Quality Assurance Project Plan

Assessment of Sediment Toxicity near Post Point (Bellingham Bay)

by
Thomas H. Gries

Environmental Assessment Program
Washington State Department of Ecology
Olympia, Washington 98504-7710

October 2007

Publication Number 07-03-113

This plan is available on the Department of Ecology's website at
www.ecy.wa.gov/biblio/0703113.html.

Quality Assurance Project Plan

Assessment of Sediment Toxicity near Post Point (Bellingham Bay)

October 2007

303(d) Listings Addressed in this Study: None

Waterbody Number: WA 01-0050

Project Code: 08-033

If you need this publication in an alternate format, call Carol Norsen at 360-407-7486.
Persons with hearing loss can call 711 for Washington Relay Service.
Persons with a speech disability can call 877- 833-6341.

Quality Assurance Project Plan

Assessment of Sediment Toxicity near Post Point (Bellingham Bay)

October 2007

Approvals

Approved by:	October 2007
Mary O'Herron, Client, Toxics Cleanup Program, Bellingham Field Office, Northwest Regional Office	Date
Approved by:	October 2007
Richard Grout, Unit Supervisor, Bellingham Field Office, Northwest Regional Office	Date
Approved by:	October 2007
Bob Warren, Acting Section Manager, Toxics Cleanup Program, Northwest Regional Office	Date
Approved by:	October 2007
Tom Gries, Project Manager, Principal Investigator, and Environmental Information Management System Data Engineer, Environmental Assessment Program	Date
Approved by:	October 2007
George Onwumere, Unit Supervisor, Environmental Assessment Program	Date
Approved by:	October 2007
Robert F. Cusimano, Section Manager, Environmental Assessment Program	Date
Approved by:	October 2007
Stuart Magoon, Director, Manchester Environmental Laboratory	Date
Approved by:	October 2007
Bill Kammin, Ecology Quality Assurance Officer	Date

Table of Contents

List of Acronyms and Abbreviations

Following are acronyms and abbreviations used frequently in this Quality Assurance Project Plan:

CSL	Cleanup screening level
DQO	Data quality objectives
Ecology	Washington State Department of Ecology
EIM	Environmental Information Management database (Department of Ecology)
EPA	U.S. Environmental Protection Agency
GPS	Global Positioning System
MEL	Manchester Environmental Laboratory (Department of Ecology)
MQO	Management quality objectives
QA	Quality assurance
QC	Quality control
SMS	Sediment Management Standards
SQS	Sediment Quality Standards
TOC	Total organic carbon
WWTP	Wastewater treatment plant

Abstract

Previous investigations near Post Point (Bellingham) have been found to exhibit significant sediment toxicity. Toxicity at some sampling locations did not appear related to Harris Avenue Shipyard activities because contaminant levels did not exceed Washington State's numeric Sediment Quality Standards for sediment chemistry. High concentrations of total sulfides have also been found in area's sediments. Sulfides could have contributed to the observed toxicity, but existing data are insufficient to identify them as the primary cause.

This study will evaluate the toxicity of surface sediment samples collected at a limited number of locations likely to exhibit toxicity or high total sulfides. A suite of four standard toxicity tests will be conducted and interpreted according to the Sediment Management Standards rule (Chapter 173-204 WAC). Results will help determine if sediments near Post Point are likely to be toxic to a degree that warrants detailed remedial investigations. Results may also provide evidence for high sulfides contributing to the observed sediment toxicity.

Background

In the late 1800s, the City of Bellingham, Washington, began collecting untreated wastewaters in a sewer system that flowed into Whatcom Creek. In 1947 the city built a primary treatment plant near the mouth of the creek and began discharging wastewater into inner Bellingham Bay. Primary treatment was moved in 1974 to a new plant located at Post Point, the promontory of land at the southwestern end of Bellingham Bay (Figure 1). This plant was upgraded in 1993 to provide secondary treatment for up to 55 million gallons per day (City of Bellingham, 2007).

The Post Point Wastewater Treatment Plant (WWTP) currently serves much of Bellingham's business community and approximately 67,000 residents. Most of the WWTP wastewater discharges to marine waters via one main outfall. A combination of treated wastewater and stormwater is discharged several times each year from the outfall that was originally installed in 1949. This occurs approximately 300 feet from shore through breaks or separations in this alternate discharge pipe, not from the end of the pipe that is now apparently buried by sediment (Hart Crowser, 2005).

A new alternate outfall pipe is under construction. When it is completed, it will extend 600 feet northwest from roughly the same point on the shoreline where the 1949 pipe enters the water.

Discharges from both WWTP outfalls have caused moderate organic enrichment of nearby sediments (2%-3% total organic carbon or TOC) relative to sediments found in most urban areas of Puget Sound (median TOC = 1.55%, Aasen, 2007). Decomposition of this organic material has led to reduced dissolved oxygen in near-bottom water. Surface sediments also show elevated concentrations of ammonia and total sulfides relative to other areas of Bellingham Bay (Ecology, 2006).

Sediment quality near the main and the alternate WWTP outfalls was investigated in 2003 (Anchor, 2004). Total sulfides up to 2,110 mg/kg were measured in bulk sediment collected near the main outfall, and higher concentrations were found near the alternate outfall.

Remedial investigations conducted adjacent to the nearby Harris Avenue Shipyard (RETEC, 2004) found that locations west of approximately 120° 30' 56.7" longitude generally did not exceed chemical or biological Sediment Quality Standards (SQS). However, toxicity was observed at some sampling locations where concentrations of Sediment Management Standards (SMS) contaminants were below the SQS. These locations had total sediment sulfide concentrations as high as 3,800 mg/kg. The data did not appear to indicate Harris Avenue Shipyard operations to be the source of the elevated sulfides, which suggests sulfides may be related to Post Point WWTP discharges.

The Washington State Department of Ecology (Ecology) conducted an investigation in 2004 that had two objectives (Ecology, 2006):

- To determine the spatial distribution of elevated total sulfide concentrations, especially between the Post Point WWTP outfalls and Harris Avenue Shipyard.
- To evaluate the sediments in the study area for compliance with biological criteria in the SMS rule (Ecology, 1995).

