be consistent with those used for the EPA Targeted Watershed Grant (Streeter 2005; Woodruff et al. 2009b) and Clallam Marine Recovery Area Septic Solutions (Soule 2013) monitoring plans. The same analytical methods are available and will also be used.

6.2.2.2 Representativeness

This will be addressed by choice of sampling sites and frequency and timing of sampling. Sites will be as close as possible to discharge points of freshwater bodies into marine waters, in order to reflect as accurately as possible the pollutant concentrations upon entry into marine waters. Trends monitoring sampling will be collected monthly for tier 1 sites, and quarterly for tier 2 sites throughout the year, and in general, stream flow status and weather will not deter going into the field. Samples will be collected during low tide periods whenever possible, and samples having appreciable salinity (e.g., > 1 ppt) will be highlighted in field logs. Segmented sampling

will be addressed by selecting a good spatial representation of the stream or creek in question, with one sample site close to the terminus, and one sample site as far upstream as possible within the project area. If/when hotspots are identified, sample sites will be established upstream and downstream of the hotspot. Grab sample protocol follows the *Standard operating procedure for manually obtaining surface water samples* (Joy, 2006).

6.2.2.3 Completeness

The goal set for this project is 90% of planned sampling to be conducted and analyzed. Tier 1 sampling will occur monthly at 13 sites from December 2019 through December 2021. FC is analyzed every month while nutrients are analyzed bi-monthly. Tier 2 sampling will occur on a quarterly basis (January, April, August, and November) at 11 sites during the same timeframe. There are many reasons for missing sampling activities in a monitoring program. These include: (1) inclement weather or flooding, (2) hazardous driving or monitoring conditions, and (3) unavailability of monitoring staff, laboratories, equipment, or supplies.

Routinely missed samples could impart bias in expressions generated from final data. Every effort will be made to sample within each target month. Field monitoring data loss due to equipment failure will be minimized by having backup equipment available. Apart from weather, unforeseen occurrences are random relative to water quality conditions. These occurrences will not affect long-term data analyses, except for effects from potential reduction in sample size.

6.3 Acceptance criteria for quality of existing data

Existing data are covered under other QAPPs and will be submitted to Ecology per these plans if they have not been already.

6.4 Model quality objectives

N/A

7.0 Sampling Process Design

7.1 Study Boundaries

The study area is the Sequim Bay-Dungeness Watershed CWD, which is bounded on the west by the Bagley Creek drainage area and on the east by the Sequim Bay drainage.

7.2 Field data collection

7.2.1 Sampling location and frequency

Please refer to Figure 3 for sampling locations.

Trends Monitoring

Trends monitoring is currently underway under a previous QAPP iteration (Chadd and Bond, 2017). Sampling will continue once a month on Tier I waterways and quarterly on Tier II waterways from December 2019 through November 2021 (Tables 2 and 3). Tier assignments are subject to change as situations change and data informs adaptation. General criteria for choosing sites and parameters are discussed below. Sampling sites will be located at or near the mouths of waterways, as feasible.

When possible, all monthly or quarterly samples will be collected on the same date. When not practical to do so, sites will be split such that all drainages to specific receiving waters will be sampled on the same day.

Windows for quarterly sampling will be the months of January, April, August, and November. These months correspond to seasonal spikes observed in past sampling.

Stream Name	Receiving Waters	Projected Monitoring Station (CCWR/EIM)	Description
Dungeness River	Dungeness Bay	Dungeness 0.7	0.3 miles downstream of Schoolhouse Bridge, access from Rivers End Rd.
Meadowbrook Creek		Meadowbrook 0.2	Near mouth, upstream of Sequim-Dungeness Way, near Three Crabs Rd.
Meadowbrook Slough		Meadowbrook Slough 0.23	Upstream of the Dungeness Farm Bridge at the end of Abernathy St.
Golden Sands Slough		Golden Sands Slough 0.0	At outlet of south side of Three Crabs Rd.
Cooper Creek		Cooper 0.1	Access from Three Crabs Rd.
Cassalery Creek		Cassalery 0.0 (or 0.6 if tide is too high)	At mouth; private but can be accessed via neighbor & beach
Matriotti Creek	Dungeness	Matriotti 0.3a	Downstream of Ward Rd.

Lotzgesell Creek	River	Lotzgesell 0.1	Upstream of confluence with Matriotti Cr., on Game Farm property
Sequim Bay State Park Creek	Sequim Bay	Sequim Bay State Park Creek 0.0 (or 0.1 if tide is too high)	Sequim Bay State Park, near mouth of creek
Bell Creek		Bell 0.2	About 30' above Schmuck Rd.
Johnson Creek		Johnson Creek 0.0	Downstream of culvert, SE end of Marina parking lot.
Jimmycomelately Cr.		Jimmycomelately 0.15	Upstream of Hwy 101, Ecology gage

Table 2: Tier I Trends sampling sites (FC monthly/ FC + nutrients bi-monthly)

CCWR = Clallam County Water Resources database

EIM = Ecology's Environmental Information Management database

Stream Name	Receiving Waters	Projected Monitoring Station (CCWR/EIM)	Description
Bagley Creek	Strait of Juan de Fuca	Bagley Creek 0.7a	Downstream of Olympic Discovery Trail bridge
Siebert Creek		Siebert Creek 1.0	At Olympic Discovery Trail parking area
Agnew Creek		Agnew Creek/Ditch 0.3	At 1079 Finn Hall Road
McDonald Creek		McDonald Creek 1.6	Downstream of Old Olympic Hwy bridge
Hurd Creek	Dungeness River	Hurd Creek 0.2	At Moore property
Gierin Creek	Dungeness Bay	Gierin 1.8	At upper end of Graysmarsh property, below tributary
Dean Creek	Sequim Bay	Dean Creek 0.17	At Olympic Discovery Bridge
No Name Creek		No Name Creek 0.03	Next to Jamestown Tribe Admin. Bridge
Chicken Coop Creek		Chicken Coop 0.24	About 50 feet upstream of culvert at Old Blyn Hwy.

Table 3: Tier II Trends sampling sites (FC)

PIC Project Monitoring

PIC project areas have been selected from a Priority Work Area List developed biennially by the CWWG after reviewing data and reports produced by the Trends Monitoring Program. The number and location of PIC project targeted sampling sites for Golden Sands Slough, Three Crabs Road, Meadowbrook Slough, and lower Meadowbrook Creek have been established, and the corrective phase of the previous PIC Pilot project will continue in these areas. Segmented sampling sites will be established for the Matriotti watershed, and the upper Meadowbrook Creek using the methods described below. PIC project monitoring will involve segmented

sampling of targeted sub-basins that have been prioritized for cleanup, in this case the lower Matriotti watershed and upper Meadowbrook Creek. The goal of segmented sampling is to locate contamination “hot spots” within a priority sub-basin. “Hot spots” will be defined as locations where the geometric mean of preferably three water quality samples exceeds the “Extraordinary” water quality standards set by Washington State (i.e., 50 fecal coliform colony-forming units per 100 mL for freshwater). Selection of the actual hot-spot sampling sites will be based on a review of available records (e.g., OSSs of concern, poorly drained soils) and visual assessments of potential pollution sources (e.g., poorly managed farms or homes with questionable septic systems).

