WASHINGTON STATE
DEPARTMENT OF
ECOLOGY

Quality Assurance Project Plan

Using Sediment Profile Imaging (SPI) to Evaluate Sediment Quality at Two Puget Sound Cleanup Sites: Part II – Port Gamble Bay

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December 2006

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Approvals

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Acronyms and Abbreviations

This list contains acronyms used frequently in this document. Other acronyms are used infrequently and defined only in the text.

DQO	data quality objective
Ecology	Washington State Department of Ecology
EIM	Environmental Information Management System
EPA	U.S. Environmental Protection Agency
GIS	Geographic Information System
GPS	Global Positioning System
LDW	Lower Duwamish Waterway
MQO	measurement quality objective
MTCA	Model Toxics Control Act
ppt	parts per thousand (for salinity)
QA	quality assurance
QC	quality control
RPD	relative percent difference
RSD	relative standard deviation
SEDQUAL	Sediment Quality Database/Information System
SPI	Sediment Profile Imaging
SQS	Sediment Quality Standards
TOC	total organic carbon
TVS	total volatile solids
WAC	Washington Administrative Code

Abstract

The Washington Department of Ecology (Ecology) is evaluating the use of preliminary Sediment Profile Imaging (SPI) surveys to streamline studies of contaminated sediment cleanup sites. This may be feasible if SPI data, such as the Redox Potential Discontinuity depth or Organism Sediment Index, can predict with reasonable accuracy at least some of the commonly measured sediment quality triad data. These data include contaminant chemistry, laboratory toxicity, and direct evidence of benthic community impairment. If this proves to be true for at least some types of benthic habitats or sediment samples, then a preliminary SPI survey might reduce the need for, scope, and cost of more detailed cleanup site investigations.

The SPI Feasibility Study involves two sites. The Lower Duwamish Waterway in Seattle has surface sediments containing mixtures of chemical contaminants, including PCBs, phthalates, trace metals, and polycyclic aromatic hydrocarbons. In contrast, the former Pope and Talbot mill site in Port Gamble contains few of the contaminants found elsewhere in Puget Sound but does have large areas of wood waste that can alter benthic communities.

This Quality Assurance Project Plan describes the project that will be conducted at the Port Gamble Bay site. The preliminary SPI survey will be conducted from August 22-24, 2006. Ecology will conduct its follow-up sediment quality survey from August 28-30, 2006.

The final report, targeted for completion in April 2007, will describe any relationships that exist between the SPI data and triad indicators of benthic community impairment for the Port Gamble site. In addition, some sample data may serve to fill data gaps, confirm earlier results, or provide a baseline for post-cleanup monitoring.

Background

Sediment Profile Imaging (SPI) is a generic term used to describe technology developed in the 1970s (Rhoads and Young, 1970) and patented in 1983 as Remote Ecological Monitoring Of The Seafloor (REMOTS). Historically, SPI has been used for three main purposes:

- To identify open-water sites deemed suitable for disposal of dredged material.
- To map recently deposited dredged material.
- To assess the degree of benthic community recolonization/recovery after a physical disturbance or other perturbation.

Valente (2004) summarized the role that SPI has played in dredged material management in many countries around the world. In the Pacific Northwest, the Dredged Material Management Program (DMMP) has used SPI technology since the late 1980s to help establish five permitted open-water disposal sites in Puget Sound and to confirm accurate placement of dredged material at those sites (e.g., PSDDA 1988a, 1988b). It has also been used more recently to assess benthic communities and their recovery after physical disturbance near the mouth of the Columbia River.

SPI technology has less frequently been used to investigate known or suspected contaminated sediment cleanup sites. Within this region, these sites include the Denny Way/Lake Union combined sewer overflow outfall (Seattle), Hylebos Waterway (Commencement Bay, Tacoma), Eagle Harbor, Port Angeles Harbor, Port Gamble, the Willamette River (Oregon), and sites in Alaska. There are also ongoing investigations of sediment cleanup sites located on the east coast that are using SPI technology.

SPI studies of cleanup sites have usually been intended to:

- Map the extent of areas potentially impaired by the presence of chemical contaminants or wood waste.
- Evaluate the efficacy of aquatic disposal or cap placement.
- Assess the recovery of benthic communities after remedial actions have occurred.

With perhaps one exception, SPI surveys associated with these cleanup sites were not designed with the express purpose of relating results to more typical sediment quality triad indicators of benthic community impairment, e.g., contaminant chemistry, laboratory toxicity, or benthic community diversity.

The Washington State Department of Ecology (Ecology) believes that if preliminary SPI surveys can screen for benthic community impairment, at least to some degree, then the need to collect sediment samples and measure sediment quality triad indicators of benthic community impairment at sediment cleanup sites would be reduced. This provides the impetus for the current SPI Feasibility Study.

Project Description

Port Gamble Bay Site

One site selected for this study is located in the town of Port Gamble, Washington (Figure 1). It is a Model Toxics Control Act (MTCA) cleanup site that includes upland soils as well as intertidal and subtidal areas of sediment located near the former Pope and Talbot mill site. Previous investigations indicate sediments in two main areas of concern; these sediments contain large amounts of wood waste, volatile solids, organic carbon, ammonia and sulfides, as well as substantial laboratory-based toxicity. A recent report by Anchor Environmental (2006) summarizes the existing data.

Two surveys will be conducted in the two areas shown. The first will use underwater video, plan-view still, and SPI cameras to collect images at a minimum of 30 surface sediment sampling locations in the bay. This will be followed closely by a survey that will collect surface sediment samples from at least 18 of those SPI stations. The sediment samples will be analyzed for conventional parameters and direct evidence of benthic community impairment. Ecology will explore potential relationships between the results of both surveys and the feasibility of using SPI survey results to narrow the scope of more in-depth and costly investigations at wood waste cleanup sites.

This Port Gamble Bay portion of the overall SPI Feasibility Study has the following three goals, listed in order of importance.

1. Evaluate the feasibility of using SPI survey data to predict certain sediment quality triad results, e.g., measures of benthic community impairment found at sediment cleanup sites dominated by wood waste.

2. Use SPI survey results to supplement existing information characterizing the spatial distribution of wood waste, benthic habitat types, and the benthic communities present.

3. Identify benthic communities that are likely to be directly or indirectly impaired from exposures to wood waste. This will be done principally by examining benthic community assessment results. However, benthic habitat and community information from SPI images, other photographic methods, and detailed community analysis may also add to weight-of-evidence evaluations of sediment quality. These evaluations may influence decisions on the need for remedial actions.