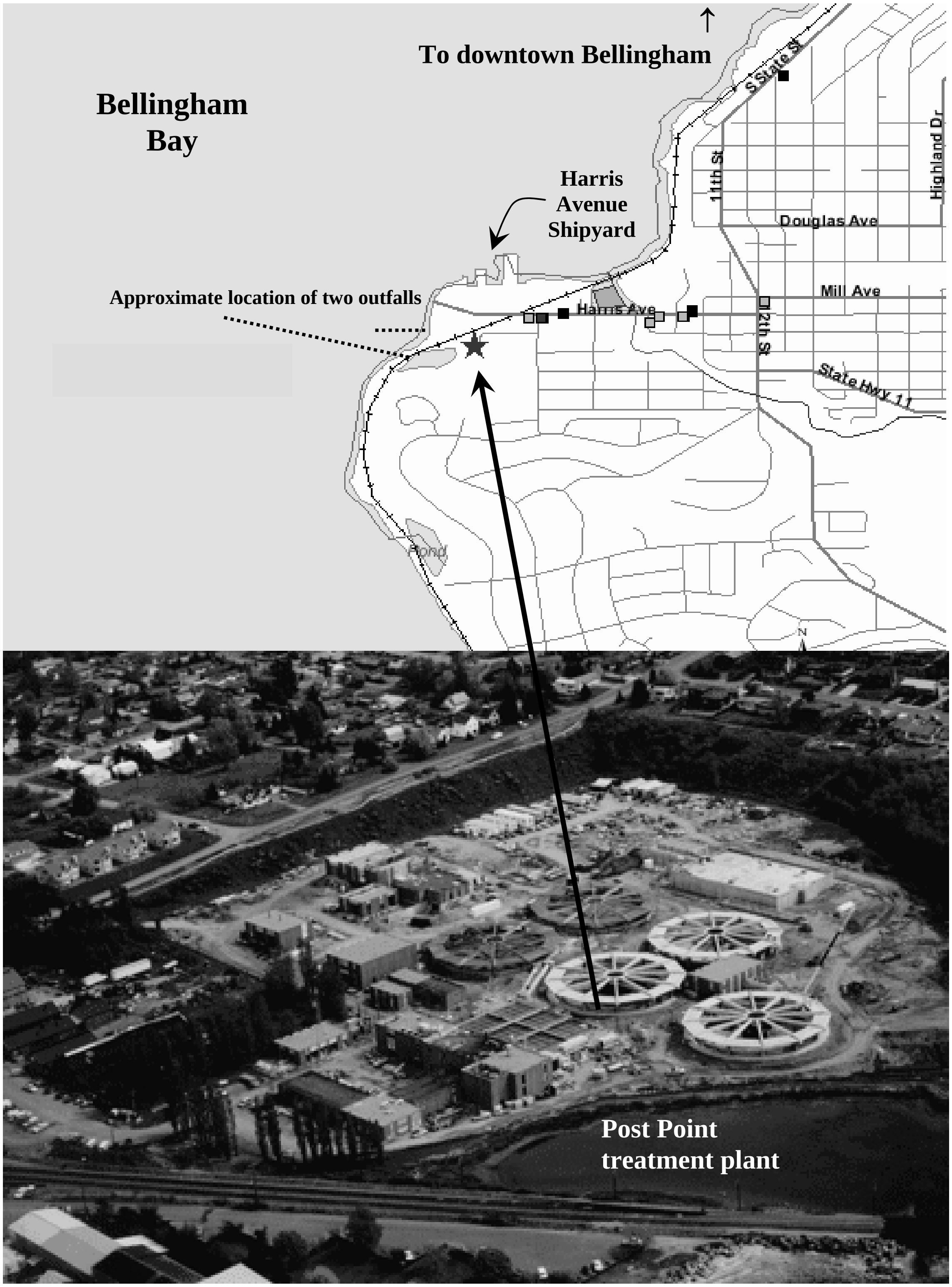

Figure 1. Location map of Post Point Wastewater Treatment Plant (Bellingham, Washington).

Results showed elevated ammonia (16-57 mg/Kg dry weight) and total sulfides (860-2600 mg/Kg dry weight) in whole sediment samples collected from all locations, including those furthest from the two outfalls. Significant sediment toxicity was observed in four locations, mainly those closer to the outfalls (Figure 2), but with no apparent relationship to concentrations of ammonia or total sulfides.

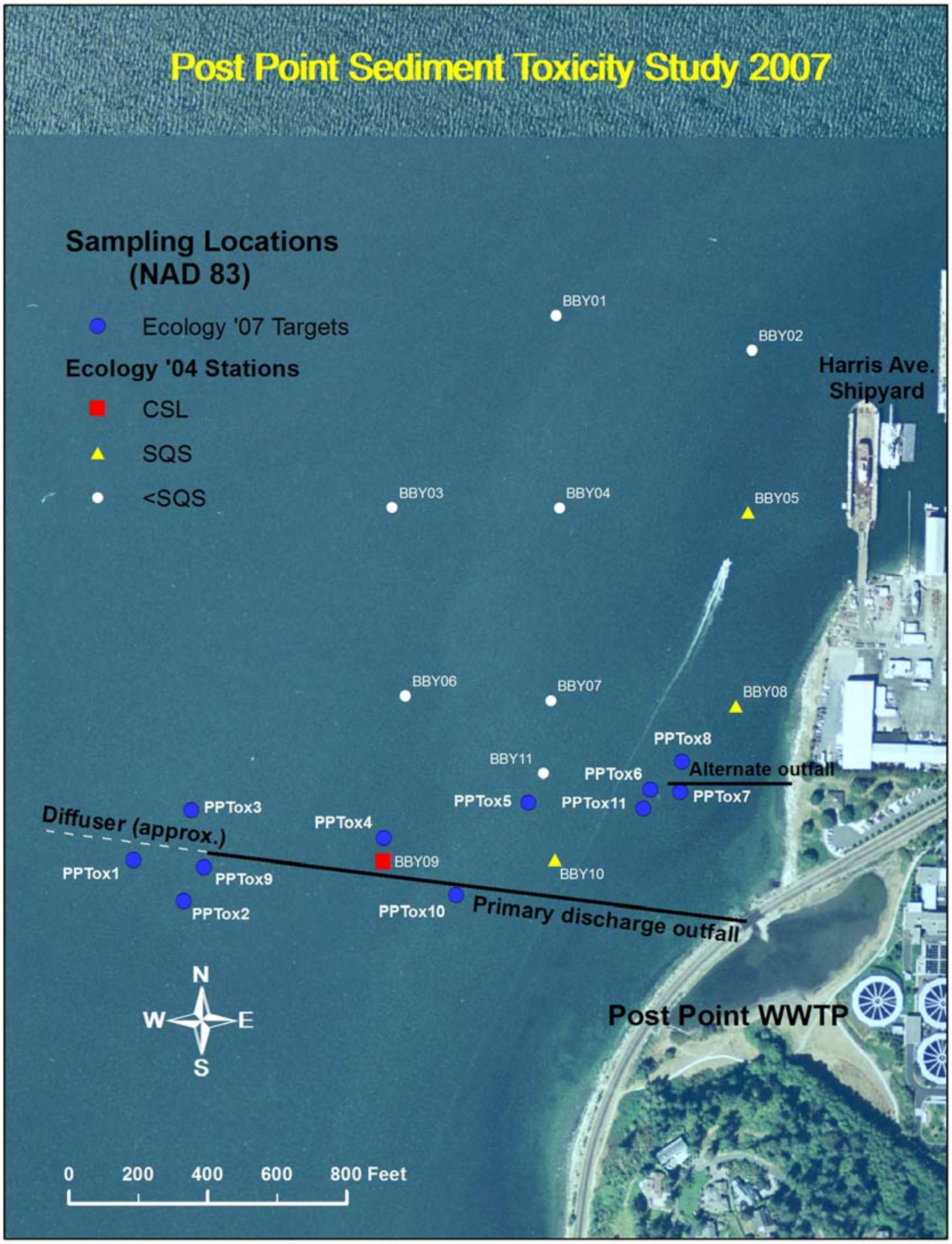

Figure 2. Map showing locations where sediment samples were collected in 2004 (Ecology, 2006) and sampling locations proposed for this study.

Project Description

Problem identification

The recent studies summarized in the *Background* section clearly indicate the presence of sediment toxicity and elevated sediment sulfides in the vicinity of the Post Point WWTP outfalls and Harris Avenue Shipyard. Shipyard operations do not appear to be the source of the elevated sulfides presumed to cause the observed toxicity. However, existing toxicity results are insufficient to identify the area in the vicinity of the two outfalls as a potential cleanup site. This is because the frequency of occurrence and degree of toxicity fall short of the criteria used to list cleanup sites: three or more contiguous sampling locations with Cleanup Screening Level (CSL) toxicity. Nevertheless, sediment toxicity remains a substantial concern to regulators. Additional sampling is needed because:

- Some toxicity tests were not conducted in the late summer when bottom-water dissolved oxygen is at a seasonal minimum and sediment sulfide-related stress is assumed to be at a seasonal maximum (RETEC, 2004; Ecology, 2006).
- Some of the acute toxicity tests that have been conducted used an organism (*Ampelisca abdita*) that constructs and lives inside a tube that reduces exposure to sediment sulfides.
- There is no clear spatial pattern in the toxicity that has been observed, and no clear relationship to potential causative agents such as hydrogen sulfide.

Goal

The main goal of this study is to finally determine whether sediments in the vicinity of the Post Point WWTP outfalls significantly impact biological resources (exhibit toxicity) such that a full remedial investigation is warranted. The study is not intended to determine the sources of any toxicity that may be observed. A secondary goal is to explore improved methods for assessing toxic concentrations of sulfides in sediment.