All samples with FC results exceeding 50 FC/100mL will be re-sampled to confirm that they are indeed hot spots. Re-sampling will occur as soon as possible, ideally within a few days of the initial collection date. When the geometric mean from samples taken exceeds 50 FC/100mL, the hot spot will be designated, warranting further investigation. All hot spots should be investigated. However, when multiple hot spots are identified, additional investigations will be prioritized using the criteria shown in Table 4.

Indicator Organism	High Priority	Medium Priority	Low Priority
<i>Fecal Coliform (FC)</i>	> 400 FC / 100mL	100 to 399 FC / 100mL	50 to 99 FC/100mL

Table 4: Scheme for prioritizing hot spot investigation

Once a hot spot has been identified, additional sampling may occur if needed to further identify the source or sources of pollution. As needed, discharges such as ditches, drainage pipes, irrigation ditches and other drains will be sampled to aid in locating possible pollution sources.

7.2.2 Field parameters and laboratory analytes to be measured

A. Trends Monitoring: Both Tier I & Tier II sampling will include the following parameters:

- Fecal coliform (CFU/100 mL)
- Salinity (ppt or PSS)
- Water temperature (°C)

Tier I sampling will also include the following parameters:

- Dissolved nutrients: NO₃, NO₂, NH₄, PO₄, and silicate (Si(OH)₄). If funding becomes a problem, we may choose to forego analyses for NO₂, PO₄, and Si(OH)₄ to decrease our costs.
- Total nutrients: N and P. Note, however, that sampling conducted within the CWD in 2013-14 indicated a high correlation between the dissolved and totals nutrients parameters, indicating that it might be possible to forego the Total N and P analyses in consultation with the CWWG.

B. PIC Targeted monitoring – Only samples for analysis of FC will be collected.

C. PIC Project monitoring – Only samples for analysis of FC will be collected.

7.3 Modeling and analysis design

N/A

7.4 Assumptions underlying design

The study area has been the target of several water quality investigations in the past two decades, both of surface and ground water. These prior investigations inform the selection of Tier I & II sites and the parameters to be measured, based on existing data and potential impact to public health and shellfish harvest. Tier II sites are assumed to contribute a smaller load of pollutants to receiving waters based on historic data, land use, or size of discharge. Sampling site selections include the following considerations:

- Attempt to sample all freshwater discharges to marine waters in the study area, plus major tributaries to those discharges.
- Sample each discharge downstream of as many possible point or non-point inputs as possible.
- If possible:
 - Avoid tidal influence so samples will represent freshwater concentrations and sources. Where there is tidal influence, sample from the uppermost, least saline, layer of water.
 - Sample at sites with the greatest ease of access, such as public access.
 - Sample at sites where there is no need to walk into the water body, to avoid invasive species contamination—see section 8.4 below.
 - Sample at sites with a rich historic data set.
 - Sites for field replicate collection should have well-mixed water and typically strong fecal coliform and nutrients signals.

This QAPP identifies analytical methods that will be used to measure nutrients in Trends Monitoring program samples (see Section 8.0). In choosing these methods, we assume that the same laboratory and methods as have been used previously will provide comparable results helpful in identifying water quality trends and pollution sources.

7.5 Possible challenges and contingencies

7.5.1 Logistical problems

Logistical problems should be minimal as the project sampling sites are easily accessed.

7.5.2 Practical constraints

Practical constraints regarding the field aspect of this project are having adequate volunteer support for sampling.

7.5.3 Schedule limitations

Limitations on schedule include the availability of staff coordination, field samplers, calibrated equipment, supplies, laboratories, weather, tides, and, most particularly, funding. Also, field days are limited by the need to submit FC samples to the CCEH Lab by 3:00 pm Thursdays.

8.0 Field Procedures

8.1 Invasive species evaluation

To avoid cross-contamination of invasive species between sites, samplers will follow the Streamkeepers of Clallam County Anti-Contamination Protocol (Chadd 2016b), which is compliant with Ecology Standard Operating Procedures (SOP) EAP070 and EAP071.

8.2 Measurement and sampling procedures

SK maintains rigorous protocols for all steps in the process of monitoring area streams, from documentation to calibration to SOPs to training. Some details from their QAPP may be useful here (Chadd 2016a).

Training:

SK offers training to volunteers, based on the procedures in the Volunteer Handbook (Chadd 2016b). Volunteers see the procedures demonstrated and have the opportunity to practice them, under supervision of staff or experienced volunteers. Training participation is recorded in SK database. New volunteers are then assigned to teams with experienced volunteers guiding them through procedures. Usually several outings are required before new volunteers feel comfortable performing procedures on their own. Only volunteers trained in a given procedure will be allowed to attach their initials to data gathered under that procedure. The SK database connects all data with a sampler, whose training history is recorded in a separate table in that database.

Qualifiers Based on QC Controls:

For each QC control performed, qualifiers indicated by a QC test will be applied to all data governed by that test. In general, instruments will be calibrated (or checked if not able to be calibrated) prior to the sampling session and then checked subsequent to the sampling session. Both pre- and post-sampling checks must meet QC criteria in order for data gathered in between to be considered acceptable.

Post-Period Drift Check Is Sufficient:

Instrument drift away from accuracy is presumed to progress in a single direction, either above or below the accuracy margins. Therefore, in a case where an instrument was checked for accuracy only subsequent to a sampling episode, if the instrument passes its QC post-check, it is presumed that the instrument performed to specifications prior to that check (R Katzneslon, personal communication, October 24, 2011), so long as no substantive maintenance or replacement of instrument parts was performed in between. This situation is to be avoided, because samplers run the risk of downgrading an entire set of data due to not having checked instrument accuracy at the outset.

Accuracy Tests:

Accuracy of water quality measurements is estimated by performance evaluation measurements of the equipment; see Tables 1 and 8 for criteria.

Precision Tests:

Precision of water quality measurements is estimated by analysis of replicate samples taken in the field at one site per team per sampling period. The variation between these sample and replicate values is a measure of variability due to short-term environmental factors, instrument operation, and sampling procedure. See Tables 1 and 8 for acceptance criteria and control limits based on comparing replicates with their paired samples.

QC qualifiers are then applied to all samples in the grouping covered by that replicate/sample pair—for example, the entire group of samples taken by that team during that sampling period. These qualifiers are only applied if they downgrade already-applied QC qualifiers; for example, if program managers have already applied a “REJ” qualifier to a result, a downgrade value of “EST” based on replicate/sample comparison will not change the “REJ” designation for that result.

Special note for QC of fecal coliform samples:

Both field and lab replicates are taken with $\geq 5\%$ of samples. Rather than randomly choosing samples for field and laboratory duplicates, we intend to choose samples likely to have high counts, on the notion that replicated samples with no counts provide little information (S Lombard, personal communication, 2007). The acceptance criteria and control limits in Table 9 are based on comparing field and laboratory replicates with their paired samples.

Side-by-Side Sampling—External:

Separate from Ecology monitoring activities, as possible, SK volunteers or staff will participate in Ecology’s Side-by-Side Sampling program (http://www.Ecology.wa.gov/programs/eap/fw_riv/SxSIndex.html), whereby water-quality monitors test water bodies at the same time Ecology tests them as part of their monthly Ambient Monitoring Program. This program affords both parties the opportunity for additional validation of their data.