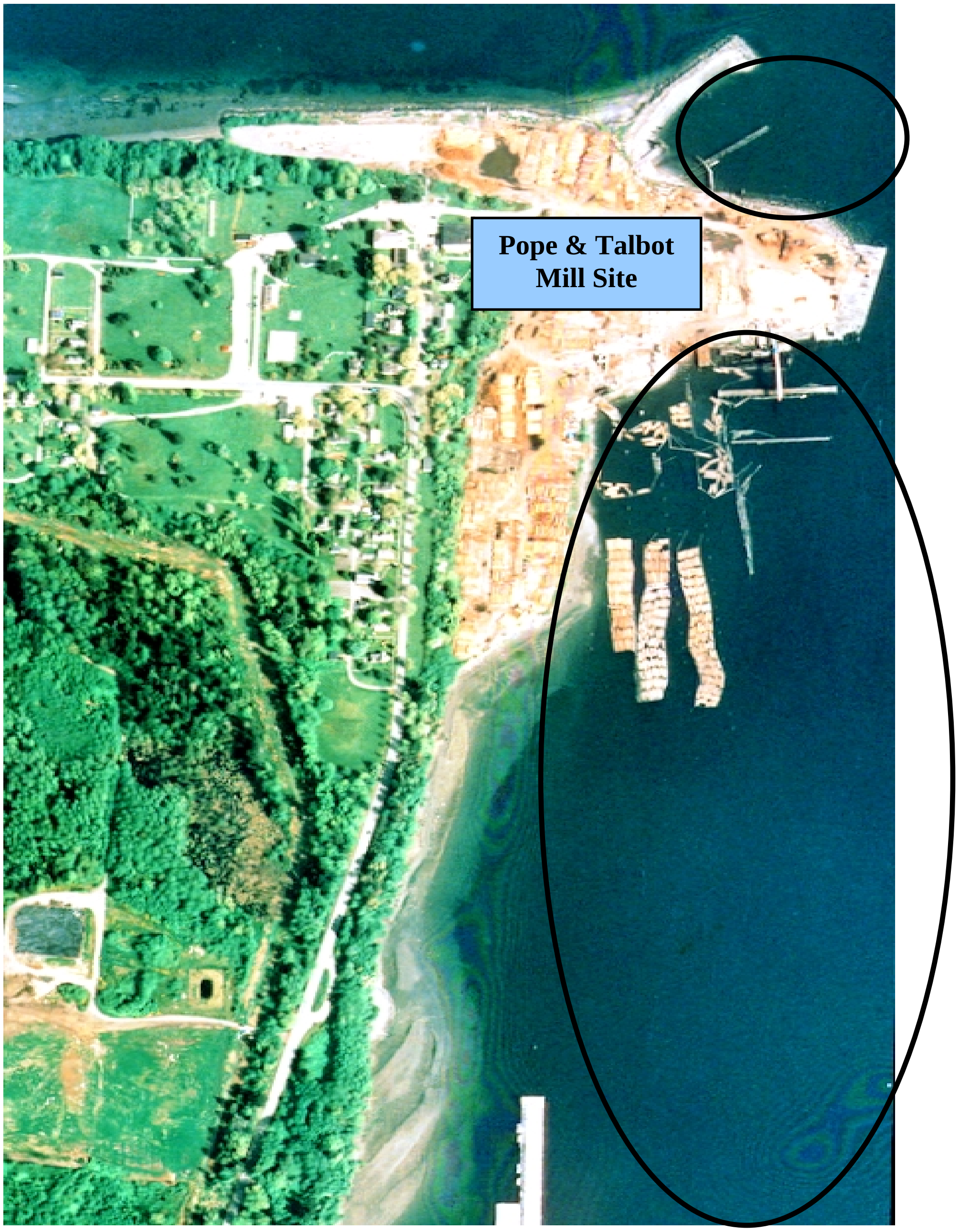


Figure 1. Port Gamble Bay Site for Ecology's SPI Feasibility Study.

The areas of concern are: (a) near the finger pier located immediately north of the peninsula on which the former Pope and Talbot timber mill and log rafting facility was located and (b) south of the peninsula where wood waste has accumulated to various degrees (the larger of the two ovals).

Objectives for this study are that Ecology will:

- Collect sediment quality triad samples from at least 18 locations that are as close as possible to the SPI stations sampled previously.

- Analyze each sample for conventional parameters (total solids, grain size distribution, total organic carbon, ammonia, total sulfides, and total volatile solids) and evidence of benthic community impairment (abundance, diversity, and richness).

- Determine whether or not any individual or combination of SPI metrics can be related to or predict any of the sediment quality triad indicators measured within the study site. Statistical analyses may include simple linear and nonlinear regressions, Chi Square tests of station classifications, Spearman rank correlations, comparisons of ordination results, or linear discriminant analysis (see Germano and Associates, 2006).

- Prepare a report that presents results of the SPI and sediment quality triad surveys. The main focus of the report will be to (1) present results of the various statistical analyses of relationships between results of the SPI survey and Ecology's sediment quality triad measures, and (2) discuss the feasibility of expanding the use of SPI technology to investigate more sediment cleanup sites.

Ecology has a vendor under contract to conduct an SPI survey in Port Gamble Bay designed to help meet the goals and the objectives described above. The vendor will provide Ecology with all image-derived data that are likely to relate to the sediment quality data that Ecology will collect.

Within one week of the SPI survey, and after discussing preliminary results with the vendor, Ecology will collect surface sediment samples from at least 18 of the final SPI stations. These samples will be analyzed for certain physical characteristics and conventional chemical parameters. Evidence for impairment of *in situ* benthic communities found at these locations will also be evaluated using regional guidelines (EPA, 1987) and various community metrics (see Ecology 1995, 2003, 2005a). Ecology will then present and summarize in a final report the results from the SPI survey, sediment quality triad sampling, and exploratory analyses of possible relationships between the two data sets.

Lower Duwamish Waterway Site

The other SPI Feasibility Study site is an area within the Lower Duwamish Waterway (LDW) extending from approximately river mile 0.0 to RM 3.5. This area is within the cleanup site that differs substantially from the Port Gamble Bay site. Instead of being dominated by wood waste, the LDW site is contaminated with PCBs and other anthropogenic toxicants. Ecology's planned investigation of the LDW study site was described in a separate QA Project Plan (Gries, 2006). Results from Ecology's investigation of the LDW site are not expected to relate to those of the Port Gamble site, and vice versa.

Organization and Schedule

This SPI Feasibility Study of the Port Gamble Bay site will be organized as depicted in Figure 2.

Dale Norton of Ecology's Environmental Assessment Program will act as project supervisor. His role will include tracking project resources and progress, ensuring consistency with program guidance, providing technical review, and helping to recruit field crew. He will also serve as pilot of Ecology's research and sampling vessel, the RV Skookum, and thus be partly responsible for positioning the vessel for the sediment triad sampling.

Tom Gries will act as project manager, chief scientist, and safety officer for the cruise. His responsibilities include:

- Managing and acting as point of contact for the overall SPI Feasibility Study.
- Managing the process by which the SPI vendor was selected.
- Overseeing SPI QA Project Plan development, SPI surveys, and reporting of SPI data.
- Preparing Ecology's QA Project Plan for collecting co-located sediment quality triad samples and data.
- Selecting and contracting with vendors to provide various purchased services, e.g., sample analyses not performed by Ecology's Manchester Environmental Laboratory.
- Overseeing all aspects of the sediment quality sampling efforts (some responsibilities may be delegated to crew members).
    - Ensuring compliance with boating safety regulations and informing crew members of potential onboard hazards.
    - Ensuring adherence to the contents of this QA Project Plan, e.g., collecting sediment samples at no more than three meters from target station locations.
    - Making decisions on plan deviations necessitated by field conditions.
    - Completing chain-of-custody forms.
    - Keeping necessary records (e.g., field logs).
- Coordinating with staff of Manchester Laboratory and Ecology's Quality Assurance officer, as needed.
- Developing GIS displays and conducting statistical analyses of field/lab data.
- Preparing the final project report.

The field crew will be composed of Ecology staff. Each crew member will be familiar with the Health and Safety Plan (Appendix B) and will be required to have taken a refresher course on Boating Safety and First Aid/Cardiopulmonary Resuscitation (CPR) within the previous year. They will be briefed by the project manager and pilot regarding avoidance of onboard hazards, e.g., handling field gear, and contingencies for problems that might arise. Crew members will help collect, handle, and store surface sediment samples so each will be familiar with elements of this QA Project Plan related to those activities. Crew members will include Environmental Assessment Program and other Ecology staff.