Objectives

The main objective of this study is to demonstrate CSL toxicity at three or more contiguous sampling locations or determine that CSL toxicity is clearly lacking from the area. This will involve collecting sediment samples and evaluating them for toxicity according to the SMS. Therefore, this study intends to:

- Collect sediment samples from appropriate locations at a time of year when biologically-available sediment sulfide concentrations are assumed (if not confirmed) to be maximal.
- Assess toxicity for each sediment sample based on usable results from at least two acute tests and one chronic test listed in the SMS rule.
- Identify sampling locations that exhibit no toxicity, SQS-level toxicity, and CSL toxicity.

The secondary objective of this study is to explore methods of measuring sulfides that are likely to be biologically available; much of the total sulfides measured in whole sediment samples are tightly bound to particles and not available. To this end, the study will:

- Determine the magnitude of change in whole sediment and porewater total sulfide concentrations due to homogenization, holding time, handling, and toxicity test set up.
- Determine if there is a relationship between observed toxicity and porewater/overlying water total sulfides.

The study will involve collecting a limited number of surface sediment samples from locations expected to show evidence of toxicity. Emphasis will be on sampling sediments in the vicinity of the two Post Point WWTP outfalls, near locations previously found to exhibit toxicity or elevated total sulfides. Samples will be submitted to one or more independent laboratories for toxicity testing. The laboratories will follow a minimum of two acute toxicity test protocols and one chronic toxicity test protocol, all listed in the SMS rule and accepted by regulators. Whole sediment and porewater samples will be collected for analysis of total sulfide to determine concentrations that may cause or contribute to toxicity that is observed.

Total sulfides will be measured in the following samples:

- Whole sediment and porewater that have not been homogenized in the field (one or two of the sampling locations only).
- Sediment porewater in test chambers at the beginning of each toxicity test.
- Overlying water in test chambers at the beginning and end of each toxicity test.
- Sediment porewater in test chambers at the end of each amphipod survival and polychaete growth test.

Results of this study will be used by regulators to make decisions about the need for more detailed investigations. A clear demonstration of CSL toxicity may result in more detailed investigations to determine its cause(s) and spatial extent. A clear lack of CSL toxicity may eliminate the need for more studies or lead only to periodical monitoring of sediment quality. However, the limited number of sediment samples that can be subjected to a full suite of toxicity tests may yield a less-than-clear picture of sediment toxicity in the area near the Post Point outfalls.

Results of this study may also lead to revision of protocols for evaluating toxicity caused by bioavailable sulfides.

Organization and Schedule

Organization

Ecology personnel who will be involved in this project are listed in Table 1, along with a brief description of their roles and responsibilities.

Table 1. Organization for sediment toxicity study near Post Point.

Name	Role	Responsibilities
George Onwumere 360-407-6730	Directed Studies Unit supervisor	• Review project scope and budget • Track progress • Review and approve QA project plan and report
Tom Gries 360-407-6327	Principal investigator and project manager	• Prepare QA project plan • Prepare needed contracts • Oversee field sampling • Distribute samples with chain of custody • Conduct QA review of data • Enter, analyze, and interpret data • Prepare report
Mary O'Herron 360-738-6246	Ecology client	• Clarify scope of work, goals • Review QA project plan and report • Approve QA project plan
Peter Adolphson 360-407-7557	Contaminated sediment cleanup specialist	• Clarify scope of work, goals • Review QA project plan and report
Nigel Blakley 360-407-6770	Principal investigator for 2004 Post Point study	Provide peer review of QA project plan and report
Tbd	Project assistant	Assist with field sampling, data analysis, and report preparation
Randy Coots 360-407-6690	*RV Skookum* pilot/operator	• Provide precision navigation • Assist with oversight of sampling • Ensure staff safety on vessel
Various	Field crew	• Record field observations • Help collect sediment samples
Pam Covey 360-871-8827	MEL point of contact	• Act as point of MEL contact • Provide sample containers
Tbd	MEL analyst	• Analyze total solids and organic carbon • Review data quality
Karin Feddersen 360-871-8829	MEL QA coordinator	• Review QA project plan • Review data quality
Tbd	Contract laboratory analyst	Analyze solids, grain size, total sulfides
Tbd	Contract laboratory analyst	Oversee assessment of sediment toxicity
Bill Kammin 360-407-6964	Ecology QA officer	Review and approve QA project plan, and assist with review of data quality
Tom Gries 360-407-6327	EIM data entry specialist	Enter sediment chemistry and toxicity data

Tbd – to be determined.

Schedule

The project will be conducted according to the schedule listed in Table 2, with the field sampling planned to occur September 18-20, 2007. In the unlikely event that the RV Skookum is not operable at this time, the sampling will occur during the week of September 24.

Table 2. Project schedule for sediment toxicity study near Post Point.

Environmental Information System (EIM) Data Set	
EIM Data Engineer	Tom Gries
EIM User Study ID	PPTox07
EIM Study Name	Sediment toxicity study near Post Point WWTP outfalls (Bellingham Bay, Washington)
EIM Completion Due	March 2008
Final Report	
Author Lead	Tom Gries
Schedule	
Draft Due to Supervisor	January 2008
Draft Due to Client/Peer Reviewer	February 2008
Draft Due to External Reviewer	February 2008
Final Report Due	March 2008

Quality Objectives

This section describes the general field and laboratory data quality objectives for this project that will ensure all data are (1) representative of environmental conditions, and (2) acceptable for the goals and objectives of the study.

The degree to which each sample represents the environment from which is collected will be addressed through the selection of sample locations, sample collection methods, sample acceptance criteria, sample handling, and sample storage prior to analysis. Samples will need to be:

- Collected between mid-August and mid-September, 2007 (Adolphson, 2007).
- Collected from locations no more than three meters from the target sampling locations identified in the final Quality Assurance (QA) Project Plan.
- Collected using sampling protocols and sample acceptance guidelines consistent with those used throughout the region and used previously at the study site.
- Acceptable according to the criteria identified in the *Sampling Procedures* section.
- Handled and stored properly prior to analysis.

Sediment sample results characterizing actual or suspected cleanup sites must be of acceptable quality and interpretable according to the SMS rule (Ecology, 1995; Ecology 2003). This will require using regionally-accepted analytical methods and protocols, analyzing appropriate quality control (QC) samples, and having QC sample results meet specified performance control limits (EPA, 1986; EPA, 1995; EPA, 1997b).

The QC samples and measurement quality objectives (MQOs) listed in Table 3 for the conventional sediment parameters that will be measured for this project are from Ecology (2003) and EPA (1986). Field replicates will be collected to assess the field variability of sediment conventionals, but there are no applicable MQOs.

The exposure conditions, QC samples and performance standards listed in Table 4 for toxicity tests that will be conducted for the study are taken from Ecology (2003) and EPA (1995). Each toxicity test will involve a positive (toxicant) control, a negative control, a suitable reference sediment sample, and monitoring of conditions during test exposures.

DQOs for data management for this project are for sediment chemistry and toxicity data to be calculated, transcribed, entered, and transferred into one or more final databases without error. To evaluate this, 50% of the samples will be randomly selected for a complete audit/review. Raw laboratory results for each will be taken through the same calculations, formatting, and data entry processes. If any of the final results do not match those that have been entered into the EIM database, then the source of errors will be identified and corrected.

Table 3. Quality control samples and measurement quality objectives (MQOs) for selected conventional sediment parameters.

