Marine Ambient and Outfall Monitoring Program-2003

Sampling and Analysis Plan

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1.0 Introduction

The Wastewater Treatment Division of the King County Department of Natural Resources and Parks operates and maintains three wastewater treatment plants (WWTP); South, West Point and Vashon and two combined sewer overflow treatment plants (CSOTP); Carkeek and Alki, that discharge treated effluent into the Central Puget Sound Basin. One of King County's responsibilities is to conduct monitoring in marine waters to confirm that these discharges are not degrading water quality in the vicinity of treatment plant outfalls or overflow sites. The routine marine monitoring program has two components; outfall monitoring that focuses on areas near treatment plant discharges and ambient monitoring that focuses on areas outside the immediate vicinity of known discharges. It is important to monitor areas outside the influence of outfall discharges in order to assess background conditions in Puget Sound and to provide data for comparison.

This sampling and analysis plan (SAP) addresses water, macroalgae, shellfish, and intertidal and subtidal sediment monitoring for the ambient program and water macroalgae, shellfish, and intertidal sediment for the outfall monitoring program. Included are descriptions of the monitoring program, sampling stations, sample design, data quality objectives, sampling and analytical methodologies, quality assurance criteria and data validation procedures. Sampling and analytical methodologies for outfall subtidal sediment monitoring are addressed in separate SAPs.

2.0 Monitoring Project Goals

The primary goals of the marine ambient monitoring program are:

- to monitor the physical, chemical and microbiological constituents of the water, sediment, shellfish tissue and macroalgae in vicinities of the WWTP and CSOTP outfalls to ensure discharges are not adversely affecting receiving waters relative to standard water quality criteria and baseline water quality conditions (WAC, 1992);
- to monitor the ambient physical, chemical and microbiological constituents of the water, sediments, shellfish tissue and macroalgae away from WWTP or CSOTP outfalls to provide baseline data.
- to assess spatial and temporal trends of the physical, chemical and microbiological constituents of water, sediment, shellfish tissue and macroalgae including tracking seasonal variability and long term changes in environmental conditions.

3.0 Monitoring Area Descriptions

King County's ambient and outfall monitoring stations are located within the Central Puget Sound Basin. Outfall monitoring stations are positioned to assess potential effects of WWTP and CSOTP effluent, whereas ambient stations are positioned to provide background data for comparison. Figures 1 and 2 show the outfall and ambient monitoring station locations, respectively. Individual station coordinates are listed in Appendix A, Tables 1 and 2.

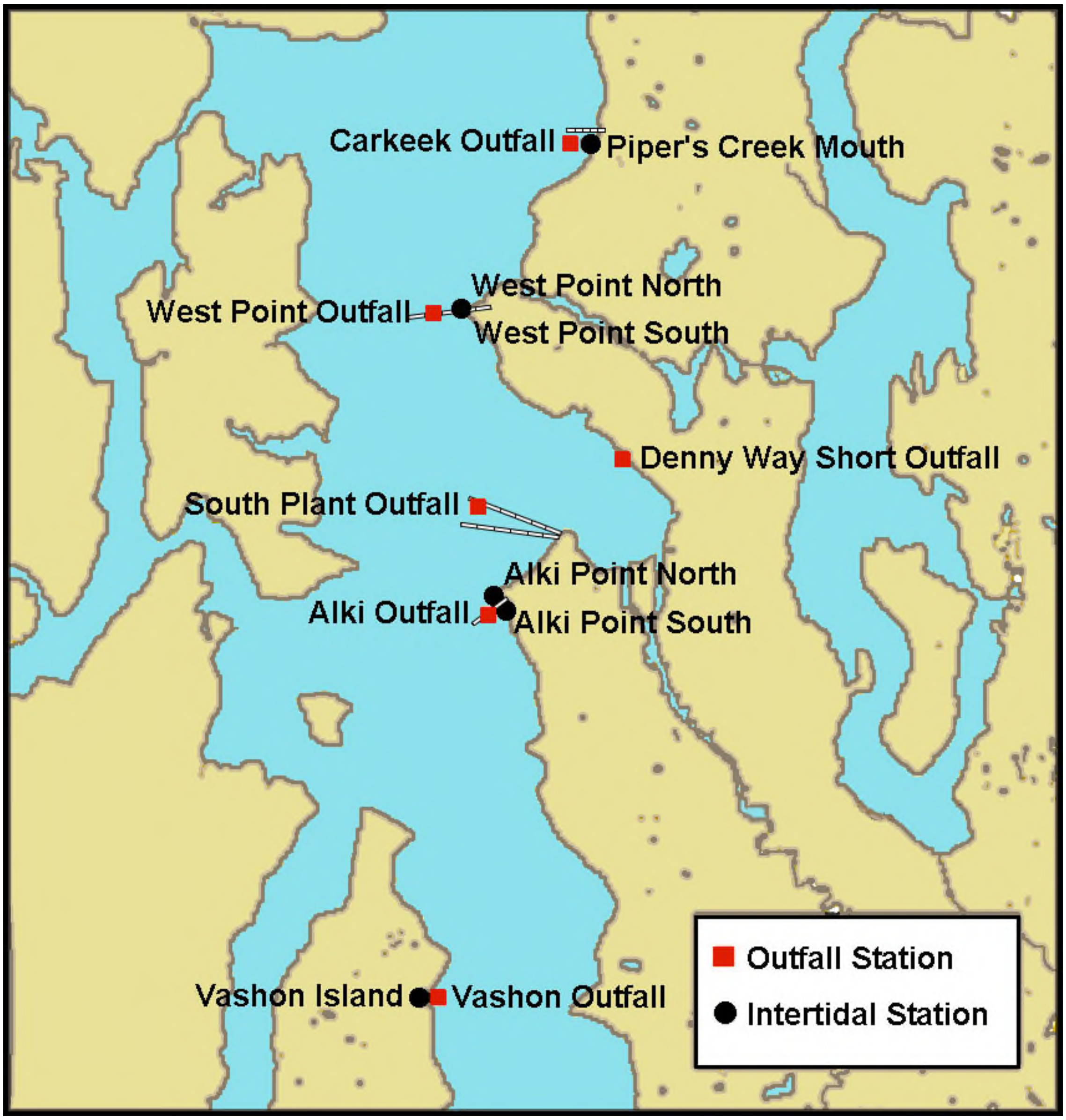

Figure 1. Outfall Monitoring Stations Map

Figure 2. Ambient Monitoring Stations Map.

4.0 Monitoring Project Design

4.1 Data Quality Objectives

4.1.1 Precision, Accuracy and Bias

Precision is the agreement among a set of results and is a measure of the reproducibility of a result. Accuracy is an estimate of the difference between the true value and the determined mean value. The accuracy of a result is affected by both systematic and random errors. Bias is a measure of the difference, due to a systematic factor, between an analytical result and the true value of an analyte. Precision, accuracy, and bias for analytical chemistry and microbiology may be measured by one or more of the following quality assurance/quality control (QA/QC) procedures:

- collection and analysis of field replicate samples; and
- analysis of various laboratory QC samples such as method blanks, matrix spikes, certified reference materials, and laboratory duplicates or triplicates. QC is expected to meet method or program specific QC acceptance limits.

A comprehensive list of QA/QC samples, frequencies and acceptance limits that are analyzed for each parameter and matrix can be found in Appendix B.

4.1.2 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at the sampling point or an environmental condition. Water, sediment, shellfish, and macroalgae samples for chemistry and microbiology analysis will be collected from stations with predetermined coordinates and sampling depths to represent specific site locations. The collection of *in situ* water column data will also be performed at stations with predetermined coordinates.

4.1.3 Completeness

Completeness is defined as the total number of samples analyzed for which acceptable analytical data are generated, compared to the total number of measurements and samples determined in the sampling plan. Sampling at stations with known position coordinates in favorable conditions will aid in providing a complete set of data for this project. The goal for completeness is 100%. If 100% completeness is not achieved, the project team will evaluate if the project DQOs can still be met or if additional samples may need to be collected and analyzed.

4.1.4 Comparability

Comparability is a qualitative assessment expressing the confidence with which one data set can be compared to another. This goal is achieved through using standard techniques to collect and analyze representative samples, along with standardized data procedures. Historical water quality data from the monitoring area will be compared with data generated from this study to enhance the monitoring data set. Previous data will be used if comparable sampling and analytical techniques have been employed and if samples were collected from similar locations and/or depths. Specific sample collection and analysis methodologies have changed over time and will likely change in the future. Documenting such changes in an addendum to this SAP will aid in data analyses for the future. The direct comparability of data collected using older methods with newer data may not be appropriate.

4.2 Sampling Strategy

4.2.1 Monitoring Schedule

The sampling schedule is designed to assess spatial and temporal variation of general water quality parameters in the water. Annual sampling events, including sediment (conventionals, metals and organics analyses), shellfish (organics and metals analyses) and macroalgae (metals analysis), are intended to monitor long term trends and make spatial comparisons. Shellfish are also analyzed monthly from May to September for indicator bacteria, e.g. fecal coliform and enterococci. Tables 1 and 2 show an overview of the outfall and ambient monitoring schedules. A comprehensive list of matrices, parameters analyzed and sampling frequency may be found in Appendix A, Tables 3 through 8.

Table 1. Annual Outfall Monitoring Schedule

Station	Locator	Sediment			Water		Shellfish			Algae
		Conventionals	Metals	Organics	Bacteria	GWQP	Metals	Organics	Bacteria	Metals
Intertidal										
Piper's Creek Mouth	KSHZ03	1	1	1	12	12	1	1	5	1
West Point North	KSSN04				12				5	1
West Point South	KSSN05	1	1	1	12	12	1	1	5	1
Alki Point North	LSKR01				12					
Alki Point South	LSKS01	1	1	1	12	12	1	1	5	1
Vashon Island	MSJL01	1	1	1	12	12	1	1	5	1
Subtidal										
Carkeek Outfall	CK200P				12	12				
West Point Outfall	KSSK02				12	12				
Denny Way Short Outfall	LTBC42				12	12				
South Plant Outfall	LSEP01				12	12				
Alki Outfall	LSKQ06				12	12				
Vashon Outfall	VO50E				12	12				

Numerical values denote sampling frequency of each parameter. Water samples are collected monthly, shellfish bacteria samples are collected monthly May-September.

Table 2. Annual Ambient Monitoring Schedule

Station	Locator	Sediment			Water		Shellfish			Algae
		Conventionals	Metals	Organics	Bacteria	GWQP	Metals	Organics	Bacteria	Metals
Intertidal Stations										
Edwards Point	ITEDWARDSPT				12	12				
Richmond Beach	JSVW04	1	1	1	12	12	1	1	5	1
Carkeek Park	ITCARKEEKP				12	12				
Piper's Creek	KTHA01				12	12				
Golden Gardens	KSLU03				12		1	1	5	1
Shilshole Bay	KSQU01				12					
Magnolia	KSYV02				12					
Inner Elliott Bay	LTAB01				12					
Inner Elliott Bay	LTEH02				12					
Seacrest	LSGY01				12					
Duwamish Head	LSFX01				12					
West Seattle	LSHV01				12					
Lincoln Park	LSTU01				12					
Fauntleroy Cove	LSVW01				12	12				
Seahurst Park	MTEC01				6					
Normandy Park	MTLD03				6		1	1	5	1
Tramp Harbor	MSSM05				6				5	
Subtidal Stations										
Point Wells	PTWELLS1				12	12				
Point Jefferson	KSBP01				12	12				
Elliott Bay	LTED04				12	12				
Dolphin Point	LSNT01				12	12				
East Passage	NSEX01				12	12				

Numerical values denote sampling frequency of each parameter. Water samples are collected monthly, shellfish bacteria samples are collected monthly May-September.

4.2.2 Parameters Measured

Water samples are collected and analyzed for bacteria and general water quality parameters (GWQP). Water samples are collected monthly with the exception of Normandy Park (MTLD03) and Tramp Harbor (MSS05), which are sampled May through October for bacteria and water temperature.

Subtidal GWQP include physical properties, (Secchi transparency, salinity, density, total suspended solids and temperature), nutrient abundance (nitrate + nitrite, ammonia, total phosphorus, and silica), dissolved oxygen, chlorophyll-a, phaeophytin, and photosynthetically active radiation. Intertidal GWQP include salinity, temperature, nitrate + nitrite, ammonia, total phosphorus, and silica. Bacteria analyses include fecal coliforms and enterococcus.

Sediments are collected annually in August and analyzed for conventional parameters, organic compounds and total metals. Conventional parameters analyzed include particle size distribution (PSD), total organic carbon (TOC), total solids and total volatile solids. Organic chemicals analyzed include pesticides, polychlorinated biphenyls (PCBs), and base/neutral/acid extractable semivolatile (BNA) compounds. Metals analyses include aluminum, arsenic, beryllium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, selenium, silver, and zinc.

Shellfish are collected monthly in May, June, July, August, and September and analyzed for fecal coliform and enterococcus bacteria. Annual shellfish samples are collected in August and analyzed for conventional parameters, organic compounds, and total metals.

Conventionals analyzed include total solids and percent lipids. Organic compounds analyzed include pesticides, polychlorinated biphenyls (PCBs, (BNA) compounds. Metals analyzed include aluminum, arsenic, beryllium, cadmium, chromium, copper, iron, lead, magnesia, mercury, nickel, selenium, silver, and zinc.

Macroalgae are collected annually in August and analyzed for totals metals including arsenic, cadmium, chromium, copper, iron, lead, mercury, nickel, selenium, silver, and zinc. Macroalgae, intertidal sediment samples and shellfish samples that will be analyzed for chemical parameters will be collected concurrently.

5.0 Sampling and Field Data Collection

The Environmental Services Section (ESS) of the King County Environmental Laboratory (KCEL) will be responsible for collecting all samples and taking all field measurements. Following a standard set of protocols for collecting samples and gathering field data will enhance the comparability and representativeness of a data set. This section describes field methodologies and protocols for collection of representative subtidal and intertidal samples, as well as the collection of *in situ* field data.

Subtidal water column samples and conductivity, temperature and density profiler (CTD) field data will generally be collected from either of King County's research vessels, *R/V Liberty* or *R/V Chinook*. If scheduling or maintenance conflicts occur, samples or field data may be collected from the University of Washington School of Oceanography's research vessel, *R/V Clifford Barnes*.

5.1 Station Positioning

5.1.1 Subtidal Water Column Samples

A precise method of station positioning is important for studies in which sampling stations are revisited multiple times. Subtidal water column sampling will not only assess spatial differences in water column characteristics over the monitoring area but seasonal variability at each particular location as well. Sampling will be conducted monthly, with samples collected at least three weeks but not more than five weeks apart. All samples in a monthly sampling event must be collected within two consecutive days, and preferably in a single day.