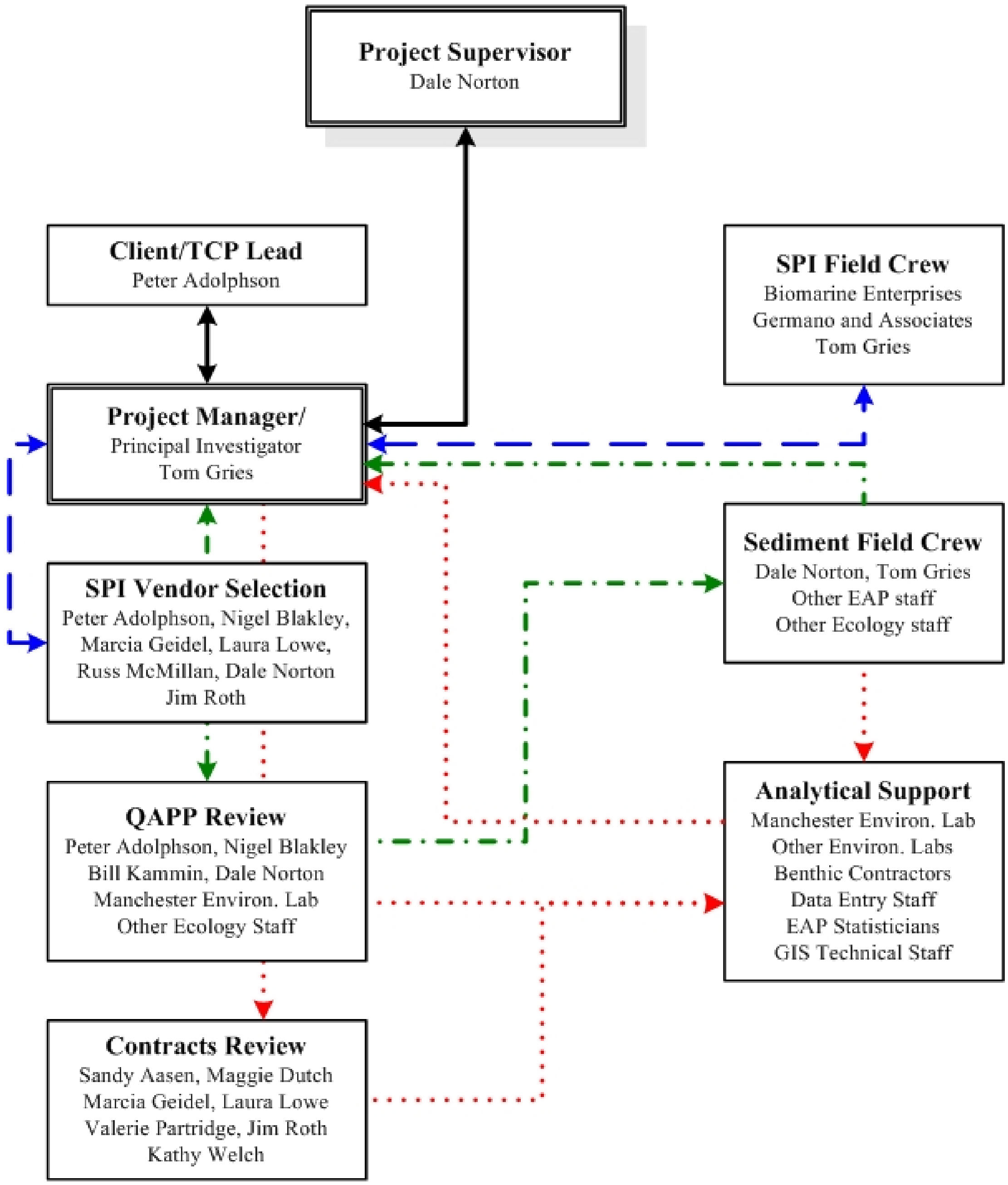


Figure 2. Organization of the SPI Feasibility Study of Port Gamble Bay, Summer 2006.

Includes Ecology and external personnel. Solid lines connect Ecology staff involved in planning and managing the project. Dashed lines indicate staff involved in selecting the SPI vendor and a feedback loop whereby preliminary SPI data are provided to the project manager. Lines with both dashes and dots indicate staff involved in developing and implementing Ecology's QA Project Plan, and a feedback loop from the field survey crew to the project manager. Dotted lines indicate staff involved in arranging for analytical services, lab staff, and feedback loop for lab data returning to the project manager.

TCP – Toxics Cleanup Program
EAP – Environmental Assessment Program
QAPP – Quality Assurance Project Plan
GIS – Geographic Information System

Manchester Laboratory staff will be responsible for analyzing sediment samples for total and percent solids, total organic carbon, and total volatile solids, as identified in this QA Project Plan. Lab staff will be familiar with contents of the final QA Project Plan and be responsible for informing the project manager of any failures to achieve applicable detection/reporting limits or QA/QC requirements. In such an event, they *may* be required to re-analyze a sample. Other Ecology staff will likely assist the project manager in entering data, developing GIS displays, conducting statistical analysis of results, and reviewing draft reports.

Private vendors will also play key roles in the project. The SPI vendor, selected by means of a competitive bid process, is Germano and Associates, LLC. Their team has prepared an Ecology-approved QA Project Plan describing details of how the SPI survey will be conducted (Germano and Associates, 2006). They will be responsible for conducting the Port Gamble SPI survey, providing Ecology with preliminary SPI results, and incorporating final results into a report describing the SPI survey. Other vendors will measure conventional sediment parameters (e.g., grain size, total solids, total volatile solids, total organic carbon, ammonia, and total sulfides) and benthic community composition in the sediment samples, as specified in this QA Project Plan.

The project will be conducted according to the schedule listed in Table 1 and depicted in Figure 3. The approximate costs of analytical services associated with the Port Gamble Bay portion of the SPI Feasibility Study are summarized in Table 2.

The major risk to timely completion of Ecology's analysis and report appears to be related to the acquisition of benthic community assessment results, e.g., sorting and taxonomic identification/ enumeration by mid-December. This will represent approximately 18 weeks between the time Ecology delivers samples to a contractor for sorting and the time final benthic community data packages are submitted back to Ecology. This is similar to the timeframe for a comparable benthic survey conducted in the Lower Duwamish Waterway (Windward, 2004). In the unlikely event that the RV Skookum is not operable when the sampling is expected to occur (August 28-30), then the sampling will occur during the week of September 5, 2006.

Table 1. Schedule for Ecology's SPI Feasibility Study of Port Gamble Bay.