Parameter	Initial calibration (correlation coefficient)	Continuing calibration (% recovery)	Lowest concentration of interest	Method blank		Blind field duplicate[1]		Laboratory replicates (% RSD)		LCS[2] or CRM (% recovery limits)		Matrix spike (% recovery limits)[3]	
			MQO[4]	Number	MQO	Number	MQO	Number	MQO[5]	Number	MQO[5]	Number	MQO[5]
Total solids (% dry wt)	--	--	0.1	--	--	1	--	1 triplicate	< 20	--	--	--	--
Grain size (% dry wt)	--	--	1	1	< RL	1	--	1 triplicate	< 20	--	--	--	--
Total organic carbon (% dry wt)	≥ 0.995	90-110	0.1	1	< RL[5]	1	--	1 triplicate	< 20	1	80-120	--	--
Total sulfides (mg/Kg dry wt.)	≥ 0.990	85-115	5	1	< RL[5]	1	--	1 triplicate	< 20	1	65-135	1	65-135
Total sulfides (mg/L porewater)	≥ 0.990	85-115	5	1	< RL[5]	--	--	1 triplicate	< 20	1	65-135	1	65-135

1. A field duplicate will be prepared from minimally homogenized material that is taken from several grab samples of surface sediment. Multiple field replicates may be prepared for analysis of total sulfides in unhomogenized whole sediment and in porewater.
2. A laboratory control sample (LCS) is prepared by spiking a reagent blank with the analyte of interest to make a concentration similar to those expected in environmental samples. Analysis of LCS or certified reference material (CRM) samples often document laboratory performance.
3. A sample of the same matrix (sediment) spiked with the analyte of interest at levels appropriate for determining recovery efficiency.
4. See Ecology, 2003 (Table 5).
5. See Ecology, 2003 (Table 13).

LCS = laboratory control sample.
CRM = certified reference material.
dry wt. = dry weight of sediment.
RSD = relative standard deviation.
mg/Kg = milligrams of analyte per kilogram of matrix (dry sediment).
mg/L = milligrams of analyte per liter of water (porewater).

Table 4. Test conditions and quality control samples for marine sediment toxicity tests (from *Sampling and Analysis Plan Appendix;* Ecology, 2003).

Toxicity Test	Species	Temp °C	Salinity (ppt)	Control Sample	Reference Sample
Amphipod 10-day survival	*Eohaustorius estuarius*	14-16	Ambient (2–28)	Survival > 90%	>75% survival
Sediment larval 48-60 hour normal development [a]	*Dendraster excentricus* [b]	14-16	Ambient (≥10)	Final normal survival > 70% of initial count	Normal survival > 65% relative of final seawater negative control
Juvenile polychaete 20-day growth	*Neanthes arenaceodentata*	20±1	Ambient (28)	Mean mortality < 10 % mean individual growth rate ≥ 0.72 mg/ individual/day.	Mean individual growth rate ≥ 80% of control
Microtox® bioluminescence	*Vibrio fischeri*	15	20±2	Final light output >80% of initial light output	Final light output > 80% of final control

[a] Normal and abnormal larvae will be counted. Normal development and combined abnormality and mortality will be reported.

[b] Most likely larval test species to be able to successfully spawn at this time of year.

Sampling Process Design (Experimental Design)

Twelve target sediment sampling locations were chosen in a subjective manner, based mainly on likely sources of organic enrichment (coordinates of outfall discharges) and the sampling locations previously shown to have sediment toxicity and elevated sulfide (Figure 2). A subjective sampling design is appropriate to the study goal of merely demonstrating CSL toxicity at three or more contiguous locations. A randomized or grid sampling design would ignore known or presumed sources of enrichment and previous results, and thus not maximize likelihood of achieving the study goal.

Surface sediment will be collected from 8 of the 12 target locations. One of the remaining 4 alternate targets will be sampled if:

- There is a physical impediment such as a vessel occupying the target location.
- The substrate is too hard for the sampling device to adequately penetrate.

The principal investigator will make final decisions regarding the sampling priority for primary and alternate locations, the order of sampling, and the acceptability of each grab sample. Surface sediment will also be collected from a single location within a recognized reference area (e.g., Carr Inlet, Samish Bay). The purpose of this sample is to serve as the point of comparison for regulatory interpretation of toxicity test results.

Prior to being homogenized, sub-samples from each grab will be set aside for analysis of total sulfides. The remaining sediment will be minimally homogenized (to reduce loss of hydrogen sulfide or H_2S) and used to characterize sediment grain size distribution, analyze conventional sediment parameters, and test for acute and chronic toxicity.

Samples of whole sediment will be analyzed for conventional sediment parameters including total solids, grain size distribution, total organic carbon, and total sulfides. Established protocols will be used (EPA, 1986), with minor modifications described in the *Methods* section of this QA Project Plan. Two acute and two chronic toxicity tests will also be conducted:

- The 10-day amphipod survival test (mortality endpoint).
- The 48-96-hour sediment larval normal development (abnormality and mortality endpoint).
- The 20-day juvenile polychaete growth (reduced mean biomass at test termination endpoint).
- The 5-minute and 15-minute Microtox® luminosity test (reduced bioluminescence endpoint).

All toxicity tests will be conducted according to the SMS requirements and regional guidelines (EPA, 1995), with minor modifications described in the *Methods* section.

This study will measure total sulfides in the porewater and the overlying water of toxicity tests. The results can be used to calculate the concentration of dissolved H_2S if temperature, salinity, and pH are also known. Dissolved H_2S is the most toxic fraction of total sulfides and therefore may be the most likely one to relate to observed toxicity. Such a relationship might be useful to regulators who currently lack a SQS for sediment sulfides.

Results from this study will be comparable to results from other studies conducted throughout Puget Sound because the methods that will be used are described in the *Sampling and Analysis Plan Appendix* to the SMS (Ecology, 2003) and based on *Puget Sound Estuary Protocols and Guidelines (EPA, 1986-2003):*

- Positioning will use a differentially-corrected global positioning system (GPS; EPA, 1998).
- Sediment samples will be collected using a van Veen grab sampler (EPA, 1997a).
- Conventional sediment parameters will be measured according to EPA (1986), with only minor modifications described in the *Methods* section.
- Toxicity tests will be conducted according to regional protocols (EPA, 1995), with minor modifications described below.

The objective for completeness is to obtain usable results for toxicity and sediment conventionals for all 8 Post Point sampling locations and the single Carr Inlet reference sampling location.

If this study demonstrates sediment toxicity sufficient to require future remedial investigations, the goals and objectives of the remedial investigation might include:

- To determine the geographic limits or boundary for the CSL and SQS toxicity.
- To determine the primary cause or causes of the observed sediment toxicity.
- To determine the geographic limits or boundary for the elevated sulfides observed in sediments near the Post Point outfalls and Harris Avenue Shipyard, assuming sulfides contribute to toxicity.

Sampling Procedures

Vessel positioning

Target sample stations will be located using a Leica MX420 differentially-corrected, 12-channel GPS receiver mounted on the stern corner of the *RV Skookum* and a Coast Guard beacon differential receiver on land. The GPS unit will receive radio broadcasts of GPS signals from satellites. The Coast Guard beacon receiver will acquire corrections to the GPS signals. Overall positioning accuracy is expected to be ± 1-2 meters and no worse than ± 3 meters.

Northing and easting coordinates of the vessel will be updated every second and displayed directly on a computer onboard the vessel. The coordinates at the time the sampling device reaches the bottom and its doors close, thus time of sediment collection, will be processed and stored in real time using a positioning data management software package. Washington State Plane Coordinates, North (North American Datum 83), will be translated into degrees and decimal minutes and be used for the horizontal datum. The vertical datum will be the National Oceanic and Atmospheric Administration (NOAA) National Ocean Service mean lower low water (MLLW) datum. Vertical control will be provided by the ship's depth finder and corrected for tidal influence after sampling is completed. Tidal elevation will be determined by using National Ocean Service tide gage readings for Cherry Point and Friday Harbor locations, or using software-predicted tides levels.

To ensure the accuracy of the navigation system, a checkpoint will be located at a known point such as a pier face, dock, piling, or similar structure that is accessible by the sampling vessel. At the beginning and end of each day, the vessel will be stationed at the check point, a GPS position reading will be taken, and the reading will be compared with the known land-survey coordinates. The two position readings should agree, within the limits of the survey vessel operational mobility, to within ± 2 meters.