In order to assess temporal changes in water column characteristics, the station must be revisited as precisely as possible. Station positioning for subtidal water column sampling will be accomplished using a Trimble Differential Global Positioning System (DGPS). Prior to the study, prescribed station coordinates (State Plane NAD83 coordinate system) are loaded into the shipboard DGPS. During the sampling event, the shipboard navigational system will utilize the differential data transmissions from regional Coast Guard base stations to automatically correct its GPS satellite data. The GPS antenna is boom-mounted above the sampler descent line to achieve a more accurate coordinate fix above the sampling point. Previous DGPS usage indicates that an average precision of one to two meters can usually be attained. Water column samples will be collected only when the DGPS coordinates are within 100 ft of the station target coordinates (King County, Jan 2003).

5.1.2 Intertidal Water Samples

Samples are collected at a single depth of less than one-quarter meter. Actual sample depth may vary depending upon wave conditions. The sample collector(s) visually position themselves at the site through the use of shoreline benchmarks and then wade into the water to a depth of approximately one meter to collect the sample. The coordinates for a given station are obtained at the upper part of the intertidal access; the actual collection point is dependent upon the tide (King County, Feb 2000).

5.1.3 Intertidal Sediment Samples

Intertidal sampling station location is selected by choosing a site at a tidal elevation of 6.5 feet, which corresponds to roughly the middle of the vertical intertidal range. Care is taken to select an area of finer sediment, as it is not practical to analyze cobble or gravelly sediment. The water level is determined with a tide chart and a timepiece. An optical level or "pea shooter" is then used to sight a measured staff being held by a second person at the waterline, who walks up and down the intertidal until at the proper elevation and sediment type. Exact sample positioning is difficult due to variation in substrate; variability with respect to precise station coordinates is to be expected (PSEP, 1996a).

5.1.4 Shellfish Samples

Shellfish sampling stations are located by using visual landmarks. An initial survey of the likely habitat in the vicinity of the station is conducted. Sampling personnel search for likely substrate with sand and cobbles. The shape of butter clam's (*Saxixdomus giganteus*) siphon holes are often distinctive and can usually be detected prior to digging (PSEP, 1996a).

5.1.5 Macroalgae Samples

Macroalgae sampling stations are located by using visual landmarks. An initial survey of the likely habitat in the vicinity of the station is conducted. Suitable macroalgae specimens are then located (PSEP, 1996a).

5.2 Field Measurement and Sample Collection Procedures

5.2.1 Subtidal Water Column Sample Collection and Handling

This section describes sampling methodologies for the collection of water column samples to be analyzed for conventional and microbiological parameters (King County, Jan 2003).

5.2.1.1 Microbiology

Microbiological samples will be collected in conjunction with the collection of samples for conventional analysis (Section 4.2.1). Samples will be transferred from the Niskin bottles into sterile sample bottles and then stored in ice-filled coolers until delivery to the laboratory. One set of field replicates will be collected per 20 analytical samples.

5.2.1.2 Conventionals

Secchi depth transparency will be determined at each sampling station using a standard 10-inch Secchi disk. *In situ* water column data including conductivity, temperature, depth, dissolved oxygen, fluorescence, light intensity and turbidity will be measured and recorded using a SeaBird Electronics CTD. Data comparability will be assessed after each water column sampling event by comparing CTD plots for each parameter to expected field conditions. Current CTD plots will also be compared with long-term trend analysis for each location and parameter.

Water samples will be collected using Niskin sample bottles attached to the CTD, which will be programmed to collect samples on the upcast at between two and seven depths, dependant upon the station depth as follows; 1, 15, 25, 35, 55, and 100 meters. A seventh depth will be sampled approximately 10 to 15 meters above the seafloor if station depth exceeds 150 meters. Exceptions to this sampling regime include Vashon Outfall (VO50E), which is sampled at 1, 5, and 10 meters, West Point Outfall (KSSK02), which is sampled to 55 meters, Elliott Bay (LTED04), which is sampled to 75 meters, Alki Outfall (LSKQ06), which is sampled to 35 meters, and Denny Way Outfall (LTBC42), which is sampled at 1 and 5 meters.

Upon retrieval of the CTD, sample aliquots will be transferred from the Niskin bottles to appropriate sample containers (see Appendix C, Table 1). Fecal coliform, enterococcus, ammonia, nitrate/nitrite, total suspended solids, silica, total phosphorus, phaeophytin, and chlorophyll-*a* will be routinely collected and analyzed. Two additional samples each day will be collected and analyzed in the laboratory for dissolved oxygen, salinity, and turbidity and compared to electronic *in situ* data for QC purposes. Samples will be stored in ice-filled coolers until delivery to the laboratory.

5.2.1.3 Subtidal Water Column Samples QC

QC samples will include field replicates (FREP) and laboratory verification samples. FREP samples are collected by re-casting the Niskin bottle. One FREP each day of the run will be collected from a station and depth combination that allows collection of all parameters, including bacteria and pigments. Two laboratory verification samples will be collected each day of the run for laboratory analysis of dissolved oxygen (Winkler), salinity, and turbidity.

5.2.1.4 CTD *In Situ* Data Collection

The SBE 25 SEALOGGER® CTD, manufactured by SeaBird Electronics of Bellevue, Washington, is a profiling system for lake, coastal, estuarine and deep-water work. In addition to measuring conductivity, temperature, and depth, (CTD) the instrument measures dissolved oxygen, fluorescence (indicative of chlorophyll concentration), light intensity (photosynthetically active radiation) and turbidity (optical backscatterance). Salinity and density are calculated from direct measurements of temperature and conductivity.

The CTD is deployed from the research vessels by hydraulic winch. The instrument is allowed to equilibrate to surface conditions for approximately five minutes before data recording begins. The CTD is lowered at a specified descent rate from the surface to approximately five meters above the sea floor (downcast). Data are recorded both on the downcast and during the instrument's return to the surface, the upcast. Data are recorded to a datalogger at a frequency of eight-hertz or approximately eight recordings per second.

Upon retrieval of the instrument, data are uploaded to a laptop computer from the datalogger prior to the next cast. System software converts parameter data into surface-to-depth plots. Temperature, conductivity, turbidity and salinity are field-reviewed for quality control. The CTD is rinsed *in situ* with marine water and is stored aboard the R/V Liberty between sampling stations (King County, Jan, 2003). CTD parameters and associated detection limits can be found in Appendix A, Table 1.

5.2.1.5 Subtidal Water Column CTD QC

QA/QC for CTD data collection will be maintained through proper instrument calibration, described below, collection of field samples for laboratory analytical verification, and assessment of data comparability.

The CTD's strain gauge, thermometer, conductivity probe, turbidity probe, light intensity probe and fluorometer will be calibrated, as recommended, on an annual basis by the instrument manufacturer/distributor. Field personnel will calibrate the dissolved oxygen probe on a monthly basis (generally following membrane changes), using Winkler titration and barometric/water bath methodology. System maintenance and calibration information is kept in instrument logbooks along with cruise-specific notes. Field samples for laboratory analytical verification and assessment of data comparability will be collected as well.

5.2.2 Intertidal Water Sampling

5.2.2.1 Conventionals and Microbiological Samples

Water temperature will be measured in the field with a digital thermometer and the value recorded on a field sheet along with the sample start time and sample method code. When positioned, sample collector(s) collect water samples by removing the caps from the sample containers and submerging the containers in an inverted position. Once under water, the sample containers are then returned to the upright position to allow air to escape and water to enter. Bottles are left with headspace to allow for shaking prior to analysis. Upon retrieval, the sample containers are capped and placed in ice-filled coolers for transport to the laboratory. This methodology will be used for collection of samples for analysis of conventional and microbiological parameters.

Several sites are routinely sampled from a fishing pier and state ferry docks. At these sites a polyethylene bucket on a rope is used. The bucket is dunked and rinsed thoroughly then filled. A drain hose is used fill the sample bottles. A digital thermometer is used for estimating the temperature of the remaining water (King County, Feb 2000).

5.2.2.2 Field Measurement QC Procedures-Intertidal Water

QA/QC for temperature data collection will be maintained through annual instrument verification and duplicate temperature measurements at the rate of one per 20 field measurements or one per sampling event.

5.2.3 Shellfish Sample Collection Methods

Butter clams (*Saxixdomus giganteus*) can be detected prior to digging; the shape of the siphon hole is often distinctive. The actual digging follows an initial survey of likely habitat. A tarp is placed next to the dig site and excavated sediment is placed on the tarp to minimize disturbance to other organisms. Sediment is replaced after a sufficient number of clams are collected as described below. Care is taken to avoid breaking the shells and clams with broken or chipped shells are not collected. Clams between 60 and 120 millimeters (mm) in size are collected. An effort is made to collect the average size that is encountered. Upon receipt at the lab all shells are measured prior to sample preparation (PSEP, 1996a).

Clams are collected for two different programs, the summer monthly microbiological sampling and the annual sampling for metals and organics. The sample containers and sample volumes differ as follows: for the monthly microbiological sampling, a minimum of 5 specimens are collected and placed into a clean sealable bag. For the annual chemical sampling at least 10 specimens are collected and put into a clean glass wide mouth jar.

5.2.3.1 Shellfish Sample Collection Field QC

Field replicate samples are collected at the rate of one per sampling event. Field replicates will consist of the appropriate number of shellfish: a minimum of 5 clams for microbiology analyses and 10 for chemistry.

5.2.4 Macroalgae Sample Collection Methods

Personnel wearing gloves collect *Ulva fenestrata* macroalgae samples. At least 50 grams of macroalgae are collected, rinsed in ambient seawater, and packed into 2 acid washed, 8-ounce plastic specimen cups. Care is taken to collect only healthy macroalgae (discolored or free-floating macroalgae are not collected). The samples are stored on ice until delivered to the laboratory.

5.2.4.1 Macroalgae Sample Collection Field QC

Field replicate samples are collected at the rate of one per sampling event. Field replicates will consist of at least 50 grams of macroalgae (PSEP, 1996a).

5.2.5 Sediment Sampling and Analysis

This section describes field methodologies and protocols for collection of representative intertidal sediment samples.

A two person sampling team will collect intertidal sediment samples by hand. Intertidal stations are sampled annually. Once the station location is determined, intertidal sediment samples are collected with a stainless steel tube, two inches in diameter, about a foot long. The tube is pushed into the sediment to a depth of five cm and then retracted. The entire volume is placed into a large stainless steel bowl. Up to 20 cores are placed in the bowl and then are homogenized using a stainless steel spoon. Separate clean sampling devices, bowls and spoons, kept wrapped in aluminum foil, are used for each sampling station (PSEP, 1996a).

5.2.5.1 Sample Acceptability Criteria

Samples should be composed mainly of finer grained sediments and should be free of cobbles and large gravel. If cobble or large gravel is found, sampling personnel will sample a location where a finer substrate is found.

5.2.5.2 Sample processing

After homogenization, sediment samples are split into appropriate sample containers. Samples are stored on ice until delivered to the KCEL at the end of the sampling day.

5.2.5.3 Intertidal Sediment Field QC

Intertidal sediment samples are composites collected from several grabs. Field replicates are collected.

5.3 Sample Storage and Delivery

All sample containers will be stored in an insulated cooler on ice immediately after collection to maintain the samples at a temperature of approximately 4^{o} C until delivery to the laboratory. Sample containers for each station will be grouped and placed in plastic bags to facilitate sample receipt and login. At the end of each sampling day, all samples will be transported back to the KCEL.

The sample delivery person will relinquish all samples to the sample login person upon arrival at the KCEL. The date and time of sample delivery will be recorded, and both parties will then sign off in the appropriate sections on the Laboratory Work Order form at this time. Once completed, the original will be archived in the respective project file. Samples delivered after regular business hours will be stored in a locked chain of custody refrigerator until the next day.

6.0 Field Documentation and Logbook Procedures

The primary means for recording all sampling details will be as follows:

- LIMS[1]-generated field sheets will contain all sample particulars.

    sample ID number
    station name
    sample depth or station bottom depth (for sediment samples)
    sediment depth (i.e., sampler penetration depth)
    physical sediment characteristics (for sediment samples)
    field data including temperature
    tidal information
    date and time of sample collection
    name of recorder

- LIMS-generated container labels

    will identify each container with a unique sample number, station and site names, collect date, analyses required, preservation method, etc.

- Ship's logbook

    will contain records of all shipboard activities, destinations, arrival and departure times, general weather and positioning information, the names of shipboard personnel and equipment problems, if applicable.

- Ship's cruise plan

    will list the prescribed stations to be sampled, along with their respective coordinates and other associated locating information.

- Electronic DGPS coordinate data

    will be electronically logged for each grab sample using both the lat/long and NAD 83 State Plane formats.

[1] LIMS is the acronym for Laboratory Information Management System.

7.0 Chain of Custody Procedures

Custody begins when a sample is collected and the sample remains in the custody of the sampler until it is transferred to the sampler manager at the lab. Documentation of the chain of custody starts when the field sheet or the sample management logbook is signed or initialed by the sampler and the sample manager. Once delivered to the laboratory, samples must remain in the secured area of the lab or be in the direct possession of an appropriate lab employee. The secured area of the lab is defined as all lab and sample management spaces inside the building which is only accessible to authorized employees and escorted guests.

8.0 Laboratory Analytical Methods

The KCEL will be responsible for analyzing analytical samples with the exception of sediment particle size distribution analysis (PSD) and total sulfides. A contract laboratory will perform these analyses.

8.1 Water Parameters

8.1.1 General Water Quality Parameters

The following section provides a brief description of each of the methods for conventional analyses. Analytical method references and associated detection limits are summarized in Appendix D, Table 2.

- Ammonia Nitrogen – This is an automated analysis of the ammonium ion. When ammonium is introduced to a basic medium it forms ammonia gas. In the membrane module, the ammonia gas diffuses across a polypropylene membrane and is retained in a slightly acidic stream. Phenol and alkaline hypochlorite react with ammonia to form indophenol blue that is proportional to the ammonia concentration. The blue color formed is intensified with sodium nitroferricyanide. The absorbance is measured at 660 nanometers (King County, Jul 2002a).
- Nitrate+Nitrite Nitrogen – This is an automated analysis where nitrate is converted to nitrite by cadmium reduction. Nitrite is determined by diazotizing with sulfanilamide and coupling with N-(1-naphthyl)-ethylenediamine dihydrochloride to form a highly colored azo dye, which is proportional to the nitrite concentration. Nitrite alone may be determined by omitting the reduction step. The absorbance is measured at 540 nm (King County, Jul 2002a).
- Total Phosphorus – Most forms of phosphorus are oxidized to orthophosphate using ammonium persulfate in an acidic medium and under high pressure and temperature. The digestate is analyzed by automated colorimetry for orthophosphate. Orthophosphate reacts with molybdenum VI and antimony III in an acidic medium to form an antimonyphosphomolybdate complex. This complex is subsequently reduced with ascorbic acid to form a blue color and the absorbance is read at 660 nm (King County, Jul 2002b).
- Silica – This is an automated analysis of silica. Silica in solution as silicic acid or silicate reacts with molybdate reagent in acid media to form β-molybdo-silicic acid. The complex is reduced by ascorbic acid to form molybdenum blue. The absorbance is measured at 660 nm (King County, Jul 2002a).
- Chlorophyll-*a* with phaeophytin-*a* – Sample is concentrated by filtering a measured volume of sample through a glass fiber filter at low vacuum. Pigment is extracted from the phytoplankton by ultrasonic disruption of the cells in an acetone medium. Concentration of chlorophyll-a is determined fluorometrically. Because phaeophytin-*a* is a positive

interferent, chlorophyll-*a* is converted to phaeophytin-*a* by acidification and then the concentration of phaeophytin-*a* is determined, allowing calculation of the original concentrations of these related pigments. The fluorometric method provides a procedure for determination of low level chlorophyll-*a* and phaeophytin-*a*, in marine phytoplankton using fluorescence detection (King County, Jun 2003).