Task Categories/Tasks	Date (approx.) 2006-07
Contracts	
Select SPI Contractor	*May 17, 2006*
Research Vessel (RV Kittiwake)	June
Conventional Parameters	July
Contaminant Chemistry (Manchester Laboratory)	July-August
Sediment Toxicity	July-August
Benthic Community Taxonomic Services	July-August
Field Preparations	
SPI QA Project Plan (Draft/Final)	*June 21/July 10*
Ecology QA Project Plan (Supervisor Draft/Draft Final)	*August 1/August 15*
Gear - purchase/schedule field gear, order lab containers, etc.	June-July
Skookum - schedule, modify deck space/equipment	June-July
Gear - assemble, organize and load	August 23-27
Field Work	
SPI Survey	*August 22-24*
Sediment Quality Sampling	*August 28-30*
Data Acquisition	
SPI Preliminary Data	*August 25*
SPI Report (Draft/Final)	*October 6/November 15*
Sediment Conventionals	*November 1*
Benthic Community Assessment	*December 20*
Environmental Information System (EIM) Data Set	
EIM Data Engineer	Carolyn Lee
EIM User Study ID	SPI_PG06
EIM Study Name	Sediment Profile Imaging Feasibility Study – Port Gamble Bay
EIM Completion Due	*April 2007*
Analysis and Reporting	
Data Analysis	*November 2 – January 31*
Report Lead Author	Thomas H. Gries
Report - Supervisor Draft Due	*February 1, 2007*
Report - Client/Peer Draft Due	February 22, 2007
Report - External Draft Due	March 16, 2007
Report - Final Due (Original)	*April 2007*

Milestones are in *italics*.

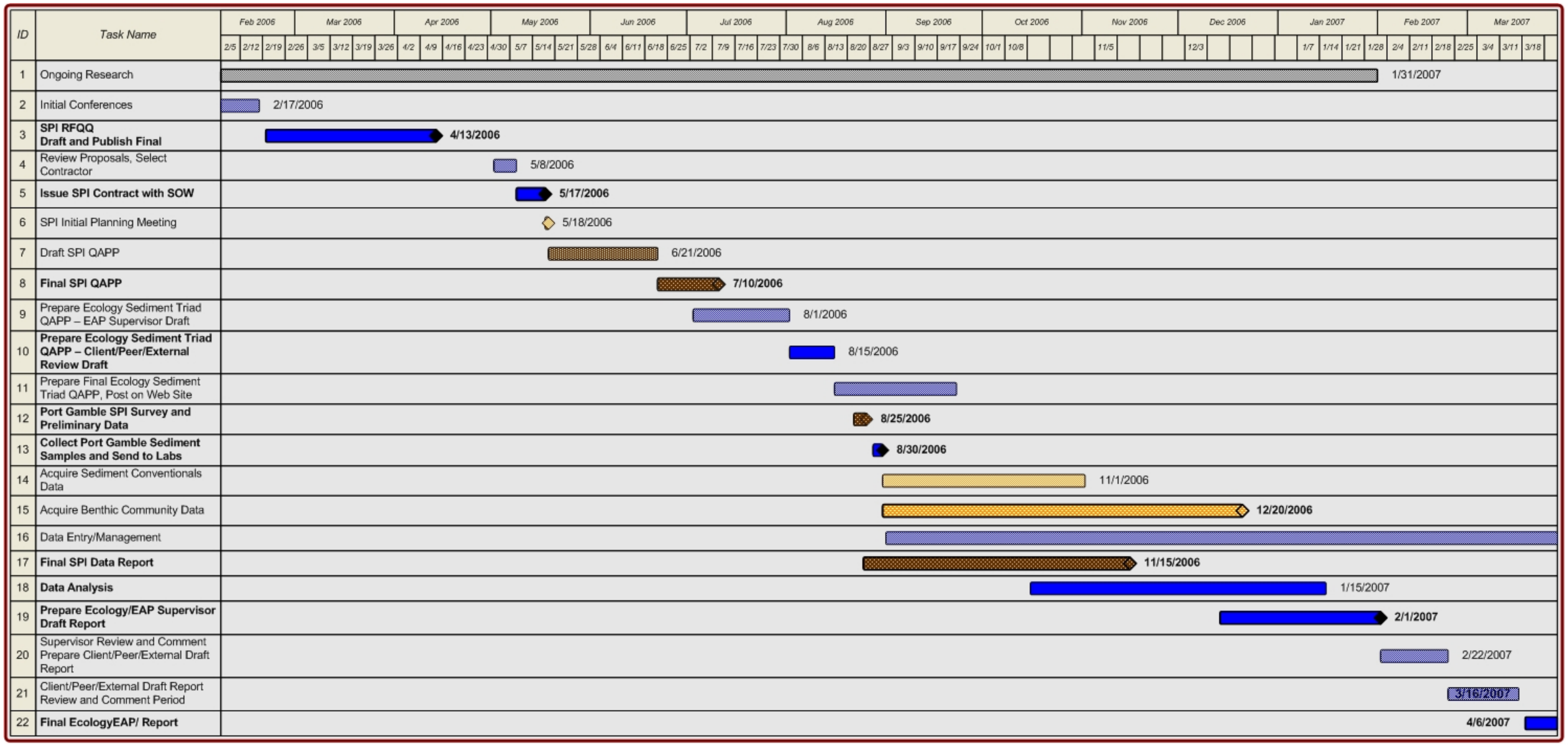


Figure 3. Schedule/Timeline for Ecology's SPI Feasibility Study of Port Gamble Bay.

Ecology tasks are shown in blue, SPI vendor tasks are shown in brown, and analytical services vendor tasks are shown in orange. Milestone tasks are denoted by bold colors.

RFQQ – Request for Quotation and Qualification
SOW – Statement of Work
QAPP – Quality Assurance Project Plan
EAP – Ecology's Environmental Assessment Program

Table 2. Summary of expected analytical costs for the sediment quality survey of the Port Gamble Bay site for Ecology's SPI Feasibility Study.

Analysis Parameter	No. Field Samples	No. QC Samples	No. Samples Total	Unit Cost ($)	Total Cost ($)
Total and % Solids	19[a]	2[b]	21	15 [d]	285
Grain Size	19[a]	2[b]	21	100	1,900
Total Ammonia	19[a]	2[b]	21	30	570
Total Organic Carbon	19[a]	2[b]	21	39[d]	819
Total Sulfides	19[a]	2[b]	21	27	513
Total and % Volatile Solids	19[a]	2[b]	21	21[d]	399
BCA	15	3[c]	18	625	11,250
TOTAL					$15,736

a Includes analysis of this parameter in one field duplicate.

b Includes analysis of this parameter in laboratory triplicates, but at no additional cost.

c Ecology will conduct an assessment of benthic communities found at three sample locations intended to serve as reference areas. These three samples will be selected from locations within Port Gamble Bay that are physically similar to other sediment quality sample locations but removed from areas of concern, e.g., do not exhibit elevated total organic carbon, total volatile solids, ammonia, or sulfide.

d Unit cost for Manchester Laboratory analyses includes a 50% price discount.

BCA = Benthic Community Assessment samples, e.g., for taxonomic analysis.

Quality Objectives

The data quality objectives (DQOs) for this project are to describe and implement field and laboratory procedures that ensure all data will be (1) representative of actual environmental conditions and (2) of known and acceptable quality for the goals and objectives described.

How well a specific surface sediment sample represents environmental conditions at the actual point of collection depends on how it is collected, handled, and preserved or stored prior to analysis. The field DQOs for surface sediment samples to be considered representative of the sampling locations are that each sample will be:

- Collected within one week of receiving preliminary SPI survey results.
- Collected from locations no more than three meters from the target sampling locations identified in the final QA Project Plan.
- Collected using sampling protocols and sample acceptance guidelines consistent with those used throughout the region and previously at the study site.
- Acceptable according to the criteria identified in Methods Procedures.
- Handled and stored properly prior to analysis.