Collecting sediment samples

The principal investigator will be responsible for collection, handling, and storage of all surface sediment samples. Sampling methods will follow the requirements of Ecology's *Sampling and Analysis Plan Appendix* (Ecology, 2003) that accompany the Sediment Management Standards (Ecology, 1995), and that are based on Puget Sound Estuary Protocols (EPA, 1997a). Sampling procedure modifications will be at the discretion of the principal investigator and recorded in the field logbook.

Samples of surface sediment will be collected from Ecology's research vessel *RV Skookum* using a stainless steel double van Veen grab (0.1 m^2 surface area each side). If a primary target location cannot be accessed then a suitable alternate target location will be chosen. Reasons for sampling at an alternate location may include physical obstruction (barge on location) and failure of the van Veen to penetrate the substrate after three attempts.

Sediment will be collected from the depth interval or horizon presumed to represent the most biologically active zone (0-10 cm). In most cases, lowering the sampler twice at each location will be sufficient to provide an adequate volume of sediment for analyzing conventional parameters, providing archive material, and conducting all toxicity tests. The detailed procedure for collecting 0-10 cm surface sediment is as follows.

- Maneuver the vessel to be near coordinates of primary or alternate target sampling locations.
- Open the grab sampler jaws into the deployment position.
- Guide the sampler overboard until clear of the vessel.
- Position the sampling vessel such that the GPS receiver, mounted on the stern corner of the vessel, registers being within 1-2 meters of the target coordinates.
- Lower the sampler through the water column at approximately 1 foot or 0.3 meters per second to a depth approximately 1 meter above the bottom.
- Lower the sampler to the bottom if the GPS still registers within 1-2 meters of target coordinates *and* if the cable is very near vertical (otherwise reposition vessel and then do so).
- Record the date, time, GPS coordinates, and water depth when the sampler reaches bottom.
- Retrieve the sampler and raise it at approximately 0.3 m/s.
- Guide the sampler aboard the vessel and place it on the work stand on the deck, using care to avoid jostling that might disturb the integrity of the sample.
- Examine the sample using the following sediment acceptance criteria:
    - The penetration depth is at least 11 cm and not more than 16 cm (not overfilled or extruding out the top of the sampler).
    - There is minimal apparent loss of overlying water (sampler closed completely), and the overlying water that remains is not excessively turbid.
    - The sediment surface (after overlying water is removed) is relatively flat or undisturbed.

In addition to the field notes listed above, the principal investigator or a field crew member will record the following observations in the field logbook after accepting a grab sample:

- Visual characteristics of surface sediment (e.g., cobble/debris/wood, colors, odors, oil/sheen, textures, biological structures).
- Characteristics of sediment with depth (e.g., change in color, Redox layer).
- Maximum depth of penetration (to 0.5 cm).
- Overall quality of the sample.

A composite sample from each location will be prepared using surface sediment from two acceptable grab samples. However, before homogenizing sediment from multiple grabs to form this composite sample, 60 mL sub-samples will be collected for analysis of total sulfides in both whole sediment and porewater. This will eliminate any loss of sulfide gases that may occur during the homogenization process (EPA, 1986). Sub-samples will be collected using a 60 mL plastic syringe with its end removed. The syringe plunger will be placed on the sediment surface, the syringe body will be gently pushed into the sediment to the 60 mL line, and a small sediment core inside the syringe will be removed from the sampler.

Approximately 60 mL of sediment will then be extruded from the syringe into a precleaned 2-ounce glass jar. Samples for analysis of total sulfides in whole *in situ* sediment will be sealed to exclude air (zero headspace). This procedure will be repeated for analysis of total sulfides in the *in situ* porewater. No preservative will be added to the containers because this would alter the porewater fraction of total sulfides by causing zinc sulfide to precipitate from solution. Three replicate sub-samples will be collected at the first sampling location only (or a location with noticeably high sulfides).

A composite sample from each location will be prepared using the material remaining from two separate grab samples. The overlying water will be siphoned off of each grab, and the top 10-cm layer of sediment that is not in contact with the sidewalls of the grab will be removed with a stainless steel spoon. The project manager will determine whether or not large rocks, pieces of wood, shells, or organisms will be removed prior to homogenization. A total volume of approximately 5 liters of sediment will then be placed in a stainless steel bowl or bucket and minimally homogenized by stirring with a different stainless steel spoon. Homogenization will be minimal to minimize loss of volatile sulfides and minimize aeration of anoxic sediment.

Sub-samples of the homogenized sediment will be placed into appropriate sample containers (usually precleaned glass jars) such that 1 cm of headspace remains (to minimize breakage), and then sealed with Teflon-lined lids. The type and size of container used for each analysis are listed in Table 3. Each glass container will be placed in a cooler with wet ice. If samples will be transported any substantial distance, bubble wrap may be used to help prevent breakage.

Sample labeling, storage, and handling

A waterproof label will be affixed to all sample containers prior to start of field work. Labels will include sample code or number, date, time, MEL sample number, type of analysis to be conducted, and initials of the person preparing the sample. Sample will be assigned identifier codes according to the scheme "PPTox##", where "PP" stands for Post Point, "Tox" refers to the main study goal, and "##" is the station number (01-12). One field duplicate, collected as a QA sample for analysis of conventional sediment parameters, will be numbered in a similar manner (with no indication of being a field duplicate). The toxicity reference sample will be labeled CITox01, with "CI" referring to Carr Inlet.

All samples will be stored in coolers on ice at 4°C and transported to MEL or contract laboratories within 72 hours of collection. Storage temperatures and holding time will be as specified by Ecology (2003) and EPA (1997) and are also listed in Table 5. Chain-of-custody will be maintained.

Contract laboratories will assign a unique identifier to each sample and ensure that each sample is tracked through all stages of preparation and analysis. At a minimum, the tracking record will contain the analytical method being performed, the name or initials of individuals responsible for conducting the analysis, and the dates on which samples were extracted, otherwise prepared, and analyzed.

Table 5. Sample containers, preservation, and holding times.

Parameter	Matrix	Laboratory	Number of Samples	Minimum Quantity Required	Container	Holding Time	Storage conditions
Total solids	Whole sediment	MEL and Contract	10 each	2 @ 50 grams	4-oz wide-mouth glass jar	7 days	4^{o} C.
Grain size	Whole sediment	Contract	10	150 grams	16-oz wide-mouth HDPE jar	6 months	4^{o} C.
Total organic carbon	Whole sediment	MEL	10	50 grams	4-oz wide-mouth glass jar	14 days 6 months	4^{o} C. $-18\ ^{o}$ C.
Total sulfides	Whole sediment, porewater	Contract	22	50 grams	4-oz wide-mouth glass jar	7 days	4^{o} C.
Sediment archive	Whole sediment	MEL and Contract	9	300 grams	8-oz wide-mouth HDPE jar	Varies	4^{o} C.
Toxicity (2 acute tests, 1-2 chronic tests)	Whole sediment, porewater	Contract	9	5 liters total	1-gallon glass jars or 1-gallon HDPE buckets	2 weeks	4^{o} C.

Decontamination

The van Veen grab sampler will be precleaned with Liquinox® detergent and rinsed with on-site seawater before beginning sampling. Decontamination of the sampler between grabs at the same target location will involve scrubbing with a coarse bristled brush and rinsing thoroughly with site water. Decontamination of the sampler between target sampling locations will involve brushing it with on-site seawater unless an oil sheen or visible contamination is observed. In that event, the sampler will be cleaned as follows.

- Rinse thoroughly with site water.
- Wash with a scrub brush until free of sediment.
- Wash with phosphate-free detergent.
- Rinse thoroughly with site water again.
- Rinse with acetone and distilled water.

Homogenizing equipment (stainless-steel mixing bowl and spoons) will be decontaminated according to established guidelines (EPA, 1990). Equipment and utensils will be precleaned by washing with Liquinox® detergent, followed by sequential rinses with tap water, deionized water, and pesticide-grade acetone. They will then be air-dried and wrapped in aluminum foil until used in the field.

Sampling devices or equipment that cannot be cleaned to the satisfaction of the project manager will be retired from use.