- Total Suspended Solids – A well-mixed sample is filtered through a pre-weighed glass fiber filter, the residue retained on the filter is dried to constant weight at 103 to 105°C. The increase in weight of the filter represents the total suspended solids (King County, Apr 2003).
- Dissolved Oxygen – Dissolved oxygen (DO) by the Winkler titration, Azide modification method. The sample is treated with manganous sulfate followed by Alkali-Iodide-Azide (A-I-A) solution. Dissolved oxygen rapidly oxidizes an equivalent amount of the dispersed divalent manganous hydroxide to form a brown precipitate, $Mn(OH)_2$. Upon acidification with sulfuric acid, manganic hydroxide forms manganic sulfate, which then acts as an oxidizing agent to liberate free Iodine from the alkali-iodide. The iodine, which is stoichiometrically equivalent to the dissolved oxygen in the sample, is then titrated with a standard solution of sodium thiosulfate. The titration end point is determined visually with a starch indicator (King County, Apr 2002a).
- Salinity – Conductance of an electrical current through the sample is measured and compared to the conductivity of a standard seawater solution. This is an analysis of salinity in saline waters, between 3-42 on the Practical Salinity Scale (King County, Aug 2002).
- Turbidity – The method is based on a comparison of the intensity of light scattered by the sample under defined conditions with the intensity of light scattered by a standard reference suspension under the same conditions. The higher the intensity of scattered light, the higher the turbidity. The range of turbidity from 0 to 2500 nephelometric units (NTU), higher values may be obtained with dilution of the sample (King County, Jan 2001).

8.1.2 Water Conventionals QC

QC samples will be analyzed at a frequency of one per analytical batch or a minimum of one per 20 analytical samples. A comprehensive list of laboratory QC samples for conventional analyses and associated control limits are listed in Appendix B, Table 1.

8.1.3 Monthly Water Microbiology

Microbiological parameters analyzed on a routine basis will include Enterococcus and fecal coliform bacteria. The following section provides a brief description of each of the methods for microbiology analyses. Analytical method references and associated detection limits are summarized in Appendix D, Table 3.

- Enterococcus – A subgroup of the traditional fecal streptococci bacteria that includes *Enterococcus faecalis, E faecium, E. gallinarum,* and *E. avium.* Enterococci are used as indicators of human fecal bacteria contamination. The analysis of water for enterococci will be done by membrane filtration (King County, Mar 2003).
- Fecal coliform – Gram negative rod, non-sporeformers, gas and acid production from lactose fermentation in 24 hours at 44.5 °Celcius. Fecal coliform bacteria are found in the intestinal tract of humans and other warm blooded animals and are used as indicators of fecal contamination. High fecal coliform densities imply the possible presence of pathogenic bacteria that are associated with fecal contamination. The analysis of water for fecal coliforms will be done by membrane filtration (King County, 2003b).

8.1.4 Water Microbiology QC

QC samples will be analyzed at a frequency of one per analytical batch or a minimum of one per 20 analytical samples. A comprehensive list of laboratory QC samples for microbiology analyses and associated control limits are listed in Appendix B, Table 2.

8.2 Shellfish

Separate shellfish samples are collected for bacterial and chemical analyses. Chemistry and bacterial analyses require different shellfish processing procedures so shellfish samples cannot be shared between the microbiology lab and the chemistry labs.

8.2.1 Shellfish Microbiology

8.2.1.1 Shellfish Processing

Shellfish for bacterial analysis are processed in accordance with Examination of Seawater and Shellfish, Greenberg Arnolde, 5th edition, 1985 (APHA). The clam's shells are measured with calipers at the largest point along the hinge axis. This measurement is recorded. The shells of the clams are scrubbed with a sterile brush and rinsed with tap water making sure that extraneous materials are removed. The clams are then shucked with sterile surgical steel autopsy knives ensuring all of the shell liquor and meats are collected for analysis. The tissues are homogenized in sterile blenders for a maximum time of 90 seconds. The fecal coliform and enterococcus analyses are initiated immediately following processing (King County, 2003a, c).

8.2.1.2 Microbiology Analytical Methods

The following section provides a brief description of each of the methods for microbiological analyses. A summary of the analytical methods for bacteria analyses and associated detection limits are summarized in Appendix D, Table 4.

- Fecal Coliform - The analysis for fecal coliforms in shellfish is by the Most Probable Number (MPN) method. Tissue samples are weighed out and homogenized with an equal weight of monopotassiumphosphate buffer with magnesium chloride (APHA water). Homogenate and appropriate dilutions are added to Lauryl Tryptose Broth (LTB) tubes, which are incubated at 35 °C. LTB tubes that show turbidity or gas formation within 48 hours are used to inoculate EC media tubes that are then incubated at 44.5 °C. The number of EC tubes that form turbidity or gas within 24 hours of inoculation and the dilution information is used to calculate the most probable number per 100 grams of sample (King County, 2003c).
- Enterococcus - The analysis for enterococcus in shellfish is by the MPN method. Tissue samples are weighed out and mixed with APHA water. After homogenization with a blender, dilutions of the homogenate are added to azide dextrose broth tubes, which are then incubated at 35 °C. The tubes that show turbidity within 48 hours are analyzed using mmE agar. The number of tubes with confirmed responses and the dilution information is used to calculate the most probable number per 100 grams of sample (King County, 2003a).

8.2.2 Shellfish Microbiology QC

Lab duplicates and positive and negative control samples A comprehensive list of laboratory QC samples and frequency for shellfish analyses and associated control limits are listed in Appendix B, Table 3.

8.2.3 Chemistry

8.2.3.1 Shellfish Processing

Shellfish are processed at the King County Environmental Laboratory in accordance with PSEP recommended protocols (PSEP, 1996b,c). The clam’s shells are measured with calipers at the largest point along the hinge axis. This measurement is recorded. The clams are rinsed with water to remove sand and other material adhering to the shells and shucked using a ceramic blade. Tissues and associated liquids are placed in a non-contaminating tissue homogenizer equipped with a titanium blade. The tissues are homogenized until resembling a fine puree, approximately one to five minutes. Samples are frozen until analyzed. A blender blank is prepared by processing an aliquot of reagent water through the homogenization process. The blender blank is used to evaluate potential cross-contamination or contribution of analytes from the homogenization equipment (King County, 2003d).

8.2.3.2 Shellfish Analytical Methodologies

After the shellfish tissues are homogenized, aliquots are analyzed for total lipids, total solids, organic compounds (semivolatile organics, pesticides and PCBs) and metals.

Organics Analytical Methodologies for Shellfish Samples

The following section provides a brief description of each of the methods for organics analyses (King County, May 2003). Analytical method references and associated detection limits are summarized in Appendix D, Tables 5, and 6.

- Percent Lipids Analysis - A 15 to 30 gram portion of tissue is mixed to a sandy texture with anhydrous sodium sulfate. A 1:1 mixture of methylene chloride ($MeCl_2$)/acetone is added. The samples are sonicated for four minutes with approximately 100 mls of 1:1 $MeCl_2$/acetone. The resulting extract is transferred to a specimen cup and dried. The residue is weighed and percent lipids are calculated (King County, Jul 1998).
- BNA Sample Preparation – The extraction procedure is EPA 3550B, which is a pulse sonication extraction technique. A 30 gram portion of tissue is mixed with anhydrous hydromatrix drying agent. Samples are spiked with the appropriate standards and a 1:1 mixture of $MeCl_2$/acetone is added. The samples are sonicated for three minutes with 100 mls of $MeCl_2$/acetone three separate times. The resulting combined extract is concentrated using the Kuderna-Danish (KD) technique, by which the solvent volume is reduced by boiling in a special glass apparatus with a three-ball Snyder column on top.
- BNA Analysis – The analytical procedure is EPA 8270 (SW846-8270) in which extracts, containing the neutral, basic and acidic organic compounds that are soluble in methylene chloride\acetone, are introduced into the GC/MS by injection into a gas chromatograph (GC) with a narrow-bore fused-silica capillary column. The GC column is temperature-programmed to separate the analytes, which are then detected with a mass spectrometer (MS) interfaced to the gas chromatograph. Analytes eluted from the capillary column are introduced into the mass spectrometer via a jet separator or a direct connection. Qualitative identification of the parameters in the extract is performed using their corresponding retention time and the relative abundance of three or more characteristic masses. Quantitative analysis is performed by comparing the response of a single characteristic (quantitation) mass

relative to an internal standard using a minimum five-point calibration curve.

- Chlorinated Pesticide and PCB Sample Preparation – The extraction procedure is EPA 3550B, which is a pulse sonication solvent extraction technique. A 30 gram portion of tissue is mixed with anhydrous hydromatrix. Samples are spiked with the appropriate standards and a 1:1 mixture of methylene chloride/acetone is added. The samples are sonicated for three minutes with 100 mls of $MeCl_2$/acetone three separate times. The resulting combined extract is concentrated using the KD technique
- Chlorinated Pesticide and PCB Analysis – The analytical method is EPA 8081/8082 performed by gas chromatograph with electron capture detector (GC-ECD). A 1 or 2 µl aliquot is introduced into the gas chromatograph (GC) via an autosampler. A temperature program is used to separate the compounds as they move through two dissimilar phased capillary columns used to retard the elution of the individual compounds. The compounds then enter the separate ECDs as discrete compounds. The detector response is transferred to a data system where the voltages are charted and analyzed. Compounds are identified by their retention times matches with standards and their presence on both the primary and confirmatory columns. Quantitation is accomplished by integrating each compound to baseline and comparing their responses with the responses of standards of known concentrations.

8.2.4 Shellfish Organics QC

QC for shellfish will include the analysis of replicate samples, samples with a surrogate added, and matrix spiked samples. Method blanks and certified reference material (CRM) samples will also be analyzed along with the shellfish tissue. A comprehensive list of laboratory QC samples and frequency for shellfish analyses and associated control limits are listed in Appendix B, Table 4.

8.2.5 Metals Analytical Methodologies for Shellfish Samples

The following section provides a brief description of each of the methods for trace metals analyses. Analytical method references and associated detection limits are summarized in Appendix D, Tables 7-9.

- Mercury Sample Preparation – a representative aliquot of the sample is digested with nitric and sulfuric acids and oxidizing agents to convert the organic and complex forms of mercury to the mercuric ion. The sample is then pre-reduced with hydroxylamine hydrochloride to reduce the excess oxidizing agents (King County, May 1998e).
- Mercury Analysis by cold vapor atomic absorption – stannous chloride, a reducing agent, is added to the sample to convert mercury ions to

Hg(0) vapor. The reduced sample is purged with argon, sweeping the mercury vapor into a quartz cell where it is measured using atomic absorption (King County, May 2003e).

- Metals Sample Preparation – a representative aliquot of the sample is digested with nitric acid and hydrogen peroxide and heat to oxidize the organic material and solubilize the analytes. The sample is then ready for analysis by ICP-OES or ICP-MS (King County, May 1998d).
- Metals Analysis – Samples are analyzed by Inductively Coupled Plasma Mass Spectrometry (ICP-MS) or Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES) depending on the concentration of each analyte. ICP-MS is a more sensitive instrument than ICP-OES. Analytes that are not detected by ICP-OES are analyzed by ICP-MS. In both cases prepared samples are aspirated through a nebulizer and spray chamber where an aerosol is formed. A stream of argon carries the sample aerosol through a quartz torch into a radio frequency induced plasma. In the plasma, the sample is desolvated and elements are dissociated into ions. For ICP-MS, the ions produced are entrained in the plasma gas and, by means of a water-cooled differentially pumped interface, introduced into a high vacuum chamber that housed a quadaprole mass spectrometer. The ions are sorted according to mass to charge ratio and measured with a channel electron multiplier detector. For ICP-OES, emission spectra are produced in the plasma, dispersed by a diffraction grating, and measured by photomultiplier tubes. The resulting signal is processed by computer and corrected for background and spectral interferences (King County, May 1998a, Aug 1998).

8.2.6 Shellfish Metals QC

Method blank, replicate, matrix spike and CRM samples and will be analyzed along with the shellfish tissue. A comprehensive list of laboratory QC samples and frequency for shellfish analyses and associated control limits are listed in Appendix B, Table 4.

8.3 Macroalgae

8.3.1 Macroalgae Metals Analysis

Macroalgae samples are homogenized using a grinder equipped with titanium blades on a stainless steel assembly. Macroalgae samples are only analyzed for metals parameters and total solids. Analytical method references and associated detection limits are summarized in Appendix D, Tables 10 through 12.

- Mercury Sample Preparation – a representative aliquot of the sample is digested with nitric and sulfuric acids and oxidizing agents to convert the organic and complex forms of mercury to the mercuric ion. The sample is then pre-reduced with hydroxylamine hydrochloride to reduce the excess oxidizing agents (King County, May 1998e).

- Mercury Analysis by cold vapor atomic absorption – stannous chloride, a reducing agent, is added to the sample to convert mercury ions to Hg(0) vapor. The reduced sample is purged with argon, sweeping the mercury vapor into a quartz cell where it is measured using atomic absorption (King County, May 2003e).
- Metals Sample Preparation – a representative aliquot of the sample is digested with nitric acid and hydrogen peroxide and heat to oxidize the organic material and solubilize the analytes. The sample is then ready for analysis by ICP-OES or ICP-MS (King County, May 1998d).
- Metals Analysis – Samples are analyzed by Inductively Coupled Plasma Mass Spectrometry (ICP-MS) or Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES) depending on the concentration of each analyte. Analytes that are not detected by ICP-OES are analyzed by ICP-MS (King County, May 1998a, Aug 1998).

8.3.2 Macroalgae Metals QC

Method blank, lab replicate, and matrix spike samples will be analyzed along with the macroalgae tissue. A comprehensive list of laboratory QC samples and frequency for shellfish analyses and associated control limits are listed in Appendix B, Table 5.

8.4 Sediment Parameter Methodologies

8.4.1 Sediment Conventionals

KCEL will analyze all conventional chemistry parameters, with the exception of total sulfides and particle size distribution (PSD). Analytical method references and associated detection limits for conventional parameters analyzed at KCEL are summarized in Appendix D, Table 13. All subcontracted chemical parameters will be analyzed in accordance with existing agreements with the subcontracting laboratory.

The following section provides a brief description of each of the methods for conventionals analyses.