It is normally vital that all sediment quality data collected at cleanup sites be of acceptable quality for interpretation according to the Sediment Management Standards rule (Ecology 1991, 1995, and 2003). This generally means that appropriate protocols are followed to ensure the data are reasonably representative, accurate, and precise. However, this investigation is preliminary in its nature and not necessarily intended to provide robust data for a full regulatory application. For example, for this study site, Ecology will only measure certain sediment conventional parameters and estimate the degree of benthic infaunal community impairment at each sampling location using a single field replicate sample. The Sediment Management Standards rule specifies use of the protocols and guidelines in EPA's Puget Sound Estuary Program (EPA, 1987) which recommends 3-5 field replicates for benthic community assessment. Thus, the benthic data collected for this study may not be deemed adequate for traditional regulatory interpretation. Collectively, though, the data may still be useful in a weight-of-evidence approach to evaluating the site.

Applicable chemical and biological methods for sediment samples collected in the Puget Sound region, as well as QA/QC requirements, can be found in the following:

- Sampling and Analysis Plan Appendix (Ecology, 2003)
- Chapter 173-204 WAC (Ecology, 1991, 1995)
- Puget Sound Estuary Program Protocols and Guidelines (EPA, 1986-2003)
- Dredged Material Management Program User's Manual (DMMP, 2003)
- Sediment Management Annual Review Meeting modifications

These methods and requirements are summarized below and in the Data Quality section of this QA Project Plan.

Conventional Sediment Parameters

Bias is the magnitude and direction of the difference of a measurement result from the true value. The measurement quality objective (MQO) for bias is expressed as the percent deviation of a sample result from the known concentration, e.g., a certified reference material, or as the percent recovery of a known concentration of analyte in a matrix spike, or laboratory control sample.

Precision is the measure of the reproducibility of individual measurements of the same analyte in the same sample and usually under similar conditions. The MQO for precision is expressed as the relative percent difference (RPD) for sample, or matrix spike duplicates, or as the relative standard deviation (RSD) in the case of triplicate laboratory analyses.

Sensitivity is a measure of the ability of the analytical method to detect an analyte and the concentration that can be reliably quantified. The MQO for sensitivity is expressed in terms of the method detection limit or the minimum concentration that can be "reliably" quantified. The latter is the practical quantitation limit or, for this project, the reporting limit.

The MQOs for bias, precision, and sensitivity for this project vary by analyte and are presented in Table 3.

Benthic Community Assessments

DQOs for benthic community assessments are that samples be collected following regional guidelines and in a manner believed to be representative of the *in situ* benthic community present in the immediate sampling vicinity (see Data Quality Objectives above). The single field replicate collected from each sampling location must be handled and prepared for taxonomic analysis according to EPA (1987) and described in Measurement Procedures. Data quality will be assessed in terms of the accuracy of the sorting, identification, and enumeration processes. The MQOs for these are 95% sorting accuracy, agreement among two independent taxonomists on the identity of all organisms, and verification of final species count by a partial recount by the second taxonomist.

Data Entry

DQOs for data management for this project are for sediment chemistry, toxicity, and benthic community data to be calculated, transcribed, entered, and transferred into one or more final databases without error for use in future analyses. To evaluate this, 20% of the samples will be randomly selected for a complete audit/review. Raw lab results for each will be taken through the same calculation, 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. An investigation will then be conducted to see if the error is systematic or specific to that sample.

Table 3. Quality control samples and measurement quality objectives for sediment conventional parameters.

The relative standard deviation among laboratory triplicates is listed below as a measure of precision, as recommended by the Toxics Cleanup Program (Ecology, 2003). The relative percent difference between duplicates may be a more standard measure of precision for some laboratories (Ecology, 2005) and so may also be acceptable.

Parameter	Reporting Limit	Method Blanks	MQO	Lab Repl	MQO	Lab Controls	MQO	Matrix Spikes	MQO
Total solids (% wet wt.)	0.1	--	<0.1	1 Tripl	35% RSD	Na	Na	Na	Na
Grain size (% dry wt.)	1	--	<1	1 Tripl	35% RSD	Na	Na	Na	Na
Ammonia (mg/kg dry wt.)	0.10	1	<0.10	1 Tripl	35% RSD	1	80-120%	1	75-125%
Total organic carbon (% dry wt)	0.1	1	<0.1	1 Tripl	20% RSD	1	80-120%	Na	Na
Total sulfides (mg/kg dry wt.)	0.10	1	<0.10	1 Tripl	35% RSD	1	65-135%	1	65-135%
Total volatile solids (% dry wt.)	0.1	1	<0.1	1 Tripl	35% RSD	1	80-120%	1	Na

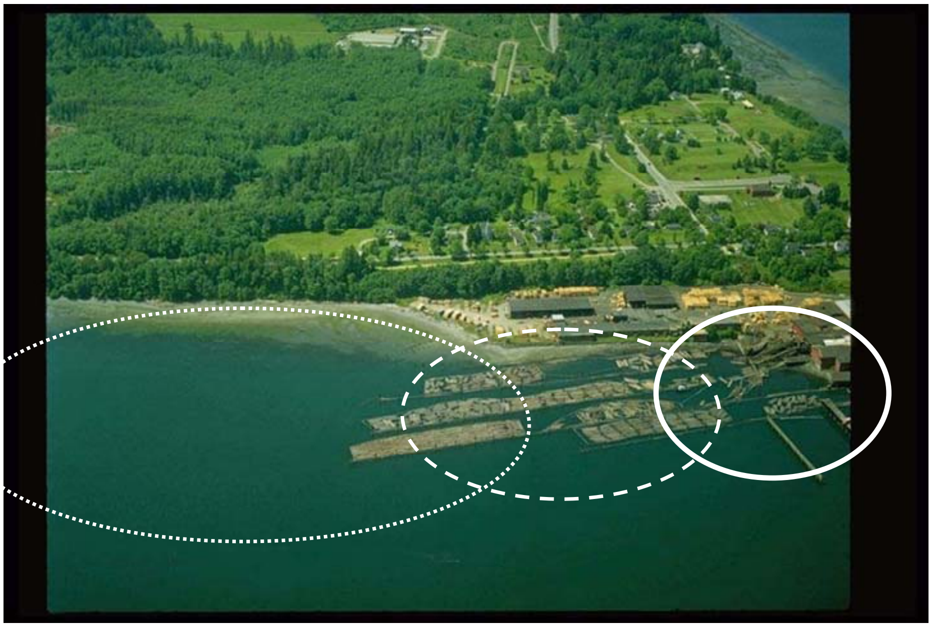
MQO = measurement quality objective
Repl = replicates
Tripl = triplicate
RSD = relative standard deviation
Na = not applicable

Sampling Process Design

The study design considers study goals, knowledge of nearby industrial activities, basin bathymetry, as well as existing data on wood waste distribution in surface sediments, certain conventional parameters, and laboratory toxicity. The primary goal of this project – to relate SPI and sediment quality data – is best approached using a stratified random sampling design. However, the limited number of sediment quality samples that can be collected and analyzed for this project dictate a design that is judgmental, but within certain strata. The sampling strata identified for this study are distinguished by the expected likelihood that benthic communities will be impaired. This in turn is based on best professional judgment and existing data on the presence and amount of wood debris present, total organic carbon (TOC), and total volatile solids (TVS; Parametrix, 2004).

Areas of highest wood debris and containing >25% TVS and >10% TOC are expected to have the highest probability of also exhibiting benthic community impairment. Locations with more moderate levels of wood debris containing 5-10% TOC have a more moderate likelihood of benthic impairment. Locations with the lowest levels of wood debris and containing <5% TOC are least likely to exhibit benthic community impairment. Collecting both SPI and triad data using this design will allow Ecology to determine whether or not relationships between the two types of sediment data may exist for areas of *low*, *moderate*, or *high* likelihood of benthic community impairment.