Waste management

Excess sediment and non-solvent decontamination rinses will be returned to the sampling location. All disposable sampling materials, such as gloves and paper towels, will be placed in a heavy-gauge, plastic garbage bag. The garbage bag will be removed from the study site at the end of each day and placed in a suitable solid waste disposal container.

Chain of custody

The principal investigator will be responsible for tracking the status and fate of all sediment samples (during collection, transport, and analysis) and all resulting sample data (electronic and printed reports) using chain-of-custody forms and procedures.

Custody forms will accompany all samples. Sample information on container labels will first be compared to field log entries. Information from individual sample labels will then be transferred to a custody form and the sample placed on ice in a cooler. Finally, information on custody forms will be compared to contents of the cooler. Custody forms will contain at least the following information:

- Ecology's Environmental Assessment Program project name and number.
- Sampling location.

- Unique sample number(s).
- Sample collection date and time.
- Any special notations on sample characteristics or problems.
- Initials of the person collecting the sample.
- Type of analysis to be conducted.
- Date and time of sample transfer of custody.
- Shipping company name and waybill number (if any).

Custody procedures will start during sample collection. The first change in custody will be when samples are delivered directly or transferred for shipping to each analytical laboratory. Any person having custody of samples will sign the form only if the samples will be properly secured and not left unattended. The principal investigator will ensure that the laboratory has accepted delivery of the shipment at the specified time. Laboratory staff will:

- Ensure that custody forms are signed upon receipt of the samples.
- Record observations or questions about sample integrity on custody forms.
- Contact the principal investigator immediately upon receipt of samples if there are discrepancies between the custody forms and the sample shipment.
- Retain copies of custody forms.
- Include copies of custody forms as an appendix to data and QA/QC reports.

Shipping

Coolers with sediment samples for analysis of conventional sediment parameters will be transported directly to MEL by Ecology courier or picked up by the contract laboratory. The temperature inside the coolers will be checked upon receipt at the laboratory by measuring the temperature of a blank water sample packed inside each cooler. Laboratory staff will note any coolers that are not sufficiently cold (4° ± 2°C). Each sample will be assigned a unique laboratory number and grouped into appropriately-sized batches for analysis.

Measurement Procedures

All surface sediment samples collected for this project will be analyzed using the laboratory measurement methods listed in Table 6.

Table 6. Measurement methods for the sediment toxicity study near Post Point.

Analyte or Test protocol	Sample Number	Expected Range of Results	Reporting Limit	Sample Preparation Method[1]	Analytical (Instrumental) Method
Total solids (% of wet weight)	10	30 – 70	0.1	---	EPA Method 160.3
Grain size	10	≥ 60	1.0	---	EPA (2003/1986) Plumb (1981)
Total organic carbon (% of dry weight)	10	0.5 – 3.5	0.1	---	PSEP-TOCM (dried at 70°C) (EPA, 1986)
Total sulfides (mg/Kg dry weight)	11	1 - 5000	5	---	PSEP (EPA, 1986)
Total sulfides in porewater (mg/L)	11	Unknown	5	---	PSEP (EPA, 1986)
Amphipod survival[2]	9	---	---	---	PSEP (EPA, 1995)
Larval development[2,3]	9	---	---	---	PSEP (EPA, 1995)
Polychaete growth[2]	9	---	---	---	PSEP (EPA, 1995)
Microtox® bioluminescence[4]	9	---	---	---	Ecology (2003)

[1] Sample preparation methods for sediment conventional analyses are described in the analytical method.
[2] Test requirements include measuring total sulfides in porewater and overlying water.
[3] Tests will most likely involve the Sand dollar *Dendraster excentricus*, but one of the following alternate species may be used instead: Pacific oyster *(Crassostrea gigas),* Blue mussel *(Mytilus galloprovincialis),* Purple sea urchin (*Strongylocentrotus purpuratus*, Green sea urchin *(Strongylocentrotus droebachiensis).*
[4] Microtox 100 percent sediment porewater extract (Ecology, 2003).
PSEP - Puget Sound Estuary Program.

Sediment chemistry

MEL will analyze total solids and total organic carbon in all sediment samples plus one blind field duplicate and laboratory triplicate. Ecology will contract with one or more accredited commercial laboratories to measure total solids, grain size, and total sulfides (*also* including a blind field duplicate and laboratory triplicates).

Table 5 summarizes how each sediment sample will be preserved, how long it will be stored before analysis, which analytical lab will measure each analyte, and methods used. Required reporting limits are listed in Table 3. Additional sediment will be frozen at -18^{o}C and archived by Ecology.

Sediment toxicity

Ecology will contract with one or more laboratories to conduct the four toxicity tests listed in Table 4. Methods will follow regional guidance described in the *Sampling and Analysis Plan Appendix* (Ecology, 2003), *Puget Sound Estuary Protocols and Guidelines* (EPA, 1995), and sediment management annual review meeting clarifications (SMARM, 1997-present). Homogenization and aeration of samples will be minimized. In addition, the principal investigator will review standard operating procedures used by each toxicity laboratory prior to issuing any contract.

Quality Control Procedures

Field

Field logs will be reviewed to evaluate how well each sample may represent the local sampling environment. In particular:

- Field samples should have been collected between mid-August and mid-September, 2007.
- Sampling locations should be no more than three meters from the target sampling locations identified in the final Quality Assurance (QA) Project Plan.
- Regional sampling protocols and sample acceptance guidelines, detailed in the *Sampling Procedures* section, should have been followed.
- Sampled should have been handled appropriately and stored as specified in Table 5.

No field blanks will be prepared for this project, but a field duplicate will be collected at one sampling location. To assess the field variability of total sulfides, as many as 5 field replicates will be collected for this analyte. There are no MQOs for variability among field replicates.

Laboratory

For analysis of conventional sediment parameters, the quality control samples to be collected in the field, or prepared and analyzed in the laboratory, are listed in Table 3. They include field replicates, method blanks, laboratory replicates, control sample or certified reference material (total organic carbon and total sulfides), and matrix spikes (total sulfides only).

Accuracy of results for sediment conventionals will be evaluated using recoveries of known amounts of the analyte from a certified reference material or spiked matrix. Precision will be evaluated using results from laboratory replicates. Sensitivity will be assessed using reporting limits, and bias will be addressed by examining recovery of analytes from various QC samples.

If sample results exceed control limits, then reasonable corrective actions will be taken by the laboratory. If such actions do not yield acceptable results, then the laboratory will discuss the need for additional corrective actions with the principal investigator. Potential corrective actions for the conventionals listed are reanalysis or assignment of appropriate data qualifiers.

The test conditions, necessary QC samples, and performance standards for both control and test samples that will apply to toxicity tests conducted for this study are listed in Table 4. The principal investigator will (1) provide laboratories any needed clarifications of test protocols, (2) review contract laboratory standard operating procedures for individual toxicity tests, (3) work closely with laboratory staff to anticipate issues before they arise, (4) be available to make decisions or troubleshoot problems that arise in conducting toxicity tests, and (5) review the final data package for compliance with QA Project Plan specifications.

The total fund currently available to pay for all goods and services associated with this project is $11,000. Table 7 estimates the itemized and total analytical costs, but does not include minor costs such as miscellaneous sampling equipment, sample containers, or shipping costs. Compensation for the apparent shortfall of approximately $10,000 will need to come from funds currently dedicated to a different sediment study sponsored by Ecology's Toxics Cleanup Program.

Table 7. Summary of estimated analytical costs (Fiscal Year 2008).