In-Situ Sampling Procedures: A basic schema of sampling and measurement procedures is presented in Section 8.2 above. The cited method sources, hereby incorporated by reference into this document, give full explanations relating to:

- collection of samples and associated field QC samples
- analytical methods for measurements/analyses done in the field as well as the laboratory
- required equipment and in-situ calibration and maintenance procedures
- required content and format of field log entries
- sampling equipment and methods for its preparation and decontamination

8.3 Containers, preservation, holding times

The field measurement methods and laboratory analytical methods that will be used for trends and PIC monitoring are summarized in Table 5. Sample container, preparation, and holding times are included. The detailed SOPs that will be used are also cited below. See Table 5.

Parameter	Field Method	Field Method Citation	Instrument/ Container type ¹	Sample Preparation	Min. Quantity, Holding time (per lab)
FIELD MEASUREMENTS ²					
Water Temperature	Electronic meter or thermometer	(Chadd 2016a)	Thermistor or thermometer	In situ	n/a
Salinity	Electronic meter or refractometer	(Chadd 2016a)	Electrode or refractometer	In situ	
LABORATORY ANALYSES					
Fecal coliform [CCEH Lab]	Manual grab	(Chadd 2016a)	Sterilized poly ≥125 mL	10°C, dark	100 mL, 8 hr or 24 hr
Nutrients (dissolved) [UW]	Manual grab	(Joy 2006)	60 mL HDPE narrow mouth acid washed	Field filter with surfactant-free cellulose acetate filter; 6°C, dark	40 mL, 48 hr (unfrozen samples)
Nutrients (total) [UW]	Manual grab	(Joy 2006)	60 mL PP wide-mouth, acid washed	6°C, dark	40 mL, 7 days

Table 5: Field and laboratory methods: sample container, preparation, and holding times

¹ Containers will be supplied by the accredited laboratory

² Additional field measurements may be taken in accordance with Streamkeeper protocols in force at the time (e.g., Chadd 2016 a & b).

8.4 Equipment decontamination

This project does not expect to be sampling substances with high levels of contaminants. For the routine sampling being performed here, it is sufficient to rinse sampling equipment (but not sample bottles) with sample water between locations (EPA 2015). Samplers will follow the Streamkeepers of Clallam County Safety SOP (Chadd 2016b).

8.5 Sample ID

Bottles will be labeled either with numbers, referenced on the field data sheet, or with the name of the site, date, and QC type (primary sample, field replicate, blank). Bottles intended for different analyses can be distinguished by size and shape, so no further labeling is necessary. Each bottle sent to a lab will be entered into the Clallam County Water Resources (CCWR) database with a unique ID, and each result from each Batch will also have a unique ID.

8.6 Chain-of-custody

Samples will be sent to the appropriate lab accompanied by a copy of the relevant field sampling log and a chain of custody form, likely be obtained from the labs, that has been signed and dated. Please refer to Figure 6 for a sample chain-of-custody form.

PIC Trends Monitoring Date: ___/___/___ Clallam County Env. Health Lab / Other: _____ Tour ID: _____ Rev. 2/8/17

Tier 1 monthly Samplers' initials: Stage/Flow: WQ: Bacteria: Nutrients: Turbidity grabs:

Field ID (fecal bottle #)	Station Name, Code, or Description (Label nutrients bottles with the same number as on the corresponding bacterial sample bottle, and send a copy of this field sheet to the nutrients lab.)	Temperature control at lab, °C	Time (military)	Gage height /Water-level/Top-down (ft)	Samples taken with ProDSS / YSI-85 (circle #)										Fecal/ lab rep counts per 100 mL factor	Fecal qualifier (U=<; G=>)	Clallam County lab #	Comments **Stream conditions: -turbid? -smelly? **Ebb or Flood Tide? (Cassalery mouth) **Problems sampling **Unusual situations (Continue on back if needed; indicate stream & location.)
					Wtr Temp to 0.1 °C	Barometric Pressure to 0.01 in Hg	Dissolved Oxygen to whole % Local	Dissolved Oxygen to 0.1 mg/L	Specific Cond SpC to whole µS/cm	Salinity to 0.1 PSU (ppt)	pH to 0.1	Turbidity to whole FNU						
	Jimmycomelately 0.15			GH														
	Sequim Bay State Pk 0.0			TD														
	Johnson 0.0			GH														
	Bell 0.2			GH														
	Cassalery 0.0			EST														
	Cassalery 0.6 (if 0.0 tidal influence, ALWAYS read gage)			GH														
	Meadowbrook Slough .23			TD														
	Cooper 0.1			TD														
	Golden Sands Slough 0.0			TD														
	Meadowbrook 0.2			TD														
	Meadowbrook 0.2 blanks																	
	Dungeness 0.7																Flow @ECY gage Dungeness: cfs @ _____	
	Lotzgesell 0.1			TD														
	Matriotti 0.3a			TD														
	Matriotti 0.3a replicates																	

GH = gage height; TD = measure top-down (record as a negative number); EST=floating-object flow estimate—see other side for calculation

Fecal lab samples submitted by (incl. initials): _____ Date: _____ Time: _____ Rec'd by: _____ Date: _____ Time: _____

Nutrients samples submitted by (incl. initials): _____ Date: _____ Time: _____ Rec'd by: _____ Date: _____ Time: _____

Figure 6: Sample Chain-of-Custody Form

8.7 Field log requirements

The field log for this project will consist of the field sampling log sheet containing the primary data, plus the additional log sheets listed below, describing the overall sampling event and calibration/drift check results. Any corrections will use strikeouts and be initialed and dated.

- Episode/Tour cover sheet—one per sampling team per sampling day
 - <http://www.clallam.net/SK/doc/EpisodTourCov.pdf>

- Instrument calibration activity & pre/post checks:
 - <http://www.clallam.net/SK/QualityAssurance.html>

8.8 Other activities

At sites with stream gages, samplers will be asked to record stage height. Sites without gages will be measured for stage from a top-down reference point where possible. Discharge will not be measured simultaneously with sampling, but stage measurements will give a relative idea of stream stage on the day of sampling.

Other General QC Measures:

- Clear, user-friendly, and detailed instructions for all procedures, minimizing judgment calls
- Equipment checked for damage prior to sampling
- Multiple observers when possible
- Each sampling team has an experienced leader
- Staff review of data, including comparing values year-to-year
- Values compared to external data from other agencies, such as stream gage data

9.0 Laboratory Procedures

9.1 Lab procedures table

The matrix for all analyses will be non-potable water. Analytical methods are listed in Table 6. All FC samples will be delivered the same day to the CCEH Water Lab in Port Angeles, WA (accreditation # M421-12) to be analyzed.

Nutrient analyses of water samples will be performed by UW School of Oceanography Marine Chemistry Laboratory in Seattle, WA (accreditation # A521-12). All nutrient samples will be shipped to UW Lab on the day of sampling. UW Lab will batch the dissolved nutrients NO₃, NO₂, NH₄, PO₄, and SiOH₄ for analysis, and will batch Total N and P for separate analysis. Si data is being collected only because UW Lab batches it in the dissolved nutrients. It is not a parameter of interest for this project.