The Port Gamble Bay study site and approximate areas representing the sampling strata are shown in Figures 4a and 4b. The area associated with the three strata cannot be calculated so allocation of samples within each stratum is based on best professional judgment. The proposed sampling event targets seven each of the *high* and *low* stations and four of the *moderate* stations. This bias toward sampling surface sediment that represents more the extreme conditions, e.g., *high* and *low*, is because it is most important to first determine *if* potentially useful relationships between SPI and triad data exist. However, actual sediment sample results may not match historical results or show this exact level of bias. Regardless, a future study may be needed to better define the SPI-triad relationship boundaries between *high* and *moderate*, and *low* and *moderate*, benthic locations.



Figures 4a and 4b. Aerial photograph of the Port Gamble Bay study site as seen from the east.

The stratified study design is indicated by the three sampling strata shown (areas are approximate). Areas with the highest probability of benthic impairment (*high*) are shown with solid lines. Areas with progressively lower probability of benthic impairment (*moderate* and *low*) are shown with dashed and dotted lines, respectively.

The general sampling scheme is represented in Table 4. Eighteen primary sediment sampling locations, representing the three strata described above, will be selected from the 30 or more SPI survey locations. After the SPI survey is completed or around August 24, 2006, Ecology will review preliminary results with the SPI vendor to determine whether or not the triplicate images associated with each sampling location are consistent with the sampling stratum. The project manager will use this information, apparent surface sediment homogeneity, and other considerations to select 18 sets of primary target coordinates and where sediment samples will be collected.

Results from the *low* sampling stations furthest from the source of wood waste (e.g., TVS, TOC, and benthic community metrics) will be examined to determine which three best represent legitimate reference samples. These three samples may be used as points of comparison for interpreting other sample benthic community data.

In addition, Ecology will strongly consider collecting some of the *high* and *moderate* (probability of benthic community impairment) samples at the same locations where private parties will collect sediment for laboratory toxicity testing. This will enable a limited exploration of relationships between SPI data and toxicity.

Coordinates for several alternate sampling locations will also be chosen. The final list of sampling coordinates will accompany the RV Skookum pilot, project manager, and crew in the field.

A judgmental sampling design is also being used for SPI-only station locations intended to address secondary project goals, e.g., to fill data gaps or possibly to provide baseline habitat and biological conditions to which future monitoring may be compared. SPI-only sampling locations were chosen to intentionally reoccupy an historic SPI sample location or fill spatial gaps in SPI data.

Sediment sampling is scheduled to begin on August 28, 2006. Samples for analysis of total solids, TOC, and TVS will be delivered to Manchester Laboratory on or about August 31, 2006. Samples for analysis of grain size, ammonia, and total sulfides will be delivered to or picked up by private vendors on or about the same date. Manchester and the private vendor laboratories will measure these sediment conventionals according to specifications provided in the next section of this QA Project Plan, with an expected turn-around time of four to eight weeks from the date of receipt. Samples for benthic community assessment will be sent to recognized private vendors for sorting, taxonomic identification, and enumeration services on or about the same date(s). Expected turn-around time for all benthic community assessment data will be four months from the date of receipt. Separate data reports containing the results of the validated chemical analyses and benthic community assessment will be submitted to Ecology.

Table 4. Summary of sampling strata, planned sample distribution among strata, and proposed identification numbers.

Stratum → (Probability of benthic community impairment)	High (>10% TOC >25% TVS)	SPI Sample Locations	Moderate (5-10% TOC)	Target SPI Locations	Low (<5% TOC)	SPI Sample Locations
Primary and Alternate Triad Sample Locations	7 samples PG TRI 01-07	Selected from PGSP101 – PGSP110 and AS01 – AS14	4 samples PG TRI 08-11	Selected from PGSP111 – PGSP115 and AS01 – AS14	7 samples* PG TRI 12-18	Selected from PGSP116 – PGSP125, PGSP129, PGSP130

* Three of these samples may serve as reference samples (see text).

Sampling strata have been operationally defined by concentrations of wood debris or waste, TOC and TVS (see text). Ecology will develop a list of target locations for sediment sampling (e.g., PG TRI 1-18) based on actual coordinates for SPI sample locations (e.g., PGSP101-PGSG130). This will be done after a preliminary review of camera images with the SPI services vendor, as well as consulting with Ecology staff and others.

Sampling Procedures

The field methods and sampling procedures that will be used to collect surface sediment samples are described below, along with contingencies for unexpected field conditions. Modification of procedures will be at the discretion of the project manager and the boat operator. Other Ecology staff may also be consulted. All modifications will be recorded in the field logbook.

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. The offset between the GPS receiver and the winch cable, vessel heading (compass bearing), and water depth will be recorded so (with water depth) final position coordinates can be corrected. Overall positioning accuracy is expected to be $\pm$ 1-2 meters and no worse than $\pm$ 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 that 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 calling the National Ocean Service for data from their automated tide gage located at Port Townsend.

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 $\pm$ 2 m.

Field Sampling

A double 0.1m^2 van Veen grab sampler will be used to collect surface sediment from the final primary target locations (EPA, 1997). If the primary location cannot be accessed because of physical obstruction, e.g., a barge occupies the location, then a suitable alternate target location will be chosen. This will also occur if the van Veen grab fails to penetrate the substrate after three attempts. Sediment will be collected from the depth interval or horizon presumed to represent that which is most biologically active, e.g., 0-10cm. In most cases, a single lowering of this sampler at each location will be sufficient to provide an adequate volume of sediment for chemical conventional parameters analysis, archive samples, and benthic community assessment. The detailed procedure for collecting 0-10 cm surface sediment is described below.

- Maneuver the vessel to be near the three sets of coordinates where triplicate SPI images have been collected
- Open the grab sampler jaws into the deployment position
- Guide the sampler overboard until it is clear of the vessel
- Position the sampling vessel such that the GPS receiver, mounted on the stern corner of the vessel, registers being within the aforementioned three sets of coordinates or within 1-2 meters of the most central SPI replicate location
- 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 being within the aforementioned three sets of coordinates or within 1-2 meters of the most central SPI replicate location *and* if the cable is very near vertical (otherwise reposition vessel and then do so)
- Record the GPS coordinates and vessel heading when the sampler reaches bottom
- Record the water depth, time, and compass heading of the vessel (to correct for horizontal offset between sampler and GPS receiver)
- 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:
  - Penetration depth at least 11 cm
  - Sediment not extruded out the top of the van Veen grab sampler
  - Minimal loss of overlying water (sampler closed completely)
  - After siphoning off the overlying water, the sediment surface is found relatively flat or undisturbed

The following observations will be noted in the field logbook after accepting a grab sample:

- GPS location (offset approximately four feet from the end of A-frame boom) and vessel compass bearing (for correction)
- Depth as per vessel's depth sounder
- 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 sample

Sample Handling

For each location, approximately two liters of sediment will be collected from one side of a double van Veen sampler, homogenized, and analyzed for several conventional parameters. All sediment from the other side of the van Veen grab will be retained for benthic community assessment, transferred to a plastic tub, gently washed through a 1.0 mm mesh screen in the field, and then rescreened at Ecology facilities prior to sorting, taxonomic analysis, and overall benthic community assessment. Prior to homogenizing the sediment in the other side of the first van Veen grab, a small core of 0-10 cm surface sediment will be collected using a 60 mL syringe. This core of sediment will be placed in a 2-ounce glass sample jar, covered with a zinc acetate preservative solution, and capped such that there is zero headspace. This subsample of unhomogenized sediment will be used for total sulfide analysis.