Analysis	Laboratory	No. of Samples	No. of QA Samples	Total No. of Samples	Unit Cost ($)	Subtotal ($)
Total solids (%)	MEL[1] and Contract	9	2	20	10	200
Grain size (%)	Contract	9	1	10	85	850
Organic carbon (%)	MEL[1]	9	1	10	40	400
Total sulfides[2] (mg/Kg)	Contract	9	4	22	35	770
10-day amphipod[3] (Survival)	Contract	8	1	9	600	5,400
48-96-hour larval[3] (Development)	Contract	8	1	9	500	4500
20-day polychaete[3] (Growth)	Contract	8	1	9	750	6,750
5-min., 15-min. Microtox[3] (Luminosity)	Contract	8	1	9	250	2,250
					Total	21,120

[1] Includes field QA samples and is based on a 50% discount rate.
[2] Total sulfides will be measured in 11 whole sediment and 11 sediment porewater samples (one field replicate for 8 sampling locations, field triplicates for one additional location).
[3] Toxicity test costs include additional total sulfide analysis.

Data Management Procedures

Field notes will be taken during all sampling activities. Notes will include date, time, meteorological observations, vessel position at time of sampling, and meter wheel water depth. Observable characteristics of all sediment samples will also be recorded. These will include grab sampler penetration depth, surface sediment physical features, organisms present, sediment color, odors, presence of sheen, and apparent depth of oxic sediment. Field notes will be recorded using a form similar to the one provided in Appendix A.

Results of laboratory analyses will be submitted to the principal investigator as follows:

- MEL will submit all analytical results for total sediment solids and TOC for test and QA samples as a printed report (with a QA summary). Output from the Laboratory Information Management System will also be submitted electronically for transfer into Ecology's EIM database.
- Deliverables from the contract *chemistry* laboratory will include all test and QA sample results for total solids, grain size, and total sulfides. A printed report of results will be accompanied by an electronic deliverable in an EIM format.
- Deliverables from the contract *toxicology* laboratory will include results for all toxicity tests, including all replicate results for all control, reference, and test samples. Test exposure conditions (initial porewater total sulfides, water quality monitoring results) will also be provided. A printed report presenting all toxicity test results, with regulatory interpretation, will be accompanied by an electronic data submittal in SEDQUAL format (unless final EIM format for toxicity results is available).

All sediment quality data generated for this project will be evaluated for completeness, accuracy, and usability. Upon completion of the final report, all usable results will be entered into Ecology's EIM database and made available to the public via Ecology's web site.

Audits and Reports

Manchester Environmental Laboratory (MEL) participates in routine performance and system audits of various analytical procedures. Audit results are available upon request. The Laboratory Accreditation Section of Ecology's Environmental Assessment Program accredits all contract laboratories that conduct environmental analyses for the agency, and the accreditation process includes performance testing and periodic lab assessments. No additional audits are envisioned.

The principal investigator will track the status of samples being analyzed by MEL and the contract chemistry lab, being particularly alert to any significant QA problems as they arise. He may visit the contract toxicity lab to observe or troubleshoot the initiation of toxicity tests. Finally, the principal investigator will keep Ecology managers apprised of the status of field work, sample analyses, data analysis, and report preparation for the study.

The scope of the study is such that no interim reports are anticipated.

The principal investigator will prepare an initial draft report describing results of this study. The first draft is targeted for completion in January 2008 and will include the following elements.

- Abstract.
- Background, problem statement, study goals, and objectives.
- Study design, with site maps showing past sediment quality data and results from this study.
- Description of field and laboratory methods.
- Sampling summary (e.g., date, time, location, and depth).
- Data quality summary highlighting exceptions to Ecology QA Project Plans and sampling difficulties encountered.
- Analysis and mapping of toxicity, including compliance with the SMS.
- Statistical analysis of relationships between toxicity and total sulfides in porewater (if any).
- All analytical results and summary of findings.
- Conclusions and recommendations.
- References.
- Appendices (e.g., reference to QA Project Plan, navigation log, field notes, raw data tables).

The draft report will undergo peer review by Ecology staff, and a final report will be prepared by March 31, 2008 (Table 2).

Upon completion of the project, all project data will be entered into the Ecology EIM system. Public access to electronic versions of the data and reports generated from this project will be available via Ecology's internet homepage (www.ecy.wa.gov).

Data Verification and Validation

Data verification and validation is a two-step process. First, data are reviewed for errors, omissions, and compliance with quality control (QC) acceptance criteria. Second, the data package is carefully examined to determine whether method quality objectives (MQOs) have been met.

The principal investigator will assess representativeness of results by reviewing field notes about where and how each surface sediment sample was collected. He will then assess the comparability of sample results to other studies. This will be accomplished by comparing the methods and protocols described in case narratives prepared by MEL and contract laboratories with the ones listed in this QA Project Plan (Table 3 and Table 4).

MEL and contract laboratory staff involved in analyzing conventional sediment parameters will review all results and prepare a case narrative. The case narrative will include a QC report that describes:

- Methods and protocols used, especially any deviating from the QA Project Plan.
- Results of initial and ongoing instrument calibrations and QC samples (method blanks, field and lab replicates, laboratory control samples, spiked samples), especially those not meeting QC acceptance criteria (control limits or performance standards).
- Intermediate calculations (e.g., accounting for sample dilution).
- Completeness (no omissions) and accuracy (calculation/transcription errors).
- Assignment of data qualifiers.

The case narrative will highlight all results not meeting acceptance criteria (outside control limits), corrective actions that have been taken (assignment of qualifier codes or reanalysis) and any further actions needed (reject results). The narrative and QC report will include a summary of results and the complete data package.

The principal investigator, with possible assistance from Ecology's QA Officer, will review all case narratives, QC reports, data summaries, and raw lab data. Most importantly, he will:

- Verify that laboratories have complied with the MQOs presented in Table 3 (chemical analysis) and Table 4 (toxicity tests).
- Summarize data verification and validation efforts in the final study report.

Data Quality (Usability) Assessment

After reviewing, verifying, and validating the laboratory data, the principal investigator will determine whether the data are usable relative to the primary study goal: regulatory characterization of sediment toxicity. Specifically, he will assess:

- How representative the data are of environmental conditions.
- How comparable the data are to results from other regional studies.
- How interpretable the data are by the SMS requirements and guidelines.
- Whether or not sufficient data were collected (number and quality) to address the main goal and objectives of the study.

Representativeness will be assessed by careful review of field notes with respect to several factors:

- Timing of sample collection.
- The proximity of final sampling coordinates to targets locations.
- The extent to which sample acceptance criteria were adhered to or observed.

Results for any sediment sample collected more than 3 meters from target coordinates, or not meeting all sample acceptance criteria, will be scrutinized for possible exclusion from analyses.

To evaluate data comparability, the principal investigator will review the final analytical methods and standard operating procedures used, as well as the QC summaries or exception reports submitted by each laboratory. Where possible, he will compare analytical results from this study to results from similar studies and locations. Reasons that certain results may not be deemed usable include the following:

- Methods or standard operating procedures differed from those listed in this QA Project Plan such that they cannot be considered adequately comparable.
- QC reports indicated conventional parameter results had a severe bias or were highly qualified for some other reason.
- Detection limits or reporting limits were greater than specified in Table 3 and Table 6.

Results are likely to be rejected if that is the recommendation made by the analytical laboratory.

The principal investigator will also interpret all toxicity test results according to regulatory requirements, written guidance, and conventions. He may reject toxicity results or be unable to interpret them if:

- Test conditions do not comply with those listed in Table 4.
- QC samples (control or reference samples) fail the performance standards listed in Table 4.

Finally, all results will be summarized using tables and GIS maps. Statistical analysis of the relationship between observed toxicity and total sulfides in sediment porewater, or overlying water of test chambers, may involve regression and ANOVA (analysis of variance).

References

Aasen, S., 2007. Personal communication requesting median value for TOC in urban embayments based on Marine Sediment Monitoring Program results. Environmental Assessment Program, Washington State Department of Ecology, Olympia, WA.

Adolphson, 2007. Personal communication with Peter Adolphson regarding need to sample between mid-August and mid-September. Toxics Cleanup Program, Washington State Department of Ecology, Olympia, WA.

Anchor, 2004. Sampling and Analysis Report. City of Bellingham Post Point NPDES Support. Prepared by Anchor Environmental, Seattle, Washington, June 2004, for City of Bellingham.