Analysis	Method Reference	EPA or Standard Method #	NELAC Code	Detection Limits ¹ (MDL)
Fecal coliform	APHA 1998	SM 9222 D (m-FC)-97	20210008	1 cfu * 100 mL /volume used in the analysis
UW Marine Chemistry Laboratory				
NO ₃ - N	UNESCO 1994	EPA 353.4_2_1997	10068209	0.0134 mg/L
NO ₂ - N				0.0010 mg/L
NH ₄ - N		EPA 349	10063000	0.0049 mg/L
PO ₄ - P		EPA 365.5_1.4_1997	10071406	0.0005 mg/L
SiO ₄ - Si		EPA 366	10071600	.0093 mg/L
Total Persulfate N	Valderrama 1981	SM 4500-NH3 B-2011	20106018	.0276 mg/L
Total Persulfate P		SM 4500-P F-2011	SM 4500-P F-2011	0.0011 mg/L

Table 6: Laboratory Analytical Procedures

¹ Detection limits for nutrients parameters are determined annually by the UW Lab per EPA methods described in 40 CFR 136.

9.2 Sample preparation methods

Please refer to Table 6 above.

9.3 Special method requirements

Table 1 outlines field and analytical parameters, expected precision for duplicates (a.k.a. replicates), method detection limits and/or resolution, and the expected range of results. The targets for precision of duplicates are based on historical performance by each laboratory.

For nutrients, field replicates and blanks will be shipped and analyzed in the same batch as regular samples. Lab duplicates (if done) will be charged the same as samples. Bias checks are

run with every run /data set. Please see Table 1 and section for further discussion on bias checks, see Table 1 concerning SRMs and Section 6.2.1.

Field Blanks taken with nutrients samples will be analyzed in the following manner:

- The time period for both analysis and reporting will be the calendar year; the choice of calendar year is based on the annual Method Detection Limit (MDL) reports issued by the University of Washington Marine Chemistry Laboratory.
- Blanks known to be faulty due to procedural irregularities will be qualified as J (estimate) or REJ (rejected).
- Outliers (qualified as OUT per definition of Ecology's Environmental Information Management system) will be determined using Tukey's fences with $k = 1.5$ (an oft-used benchmark). The Result Comment accompanying such Blanks will be "Exceeds upper Tukey fence with $k = 1.5$."

The UW lab does not report reporting limits (RLs), but the remaining Blank data (without the above qualifiers) will be used to calculate synthesized RLs for the various parameters, with this procedure developed in consultation with EPA: The synthetic RL will be the larger of $3.18 * MDL$ or the mean +1 standard deviation of the non-OUT field blanks (D Matheny, personal communication, 2014).

Dissolved nutrient samples will be filtered in situ (see Table 5).

9.4 Laboratories accredited for methods

This PIC project will contract with CCEH Water Lab for monthly trends analysis and segmented analysis of FC samples and UW Marine Chemistry Lab for bi-monthly analysis of nutrient samples.

10.0 Quality Control

10.1 Table of field and lab quality controls

QC procedures for the field and laboratory are summarized in Tables 7, 8 and 9. A “tour” is a round of sampling conducted on a given day by a given field team. A “run” is a batch of samples processed by the lab. Laboratory QC samples will be obtained by SK for documentation purposes.

Parameter	FIELD		LABORATORY			
	Blanks	Replicates	Method Blanks	Spiked Blanks	Analytical Duplicates	Matrix Spikes
Fecal coliform	≥ 1 per tour and 5% of sites		2 per ≤ 10 samples (See Table 8)	None	1 per ≤ 10 samples	n/a
Dissolved Nutrients			2 per run	2 per run	None	None
Total N & P			2 per run	2 per run		
Water temperature	n/a	≥ 1 per tour & 5% of sites	n/a	n/a	n/a	n/a
Salinity						

Table 7: QC Samples, Types, and Frequency

NOTE: NIST SRMs for nutrients will also be run as QC samples to help assess bias (Table 1).

Parameter	Office prep (start of each sampling period)	Maintenance measures (office & field)	Field prep/ checks	Bias checks	Accuracy qualification per bias checks	Replicates for precision control	Precision qualification (per rep/ sample difference)
Temperature	2-pt. (~0° & 20°C) check vs. NIST-traceable thermo-meter	Keep sensor clean		2-pt. calibration check vs. NIST-traceable thermo-meter	“EST” if $> \pm 0.2^\circ\text{C}$; “REJ” if $> \pm 0.5^\circ\text{C}$	1 per tour	“EST” if $> \pm 0.2^\circ\text{C}$; “REJ” if $> \pm 0.5^\circ\text{C}$

Parameter	Office prep (start of each sampling period)	Maintenance measures (office & field)	Field prep/ checks	Bias checks	Accuracy qualification per bias checks	Replicates for precision control	Precision qualification (per rep/ sample difference)
Salinity	Calibration with NIST-traceable standard	Electrode cleaning solution	Check / rinse electrodes	Post-season check against NIST-traceable standard	“EST” if $> \pm 10\%$ of standard value; “REJ” if $> \pm 15\%$ of standard value		“EST” if RSD $> 5\%$; “REJ” if RSD $> 10\%$
Fecal Coliform	Verification of colonies once a month; annual proficiency testing with state	Checks of medium, filters, funnels, thermometer, rinse & dilution water	Sterilized bottles, 4 oz. (125 mL) minimum; observe holding specs	Pre- and post-sample blanks; control blanks for 1/10 of samples	Adjust/flag data as needed per blank results	Field / lab replicates: ≥ 1 / tour & $\geq 5\%$ of sites	“REJ” if $> \pm 10$ and log-transformed values $> \pm 0.6$ (RSD $> 85\%$) (see text below)

Table 8: Field and Lab Equipment QA/QC Measures

RSD in the table above refers to the relative standard deviation or RSD (also known as the coefficient of variation), which, when $n = 2$ (as when comparing a sample with a replicate), is defined as:

$$RSD = \text{abs}(\text{difference/sum}) \times \text{sqrt}(2), \text{ where abs} = \text{absolute value and sqrt} = \text{square root}$$

Control measure used: variance between sample and field or lab replicate
If absolute difference ≤ 10 or difference between base-10 logs ≤ 0.6 (RSD $\leq 85\%$): No qualifier
Otherwise, qualify per the following, using best professional judgment of program manager and laboratory analyst: <ul style="list-style-type: none"> • Flag sample as "R" (unacceptable); • If other rep/sample pairs from that day’s analysis were within tolerance, do not flag the other data, unless there is reason to question the entire batch; • If no other rep/sample pairs in that batch, use best professional judgment of laboratory and monitoring program managers to decide whether to flag other data; • If other rep/sample pairs from that day’s analysis exceeded tolerance, consider flagging all the data from that day, or possibly from the team(s) which collected those samples.

Table 9: QC Measures for Bacterial Samples

10.2 Corrective action processes

For CCEH Water Lab FC analyses, QC will be performed using “Standard Methods 9020B Intra-laboratory Quality Control Guidelines” (B Pero, personal communication, 2013).