The remaining sediment that is not in contact with the side walls of the sampler will be transferred to a pre-cleaned stainless-steel bowl and homogenized using a clean stainless steel spoon or paint stirring paddle until the texture and color of the sediment appear uniform (EPA, 1997). The project manager will determine whether or not large rocks, pieces of wood, shells, or organisms will be removed prior to homogenization. The homogenized sediment will then be split and dispensed using a stainless steel spoon into appropriate sample containers as shown in Table 5.

Aliquots of sediment for analysis of conventional sediment parameters will be taken from the total volume of homogenized sediment and placed in certified-clean, labeled, appropriately sized wide-mouth jars, and capped with Teflon®-lined lids (see Table 6). Sediment sample containers will be filled leaving at least 1 cm headspace to prevent breakage during shipping and storage. Each glass container will be placed in a cooler with wet ice so as to minimize breakage. If samples will be transported any substantial distance, bubble wrap may be used to help prevent breakage. Benthic community samples will be gently washed through a 1.0 mm mesh wire screen. Organisms will be gently collected off the screen, placed in one-gallon Zip-lock bags, and mixed with and covered by a solution of 10% formalin. Formalin-containing benthic community sample bags will also be stored inside a sealed secondary container such as a plastic HDPE bucket.

A waterproof label will be affixed to all sample containers prior to start of field work. Labels will list triad sample and Manchester Laboratory identification numbers, parameter(s) to be analyzed, collection date and time, and initials of the person preparing the sample.

At each laboratory, a unique identifier will be assigned to each sample (using either project ID or laboratory ID). The laboratory will ensure that a sample tracking record follows each sample through all stages of laboratory processing. The tracking record must contain, at a minimum, the name/initials of responsible individuals performing the analyses, dates of sample extraction/ preparation and analysis, and the type of analysis being performed.

Table 5. Container description and laboratories measuring conventional sediment parameters or conducting benthic community assessments.

Physical Parameter/Chemical Analyte/ Biological Test	Sample No.	Amount of Sample Needed (grams wet weight)	Container (size, material)	Laboratory
Total solids and total volatile solids	19	150	4 oz wide-mouth glass jar	MEL
Grain size	19	150	16 oz wide-mouth HDPE jar	(tbd)
Total sediment ammonia[a]	19	30	4 oz wide-mouth glass jar	ARI
Total sulfides (preserved)	19	50	2 oz wide-mouth glass jar with no headspace and covered with 5 mL 2N zinc acetate	ARI
Total organic carbon	19	100	4 oz wide-mouth glass jar	MEL
Sediment archive	19	300	8 oz wide-mouth HDPE jar	MEL or ARI
Benthic community assessment	18	-- [b]	1 gallon sealable plastic bag	(tbd)
		Total: <5.0 liters		

[a] Homogenized sediment sample analyzed as soon as possible after sampling.
[b] Large volume benthic community samples will be reduced to a variable volume by sieving them through a 1.0 mm screen prior to placing them in plastic bags.

HDPE - high density polyethylene
MEL - Manchester Environmental Laboratory
ARI - Analytical Resources, Inc.
tbd - To be determined

Decontamination

Sediment sampling devices and homogenizing equipment, e.g., mixing bowl, stainless-steel paddle and spoons, will be decontaminated according to established guidelines (EPA, 1997). Decontamination between grabs collected from the same target location will consist of a scrubbing the sampler with a coarse bristled brush and rinsing thoroughly with site water. Between target locations, decontamination will consist of the following procedure.

- 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 if visible contamination present

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

Waste Management

All excess sediment and non-solvent decontamination rinses will be returned to the sampling location after sampling is completed at each target 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

Ecology will track the status and fate of all sediment samples (e.g., throughout the collection, transport, and analyses) and all resulting sample data (e.g., electronic and printed reports) using chain-of-custody procedures. Custody procedures will start during sample collection and the first change in custody will occur either 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. Minimum documentation of sample handling and custody will include:

- Sample location, Environmental Assessment Program project name/number
- Unique sample number(s)
- Sample collection date and time
- Any special notations on sample characteristics or problems
- Initials of the person collecting the sample
- Date sample was sent to the laboratory
- Shipping company name and waybill number

The project manager will be responsible for (1) all sample tracking and custody procedures for samples in the field, (2) final sample inventory and maintaining sample custody documentation, and (3) completing custody forms prior to removing samples from the sampling area. At the end of each day, and prior to transfer, custody entries will be made for all samples. Information on the labels will be checked against sample log entries, and sample tracking forms and samples will be recounted. Custody forms will accompany all samples. The custody forms will be signed at each point of transfer. Copies of all custody forms will be retained and included as appendices to QA/QC reports and data reports. Sediment samples will be shipped or otherwise transported in sealed coolers to the analytical laboratories. The project manager will ensure that the laboratory has accepted delivery of the shipment at the specified time.

The laboratories will ensure that custody forms are properly signed upon receipt of the samples and will note questions or observations concerning sample integrity on the custody forms. The laboratories will contact the project manager immediately if discrepancies are discovered between the custody forms and the sample shipment upon receipt.

The laboratory will ensure that a sample-tracking record follows each sample through all stages of laboratory processing. The sample-tracking record must contain, at a minimum, the name/initials of individuals responsible for performing the analyses, dates of sample extraction/preparation and analysis, and the types of analyses being performed.

Shipping

Coolers with sediment samples for analysis of conventional sediment parameters will be transported directly to Manchester Laboratory by Ecology courier or picked up by the appropriate analytical services vendor, e.g., Analytical Resources, Inc. 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. Benthic community samples will be rescreened within three weeks of collection, either by the project manager and/or other Ecology staff, and preserved in 70% ethanol with Rose Bengal. These samples will be transported via courier to or picked up by a taxonomic services vendor. Laboratories and taxonomists will not dispose of the environmental samples for this project until notified in writing by the project manager or QA/QC coordinator.

Measurement Procedures

This section describes sample handling, storage, laboratory analytical methods and data quality objectives for the physical, chemical, and biological analyses of the sediment samples that will be collected for this study.

Sediment Chemistry

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

Table 6 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.

Benthic Community Assessment

Ecology will collect surface sediment samples from the Port Gamble Bay study site within 2-3 meters of the target locations identified in the final QA Project Plan (as potentially modified by SPI images and recommendations of the SPI contractor, Germano and Associates). These samples will represent similar subtidal marine habitats that are contaminated to various degrees.

Benthic samples will be collected, handled, sieved, sorted and analyzed according to protocols and QA requirements described in the Puget Sound Estuary Program (EPA, 1987) and below, except that only a single van Veen field replicate, e.g., grab, will be collected. This constraint is dictated by the study budget for benthic community sorting and taxonomic analysis. A 0.1 m^2 van Veen sampler will be used to collect surface sediment, with all samples first inspected for acceptability (see above). The top 10 cm of material from each acceptable grab will be placed on a 1.0 mm mesh screen in the field, rinsed with a gentle stream of seawater to separate organisms from sediment and organic matter, placed into a pre-labeled plastic zip-lock bag containing a buffered preservative (10% formalin prepared using saline site water), and gently mixed.