City of Bellingham, 2007. Department of Public Works internet web site: www.cob.org/pw/sewer.htm

Ecology, 1995. Chapter 173-204. Sediment Management Standards rule.

Ecology, 2003. Sediment Sampling and Analysis Plan Appendix. Washington State Department of Ecology, Olympia, WA. Publication No. 03-09-043. www.ecy.wa.gov/biblio/0309043.html

Ecology, 2006. Post Point (Bellingham Bay) Sediment Sulfide and Toxicity Assessment. Washington State Department of Ecology, Olympia, WA. Publication No. 06-03-002. www.ecy.wa.gov/biblio/0603002.html

EPA, 1986. Recommended protocols for measuring conventional sediment variables in Puget Sound. Prepared by the U.S. Environmental Protection Agency, Region 10, Office of Puget Sound, Seattle, Washington, and the Puget Sound Water Quality Authority.

EPA, 1990. Specifications and Guidance for Obtaining Contaminant-Free Sample Containers. Directive #9240.0-05. Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 1995. Recommended guidelines for conducting laboratory bioassays on Puget Sound sediments. Prepared by the U.S. Environmental Protection Agency, Region 10, Office of Puget Sound, Seattle, Washington, and the Puget Sound Water Quality Authority.

EPA, 1997a. Recommended guidelines for sampling marine sediment, water column, and tissue in Puget Sound. Prepared by the U.S. Environmental Protection Agency, Region 10, Office of Puget Sound, Seattle, Washington, and the Puget Sound Water Quality Authority.

EPA, 1997b. Recommended quality assurance and quality control guidelines for collection of environmental data in Puget Sound. Prepared by the U.S. Environmental Protection Agency, Region 10, Office of Puget Sound, Seattle, Washington, and the Puget Sound Water Quality Authority.

EPA, 1998. Recommended guidelines for station positioning in Puget Sound. Prepared by the U.S. Environmental Protection Agency, Region 10, Office of Puget Sound, Seattle, Washington, and the Puget Sound Water Quality Authority.

Hart Crowser, 2005. Biological Evaluation for Post Point Outfall Repair. Bellingham, WA. October 11, 2005.

RETEC, 2004. Sediments Remedial Investigation and Feasibility Study: Harris Avenue Shipyard, Bellingham, Washington. Prepared by The RETEC Group, Inc. for the Port of Bellingham. Review draft, August 27, 2004.

SMARM, 1997-present. Various program clarifications to guidelines for conducting sediment toxicity tests.
www.nws.usace.army.mil/PublicMenu/Menu.cfm?sitename=dmmo&pagename=Bioassays

Appendices

Appendix A - Example Field Log

Washington State Department of Ecology
Post Point Sediment Toxicity Study
Directed Studies Unit
September 2007 Field Log

SAMPLE No.: ______________ MEL Lab ID: ______________
☐ CHEM SPLIT SPLIT SAMPLE No.: ___________ SPLIT MEL Lab ID: ____________

CREW: ☐ Tom Gries ☐ Randy Coots ☐ Sandy Aasen ☐ Maggie Dutch

WEATHER: ☐Clear ☐Cloudy ☐Fog ☐Overcast ☐Continuous layer of clouds ☐Rain
☐Windy ☐Thunderstorm

SEA STATE: ☐Calm ☐Choppy ☐Rough ☐Strong Current

GRAB USED: ☐Weighted ☐Unweighted

LOCATION COORDINATES: ____
TARGET DGPS LAT: ______________________ **LONG:** ________________________
☐TARGET MOVED 100m

SAMPLING DATE: ______/______/2007 **TIME OF:** 1ST GRAB: _______am/pm
LAST GRAB: ______ am/pm

STRATUM: ☐Basin ☐Harbor ☐Passage ☐Rural ☐Urban
STATION DESCRIPTION: ____
____

STATION STATUS:
☐ Target & Sampled ☐ Not Needed ☐ Not Sampled ☐ Not Targeted ☐ OS-Other Sample
☐ Physically Inaccessible ☐ALTERNATE for Sample No.: ___________

STATION FAIL REASON:
☐ Abandoned ☐ Washed ☐ Poor Closure ☐ Disturbed Surface ☐ Shallow penetration
☐ Rocky bottom ☐ Algal Mats

GRAB INFORMATION (GRAB NO. __)

GRAB ACCEPTIBILITY: No. Taken: _______ No. Rejected: _______

REASON FOR REJECT: ☐Abandoned ☐Washed ☐Poor Closure ☐Disturbed Surface ☐Shallow penetration ☐Rocky bottom ☐Algal Mats

METER WHEEL DEPTH: _________ m **DEPTH SOUNDER DEPTH:** _________ m

TEMP: _________ ºC **SURFACE SALINITY:** __________ ppt

PENETRATION DEPTH: ________cm **RPD:** ________cm

SEDIMENT TYPE: ☐Cobble ☐Gravel ☐Sand ☐Silt-Clay

MATERIAL IN/ON SEDIMENT: ☐Wood Fragments ☐Shell Fragments ☐Plant Fragments ☐Macroalgae

SEDIMENT COLOR:
☐Olive ☐Gray ☐Brown ☐Black **OVER** ☐Olive ☐Gray ☐Brown ☐Black / ☐Sheen?

SEDIMENT ODOR: ☐None ☐H_2S ☐Petroleum ☐Other: _________________________
☐Slight ☐Moderate ☐Strong

PARAMETERS SAMPLED: ☐ Conventionals ☐ Chemistry ☐ Toxicity ☐ Infauna
Other: Sulfides

FAUNA OBSERVED :

____
____
____
____
____

COMMENTS:

____
____
____
____
____

RECORDED BY:

Appendix B - Health and Safety Plan

The following is an abbreviated Health and Safety Plan for Ecology's sediment toxicity study near Post Point (Bellingham Bay, Washington)\. It is a slightly modified version of the one found in Ecology's Environmental Assessment Program Safety Manual. All participants in the study must be familiar with this Safety Manual.

Name of Ecology staff: _Tom Gries, Randy Coots, Mark Henderson, Dan Sherratt, Sandy Aasen_

Training requirements: _First Aid and CPR, familiarity with the EAP Safety Plan, (Boating Safety recommended._

Medical monitoring requirements: _None_

Date: _September 18-20, 2007_ Arrival time _8:30 a.m._

Site name and location: _Southern Bellingham Bay, marina nearest Post Point wastewater treatment plant._

Nearest city: _Bellingham_ Nearest hospital: _St. Joseph Hospital (2901 Squalicum Pkwy (360) 734-5400))_

Emergency numbers: Statewide 911 Hospital: _(360) 734-5400)_
Ambulance: ______________

Is site currently active? Yes _X_ No ___ Will the buddy system be used? Yes _X_ No ___

Site description: _Potential MTCA/SMS sediment cleanup site, minimal chemical contamination but possible toxicity due to ammonia and sulfides (from organic loading). Study site is under water. Risk of exposure to contaminants from handling sediment samples is low. Physical hazards associated with handling sampling gear are low to moderate._

Scope/objective of work: _To collect 8 surface sediment samples from the vicinity of Post Point treatment plant discharge outfalls._

Known contaminants on site: Low concentrations of trace metals and organics.

Routes of chemical exposure: Inhalation _X_ Dermal _X_ No exposure _____

Overall risk of chemical exposure: Serious _____ Moderate _____ Low _X_

Physical hazards: Confined space __________ Noise __________ Heat/cold stress _Yes_

Describe any area on site that could function as a confined space: *Only vessel engine room.*
____

Was air monitoring conducted? Yes _____ No __*X*__

Personal protection level required: A ____ B ____ C ____ D __*X*__

Personal protective equipment required: Boots, hard hat, foul weather gear, gloves, PFD
____

Overall risk of physical hazards: Serious _____ Moderate _____ Low *X* Unknown ____

Expected parameters/contaminants to be sampled: *Sediment conventionals, sediment for toxicity testing.*

Sampling matrix: Air _____ Surface water _____ Groundwater _____ Soil _____
Sediment *X* Containers _____ Other __