- Total Organic Carbon – Samples are dried at 70°C, pulverized, treated with 10% phosphoric acid to remove inorganic carbon, and dried again at 70°C. Subsamples are then combusted in an oxygen environment at 950°C, forming carbon dioxide, which is then measured by a nondispersive infrared detector (NDIR) and compared to a known concentration (King County, Apr 2002b).
- Total Solids – A well-mixed sample is weighed in an aluminum dish and dried at 103-105 °C to constant weight. The resulting net weight

represents the total solids portion of the sample (King County, Apr 1999c).

- Total Volatile Solids - A well-mixed sample is weighed in an aluminum dish and dried at 103-105 °C until a constant weight is achieved. The resulting net weight represents the total solids portion of the sample. The dried sample is then ignited at 550 °C for approximately 15 minutes until a constant weight is achieved. The resulting weight loss represents the total volatile solids portion of the sample (King County, Apr 1999c).
- Total Oil and Grease - The sample is acidified to a low pH (<2), desiccated by mixing with Magnesium Sulfate ($MgSO_4$*H_20) and extracted into freon using a Soxhlet apparatus. The solvent is evaporated from the extract and the residue weighed (King County, Apr 1999b).
- Ammonia Nitrogen - Ammonium is extracted with 2 M KCl by the physical means of shaking the sample for a standard duration. Sample analysis is automated using a Flow Solution series segmented flow autoanalyzer. (King County, Jul 2002).

8.4.2 Sediment Conventionals QC

Method blank, replicate and spiked blank samples will be analyzed along with the sediment samples. A comprehensive list of laboratory QC samples and frequency for sediment analyses and associated control limits are listed in Appendix B, Tables 6, and 7.

8.4.3 Sediment Organics

KCEL will analyze all organic parameters. Results will be compared against regulatory standards established by the Washington State Department of Ecology Sediment Management Standards (SMS). The ability of the laboratory to attain detection limits which meet TOC-normalized numeric sediment criteria will depend upon the TOC content of each sample (The RDLs and MDLs listed in this section are not TOC-corrected.). Detection limits have been requested that meet Sediment Quality Standards for target analytes. Analytical method references and associated detection limits are listed in Appendix D, Tables 14 and 15.

The following section provides a brief description of each of the methods for trace organics analyses.

- BNA Sample Preparation – The extraction procedure is EPA 3550B, which is a pulse sonication extraction technique (King County, May 1998b).
- BNA Analysis – The analytical procedure is EPA 8270 (SW846-8270) (King County, Jan 1999a).

- Chlorinated Pesticide and PCB Sample Preparation – The extraction procedure is EPA 3550B, which is a pulse sonication extraction technique (King County, May 1998b).
- Chlorinated Pesticide and PCB Analysis – The analytical method is EPA 8081/8082 performed by gas chromatograph with electron capture detector (GC-ECD) (King County, May 1998f).

8.4.4 Sediment Organics QC

QC samples will include the analysis of sample replicates, matrix spiked and surrogate spiked samples, CRM, and method and spiked blanks. A comprehensive list of laboratory QC samples and frequency for sediment analyses and associated control limits are listed in Appendix B, Tables 6 and 7.

8.4.5 Sediment Metals

KCEL will analyze all metal parameters. Detection limits have been requested that meet Sediment Quality Standards (SQS) for target analytes. Analytical method references and associated detection limits are listed in Appendix D, Table 16.

The following section provides a brief description of each of the methods for trace metals analyses.

- Mercury Sample Preparation – a representative aliquot of the sample is digested with aqua regia and oxidizing agents to convert the organic and complex forms of mercury to the mercuric ion. The sample is then pre-reduced with hydroxylamine hydrochloride to reduce the excess oxidizing agents (King County, May 1998c).
- Mercury Analysis by cold vapor atomic absorption – stannous chloride, is added to the sample to convert mercury ions to Hg(0) vapor. The reduced sample is measured using atomic absorption (King County, May 2003e).
- Metals Sample Preparation – a representative aliquot of the sample is digested with acid, H_2O_2, and heat to oxidize the organic material and solubilize the analytes. Samples are allowed to settle or filtered. The sample is then ready for analysis by ICP-OES (King County, Jul 2000).
- Metals Analysis – Samples are analyzed by Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES) (King County, May 1998b, Aug 1998).

8.4.6 Sediment Metals QC

Method blank, replicate, SRM, and matrix spike samples will be analyzed along with the sediment samples. A comprehensive list of laboratory QC samples and frequency for sediment analyses and associated control limits are listed in Appendix B, Tables 6, 7, and 8.

9.0 Documentation and Record Keeping

9.1 Data Reporting

The KCEL will provide a 90-day turnaround time for all chemistry analytical data, starting upon receipt of the last sample collected. Data will be reported to LIMS.

CTD electronic files will be stored in a secure area on the lab network. These include the original '.hex' and '.afm' files, processed files and the raw Licor (surface light intensity) files. Summary data for specified depths are entered into LIMS and printed to hard copy. Hard copies of the bottle data and color printouts of the CTD casts are also produced and archived.

Water, shellfish, macroalgae and sediment data will be reported and discussed in the *Water Quality Status Report for Marine Waters, 2003.*

Sediment chemistry data resulting from samples analyzed by the KCEL or its subcontract laboratory will be reported in a QA1 format, as defined by the Washington State Department of Ecology. The final QA1 report will contain the following information and deliverables:

- A QA1 narrative discussing data quality in relation to site objectives and data qualification criteria.
- A summary of all associated QC data.
- A comprehensive report containing all qualified analytical and field data.

Sediment data will be reported in the SEDQUAL format and delivered to WDOE following completion of the QA/QC (QA1) review by the KCEL.

9.2 Data Analysis Tools

The Marine and Sediment Assessment group of the King County Science and Technical Support unit will analyze the data and produce the Water Quality Status Report for Marine Waters, 2003.

> *Water data results will be compared against Washington State water quality standards for pesticides and PCBs (WAC 1997). The water quality standards include both acute and chronic values. Bacterial data will be compared against state surface water standards for fecal coliform bacteria (WAC 1992). The data will be compared against the Class AA marine water standard.*

Sediment chemistry data results will be evaluated by making direct comparisons between the targeted parameter concentrations found within each sample to sediment chemical criteria represented in the Washington State SMS. It is the intention to report non-ionizable organics data in both a dry weight and TOC-normalized format if the organic carbon content is greater than 0.5% and results will be compared to SQS numeric criteria. However, if the organic carbon content at any particular station is below 0.5%, then only dry weight results will be reported and compared to the Lowest Apparent Effects Threshold (LAET) guidelines (EPA, 1988).

Shellfish data results will be compared against U.S. Food and Drug Administration (FDA) guidance values termed Levels of Concern. Levels of concern are established for five metals: arsenic, cadmium, chromium, lead, and nickel (FDA 1993 a, b, c, d, e). Mercury data will be compared against the FDA's Action Level, the value above which shellfish cannot be commercially traded (FDA 1995).

Charts and graphs will be used to assess spatial and temporal trends. T-Tests, ANOVAs and correlation analyses may also be used to analyze the data to answer specific questions. Several assumptions of the data must be met in order to use statistical analyses including those of independence, normality (or log-normal distribution), and homogeneity of variance. T-tests, ANOVAs and other statistical tests should meet a confidence level of 95 % and a power of alpha = 0.05.

9.3 Record Keeping Requirements

All laboratory analytical data and some *in situ* data are maintained in perpetuity on LIMS. Data may be viewed on-line in LIMS by King County personnel only. Project data may also be downloaded from LIMS into a hard copy format using Microsoft Excel®. Sediment data will be reported on a routine basis in Excel® format along with an accompanying QA1 review narrative.

All field and sampling records, custody documents, raw lab data, quality control data, summaries and narratives will be kept at the KCEL for one year and then sent to the King County Archives and Records Management Office.

The following data will be kept at the King County Records Storage for a minimum of 10 years form the sample collection date: sample preparation logs, standard preparation logs, instrument run logs, instrument maintenance data, instrument calibration data, raw data printouts, quality control/quality assurance data, balance and pipette calibration logs, quality control calculation spreadsheets and database reports, instrument performance checks, data review forms, corrective action forms, method detection limit studies, chain of custody and sample logbooks and sample disposal logbooks.

9.4 Data Validation

Data validation is critical in the evaluation of how well analytical and field data meet project DQOs. All analytical data and most field measurements are entered into King County's Laboratory Information Management System (LIMS).

Field data, such as *in situ* data measurements or recorded environmental observations, are peer reviewed prior to entry into LIMS. Laboratory analytical data are reviewed, first by the primary analyst and then by a peer reviewer, prior to entry of the data into LIMS.

Analytical data are peer reviewed for completeness and QC sample data are viewed for compliance with project and method QA/QC requirements.

Quality control results that exceed the acceptance limits will be evaluated to determine appropriate corrective actions. Samples will typically be reanalyzed if the unacceptable QC results indicate a systematic problem with the overall analysis. Unacceptable QC results caused by a particular sample or matrix will not require reanalysis unless an allowed method modification would improve the results. Analytical results that are outside the acceptance limits shown in the table above will be qualified according to QA1 data validation guidance. See Appendix E for a comprehensive list of data qualifiers.

10.0 Health and Safety Requirements

The following general health and safety guidelines have been provided in lieu of a site-specific Health and Safety Plan. These guidelines will be read and understood by all members of the sampling crew.

10.1 General Vessel Safety

To help prevent accidents and ensure adequate preparation for emergencies that may possibly arise, the following safety equipment will be required on the KCEL research vessels *Liberty* and *Chinook*:

- one personal floatation device for each crew member as well as at least one throwable floatation device,
- an accessible, clearly labeled, fully stocked first-aid/CPR kit,
- an accessible and clearly labeled eye wash,
- one (preferably two) VHF marine radio(s) with weather channel,
- a cellular telephone,
- a horn,
- navigation lights,
- an emergency life raft with oars or paddles,
- an anchor and suitable line,
- signal flares, and
- a reach pole or shepherd's hook.

Personal protective equipment will be selected and used that will protect workers involved in sediment sampling from the hazards and potential hazards likely to be encountered. Minimum required personal protective equipment for marine sediment sampling shall include the following:

- hard hat,
- steel-toe rubber boots,
- chemical-resistant gloves (i.e. Nitrile), and
- safety glasses (UV protective).

Recommended additional personal protective equipment will include rain gear and hearing protection when on board the *Liberty* and *Chinook.*

10.2 Sediment Grab Sampling Safety

Sampler deployment and sediment retrieval present physical hazards due in part to the heavy weight of the grab sampler, its suspension above the vessel deck, and the risk of accidental or premature closure. Prior to each sampling event, all cabling shackles, pins, housings, and swivels will be inspected to ensure the integrity of all points along the sampling assembly.

The sampler will always be set while it is resting on a stable surface. Once set, a safety pin will be set in place on the triggering mechanism and remain in place until the sampler is swung outboard of the vessel rail. Special care will be exercised when removing the safety pin to ensure personal safety in the event of a gear or winch failure. Fingers will not be placed through the ring of the pin when it is removed and hands will be kept completely clear of the sampler interior after the pin has been removed. If a sampler is retrieved that has not been tripped, it will be lowered to a stable surface before any worker contact.

During grab retrieval, one crewmember will watch for the appearance of the grab sampler and alert the winch operator when the sampler is first visible below the water surface. Attempting to bring a swinging grab sampler on board poses a serious risk of being hit or knocked overboard. The winch operator will minimize swinging before the grab sampler is brought on board for the crew to secure. Hard hats and gloves will always be worn when handling the grab sampler.

The winch drum, blocks, capstan, and any area between the grab sampler and railings, the deck, and heavy equipment all represent significant pinching and crushing hazards. Only experienced crewmembers will operate the winch or capstan during a sampling event. Other crewmembers will exercise care to avoid these potentially hazardous areas.

10.3 Intertidal Sampling Hazards

Intertidal sediment sampling presents physical hazards related to the sampling locations. Some sites have rough terrain that must be navigated including boulders and driftwood where slips or falls are possible. Care must be taken when crossing rough terrain and appropriate footwear must be worn. Some sampling locations require crossing railroad tracks where attention must be paid to passing trains.

10.4 Chemical Hazards

Contact with marine sediment at some sampling stations may present a health hazard from chemical constituents of the sediment. Potential routes of exposure to chemical hazards include inhalation, skin and eye absorption, ingestion and injection. Potentially hazardous chemical sediment constituents at the sites included in this SAP may include hydrogen sulfide, mercury, polynuclear aromatic hydrocarbons, polychlorinated biphenyls, and other organic chemicals.

Crewmembers will exercise caution to avoid coming into contact with sediment at all stations during sampling operations. Protective equipment may include chemical-resistant gloves, safety glasses or goggles, and protective clothing (i.e. rain gear). Crewmembers will exercise good personal hygiene after sampling and prior to eating or drinking.

11.0 References

FDA. 1993a. *Guidance Document for Arsenic in Shellfish*. Center for Food Safety and Applied Nutrition, Food and Drug Administration, Washington, D.C.

FDA. 1993b. *Guidance Document for Cadmium in Shellfish*. Center for Food Safety and Applied Nutrition, Food and Drug Administration, Washington, D.C.

FDA. 1993c. *Guidance Document for Chromium in Shellfish*. Center for Food Safety and Applied Nutrition, Food and Drug Administration, Washington, D.C.

FDA. 1993d. *Guidance Document for Lead in Shellfish*. Center for Food Safety and Applied Nutrition, Food and Drug Administration, Washington, D.C.

FDA. 1993e. *Guidance Document for Nickel in Shellfish*. Center for Food Safety and Applied Nutrition, Food and Drug Administration, Washington, D.C.

FDA. 1995. *Action Levels for Poisonous or Deleterious Substances in Human Food and Animal Feed*. Center for Food Safety and Applied Nutrition, Food and Drug Administration, Washington, D.C.

King County, May 1998a. *Standard Operating Procedure for Instrumental Analysis for Trace Elements in Environmental Samples by Inductively Coupled Plasma Optical Emission Spectrometry (SOP# 06-02-004-002).* King County Environmental Laboratory. Seattle, Washington.

King County, May 1998b. *Standard Operating Procedure for Low Level Extraction of Organic Compounds from Soil and Sediment by Pulsed Sonication (SOP# 07-01-003-002).* King County Environmental Laboratory. Seattle, Washington.

King County, May 1998c. *Standard Operating Procedure for Preparation of Soil, Sediment and Sludge Samples for High Concentration Range Analysis of Total Mercury by Automated Cold Vapor Atomic Absorption Spectrometry (SOP# 06-01-002-001).* King County Environmental Laboratory. Seattle, Washington.

King County, May 1998d. *Standard Operating Procedure for Preparation of Tissue Samples for Analysis of Total Metals by Inductively Coupled Plasma - Mass Spectrometry (ICP-MS) or by Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES) (SOP # 06-02-003-001).* King County Environmental Laboratory. Seattle, Washington.

King County, May 1998e. *Standard Operating Procedure for Preparation of Tissue Samples for Routine Tissue Calibration Range Analysis of Total Mercury by Automated Cold Vapor Atomic Absorption Spectrometry (SOP # 06-01-003-001).* King County Environmental Laboratory. Seattle, Washington.