UW Lab indicated that analytical QC criteria listed for nutrients and Total N and P in Tables 1 and 6 will always be met. Method blank and spiked blank checks are performed at the beginning and end of each run; both must be within the QC range, or the samples are run again (K Krogslund, personal communication, 2019).

Qualifiers will be assigned to data as appropriate, based on qualifier codes developed by the EIM. To be unqualified (i.e., acceptable without qualification for submission for the State Water Quality Report), data must be gathered in accordance with established monitoring procedures, be fully documented, and pass all QC screens. The most common data qualifiers are:

- **J-variants** (laboratory-data estimate): Apply if laboratory identifies sample as an estimate, or if established QC procedures have not been followed or documented (for example, lab duplicates were not run), or one or more QC screens have not passed (for example, lab duplicates were outside precision targets), but the QA officer believes the data to be reasonably trustworthy for general water-quality assessments.
- **J** (Estimated: The analyte was positively identified and the associated numerical value is the approximate concentration of the analyte in the sample): Apply if established procedures have not been followed or documented, or one or more QC screens have not passed, but QA officer believes the data to be reasonably trustworthy for general water-quality assessments.
- **OUT** (outlier within dataset): Apply to Field Blanks that fail Tukey fence analysis with $k = 1.5$. (See Section 6.2.)
- **REJ** (rejected): Apply if established procedures have not been followed and/or documented, or one or more QC screens have not passed, and QA officer believes the data to be untrustworthy for any purpose.

If data are qualified by the laboratory or adjusted due to blanks, replicates, spikes, or blind standards, these adjustments will be documented along with the data and flagged appropriately.

Field blank and sample results for each parameter for each day will be processed using the following steps, developed in consultation with state and federal scientists (N Mathieu, personal communication, 2014; D Matheny, personal communication, 2014; T Gries, personal communication, 2018; APHA, 2012):

- If, after procedural QC and outlier analysis, Field Blank (FB) has not been qualified and $FB \leq \text{Reporting Limit (RL)}$, no qualifier for the field samples.
- If FB has been qualified, qualify all field samples as J or R per judgment of the QA officer, and record a comment alongside the data explaining why that qualifier was applied; for example, “FB is OUT but data deemed reasonable.”

- Else, if $FB > RL$, qualify the FB as J with the comment “>RL”. Designate $(FB - RL)$ as the absolute bias for that day, in which case the relative bias for a given measurement would be $(\text{absolute bias}) / (\text{sample value})$. Then apply qualifiers per the MQOs for bias in Table 1:
 - If $(\text{relative bias}) \leq (\text{target bias})$ for that parameter, no qualifier for field samples.
 - If $(\text{relative bias}) > (\text{target bias})$ but field sample value $\leq RL$, qualify it as B, defined by EIM as “Analyte detected in sample and method blank. Reported result is sample concentration without blank correction” (Ecology, 2019); the rationale is that field data with a value $<$ the RL (and also $<$ the FB) is indicative of a truly low value that should not be rejected, regardless of potential contamination issues evidenced by the high FB.
 - Else, qualify all field samples as J or R per judgment of the QA officer, and record a comment alongside the data explaining why that qualifier was applied; for example, “ $FB > RL$ and rel bias $>$ target bias, but data deemed reasonable.”

For in-situ measurements, see Additional QC notes in section 8.2.

11.0 Data Management Procedures

11.1 Data recording and reporting requirements

Data collection, quality control, management, and reporting will be coordinated by SK. See Section 5.0 for more details.

Recording Field Data

Field data will be collected on custom-designed data sheets. The primary field data sheet, as well as ancillary data sheets (Episode and Tour cover sheets, calibration/check sheets), are on the SK website at <http://www.clallam.net/SK/monitoringusables.html>. Field samplers will record data and enter their names and initials on these sheets. When all data have been collected at a site, the team leader looks over the sheets for completeness, legibility, and obvious errors, and gets further information from team members as appropriate. Any problems with data collection are noted in a “Comments” section of the data sheet. The team leader initials and dates this review, then initials and dates again when turning the sheets in to the office. Then staff initials and dates receipt and QC review of the data. This latter review is a thorough process that includes troubleshooting for decimal and rounding errors, data entered into the wrong field, incomplete data, etc.

Requirements for Laboratory Data Packages

The microbiology and chemical laboratories will report sample results on report forms provided by SK or of their own making. They will indicate their QC review and approval of the data presented. Laboratories will not be required to submit internal QA/QC documentation, such as blanks, spikes, and blind standards, used to determine the adequacy of the analytical procedures, providing their procedures met all internal laboratory QA/QC requirements; but they will be required to keep all such internal records for a minimum of five years.

Transferring Data to Electronic Form

Once field data sheets have been received and reviewed at the Streamkeepers office, volunteers will enter the Trends Monitoring data into the CCWR database. Detailed procedures will be provided to the volunteers, both in written form and in one-on-one training, and staff will be available to volunteers as they perform data entry. Volunteers subsequently will check database entries against field sheets.

Laboratory Data Upload

When laboratories report data in a standard electronic format, SK staff and volunteers will devise database queries to upload the data.

Automated Data Checks

Our intention is to program the CCWR database to automatically perform some of the statistical checks described in the “Quality Control” section above, and in some cases to downgrade data automatically as appropriate (leaving a record of the downgrade). In other cases the database will display a message instructing program managers to examine data and apply downgrades as

appropriate. These automated routines will ensure compliance with QC procedures. In the absence of automation, data qualifiers will be applied manually by the QC officer.

Final Sign-Off of Data

Once all of the above checks have been performed, the QA officer will do a final review of data, including examination of outliers, and sign off that the data are ready for publication.

Management and Storage of Database

The CCWR database is managed by SK It is stored on Clallam County's network drive, which is backed up daily. The database itself is actually two files: CCWR_Data consists exclusively of data tables, while CCWR_User comprises data-entry forms, database queries, reports, lookup tables, metadata, and other database objects. This structure provides stable storage for the data.

Retrieval of Data

Data can be retrieved from the CCWR database in a variety of ways. A number of custom-made reports and queries have been designed to portray the environmental data in the database. Data can also be retrieved via user queries. A variety of CCWR data is also available on the Streamkeepers website: <http://www.clallam.net/SK/studies.html>.

11.2 Lab data package requirements

Lab documentation should always include all QC results associated with the data, a case narrative discussing any problems with the analyses, corrective actions taken, changes to the referenced method, and an explanation of data qualifiers.

The CCEH Water Lab reports results directly on data sheets provided for the project. Outside laboratories will report results and QC information on their standard forms.

11.3 Electronic transfer requirements

Any electronic data transfer will need to be in format readable by SK.

11.4 EIM or WQX data upload procedures

All new data will be uploaded from the CCWR database to Ecology's EIM database for subsequent transfer by Ecology to EPA's WQX database. Upon upload of data to EIM, the data manager will request confirmation that the data have, in turn, been sent to EPA's WQX.

11.5 Model information management

Not applicable.

12.0 Audits and Reports

12.1 Field, laboratory, and other audits

and

12.2 Responsible personnel

Formal program audits are not planned at this time but the need for a program audit may be considered in the future. In lieu of such an audit, the QA officer will be responsible for day-to-day compliance with this document, including assuring that quality of the data is acceptable and that corrective actions are implemented in a timely manner. QC review and signoff will be conducted after each sampling period. In addition, the project manager will review the data and metadata in consultation with the QA officer at some point early in the project and at the end of the project, to assure that procedures have been followed as outlined in this document.