King County, May 1998f. *Standard Operating Procedure for Analysis of Chlorinated Pesticides and PCBs by GC_ECD (SOP #* 07-03-003-002*).* King County Environmental Laboratory. Seattle, Washington.

King County, Jul 1998. *Standard Operating Procedure for Determining Percent Lipids by Pulsed Sonication (SOP# 07-03-010-001)*. King County Environmental Laboratory. Seattle, Washington.

King County, Aug 1998. *Standard Operating Procedure for Instrumental Analysis of Environmental Samples for Trace Metals Using a VG PlasmaQuad 2+ Inductively Coupled Plasma Mass Spectrometer (SOP# 06-03-004-001)*. King County Environmental Laboratory. Seattle, Washington.

King County, Jan 1999a. *Standard Operating Procedure for Analysis of Semivolatile Compounds by GC/MS (SOP# 07-03-001-004)*. King County Environmental Laboratory. Seattle, Washington.

King County, Jan 1999b. *Standard Operating Procedure for Total, Polar and Non Polar Oil and Grease Gravimetric Analysis of Solids (SOP# 07-03-017-000)*. King County Environmental Laboratory. Seattle, Washington.

King County, Jan 1999c. *Standard Operating Procedure for Total Solids and Total Volatile Solids (SOP# 03-01-007-001)*. King County Environmental Laboratory. Seattle, Washington.

King County, Feb 2000. *Standard Operating Procedure for Clean Sampling for Ultra Trace Metals, Trace Organics, Microbiology and Conventional Chemistry Parameters Using Surface Grabs (SOP# 02-02-13-000)*. King County Environmental Laboratory. Seattle, Washington.

King County, Jul 2000. *Standard Operating Procedure for Preparation of Soil, Sediment and Biosolids (Sludge) Samples for Analysis of Total Metals Analysis by ICP-OES (SOP# 06-02-002-002)*. King County Environmental Laboratory. Seattle, Washington.

King County, Jan 2001. *Standard Operating Procedure for Turbidity (SOP# 03-01-011-003)*. King County Environmental Laboratory. Seattle, Washington.

King County, Jul 2001. *Standard Operating Procedure for Analysis of Ammonia Nitrogen, Nitrate Nitrogen, Nitrite Nitrogen, Extractable Phosphorous, Total Nitrogen, and Total Phosphorus in Sediments, Soils & Sludge (SOP# 03-03-0014-001)*. King County Environmental Laboratory. Seattle, Washington.

King County, Apr 2002a. *Standard Operating Procedure for Oxygen, Dissolved -- Winkler Titration, Azide Modification (SOP # 03-03-007-002)*. King County Environmental Laboratory. Seattle, Washington.

King County, Apr 2002b. *Standard Operating Procedure for Total Organic Carbon in Sediments and Soils (SOP# 03-04-002-002)*. King County Environmental Laboratory. Seattle, Washington.

King County, Jul 2002a. *Standard Operating Procedure for Ammonia Nitrogen, Bioavailable Phosphorus, Nitrate Nitrogen, Nitrite Nitrogen, ortho-Phosphate, and Silica* *in Liquid Matrices* (SOP# 03-03-012-002). King County Environmental Laboratory. Seattle, Washington.

King County, Jul, 2002b. *Standard Operating Procedure for Total Phosphorus, Total Dissolved Phosphorus, Total Nitrogen and Total Dissolved Nitrogen in Liquid Matrices (SOP# 07-03-013-001)*. King County Environmental Laboratory. Seattle, Washington.

King County, Aug 2002. *Standard Operating Procedure for Salinity (SOP# 03-03-003-002)*. King County Environmental Laboratory. Seattle, Washington.

King County, Jan 2003. *Standard Operating Procedure for Sampling Methods for Marine Offshore Water Column (SOP# 02-02-002-001)*. King County Environmental Laboratory. Seattle, Washington.

King County, Mar 2003. *Standard Operating Procedure for Enterococcus in Environmental Water by Membrane Filtration (SOP# 05-04-001-000)*. King County Environmental Laboratory. Seattle, Washington.

King County, Apr 2003. *Standard Operating Procedure for Suspended Solids - Total, 0.45 μm, and Volatile (SOP# 03-01-009-002)*. King County Environmental Laboratory. Seattle, Washington.

King County, May 2003. *Standard Operating Procedure for Tissue Analysis of Pesticides and PCBs and Congeners by QC-ECD (SOP# 07-03-013-000)*. King County Environmental Laboratory. Seattle, Washington.

King County, Jun 2003. *Standard Operating Procedure Chlorophyll-a and Pheophytin-a Fluorometric Method (SOP# 03-02-002F-003)*. King County Environmental Laboratory. Seattle, Washington.

King County, 2003a. *Standard Operating Procedure for Enterococcus in Tissue and Algae by MPN (SOP# 05-04-005-000). Draft*. King County Environmental Laboratory. Seattle, Washington.

King County, 2003b. *Standard Operating Procedure for Fecal Coliform in Environmental Water by Membrane Filtration (SOP# 05-03-001-000). Draft*. King County Environmental Laboratory. Seattle, Washington.

King County, 2003c. *Standard Operating Procedure for Fecal Coliform in Tissue and Algae by MPN (SOP# 05-03-006-000). Draft*. King County Environmental Laboratory. Seattle, Washington.

King County, 2003d. *Standard Operating Procedure for Homogenization of Tissue Samples for the Analysis of Trace Metals, Trace Organics and Conventional Laboratory Parameters (SOP# 01-01-006-000)*. King County Environmental Laboratory. Seattle, Washington.

King County, 2003e. *Standard Operating Procedure for Instrumental Analysis for Mercury in Environmental Samples by Automated Cold Vapor Atomic Absorption Spectrometry (SOP # 06-01-004-003)*. King County Environmental Laboratory. Seattle, Washington.

PSEP, 1996a. *Recommended Guidelines for Sampling Marine Sediment, Water Column, and Tissue in Puget Sound. Prepared for the Puget Sound Estuary Program* (U.S. Environmental Protection Agency Region 10) by the King County Environmental Laboratory. Seattle, Washington.

PSEP, 1996b. *Recommended Guidelines for Measuring Metals in Puget Sound Marine Water, Sediment and Tissue Samples. Prepared for the Puget Sound Estuary Program* (U.S. Environmental Protection Agency Region 10) by the King County Environmental Laboratory. Seattle, Washington.

PSEP, 1996c. *Recommended Guidelines for Measuring Organic Compounds in Puget Sound Marine Water, Sediment and Tissue Samples. Prepared for the Puget Sound Estuary Program* (U.S. Environmental Protection Agency Region 10) by the King County Environmental Laboratory. Seattle, Washington.

U.S. Environmental Protection Agency. 1995. Method 1669: *Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels* EPA-R-95-034 (April 1995 Draft), Office of Water, Washington, DC.

U.S. Environmental Protection Agency. 1998. *Sediment Quality Values Refinement, 1998 Update and Evaluation of AETs. Volume I.* Prepared by the Puget Sound Estuary Program.

Washington Administrative Code (WAC). 1992. Chapter 173-201a. November 25, 1992. Olympia, Washington.

Washington Administrative Code (WAC). 1997. Chapter 173-201a. November 25, 1992. Olympia, Washington.

APPENDIX A

MONITORING STATIONS AND PARAMETERS

Table A-1 Outfall Monitoring Station Coordinates

Sampling Stations		State Plane Coordinates			Matrices Sampled			
Locator	Station Description	NAD 83 Northing	NAD 83 Easting	Number of Depths for Water Samples	Sediment	Water	Shellfish	Algae
Intertidal								
KSHZ03	Piper's Creek Mouth	263736	1259784	1	◆	◆	◆	◆
KSSN04	West Point North	245728	1246032	1		◆	◆	◆
KSSN05	West Point South	245272	1245980	1	◆	◆	◆	◆
LSKR01	Alki Point North	213666	1249416	1		◆		
LSKS01	Alki Point South	212834	1250427	1	◆	◆	◆	◆
MSJL01	Vashon Island	169666	1241897	1	◆	◆	◆	◆
Subtidal								
CK200P	Carkeek Outfall	263819	1257728	5		◆		
KSSK02	West Point Outfall	245121	1242740	5		◆		
LTBC42	Denny Way Short Outfall	229116	1263611	2		◆		
LSEP01	South Plant Outfall	223360	1247400	7		◆		
LSKQ06	Alki Outfall	212165	1248496	4		◆		
VO50E	Vashon Outfall	169454	1243253	3		◆		

Table A-2 Ambient Monitoring Station Coordinates

Sampling Stations		State Plane Coordinates			Matrices Sampled			
Locator	Station Description	NAD 83 Northing	NAD 83 Easting	Number of Depths for Water Samples	Sediment	Water	Shellfish	Algae
Intertidal								
ITEDWARDSPT	Edwards Point	297035	1256652	1		◆		
JSVW04	Richmond Beach	286171	1257194	1	◆	◆	◆	◆
ITCARKEEKP	Carkeek Park	263760	1259886	1		◆		
KTHA01	Piper's Creek	263290	1261108	1		◆		
KSLU03	Golden Gardens	256354	1253305	1		◆	◆	◆
KSQU01	Shilshole Bay	249160	1253227	1		◆		
KSYV02	Magnolia	234436	1254742	1		◆		
LTAB01	Inner Elliott Bay	232168	1261581	1		◆		
LTEH02	Inner Elliott Bay	222696	1269069	1		◆		
LSGY01	Seacrest	218711	1258776	1		◆		
LSFX01	Duwamish Head	222264	1256896	1		◆		
LSHV01	West Seattle	217159	1253750	1		◆		
LSTU01	Lincoln Park	197289	1253039	1		◆		
LSVW01	Fauntleroy Cove	194969	1254846	1		◆		
MTEC01	Seahurst Park	174011	1260832	1		◆		
MTLD03	Normandy Park	165142	1263285	1		◆	◆	◆
MSSM05	Tramp Harbor	154908	1243459	1		◆	◆	
0305	West Waterway	211346	1265729	2		◆		
0307	Duwamish River	195911	1277781	2		◆		
Subtidal								
PTWELLS1	Point Wells	290395	1253659	7		◆		
KSBP01	Point Jefferson	275214	1247880	7		◆		
LTED04	Elliott Bay	224199	1264780	6		◆		
LSNT01	Dolphin Point	198653	1245194	7		◆		
NSEX01	East Passage	134701	1255331	7		◆		

Table A-3 Monthly Outfall Water Column Monitoring Laboratory and Field Parameters

		Bacteria		Conventionals							CTD								Field		
Station	Depth (m)	Enterococcus	Fecal Coliform	Ammonia Nitrogen	Chlorophyll-a	Nitrite + Nitrate Nitrogen	Phaeophytin	Silica	Total Phosphorus	Total Suspended Solids	Chlorophyll, Field	Density, Field	Dissolved Oxygen, Field	Light Intensity (PAR), Field	Salinity, Field	Sample Temperature, Field	Surface Light Intensity (PAR), Fiel	Turbidity, Field	Sample Depth	Sample Start Time	Secchi Transparency
CK200P	1	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
	15	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12		
	25	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12		
	35	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12		
	55	12	12	12		12		12	12	12	12	12	12	12	12	12	12	12	12		
KSSK02	1	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
	15	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12		
	25	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12		
	35	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12		
	55	12	12	12		12		12	12	12	12	12	12	12	12	12	12	12	12		
LTBC42	1	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
	5	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12		
LSEP01	1	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
	15	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12		
	25	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12		
	35	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12		
	55	12	12	12		12		12	12	12	12	12	12	12	12	12	12	12	12		
	100	12	12	12		12		12	12	12	12	12	12	12	12	12	12	12	12		
	190	12	12	12		12		12	12	12	12	12	12	12	12	12	12	12	12		
LSKQ06	1	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
	15	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12		
	25	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12		
	35	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12		
VO50E	1	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
	5	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12		
	10	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12		

Values in parameter columns indicate number of samples collected annually.

Table A-4 Monthly Ambient Water Column Monitoring Laboratory and Field Parameters

		Bacteria		Conventionals							CTD								Field		
Station	Depth (m)	Enterococcus	Fecal Coliform	Ammonia Nitrogen	Chlorophyll-a	Nitrite + Nitrate Nitrogen	Phaeophytin	Silica	Total Phosphorus	Total Suspended Solids	Chlorophyll, Field	Density, Field	Dissolved Oxygen, Field	Light Intensity (PAR), Field	Salinity, Field	Sample Temperature, Field	Surface Light Intensity (PAR), Field	Turbidity, Field	Sample Depth	Sample Start Time	Secchi Transparency
PTWELLS1	1	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
	15			12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12		
	25			12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12		
	35			12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12		
	55			12		12		12	12	12	12	12	12	12	12	12	12	12	12		
	100			12		12		12	12	12	12	12	12	12	12	12	12	12	12		
	130			12		12		12	12	12	12	12	12	12	12	12	12	12	12		
KSBP01	1	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
	15			12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12		
	25			12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12		
	35			12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12		
	55			12		12		12	12	12	12	12	12	12	12	12	12	12	12		
	100			12		12		12	12	12	12	12	12	12	12	12	12	12	12		
	200			12		12		12	12	12	12	12	12	12	12	12	12	12	12		
LTED04	1	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
	15			12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12		
	25			12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12		
	35			12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12		
	55			12		12		12	12	12	12	12	12	12	12	12	12	12	12		
	75			12		12		12	12	12	12	12	12	12	12	12	12	12	12		
LSNT01	1	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
	15			12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12		
	25			12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12		
	35			12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12		
	55			12		12		12	12	12	12	12	12	12	12	12	12	12	12		
	100			12		12		12	12	12	12	12	12	12	12	12	12	12	12		
	200			12		12		12	12	12	12	12	12	12	12	12	12	12	12		
NSEX01	1	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
	15			12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12		
	25			12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12		
	35			12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12		
	55			12		12		12	12	12	12	12	12	12	12	12	12	12	12		
	100			12		12		12	12	12	12	12	12	12	12	12	12	12	12		
	170			12		12		12	12	12	12	12	12	12	12	12	12	12	12		

Values in parameter columns indicate number of samples collected annually.

Table A-5 Monthly Outfall Intertidal Water Monitoring Laboratory and Field Parameters

	Bacteria		Conventionals					Field		
Locator	Enterococcus	Fecal Coliform	Ammonia Nitrogen	Nitrite + Nitrate Nitrogen	Salinity	Silica	Total Phosphorus	Sample Temperature	Sample Start Time	Sampling Method
KSHZ03	12	12	12	12	12	12	12	12	12	12
KSSN04	12	12						12	12	12
KSSN05	12	12	12	12	12	12	12	12	12	12
LSKR01	12	12						12	12	12
LSKS01	12	12	12	12	12	12	12	12	12	12
MSJL01	12	12	12	12	12	12	12	12	12	12

Values in parameter columns indicate number of samples collected annually.