Laboratories participate in performance and system audits of their own procedures; these are available on request.

12.3 Frequency and distribution of report

Data will be submitted annually to Ecology through EIM. Ecology will forward data on to EPA's WQX's database.

12.4 Responsibility for reports

The data manager will summarize data on a quarterly basis at CWWG meetings. An annual data report will be prepared for the CWWG. A draft of this report will also be made available to WDOH staff, Ecology staff, and peers for review and comment.

13.0 Data Verification

13.1 Field data verification, requirements, and responsibilities

Field team leaders will verify data before turning in data sheets. The QA officer will examine the data and metadata for errors or omissions as well as completeness and compliance with QC acceptance criteria, and will apply data qualifiers as needed.

13.2 Laboratory data verification

Laboratory results are reviewed and verified by qualified and experienced lab staff, with findings documented in a case narrative.

13.3 Validation requirements, if necessary

The complete data package, along with the laboratories' written reports, will be assessed by the QA officer and project manager for completeness and reasonableness. There will be no independent data validation.

13.4 Model quality assessment

Not applicable.

14.0 Data Quality (Usability) Assessment

14.1 Process for determining project objectives were met

The project manager, in consultation with other staff and laboratories working on this project, will comment in the project final report on whether the data are of sufficient quality and quantity to have achieved the project goals.

14.2 Treatment of non-detects

If the lab does not report a value for analyte concentrations less than the MDL (see Table 6 in Section 9), results will be reported at the MDL.

14.3 Data analysis and presentation methods

All data generated by the activities described in this QAPP, as per the Ecology grant requirements, will be uploaded to Ecology's EIM database. Ecology will forward this data on to EPA's WQX database.

14.4 Sampling design evaluation

The project manager, in consultation with others working on this project, will comment in the project final report on the adequacy of the sampling design and whether changes should be made in further efforts.

14.5 Documentation of assessment

The project manager, in consultation with others working on this project, will comment in the project final report on the adequacy of the sampling design and whether changes should be made in further efforts.

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16.0 Appendix A- Glossaries, Acronyms, and Abbreviations

Glossary of General Terms

Ambient: Background or away from point sources of contamination. Surrounding environmental condition.

Anthropogenic: Human-caused.

Clean Water Act: A federal act passed in 1972 that contains provisions to restore and maintain the quality of the nation's waters. Section 303(d) of the Clean Water Act establishes the TMDL program.

Conductivity: A measure of water's ability to conduct an electrical current. Conductivity is related to the concentration and charge of dissolved ions in water.

Designated uses: Those uses specified in Chapter 173-201A WAC (Water Quality Standards for Surface Waters of the State of Washington) for each water body or segment, regardless of whether or not the uses are currently attained.

Dissolved oxygen (DO): A measure of the amount of oxygen dissolved in water.

Effluent: An outflowing of water from a natural body of water or from a human-made structure. For example, the treated outflow from a wastewater treatment plant.

Eutrophic: Nutrient rich and high in productivity resulting from human activities such as fertilizer runoff and leaky septic systems.

Existing uses: Those uses actually attained in fresh and marine waters on or after November 28, 1975, whether or not they are designated uses. Introduced species that are not native to Washington, and put-and-take fisheries comprised of non-self-replicating introduced native species, do not need to receive full support as an existing use.

Fecal coliform (FC): That portion of the coliform group of bacteria which is present in intestinal tracts and feces of warm-blooded animals as detected by the product of acid or gas from lactose in a suitable culture medium within 24 hours at 44.5 plus or minus 0.2

degrees Celsius. Fecal coliform bacteria are “indicator” organisms that suggest the possible presence of disease-causing organisms. Concentrations are measured in colony forming units per 100 milliliters of water (cfu/100 mL).

Geometric mean: A mathematical expression of the central tendency (an average) of multiple sample values. A geometric mean, unlike an arithmetic mean, tends to dampen the effect of very high or low values, which might bias the mean if a straight average (arithmetic mean) were calculated. This is helpful when analyzing bacteria concentrations, because levels may vary anywhere from 10 to 10,000 fold over a given period. The calculation is performed by either:

(1) taking the n th root of a product of n factors, or (2) taking the antilogarithm of the arithmetic mean of the logarithms of the individual values.

Load allocation: The portion of a receiving water’s loading capacity attributed to one or more of its existing or future sources of nonpoint pollution or to natural background sources.

Loading capacity: The greatest amount of a substance that a water body can receive and still meet water quality standards.

Margin of safety: Required component of TMDLs that accounts for uncertainty about the relationship between pollutant loads and quality of the receiving water body.

Municipal separate storm sewer systems (MS4): A conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, manmade channels, or storm drains): (1) owned or operated by a state, city, town, borough, county, parish, district, association, or other public body having jurisdiction over disposal of wastes, stormwater, or other wastes and (2) designed or used for collecting or conveying stormwater; (3) which is not a combined sewer; and (4) which is not part of a Publicly Owned Treatment Works (POTW) as defined in the Code of Federal Regulations at 40 CFR 122.2.

Nonpoint source: Pollution that enters any waters of the state from any dispersed land-based or water-based activities, including but not limited to atmospheric deposition, surface-water runoff from agricultural lands, urban areas, or forest lands, subsurface or underground sources, or discharges from boats or marine vessels not otherwise regulated under the NPDES program. Generally, any

unconfined and diffuse source of contamination. Legally, any source of water pollution that does not meet the legal definition of “point source” in section 502(14) of the Clean Water Act.

Nutrient: Substance such as carbon, nitrogen, and phosphorus used by organisms to live and grow. Too many nutrients in the water can promote algal blooms and rob the water of oxygen vital to aquatic organisms.

Pathogen: Disease-causing microorganisms such as bacteria, protozoa, viruses.

pH: A measure of the acidity or alkalinity of water. A low pH value (0 to 7) indicates that an acidic condition is present, while a high pH (7 to 14) indicates a basic or alkaline condition. A pH of 7 is considered to be neutral. Since the pH scale is logarithmic, a water sample with a pH of 8 is ten times more basic than one with a pH of 7.

Point source: Source of pollution that discharges at a specific location from pipes, outfalls, and conveyance channels to a surface water. Examples of point source discharges include municipal wastewater treatment plants, municipal stormwater systems, industrial waste treatment facilities, and construction sites where more than 5 acres of land have been cleared.

Pollution: Contamination or other alteration of the physical, chemical, or biological properties of any waters of the state. This includes change in temperature, taste, color, turbidity, or odor of the waters. It also includes discharge of any liquid, gaseous, solid, radioactive, or other substance into any waters of the state. This definition assumes that these changes will, or are likely to, create a nuisance or render such waters harmful, detrimental, or injurious to (1) public health, safety, or welfare, or (2) domestic, commercial, industrial, agricultural, recreational, or other legitimate beneficial uses, or (3) livestock, wild animals, birds, fish, or other aquatic life.

Riparian: Relating to the banks along a natural course of water.

Salmonid: Fish that belong to the family *Salmonidae*. Species of salmon, trout, or char.