Table A-6 Monthly Ambient Intertidal Water Monitoring Laboratory and Field Parameters

	Bacteria		Conventionals					Field		
Locator	Enterococcus	Fecal Coliform	Ammonia Nitrogen	Nitrite + Nitrate Nitrogen	Salinity	Silica	Total Phosphorus	Sample Temperature	Sample Start Time	Sampling Method
ITEDWARDSPT	12	12	12	12	12	12	12	12	12	12
JSVW04	12	12	12	12	12	12	12	12	12	12
ITCARKEEKP	12	12	12	12	12	12	12	12	12	12
KTHA01	12	12	12	12		12	12	12	12	12
KSLU03	12	12						12	12	12
KSQU01	12	12						12	12	12
KSYV02	12	12						12	12	12
LTAB01	12	12						12	12	12
LTEH02	12	12						12	12	12
LSGY01	12	12						12	12	12
LSFX01	12	12						12	12	12
LSHV01	12	12						12	12	12
LSTU01	12	12						12	12	12
LSVW01	12	12	12	12	12	12	12	12	12	12
MTEC01	6	6						6	6	6
MTLD03	6	6						6	6	6
MSSM05	6	6						6	6	6
0305*	12	12	12	12	12	12	12	12	12	12
0307*	12	12	12	12	12	12	12	12	12	12

Values in parameter columns indicate number of samples collected annually.
* Stations will be sampled for the following additional parameters: alkalinity, conductivity, DO, total nitrogen, TSS, turbidity, and pH.

Table A-7 Annual Shellfish Parameters

	Bacteria [1]		Annual Parameters[2]					Field[3]	
Locator	Enterococcus	Fecal Coliform	BNAs	Chlorinated Pest/PCBs	Percent Lipids	Total Metals	Total Solids	Sample Description	Sample Start Time
JSVW04	5	5	1	1	1	1	1	5	5
KSHZ03	5	5	1	1	1	1	1	5	5
KSLU03	5	5	1	1	1	1	1	5	5
KSSN04	5	5						5	5
KSSN05	5	5	1	1	1	1	1	5	5
LSKS01	5	5	1	1	1	1	1	5	5
MTLD03	5	5	1	1	1	1	1	5	5
MSSM05	5	5						5	5
MSJL01	5	5	1	1	1	1	1	5	5

[1]Shellfish bacteria samples collected monthly in May, June, July, August, and September.
[2]Shellfish organic, metal, and conventional samples collected once, in August.
[3]Shellfish field records entered monthly in May, June, July, August, and September.
Values in parameter columns indicate number of samples collected annually.

Table A-8 Annual Macroalgae and Intertidal Sediment Parameters

	Algae			Sediment									
Locator	Total Metals	Total Solids	Sample Start Time	BNAs	Chlorinated Pest/PCBs	Total Oil & Grease	Total Metals	PSD	Total Solids	Total Organic Carbon	Sediment Sampling Depth	Sample Start Time	Sampling Method
JSVW04	1	1	1	1	1	1	1	1	1	1	1	1	1
KSHZ03	1	1	1	1	1	1	1	1	1	1	1	1	1
KSLU03	1	1	1										
KSSN04	1	1	1										
KSSN05	1	1	1	1	1	1	1	1	1	1	1	1	1
LSKS01	1	1	1	1	1	1	1	1	1	1	1	1	1
MTLD03	1	1	1										
MSJL01	1	1	1	1	1	1	1	1	1	1	1	1	1

Macroalgae and sediment samples collected once, in August, along with annual shellfish samples.
Values in parameter columns indicate number of samples collected annually.

APPENDIX B

QC/QC SAMPLES

Water

Table B-1 Water Conventional QA/QC Samples

Analysis	Method Blank	Duplicate RPD	LCS % Recovery	Matrix Spike % Recovery
Ammonia Nitrogen	< MDL	20%	85 – 115	75 – 125
Nitrate+Nitrite Nitrogen	< MDL	20%	85 – 115	75 – 125
Total Phosphorous	< MDL	20%	85 – 115	75 – 125
Silica	< MDL	20%	85 – 115	65 – 120
Chlorophyll-a/phaeophytin-a	< MDL	25%/50%	95 – 105*	N/A
Total Suspended Solids	< MDL	25%	80-120	N/A
Dissolved Oxygen	N/A	N/A	N/A	N/A
Salinity	N/A	0.05 PSS**	98.5-101.5	N/A
Turbidity	N/A	20%	90 – 110	N/A

RPD – Relative Percent Difference
LCS – Laboratory Control Sample
* LCS for Chlorophyll only, no LCS for Phaeophytin
** Duplicate RPD for salinity should be within 0.05 Practical Salinity Scale
N/A – Not Applicable
< MDL – Less Than Method Detection Limit

Table B-2 Water Microbiology QA/QC Samples

Analysis	Lab Duplicate	Positive Control	Negative Control	System Control
Enterococcus	Pass/Fail	Pass/Fail	Pass/Fail	Pass/Fail
Fecal Coliforms	Pass/Fail	Pass/Fail	Pass/Fail	Pass/Fail

Pass: Meets established quality control guidelines as described in the King County Environmental Laboratory QA/QC Standard Operating Procedure Manual.
Fail: Does not meet established quality control guidelines as described in the King County Environmental Laboratory QA/QC Standard Operating Procedure Manual.

Shellfish

Table B-3 Shellfish Microbiology QA/QC Samples

Analysis	Lab Duplicate	Positive Control	Negative Control
Enterococcus	Pass/Fail	Pass/Fail	Pass/Fail
Fecal Coliforms	Pass/Fail	Pass/Fail	Pass/Fail

Pass: Meets established quality control guidelines as described in the King County Environmental Laboratory QA/QC Standard Operating Procedure Manual.
Fail: Does not meet established quality control guidelines as described in the King County Environmental Laboratory QA/QC Standard Operating Procedure Manual.

Table B-4 Shellfish Chemistry QA/QC Samples

Parameter	Method Blank	Replicate	Matrix Spike	CRM	Surrogate
Metals	1 per QC batch	5% or 1 per QC batch	5% or 1 per extraction batch	1 per QC batch	N/A
BNA	1 per QC batch	5% or 1 per QC batch	5% or 1 per extraction batch	1 per extraction batch	every sample
Pesticide/PCB	1 per QC batch	5% or 1 per QC batch	5% or 1 per extraction batch	1 per extraction batch	every sample

One QC batch represents a maximum of 20 samples or less.
CRM = Certified Reference Material. A blank spike may be used if a CRM is unavailable.
N/A Not Applicable
BNA Base Neutral Acid compounds
PCB Polychlorinated Biphenyl

Macroalgae

Table B-5 Macroalgae QA/QC Samples

Parameter	Method Blank	Lab Replicate	Matrix Spike
Metals	1 per QC batch	5% or 1 per QC batch	5% or 1 per QC batch

Sediment

Table B-6 Sediment QA/QC Samples

Parameter	Method Blank	Duplicate	Triplicate	Matrix Spike	CRM	Surrogate	Spiked Blank
Total Organic Carbon	1 per QC batch	N/A	Min. 5% or 1 per QC batch	N/A	1 per batch	N/A	N/A
Total Solids	1 per QC batch	N/A	Min. 5% or 1 per QC batch	N/A	N/A	N/A	N/A
Total Sulfides	1 per QC batch	N/A	Min. 5% or 1 per QC batch	1 per QC batch	N/A	N/A	N/A
Total Volatile Solids	1 per QC batch	N/A	Min. 5% or 1 per QC batch	N/A	N/A	N/A	N/A
Particle Size Distribution	N/A	N/A	Min. 5% or 1 per QC batch	N/A	N/A	N/A	N/A
Total Oil and Grease	1 per QC batch	Min. 5% or 1 per QC batch	N/A	1 per extraction batch	N/A	N/A	1 per extraction batch
Ammonia Nitrogen	1 per QC batch	N/A	Min. 5% or 1 per QC batch	1 per QC batch	N/A	N/A	N/A
Metals	1 per QC batch	Min. 5% or 1 per QC batch	N/A	Min. 5% or 1 per QC batch	1 per QC batch	N/A	N/A
Semi-volatile Organics	1 per QC batch	Min. 5% or 1 per QC batch	N/A	Min. 5% or 1 MS per extraction MSD batch	1 per extraction batch	every sample	1 per extraction batch
Pesticides/PCB	1 per QC batch	Min. 5% or 1 per QC batch	N/A	Min. 5% or 1 MS per extraction MSD batch	1 per extraction batch	every sample	1 per extraction batch

One batch represents a maximum of 20 samples or less.
CRM = Certified Reference Material. A blank spike may be used if a CRM is unavailable.
N/A= Not Applicable
NOTE: It is not possible to spike all pesticide and PCB compounds into the same sample and obtain useful recovery information. Selected PCB and pesticide target compounds will be used in two separate spikes.

Table B-7 Chemistry Acceptance Limits for Sediment Samples

Parameter	Lab Replicate	Matrix Spike	CRM/SRM	Method Blank	Spiked Blank	Surrogate
Ammonia	≤ 20% RSD	75 - 125%	N/A	< MDL	N/A	N/A
Semi-volatile Organics (a)	≤ 100% RPD	50 - 150%	80 - 120%	< MDL	50-150%	50-150%
Metals (except Mercury) (b)	< 20% RPD	75 - 125%	≤ 120%	< MDL	N/A	N/A
Mercury	< 20% RPD	75 - 125%	80 - 120%	< MDL	N/A	N/A
Total Oil and Grease	≤ 100% RPD	50 - 150%	N/A	< MDL	80-120%	N/A
PSDs	≤ 20% RSD	N/A	N/A	N/A	N/A	N/A
Pesticides/PCBs	≤ 100% RPD	50 - 150%	80 - 120%	< MDL	50-150%	50-150%
TOC	≤ 20% RSD	N/A	80 - 120%	< MDL	N/A	N/A
Total Sulfides (subcontracted)	≤ 20% RSD	65 - 135%	N/A	< MDL	N/A	N/A
Total Volatile Solids	≤ 20% RSD	N/A	N/A	< MDL	N/A	N/A

(a) EPA 8270 list
(b) Metals = Priority Pollutant Metals
CRM = Certified Reference Material
SRM = Standard Reference Material
RPD = Relative Percent Difference (used for duplicates)
RSD = Relative Standard Deviation (used for triplicates)
MDL = Method Detection Limit
N/A = Not Analyzed or Not Applicable

APPENDIX C

SAMPLE CONTAINERS, HOLDING TIMES, AND PRESERVATON REQUIREMENTS

Table C-1 Conventional Parameters Containers, Preservation Methods and Holding Times

Parameter	Matrix	Container	Preservation	Holding Time
Water				
Ammonia	water	500-ml HDPE, AWM	H_2SO_4 to pH<2, 4^o C	28 days
Nitrate+Nitrite	water	500-ml HDPE, AWM	H_2SO_4 to pH<2, 4^o C	28 days
Total Phosphorus	water	500-ml HDPE, AWM	H_2SO_4 to pH<2, 4^o C	28 days
Silica	water	250-ml HDPE, AWM	4^o C	28 days
Dissolved Oxygen	water	300-ml BOD bottle	$MnSO_4$ & AIA, store in the dark	<10 hrs
Chlorophyll-*a*	water	1-L HDPE, ANM or AWM	filter, add $MgCO_3$, -18^o C	28 days
Phaeophytin-*a*	water	1-L HDPE, ANM or AWM	filter, add $MgCO_3$, -18^o C	28 days
Salinity	water	250-ml HDPE, AWM	room temperature	28 days
Total Suspended Solids	water	1-liter HDPE, CWM	4^o C	7days
Turbidity	water	500-ml HDPE, AWM	4^o C	48 hours
Sediment				
Total Solids	sediment	4-oz G, WM	4^o C	14 days
Particle size distribution	sediment	4-oz G, WM	4^o C	6 months
Total Organic Carbon	sediment	4-oz G, WM	4^o C	14 days
Ammonia	sediment	4-oz G, WM	4^0 C	7 days
Total Sulfides	sediment	4-oz G, WM	Zn acetate to ph= 9, 4^o C	7 days
Total Volatile Solids	sediment	4-oz G, WM	4^o C	14 days

L liter
HDPE high density polyethylene
ANM amber narrow mouth
AWM amber wide mouth
BOD biochemical oxygen demand
G glass
WM wide mouth
C degrees centigrade

Table C-2 Metals Containers, Preservation Methods and Holding Times

Parameter	Matrix	Container	Preservation	Holding Time
Macroalgae				
Mercury	macroalgae	8-oz HDPE	4^o C	28 days
Other Metals	macroalgae	8-oz HDPE	4^o C	180 days
Sediment				
Mercury	sediment	8-oz HDPE	-18^O C	28 days
Other Metals	sediment	8-oz HDPE	-18^O C	2 years
Shellfish				
Mercury	shellfish	1-liter G WM	-18^O C	28 days
Other Metals	shellfish	1-liter G WM	-18^O C	2 years

HDPE high density polyethylene
G glass
WM wide mouth
C degrees centigrade

Table C-3 Organics Parameters Containers, Preservation Methods and Holding Times

Parameter	Matrix	Container	Preservation	Holding Time
Sediment				
BNA (8270)	sediment	8-oz G, Teflon lid	-18^O C	1 year to extract, then 40 days to analyze
Pesticides/PCBs (8080)	sediment	8-oz G, Teflon lid	-18^O C	1 year to extract, then 40 days to analyze
Shellfish				
BNA (8270)	shellfish	sealable plastic bag	-18^O C	1 year while frozen, 40 days to analyze after thawing
Pesticides/PCBs (8080)	shellfish	sealable plastic bag	-18^O C	1 year while frozen, 40 days to analyze after thawing

G glass
C degrees centigrade

Table C-4 Microbiological Parameters Containers, Preservation Methods and Holding Times

Parameter	Matrix	Container	Preservation	Holding Time
Water				
Fecal coliform	water	500-mL PP (sterile)	4^{o} C	24 hours
Enterococcus	water	500-mL PP (sterile)	4^{o} C	24 hours
Shellfish				
Fecal coliform	shellfish	resealable plastic bag	4^{o} C	24 hours
Enterococcus	shellfish	resealable plastic bag	4^{o} C	24 hours

mL milliliter
PP polypropylene
C degrees centigrade

APPENDIX D

METHOD DETECTION LIMITS

Water

Table D-1 CTD Parameters Detection Limits

Parameter	Units	MDL	RDL
Salinity, Field	PSS	n/a	n/a
Dissolved Oxygen, Field	mg/L	0.5	1
Chlorophyll, Field	µg/L	0.06	0.12
Turbidity, Field	FTU	0.5	1
Sample Temperature	deg C	n/a	n/a
Light Intensity (PAR), Field	µmol/sm2	n/a	n/a
Surface Light Intensity (PAR), Field	µmol/sm2	n/a	n/a
Density, Field	kg/m3	n/a	n/a
Conductivity, Field	µmhos/cm	0.5	1

µmol/sm2 – micromoles per siemens per square meter
kg/m3 – Kilogram Per Cubic Meter
µg/L - Microgram Per Liter
FTU - Fluorometric Turbidity Units
N/A – Not Analyzed
mg/L - Milligram Per Liter
PSS - Practical Salinity Scale
Deg C- Degrees Celsius

Table D-2 Water Conventional Parameters Detection Limits

Analyte	Method	MDL	RDL	Units
Chlorophyll-a	EPA 445.0	0.01	0.02	µg/L
Nitrogen, Ammonia	SM4500-NH3-G	0.01	0.02	mg/L
Nitrogen, Nitrate+Nitrite	SM4500-NO3-F	0.02	0.04	mg/L
Oxygen, Dissolved	SM4500-O-C	0.5	1	mg/L
Phaeophytin	EPA 445.0	0.02	0.04	µg/L
Phosphorus, Total	SM4500-P-B,F (mod.)	0.005	0.01	mg/L
Salinity	SM2520-B	2	3	PSS
Silica	Whitlege. 1981	0.05	0.1	mg/L
Solids, Total Suspended	SM2540-D	0.5	1	mg/L
Turbidity	SM2130-B	0.5	2	NTU

SM - Standard Method
mg/L - Milligram Per Liter
PSS - Practical Salinity Scale
EPA - Environmental Protection Agency
µg/L - Microgram Per Liter
NTU - Nephelometric Turbidity Units

Table D-3 Water Bacteria Detection Limits

Analyte	Method	MDL	RDL	Units
Enterococcus	SM9230C, 19th ed.	1	N/A	CFU/100 ml
Fecal Coliforms	SM9222D, 19th ed.	1	N/A	CFU/100 ml

SM - Standard Method
CFU/100 ml – Colony Forming Units Per 100 Milliliters

Shellfish

Table D-4 Shellfish Conventional and Bacteria Detection Limits

Analyte	Method	MDL	RDL	Units
Total Solids	SM2540-G	0.005		%
Total Lipids	KCEL OR 07-01-001	0.1		%
Fecal Coliform Bacteria	APHA	< 20		MPN/100g
Enterococcus Bacteria	APHA	< 20		MPN/100g

MPN Most Probable Number
SM Standard Methods for the Examination of Water and Wastewater
APHA Lab Procedures for the Examination of Seawater and Shellfish
KCEL King County Environmental Laboratory

Table D-5 Shellfish Pesticide and PCBs Detection Limits - EPA Method 3550/8081/8082

Compound	MDL	RDL	Compound	MDL	RDL	Units
Aroclor 1016	13.4	26.7	Chlordane	1.34	2.67	µg/Kg wet wt.
Aroclor 1221	13.4	26.7	Delta-BHC	1.34	2.67	µg/Kg wet wt.
Aroclor 1232	13.4	26.7	Dieldrin	1.34	2.67	µg/Kg wet wt.
Aroclor 1242	13.4	26.7	Endosulfan I	1.34	2.67	µg/Kg wet wt.
Aroclor 1248	13.4	26.7	Endosulfan II	1.34	2.67	µg/Kg wet wt.
Aroclor 1254	13.4	26.7	Endosulfan Sulfate	1.34	2.67	µg/Kg wet wt.
Aroclor 1260	13.4	26.7	Endrin	1.34	2.67	µg/Kg wet wt.
4,4'-DDD	1.34	2.67	Endrin Aldehyde	1.34	2.67	µg/Kg wet wt.
4,4'-DDE	1.34	2.67	Gamma-BHC (Lindane)	1.34	2.67	µg/Kg wet wt.
4,4'-DDT	1.34	2.67	Heptachlor	1.34	2.67	µg/Kg wet wt.
Aldrin	1.34	2.67	Heptachlor Epoxide	1.34	2.67	µg/Kg wet wt.
Alpha-BHC	1.34	2.67	Methoxychlor	6.68	13.4	µg/Kg wet wt.
Beta-BHC	1.34	2.67	Toxaphene	13.4	26.7	µg/Kg wet wt.

µg/Kg – Microgram Per Kilogram

Table D-6 Shellfish Semi-volatile Organics Detection Limits - EPA Method 3550B/8270

COMPOUND	MDL	RDL	COMPOUND	MDL	RDL	Units
1,2,4-Trichlorobenzene	16	26.7	Benzo(k)fluoranthene	43	80	µg/Kg wet wt.
1,2-Dichlorobenzene	16	26.7	Benzoic Acid	107	160	µg/Kg wet wt.
1,2-Diphenylhydrazine	53	107	Benzyl Alcohol	27	53.3	µg/Kg wet wt.
1,3-Dichlorobenzene	16	26.7	Benzyl Butyl Phthalate	16	26.7	µg/Kg wet wt.
1,4-Dichlorobenzene	16	26.7	Bis(2-Chloroethoxy)Methane	27	53.3	µg/Kg wet wt.
2,3-Dichloroaniline	53	107	Bis(2-Chloroethyl)Ether	16	26.7	µg/Kg wet wt.
2,4,5-Trichlorophenol	107	213	Bis(2-Chloroisopropyl)Ether	53	107	µg/Kg wet wt.
2,4,6-Trichlorophenol	107	213	Bis(2-Ethylhexyl)Phthalate	16	26.7	µg/Kg wet wt.
2,4-Dichlorophenol	27	53.3	Caffeine	5.3	26.7	µg/Kg wet wt.
2,4-Dimethylphenol	27	53.3	Carbazole	27	53.3	µg/Kg wet wt.
2,4-Dinitrophenol	53	107	Chrysene	16	26.7	µg/Kg wet wt.
2,4-Dinitrotoluene	11	21.3	Coprostanol	267	533	µg/Kg wet wt.
2,6-Dinitrotoluene	11	21.3	Dibenzo(a,h)anthracene	43	80	µg/Kg wet wt.
2-Chloronaphthalene	16	26.7	Dibenzofuran	27	53.3	µg/Kg wet wt.
2-Chlorophenol	53	107	Diethyl Phthalate	27	53.3	µg/Kg wet wt.
2-Methylnaphthalene	43	80	Dimethyl Phthalate	11	16	µg/Kg wet wt.
2-Methylphenol	27	53.3	Di-N-Butyl Phthalate	27	53.3	µg/Kg wet wt.
2-Nitroaniline	107	160	Di-N-Octyl Phthalate	16	26.7	µg/Kg wet wt.
2-Nitrophenol	27	53.3	Fluoranthene	16	32	µg/Kg wet wt.
3,3'-Dichlorobenzidine	27	53.3	Fluorene	16	26.7	µg/Kg wet wt.
3-Nitroaniline	107	160	Hexachlorobenzene	16	26.7	µg/Kg wet wt.
4,6-Dinitro-O-Cresol	53	107	Hexachlorobutadiene	27	53.3	µg/Kg wet wt.
4-Bromophenyl Phenyl Ether	11	16	Hexachlorocyclopentadiene	27	53.3	µg/Kg wet wt.
4-Chloro-3-Methylphenol	53	107	Hexachloroethane	27	53.3	µg/Kg wet wt.
4-Chloroaniline	53	107	Indeno(1,2,3-Cd)Pyrene	27	53.3	µg/Kg wet wt.
4-Chlorophenyl Phenyl Ether	16	26.7	Isophorone	27	53.3	µg/Kg wet wt.
4-Methylphenol	27	53.3	Naphthalene	43	80	µg/Kg wet wt.
4-Nitroaniline	107	160	n-Decane	16	32	µg/Kg wet wt.
4-Nitrophenol	53	107	Nitrobenzene	27	53.3	µg/Kg wet wt.
Acenaphthene	11	21.3	N-Nitrosodimethylamine	107	160	µg/Kg wet wt.
Acenaphthylene	16	26.7	N-Nitrosodi-N-Propylamine	27	53.3	µg/Kg wet wt.
Aniline	53	107	N-Nitrosodiphenylamine	27	53.3	µg/Kg wet wt.
Anthracene	16	26.7	n-Octadecane	16	32	µg/Kg wet wt.
Benzidine	640	1280	Pentachlorophenol	27	53.3	µg/Kg wet wt.
Benzo(a)anthracene	16	26.7	Phenanthrene	16	26.7	µg/Kg wet wt.
Benzo(a)pyrene	27	53.3	Phenol	107	160	µg/Kg wet wt.
Benzo(b)fluoranthene	43	80	Pyrene	16	26.7	µg/Kg wet wt.
Benzo(g,h,i)perylene	27	53.3				µg/Kg wet wt.

µg/Kg – Microgram Per Kilogram

Table D-7 Shellfish Metals by ICP-OES PSEP 1996 Detection Limits

Analyte	Method	MDL	RDL	Units
Aluminum	ICP-OES PSEP 1996	1	5	mg/Kg wet wt.
Arsenic	ICP-OES PSEP 1996	0.5	2.5	mg/Kg wet wt.
Beryllium	ICP-OES PSEP 1996	0.01	0.05	mg/Kg wet wt.
Cadmium	ICP-OES PSEP 1996	0.03	0.15	mg/Kg wet wt.
Chromium	ICP-OES PSEP 1996	0.05	0.25	mg/Kg wet wt.
Copper	ICP-OES PSEP 1996	0.04	0.2	mg/Kg wet wt.
Iron	ICP-OES PSEP 1996	0.5	2.5	mg/Kg wet wt.
Lead	ICP-OES PSEP 1996	0.3	1.5	mg/Kg wet wt.
Manganese	ICP-OES PSEP 1996	0.02	0.1	mg/Kg wet wt.
Nickel	ICP-OES PSEP 1996	0.2	1	mg/Kg wet wt.
Selenium	ICP-OES PSEP 1996	2.5	12.5	mg/Kg wet wt.
Silver	ICP-OES PSEP 1996	0.04	0.2	mg/Kg wet wt.
Zinc	ICP-OES PSEP 1996	0.05	0.25	mg/Kg wet wt.

ICP-OES – Inductively Coupled Optical Emission Spectroscopy
mg/Kg Milligrams per Kilogram
PSEP – Puget Sound Estuary Program

Table D-8 Shellfish Metals by ICP-MS PSEP 1996 Detection Limits

Analyte	Method	MDL	RDL	Units
Antimony	ICP-MS PSEP 1996	0.02	0.1	mg/Kg wet wt.
Arsenic	ICP-MS PSEP 1996	0.02	0.1	mg/Kg wet wt.
Beryllium	ICP-MS PSEP 1996	0.008	0.04	mg/Kg wet wt.
Cadmium	ICP-MS PSEP 1996	0.004	0.02	mg/Kg wet wt.
Chromium	ICP-MS PSEP 1996	0.016	0.08	mg/Kg wet wt.
Copper	ICP-MS PSEP 1996	0.016	0.08	mg/Kg wet wt.
Lead	ICP-MS PSEP 1996	0.008	0.04	mg/Kg wet wt.
Nickel	ICP-MS PSEP 1996	0.012	0.06	mg/Kg wet wt.
Selenium	ICP-MS PSEP 1996	0.06	0.3	mg/Kg wet wt.
Silver	ICP-MS PSEP 1996	0.008	0.04	mg/Kg wet wt.
Thallium	ICP-MS PSEP 1996	0.008	0.04	mg/Kg wet wt.
Zinc	ICP-MS PSEP 1996	0.02	0.1	mg/Kg wet wt.

ICP-MS – Inductively Coupled Plasma Mass Spectroscopy
mg/Kg Milligrams per Kilogram
PSEP – Puget Sound Estuary Program

Table D-9 Shellfish Mercury by CVAA Detection Limits

Analyte	Method	MDL	RDL	Units
Mercury (High)	CVAA - PSEP 1996	0.004	0.012	mg/Kg wet wt.
Mercury (Low)	CVAA - PSEP 1996	0.0004	0.001	mg/Kg wet wt.

CVAA Cold Vapor Atomic Absorption
mg/Kg Milligrams per Kilogram
PSEP – Puget Sound Estuary Program

Macroalgae

Table D-10 Macroalgae Metals by ICP-OES PSEP 1996 Detection Limits

Analyte	Method	MDL	RDL	Units
Aluminum	ICP-OES PSEP 1996	1	5	mg/Kg wet wt.
Arsenic	ICP-OES PSEP 1996	0.5	2.5	mg/Kg wet wt.
Beryllium	ICP-OES PSEP 1996	0.01	0.05	mg/Kg wet wt.
Cadmium	ICP-OES PSEP 1996	0.03	0.15	mg/Kg wet wt.
Chromium	ICP-OES PSEP 1996	0.05	0.25	mg/Kg wet wt.
Copper	ICP-OES PSEP 1996	0.04	0.2	mg/Kg wet wt.
Iron	ICP-OES PSEP 1996	0.5	2.5	mg/Kg wet wt.
Lead	ICP-OES PSEP 1996	0.3	1.5	mg/Kg wet wt.
Manganese	ICP-OES PSEP 1996	0.02	0.1	mg/Kg wet wt.
Nickel	ICP-OES PSEP 1996	0.2	1	mg/Kg wet wt.
Selenium	ICP-OES PSEP 1996	2.5	12.5	mg/Kg wet wt.
Silver	ICP-OES PSEP 1996	0.04	0.2	mg/Kg wet wt.
Zinc	ICP-OES PSEP 1996	0.05	0.25	mg/Kg wet wt.

ICP-OES – Inductively Coupled Optical Emission Spectroscopy
mg/Kg Milligrams per Kilogram
PSEP – Puget Sound Estuary Program

Table D-11 Macroalgae Metals by ICP-MS PSEP 1996 Detection Limits

Analyte	Method	MDL	RDL	Units
Antimony	ICP-MS PSEP 1996	0.02	0.1	mg/Kg wet wt.
Arsenic	ICP-MS PSEP 1996	0.02	0.1	mg/Kg wet wt.
Beryllium	ICP-MS PSEP 1996	0.008	0.04	mg/Kg wet wt.
Cadmium	ICP-MS PSEP 1996	0.004	0.02	mg/Kg wet wt.
Chromium	ICP-MS PSEP 1996	0.016	0.08	mg/Kg wet wt.
Copper	ICP-MS PSEP 1996	0.016	0.08	mg/Kg wet wt.
Lead	ICP-MS PSEP 1996	0.008	0.04	mg/Kg wet wt.
Nickel	ICP-MS PSEP 1996	0.012	0.06	mg/Kg wet wt.
Selenium	ICP-MS PSEP 1996	0.06	0.3	mg/Kg wet wt.
Silver	ICP-MS PSEP 1996	0.008	0.04	mg/Kg wet wt.
Thallium	ICP-MS PSEP 1996	0.008	0.04	mg/Kg wet wt.
Zinc	ICP-MS PSEP 1996	0.02	0.1	mg/Kg wet wt.

ICP-MS – Inductively Coupled Plasma Mass Spectroscopy
mg/Kg Milligrams per Kilogram
PSEP – Puget Sound Estuary Program

Table D-12 Macroalgae Mercury by CVAA Detection Limits

Analyte	Method	MDL	RDL	Units
Mercury (High)	CVAA - PSEP 1996	0.004	0.012	mg/Kg wet wt.
Mercury (Low)	CVAA - PSEP 1996	0.0004	0.001	mg/Kg wet wt.