Sediment: Soil and organic matter that is covered with water (for example, river or lake bottom).

Stormwater: The portion of precipitation that does not naturally percolate into the ground or evaporate but instead runs off roads, pavement, and roofs during rainfall or snow melt. Stormwater can also come from hard or saturated grass surfaces such as lawns, pastures, playfields, and from gravel roads and parking lots.

Streamflow: Discharge of water in a surface stream (river or creek).

Surface waters of the state: Lakes, rivers, ponds, streams, inland waters, salt waters, wetlands and all other surface waters and water courses within the jurisdiction of Washington State.

Total Maximum Daily Load (TMDL): A distribution of a substance in a water body designed to protect it from not meeting (exceeding) water quality standards. A TMDL is equal to the sum of all of the following: (1) individual wasteload allocations for point sources, (2) the load allocations for nonpoint sources, (3) the contribution of natural sources, and (4) a margin of safety to allow for uncertainty in the wasteload determination. A reserve for future growth is also generally provided.

Turbidity: A measure of water clarity. High levels of turbidity can have a negative impact on aquatic life.

Watershed: A drainage area or basin in which all land and water areas drain or flow toward a central collector such as a stream, river, or lake at a lower elevation.

303(d) list: Section 303(d) of the federal Clean Water Act, requiring Washington State to periodically prepare a list of all surface waters in the state for which beneficial uses of the water – such as for drinking, recreation, aquatic habitat, and industrial use – are impaired by pollutants. These are water quality-limited estuaries, lakes, and streams that fall short of state surface water quality standards and are not expected to improve within the next two years.

90th percentile: An estimated portion of a sample population based on a statistical determination of distribution characteristics. The 90th percentile value is a statistically derived estimate of the division between 90% of samples, which should be less than the value, and 10% of samples, which are expected to exceed the value.

Acronyms and Abbreviations

BMP	Best management practice
CCD	Clallam Conservation District
CCC	Clallam County Code
CCEH	Clallam County Environmental Health
CCWR	Clallam County Water Resources Database
CWD	Sequim-Dungeness Clean Water District
CWWG	Clean Water Work Group
DCD	Clallam County Department of Community Development
DO	(see Glossary above)
DQO	Data quality objective
e.g.	For example
Ecology	Washington State Department of Ecology
EIM	Environmental Information Management database
EPA	U.S. Environmental Protection Agency
et al.	And others
FB	Field Blank
FC	(see Glossary above)
GIS	Geographic Information System software

GPS	Global Positioning System
i.e.	In other words
JS'KT	Jamestown S'Klallam Tribe
MDL	Method detection limits
MQOs	Measurement quality objectives
MRA	Marine recovery area
NEP	National Estuary Project
NH3	Ammonia
NH4	Ammonium
NIST	National Institute of Standards and Technology
NO2	Nitrite
NO3	Nitrate
NTA	Near term action
NTR	National Toxics Rule
OSS	Onsite septic system
PIC	Pollution Identification & Correction
PO4	Phosphate
QA	Quality assurance

QAPP	Quality assurance project plan
QC	Quality control
RL	Reporting limit
RM	River mile
RPD	Relative percent difference
RSD	Relative standard deviation
Si	Silicon
Si(OH) ₄	Silicate
SK	Streamkeepers of Clallam County
SOP	Standard operating procedures
SRM	Standard reference materials
WQX	EPA's storage and retrieval water quality database
SQRT	Square root
TIN	Total inorganic nitrogen
TMDL	(See Glossary above)
TN	Total Nitrogen
TP	Total phosphorus
TSS	(See Glossary above)

UGA	Urban growth area
UW	University of Washington Marine Chemistry Lab
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WDOH	Washington Department of Health
WQA	Water Quality Assessment
WRIA	Water Resource Inventory Area
WSU	Washington State University

Units of Measurement

°C	degrees centigrade
cfs	cubic feet per second
cfu	colony forming units
cms	cubic meters per second, a unit of flow
ft	feet
g	gram, a unit of mass
kg	kilograms, a unit of mass equal to 1,000 grams
m	meter
mg	milligram
mg/d	milligrams per day
mg/L	milligrams per liter (parts per million)
mg/L/hr	milligrams per liter per hour
mL	milliliter
s.u.	standard unit
µg/kg	micrograms per kilogram (parts per billion)
µg/L	micrograms per liter (parts per billion)

Quality Assurance Glossary

Accreditation: A certification process for laboratories, designed to evaluate and document a lab's ability to perform analytical methods and produce acceptable data. For Ecology, it is "Formal recognition by (Ecology)...that an environmental laboratory is capable of producing accurate analytical data." [WAC 173-50-040] (Kammin, 2010)

Accuracy: The degree to which a measured value agrees with the true value of the measured property. USEPA recommends that this term not be used, and that the terms *precision* and *bias* be used to convey the information associated with the term *accuracy* (USGS, 1998).

Analyte: An element, ion, compound, or chemical moiety (pH, alkalinity) which is to be determined. The definition can be expanded to include organisms, e.g., fecal coliform, Klebsiella (Kammin, 2010).

Bias: The difference between the sample mean and the true value. Bias usually describes a systematic difference reproducible over time and is characteristic of both the measurement system and the analyte(s) being measured. Bias is a commonly used data quality indicator (DQI) (Kammin, 2010; Ecology, 2004).

Blank: A synthetic sample, free of the analyte(s) of interest. For example, in water analysis, pure water is used for the blank. In chemical analysis, a blank is used to estimate the analytical response to all factors other than the analyte in the sample. In general, blanks are used to assess possible contamination or inadvertent introduction of analyte during various stages of the sampling and analytical process (USGS, 1998).

Calibration: The process of establishing the relationship between the response of a measurement system and the concentration of the parameter being measured (Ecology, 2004).

Check standard: A substance or reference material obtained from a source independent from the source of the calibration standard; used to assess bias for an analytical method. This is an obsolete term, and its use is highly discouraged. See Calibration Verification Standards, Lab Control Samples (LCS), Certified Reference Materials (CRM), and/or spiked blanks. These are all check standards but should be referred to by their actual designator, e.g., CRM, LCS (Kammin, 2010; Ecology, 2004).

Comparability: The degree to which different methods, data sets and/or decisions agree or can be represented as similar; a data quality indicator (USEPA, 1997).

Completeness: The amount of valid data obtained from a project compared to the planned amount. Usually expressed as a percentage. A data quality indicator (USEPA, 1997).

Continuing Calibration Verification Standard (CCV): A quality control (QC) sample analyzed with samples to check for acceptable bias in the measurement system. The CCV is usually a midpoint calibration standard that is re-run at an established frequency during the course of an analytical run (Kammin, 2010).

Control chart: A graphical representation of quality control results demonstrating the performance of an aspect of a measurement system (Kammin, 2010; Ecology 2004).

Control limits: Statistical warning and action limits calculated based on control charts. Warning limits are generally set at +/- 2 standard deviations from the mean, action limits at +/- 3 standard deviations from the mean (Kammin, 2010).

Data integrity: A qualitative DQI that evaluates the extent to which a data set contains data that is misrepresented, falsified, or deliberately misleading (Kammin, 2010).

Data quality indicators (DQI): Commonly used measures of acceptability for environmental data. The principal DQIs are precision, bias, representativeness, comparability, completeness, sensitivity, and integrity (USEPA, 2006).