CVAA Cold Vapor Atomic Absorption
mg/Kg Milligrams per Kilogram
PSEP – Puget Sound Estuary Program

Sediment

Table D-13 Sediment Conventional Parameters Detection Limits

Analyte	Method	MDL	RDL	Units
Total Organic Carbon	EPA 9060-PSEP96	500	1000	mg/Kg wet wt.
Nitrogen, Ammonia	SM 4500 NH3 G (KCL ext)	0.1	0.2	mg/Kg wet wt.
Oil and Grease, Total	SM 9071 A	200	500	mg/Kg wet wt.
Solids, Total	SM 2540 G	0.005	0.01	percent wet wt.
Solids, Total Volatile	SM 2540 G	0.005	0.01	percent wet wt.
Particle Size Distribution	PSEP p. 9 ASTM 422	0.1	N/A	percent wet wt.
Total Sulfides	EPA 9030 and 376.2	20	N/A	mg/kg wet wt.

SM - Standard Method
PSEP – Puget Sound Estuary Program
EPA - Environmental Protection Agency
mg/Kg – Milligrams Per Kilogram

Table D-14 Sediment Pesticide and PCBs Detection Limits- EPA Method 3550/8081/8082

Compound	MDL	RDL	Compound	MDL	RDL	Units
Aroclor 1016	2.67	5.33	Chlordane	0.27	0.53	µg/Kg wet wt.
Aroclor 1221	2.67	5.33	Delta-BHC	0.27	0.53	µg/Kg wet wt.
Aroclor 1232	2.67	5.33	Dieldrin	0.27	0.53	µg/Kg wet wt.
Aroclor 1242	2.67	5.33	Endosulfan I	0.27	0.53	µg/Kg wet wt.
Aroclor 1248	2.67	5.33	Endosulfan II	0.27	0.53	µg/Kg wet wt.
Aroclor 1254	2.67	5.33	Endosulfan Sulfate	0.27	0.53	µg/Kg wet wt.
Aroclor 1260	2.67	5.33	Endrin	0.27	0.53	µg/Kg wet wt.
4,4'-DDD	0.27	0.53	Endrin Aldehyde	0.27	0.53	µg/Kg wet wt.
4,4'-DDE	0.27	0.53	Gamma-BHC (Lindane)	0.27	0.53	µg/Kg wet wt.
4,4'-DDT	0.27	0.53	Heptachlor	0.27	0.53	µg/Kg wet wt.
Aldrin	0.27	0.53	Heptachlor Epoxide	0.27	0.53	µg/Kg wet wt.
Alpha-BHC	0.27	0.53	Methoxychlor	1.33	2.67	µg/Kg wet wt.
Beta-BHC	0.27	0.53	Toxaphene	2.67	5.33	µg/Kg wet wt.

µg/Kg – Microgram Per Kilogram

Table D-15 Sediment Semi-volatile Organic Parameter Detection Limits- EPA Method 3550B/8270

COMPOUND	MDL	RDL	COMPOUND	MDL	RDL	Units
1,2,4-Trichlorobenzene	0.26	0.53	Bis(2-Chloroethoxy)Methane	17	34	µg/Kg wet wt.
1,2-Dichlorobenzene	0.26	0.53	Bis(2-Chloroethyl)Ether	15	30	µg/Kg wet wt.
1,2-Diphenylhydrazine	10	20	Bis(2-Chloroisopropyl)Ether	15	30	µg/Kg wet wt.
1,3-Dichlorobenzene	0.26	0.53	Bis(2-Ethylhexyl)Phthalate	6.7	13.5	µg/Kg wet wt.
1,4-Dichlorobenzene	0.13	0.26	Caffeine	6	12	µg/Kg wet wt.
2,4,5-Trichlorophenol	12	24	Carbazole	7	14	µg/Kg wet wt.
2,4,6-Trichlorophenol	13	26	Chrysene	4	8	µg/Kg wet wt.
2,4-Dichlorophenol	16	32	Coprostanol	14	28	µg/Kg wet wt.
2,4-Dimethylphenol	7	14	Dibenzo(a,h)anthracene	7	14	µg/Kg wet wt.
2,4-Dinitrotoluene	3	6	Dibenzofuran	14	28	µg/Kg wet wt.
2,6-Dinitrotoluene	10	20	Diethyl Phthalate	6	12	µg/Kg wet wt.
2-Chloronaphthalene	16	32	Dimethyl Phthalate	11	22	µg/Kg wet wt.
2-Chlorophenol	8	16	Di-N-Butyl Phthalate	5	10	µg/Kg wet wt.
2-Methylnaphthalene	14	28	Di-N-Octyl Phthalate	8	16	µg/Kg wet wt.
2-Methylphenol	19	38	Fluoranthene	8	16	µg/Kg wet wt.
2-Nitrophenol	15	30	Fluorene	13	26	µg/Kg wet wt.
4-Bromophenyl Phenyl Ether	9	18	Hexachlorobenzene	0.7	1.3	µg/Kg wet wt.
4-Chlorophenyl Phenyl Ether	13	26	Hexachlorobutadiene	0.8	1.5	µg/Kg wet wt.
4-Methylphenol	16	32	Hexachloroethane	15	30	µg/Kg wet wt.
Acenaphthene	7	14	Indeno(1,2,3-Cd)Pyrene	9	18	µg/Kg wet wt.
Acenaphthylene	15	30	Isophorone	19	38	µg/Kg wet wt.
Aniline	19	38	Naphthalene	14	28	µg/Kg wet wt.
Anthracene	4	8	Nitrobenzene	16	32	µg/Kg wet wt.
Benzo(a)anthracene	2	4	N-Nitrosodimethylamine	20	40	µg/Kg wet wt.
Benzo(a)pyrene	3	6	N-Nitrosodi-N-Propylamine	9	18	µg/Kg wet wt.
Benzo(b)fluoranthene	3	6	N-Nitrosodiphenylamine	20	40	µg/Kg wet wt.
Benzo(g,h,i)perylene	8	16	Pentachlorophenol	5	10	µg/Kg wet wt.
Benzo(k)fluoranthene	3	6	Phenanthrene	4	8	µg/Kg wet wt.
Benzoic Acid	6	12	Phenol	9	18	µg/Kg wet wt.
Benzyl Alcohol	6	12	Pyrene	4	8	µg/Kg wet wt.
Benzyl Butyl Phthalate	6	12				

µg/Kg – Microgram Per Kilogram

Table D-16 Sediment Metals Detection Limits

Analyte	Method	MDL	RDL	Units
Aluminum	EPA 3050/6010	5	25	mg/Kg wet wt.
Antimony	EPA 3050/6010	1.5	7.5	mg/Kg wet wt.
Arsenic	EPA 3050/6010	2.5	12.5	mg/Kg wet wt.
Beryllium	EPA 3050/6010	0.05	0.25	mg/Kg wet wt.
Cadmium	EPA 3050/6010	0.15	0.75	mg/Kg wet wt.
Chromium	EPA 3050/6010	0.25	1.25	mg/Kg wet wt.
Copper	EPA 3050/6010	0.2	1	mg/Kg wet wt.
Iron	EPA 3050/6010	2.5	12.5	mg/Kg wet wt.
Lead	EPA 3050/6010	1.5	7.5	mg/Kg wet wt.
Manganese	EPA 3050/6010	0.1	0.5	mg/Kg wet wt.
Mercury	EPA Method 7471 (CVAA)	0.02	0.2	mg/Kg wet wt.
Nickel	EPA 3050/6010	1	5	mg/Kg wet wt.
Selenium	EPA 3050/6010	2.5	12.5	mg/Kg wet wt.
Silver	EPA 3050/6010	0.2	1	mg/Kg wet wt.
Thallium	EPA 3050/6010	10	50	mg/Kg wet wt.
Zinc	EPA 3050/6010	0.25	1.25	mg/Kg wet wt.

EPA - Environmental Protection Agency
mg/Kg – Milligrams Per Kilogram

APPENDIX E

DATA QUALIFIERS

Field Procedures Qualifiers

H indicates that a sample handling criterion was not met in some manner prior to analysis. The sample may have been compromised during the sampling procedure or may not comply with holding times, storage conditions or preservation requirements. The qualifier will be applied to analytical results for affected samples.

General Lab Qualifiers

B is applied when the parameter was detected at a concentration at or above the MDL in the associated blank(s) and may have significantly biased the sample result. Application of the B flag may depend on the ratio of the sample to blank result. See QA Manual, Appendix C for specific ratios used for different methods.

E is applied to a parameter result when the reported result should be used as an estimate of the true value based on the professional judgment of the analyst or reviewer. Due to observed interferences or compromised analysis conditions the measured result is likely to be outside the expected accuracy limits of the method. The E flag is intended to indicate matrix interference problems that can not be resolved with available corrective actions. The E flag is not be used for situations already covered by the B, J, H, >MR or R flags. A text comment must be added to each parameter with an E flag to indicate the specific reason for the qualifier. Also see sediment and biology qualifiers for additional specific uses of the E flag.

H indicates that a sample handling criterion was not met in some manner prior to analysis. The sample may have been compromised during the sampling procedure or may not comply with holding times, storage conditions, or preservation requirements. Text comments must be added to each parameter with an H flag to indicate the specific reason(s) for the qualifier. The amount of time by which a holding time was missed must be indicated.

R indicates that the numerical result for the parameter, based on the professional judgment of the laboratory, is neither scientifically defensible nor representative of the true value for a sample. Indefensible and non-representative data occur whenever sample collection, sample handling, critical analysis conditions or other system failures occur that would prevent the use of the result for any purpose other than an approximate minimum or maximum value. The R flag may be combined with other applicable flags (B or H) to indicate the magnitude of the original flag(s). A text comment must be added to each parameter with an R flag to indicate the specific reason for the qualifier.

<MDL is applied when a target analyte is not detected or detected at a concentration less than the associated method detection limit (MDL). MDL is defined as the lowest concentration at which an analyte can be reliably detected. The MDL is the lowest concentration at which a numeric sample result will be reported.

<RDL is applied when a target analyte is detected at a concentration greater than or equal to the associated MDL but less than the associated reporting detection limit (RDL). RDL is defined as the lowest concentration at which an analyte can reliably be quantified. The

RDL represents the minimum concentration at which method performance becomes quantitatively accurate to the expected capability of the method and is not subject to the higher degree of variation observed at concentrations between the MDL and RDL.

RDL is applied when a target analyte is detected at a concentration equal to the RDL.

TA is applied to a sample result when additional narrative information is available in the text field. The additional information may help to qualify the result for a particular parameter that is not necessarily covered by any of the standard qualifiers. TA need not be used as part of the H, R, and E flags since comments are mandatory for those three qualifiers.

Chemistry Qualifiers

>MR is applied when a target analyte concentration or property completely exceeds the quantitative capacity (Measurable Range) of the method. The observed response indicates the method is saturated and is, at best, an estimate of the minimum value. The qualifier is applied when the analyte concentration has saturated the detection method and further dilution or re-analysis is not feasible. A numeric value, representing the minimum concentration, is added to the numvalue field. For situations where the measured response is less than complete saturation but above the linear limit of the method, an E qualifier should be applied. The R qualifier should be used if no minimum concentration can be determined from the measured response or if the saturated response was due to an instrument or analysis failure. Text comments are not required when using the >MR qualifier but if added, the TA qualifier must also be used.

Sediment Qualifiers

B is applied to a sample parameter result when the analyte was detected at a concentration at or greater than the MDL in the associated batch method blank. The qualifier indicates that the reported concentration for the sample may include laboratory contamination. Whenever the measured concentration of the blank(s) is at or greater than the MDL, all associated sediment sample results are qualified with the B flag regardless of the ratio of the sample result to the blank.

H indicates that a holding time was exceeded. Text comments must be added to each parameter with an H flag to indicate the amount of time by which a holding time was missed.

X indicates very low biased data. This is based on either surrogate or matrix spike recovery results that are less than 10%. Surrogate recovery qualifier application is sample-specific and matrix spike recovery qualifiers are applied to all samples in the associated QC batch.

G indicates low biased data wherein the true analyte concentration may be greater than the reported value based on either surrogate, matrix spike or standard reference material recovery. Surrogate recovery qualifier application is sample-specific while matrix spike and standard reference material recovery qualifiers are applied to all samples in the associated QC batch.

L indicates high biased data wherein the true analyte concentration may be lower than the reported value based on either surrogate, matrix spike or standard reference material recovery. Surrogate recovery qualifier application is sample-specific while matrix spike and standard reference material recovery qualifiers are applied to all samples in the associated QC batch.

E indicates the reported value may be an estimate of the true concentration based on unacceptable precision of the laboratory replicate. The E qualifier, when applied to sediment samples with unacceptable lab replicate precision, is applied to all samples in the associated QC batch. To be consistent with its use as a general laboratory qualifier, the E flag used for sediment samples should include a descriptive comment that states the precision of the laboratory replicates did not meet the acceptance limits.

R indicates that the associated data are judged unusable by the data reviewer. The qualifier is applied based on the professional judgment of the data reviewer rather than any specific set of QC parameters and is applied when the reviewer feels that the data may not or will not provide any useful quantitative information to the data user. All client notification and decision processes required for the R flag used as a General Laboratory Qualifier (see 1.1) must also be applied when the R flag is used for sediments. A text comment is also required to explain the use of this qualifier.

Microbiology Qualifiers

C is applied to Microbiology data when the sample analysis exhibits confluent growth of organisms. The value reported can be reliably used as an indicator of relative abundance; however, it can not be used as an accurate count of the associated organism. The C qualifier is applied to MF or HPC procedures whenever the analyst observes confluent growth that would compromise the accuracy of the measured response. The C qualifier can be used with an E qualifier, if applicable. The measured value is entered into the numvalue field only if the analyst believes the measured value is a good estimate of the true count.

D is applied to Microbiology data to indicate that a target organism was evaluated to be the Dominant or largest sub-population recovered from the sample. The evaluation is based on biomass. This qualifier is used for algae data only where an indication of the dominant organism is required.

E is applied to microbiological data when a standard method for estimating the number of microorganisms has been employed during analysis rather than an actual count. A comment must be added to the text field whenever this qualifier is used for microbiological parameters to indicate that a specific estimation technique was used to generate the reported value.

NF is applied to Microbiology sample data to indicate that a target organism was not recovered (Not Found) or identified in a sample. For Microbiology QC samples (positive and negative controls), the **NF** is applied when the results are unacceptable (Failing).

P is applied to Microbiology sample data to indicate that a target organism was recovered (Present) or identified in a sample. For Microbiology QC samples (positive and negative controls), the **P** is applied when the results are acceptable (Passing).

S is applied to Microbiology data to indicate that a target organism was evaluated to be the Second largest contributory sub-population recovered from the sample. The evaluation is based on biomass. This qualifier is used for algae data only where an indication of the second to dominant organism is required.

>##### is applied when the population count exceeds the method capacity to measure quantitatively. The number in the qualifier (entered in place of the #####), is the highest procedural count or concentration possible for the sample dilutions analyzed. A value is not entered into the numvalue field. The actual population count is at least as great as or greater than the value reported in the qualifier. This reporting convention is consistent with the requirements in Standard Methods.