Data quality objectives (DQO): Qualitative and quantitative statements derived from systematic planning processes that clarify study objectives, define the appropriate type of data, and specify tolerable levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions (USEPA, 2006).

Data set: A grouping of samples organized by date, time, analyte, etc. (Kammin, 2010).

Data validation: An analyte-specific and sample-specific process that extends the evaluation of data beyond data verification to determine the usability of a specific data set. It involves a detailed examination of the data package, using both professional judgment

and objective criteria, to determine whether the MQOs for precision, bias, and sensitivity have been met. It may also include an assessment of completeness, representativeness, comparability, and integrity, as these criteria relate to the usability of the data set. Ecology considers four key criteria to determine if data validation has actually occurred. These are:

- Use of raw or instrument data for evaluation.
- Use of third-party assessors.
- Data set is complex.
- Use of EPA Functional Guidelines or equivalent for review.

Examples of data types commonly validated would be:

- Gas Chromatography (GC).
- Gas Chromatography-Mass Spectrometry (GC-MS).
- Inductively Coupled Plasma (ICP).

The end result of a formal validation process is a determination of usability that assigns qualifiers to indicate usability status for every measurement result. These qualifiers include:

- No qualifier – data are usable for intended purposes.
- J (or a J variant) – data are estimated, may be usable, may be biased high or low.
- REJ – data are rejected, cannot be used for intended purposes.
(Kammin, 2010; Ecology, 2004).

Data verification: Examination of a data set for errors or omissions, and assessment of the Data Quality Indicators related to that data set for compliance with acceptance criteria (MQOs). Verification is a detailed quality review of a data set (Ecology, 2004).

Detection limit (limit of detection): The concentration or amount of an analyte which can be determined to a specified level of certainty to be greater than zero (Ecology, 2004).

Duplicate samples: Two samples taken from and representative of the same population, and carried through and steps of the sampling and analytical procedures in an identical manner. Duplicate samples are used to assess variability of all method activities including sampling and analysis (USEPA, 1997).

Field blank: A blank used to obtain information on contamination introduced during sample collection, storage, and transport (Ecology, 2004).

Initial Calibration Verification Standard (ICV): A QC sample prepared independently of calibration standards and analyzed along with the samples to check for acceptable bias in the measurement system. The ICV is analyzed prior to the analysis of any samples (Kammin, 2010).

Laboratory Control Sample (LCS): A sample of known composition prepared using contaminant-free water or an inert solid that is spiked with analytes of interest at the midpoint of the calibration curve or at the level of concern. It is prepared and analyzed in the same batch of regular samples using the same sample preparation method, reagents, and analytical methods employed for regular samples (USEPA, 1997).

Matrix spike: A QC sample prepared by adding a known amount of the target analyte(s) to an aliquot of a sample to check for bias due to interference or matrix effects (Ecology, 2004).

Measurement Quality Objectives (MQOs): Performance or acceptance criteria for individual data quality indicators, usually including precision, bias, sensitivity, completeness, comparability, and representativeness (USEPA, 2006).

Measurement result: A value obtained by performing the procedure described in a method (Ecology, 2004).

Method: A formalized group of procedures and techniques for performing an activity (e.g., sampling, chemical analysis, data analysis), systematically presented in the order in which they are to be executed (EPA, 1997).

Method blank: A blank prepared to represent the sample matrix, prepared and analyzed with a batch of samples. A method blank will contain all reagents used in the preparation of a sample, and the same preparation process is used for the method blank and samples (Ecology, 2004; Kammin, 2010).

Method Detection Limit (MDL): This definition for detection was first formally advanced in 40CFR 136, October 26, 1984 edition. MDL is defined there as the minimum concentration of an analyte that, in a given matrix and with a specific method, has a 99% probability of being identified, and reported to be greater than zero (Federal Register, October 26, 1984).

Percent Relative Standard Deviation (%RSD): A statistic used to evaluate precision in environmental analysis. It is determined in the following manner:

$$\%RSD = (100 * s)/x$$

where s is the sample standard deviation and x is the mean of results from more than two replicate samples (Kammin, 2010).

Parameter: A specified characteristic of a population or sample. Also, an analyte or grouping of analytes. Benzene and nitrate + nitrite are all parameters (Kammin, 2010; Ecology, 2004).

Population: The hypothetical set of all possible observations of the type being investigated (Ecology, 2004).

Precision: The extent of random variability among replicate measurements of the same property; a data quality indicator (USGS, 1998).

Quality assurance (QA): A set of activities designed to establish and document the reliability and usability of measurement data (Kammin, 2010).

Quality Assurance Project Plan (QAPP): A document that describes the objectives of a project, and the processes and activities necessary to develop data that will support those objectives (Kammin, 2010; Ecology, 2004).

Quality control (QC): The routine application of measurement and statistical procedures to assess the accuracy of measurement data (Ecology, 2004).

Relative Percent Difference (RPD): RPD is commonly used to evaluate precision. The following formula is used:

$$[\text{Abs}(a-b)/((a + b)/2)] * 100$$

where “Abs()” is absolute value and a and b are results for the two replicate samples. RPD can be used only with 2 values. Percent Relative Standard Deviation is (%RSD) is used if there are results for more than 2 replicate samples (Ecology, 2004).

Replicate samples: Two or more samples taken from the environment at the same time and place, using the same protocols. Replicates are used to estimate the random variability of the material sampled (USGS, 1998).

Representativeness: The degree to which a sample reflects the population from which it is taken; a data quality indicator (USGS, 1998).

Sample (field): A portion of a population (environmental entity) that is measured and assumed to represent the entire population (USGS, 1998).

Sample (statistical): A finite part or subset of a statistical population (USEPA, 1997).

Sensitivity: In general, denotes the rate at which the analytical response (e.g., absorbance, volume, meter reading) varies with the concentration of the parameter being determined. In a specialized sense, it has the same meaning as the detection limit (Ecology, 2004).

Spiked blank: A specified amount of reagent blank fortified with a known mass of the target analyte(s); usually used to assess the recovery efficiency of the method (USEPA, 1997).

Spiked sample: A sample prepared by adding a known mass of target analyte(s) to a specified amount of matrix sample for which an independent estimate of target analyte(s) concentration is available. Spiked samples can be used to determine the effect of the matrix on a method’s recovery efficiency (USEPA, 1997).

Split sample: A discrete sample subdivided into portions, usually duplicates (Kammin, 2010).

Standard Operating Procedure (SOP): A document which describes in detail a reproducible and repeatable organized activity (Kammin, 2010).

Surrogate: For environmental chemistry, a surrogate is a substance with properties similar to those of the target analyte(s). Surrogates are unlikely to be native to environmental samples. They are added to environmental samples for quality control purposes, to track extraction efficiency and/or measure analyte recovery. Deuterated organic compounds are examples of surrogates commonly used in organic compound analysis (Kammin, 2010).

Systematic planning: A step-wise process which develops a clear description of the goals and objectives of a project, and produces decisions on the type, quantity, and quality of data that will be needed to meet those goals and objectives. The DQO process is a specialized type of systematic planning (USEPA, 2006).

References for QA Glossary

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