Benthic community samples will then be transported to Ecology's wet laboratory and transferred into ethanol within three weeks of collection. The samples will subsequently be resorted by a contractor into major taxonomic groups (Annelida, Crustacea, Mollusca, and miscellaneous phyla) as described below.

Table 6. Handling requirements and analytical methods for conventional sediment parameters.

Physical Parameter/ Chemical Class/ Analyte	Preserved	Holding Times[a]	Lab	Method	Reference
Total solids, % solids	Cool/4°C	7 days (6 months at –18°C)	MEL	Oven-dried	Standard Methods 2540B APHA (2005)
Grain size	Cool/4°C	6 months	(tbd)	Sieve/pipette	EPA (1986)
Total organic carbon	Cool/4°C	14 days (6 months at –18°C)	MEL	Combustion (70°C)	EPA (1997) or Method 9030 (EPA, 1996)
Ammonia	Cool/4°C	7 days	ARI	Automated phenate	EPA 350.1 (after extraction)
Total sulfides	2N zinc acetate Cool/4°C	7 days	ARI	Spectrophotometric	EPA 376.2 (after extraction)
Total volatile solids, % TVS	Cool/4°C	7 days (6 months at –18°C)	MEL	Loss after combustion (550°C)	Standard Methods 2540G APHA (2005)
Sediment archive sample	Frozen/-18°C	6 months	Ecology		

[a] Holding times taken from Ecology's Sampling and Analysis Plan (Ecology, 2003), the Manchester Laboratory Manual (Ecology, 2005b), and individual methods.

MEL - Manchester Environmental Laboratory (Ecology)
ARI - Analytical Resources Incorporated
tbd - To be determined
EPA - U.S. Environmental Protection Agency

The following procedure will be used to sort invertebrates from relatively coarse-grained sediment containing relatively little organic matter: each sample will be washed gently through a 0.5 mm mesh sieve into a shallow pan of water. Invertebrates attached to any larger rock, shell, or wood debris will be collected using forceps and the debris disposed of appropriately. Organic matter will be separated from inorganic sediments by means of gentle agitation, with lighter organic matter being placed back onto the 0.5 mm sieve. This procedure will be repeated until visual inspection reveals no organic material remaining in the pan.

The following procedure will be used to separate benthic organisms from finer grained sediments containing relatively more organic matter: small amounts of each sample will be placed into a Petri dish, from which the sorter will use a pair of fine forceps to remove organisms and place them into the appropriately labeled containers (Annelida, Crustacea, Mollusca, or miscellaneous phyla). Each Petri dish of material will be "picked" twice, and this process will be repeated using new material until the entire samples has been sorted.

Organisms will be preserved using 90% ethanol to achieve a final concentration of approximately 70% ethanol. The volume of ethanol added to each sample will vary depending on sample characteristics, but an equal ratio of preservative volume to sample volume will usually result in the target ethanol concentration.

Ecology will contract with experienced taxonomists to photograph the sorted samples, identify all organisms at the lowest taxonomic level practical (generally species), and count them. The taxonomists will use only readily available, peer-reviewed taxonomic keys to identify organisms. Once all organisms have been identified, they will be returned to original vials. Abundance data for each sample will be reported at the major taxonomic group level (Annelida, Crustacea, Mollusca, Echinodermata, and miscellaneous phyla) and the lowest practical taxon level. A reference collection of specimens will be placed in vials and archived by Ecology. Each taxonomist will complete the analyses and submit final benthic community data to Ecology by December 20, 2006, in electronic EIM format (or substantive equivalent).

Quality Control

Conventional Parameters

The measurement quality objectives (MQOs) for sediment conventionals that will be measured for this project and study site are listed in Table 3. In the event that results do not fall within control limits, the labs will discuss need for corrective actions with the project manager. Potential corrective actions for the conventionals listed are reanalysis or assignment of appropriate data qualifiers.

Benthic Community Assessment

The data quality objectives (DQOs) will be to obtain benthic community data that are representative of a location (and point in time or season) and accurate. If the data are representative and accurate, they will be interpretable and usable for the purposes of this study. Specific DQOs for benthic data will be:

- Collect samples likely to be representative of *in situ* benthic communities found in the area by using appropriate field methods and by documenting any deviations from these.
- Sort benthic samples accurately by following appropriate sample handling, picking, and sorting protocols.
- Identify and count benthic organisms accurately.

The degree to which a benthic community sample is likely to be representative of the immediate area will be assessed in two ways:

1. Each sample will be collected from a location as close as possible to where an SPI image was taken or from within an area shown by triplicate SPI images to have homogeneous surface sediments.
2. The crew will carefully observe sample acceptance criteria (as described above).

The surface sediment of a sample will be intact within the van Veen grab sampler, e.g., overlying water will be present, and there will be evidence of no or minimal loss of surface sediment from the 0-10 cm depth interval within the entire 0.1 m^2 area.

The picking and sorting process for each sample will meet the recommended 95% accuracy for the total number of individuals, as recommended in the Puget Sound Estuary Protocols (EPA, 1987), or the entire sample will be re-sorted.

The organisms from each of the major taxonomic groups (Annelida, Crustacea, Mollusca, and miscellaneous phyla) will be identified by an experienced taxonomist. The accuracy of each primary taxonomist's species identifications will be assessed in two ways:

1. Organisms in 5% of the samples will be re-identified by a second experienced taxonomist (EPA, 1987)

2. A reference collection of organisms will be created by the primary taxonomist and verified by a second taxonomist. There will be a minimum of 95% agreement on species identification between the two taxonomists.

Where there is disagreement, the two taxonomists will reach consensus on the proper identification of a species and ensure that the data were edited appropriately. When sample identification and QC have been completed, archived and reference specimen vials will be placed in jars with a small amount of 70% ethanol, tightly capped, and stored by station and date at Ecology.

Data Management Procedures

All sediment quality data generated for this project will first be evaluated for completeness and usability. This includes data for sediment conventional parameters generated by Manchester Laboratory and stored in its LIMS database, data from analysis of some conventional parameters from contract laboratories, and all biological data generated by contract laboratories or taxonomists. All data will be entered into Ecology's Environmental Information Management (EIM) System. If it facilitates data analysis, these data *may* also be processed into valid electronic SEDQUAL templates and transferred into Ecology's SEDQUAL database. Ecology staff will also explore the existing capabilities of its EIM System to store SPI data.

Audits and Reports

Manchester Laboratory participates in performance and system audits of routine procedures, with audit results available on 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. There will be no additional audits performed for this project.

An initial draft report describing the results of this project is targeted for completion in February 2007, with the final report due in April. The report will include the following elements.

- Abstract.
- Background, problem statement, and study goals.
- Study design, with maps of past sediment quality data and new SPI/triad sample locations.
- SPI and triad methods, both field and laboratory.
- Sampling summary (e.g., date, time, location, and depth) for SPI and triad samples.
- Data quality summary highlighting exceptions to SPI and Ecology QA Project Plans and any sampling difficulties encountered.
- Maps showing patterns in SPI and sediment quality.
- Analysis and mapping of toxicity and benthic community sample results, including compliance with Sediment Management Standards.
- Results of statistical analyses exploring relationships between SPI and triad data.
- Summary of findings related to other goals (e.g., confirming previous results).
- Conclusions and recommendations.
- References.
- Appendices (e.g., QA Project Plans, SPI images, SPI and triad raw data tables).

The final report and raw data will be linked to this QA Project Plan at www.ecy.wa.gov/biblio/0603117.html

Data Verification

Manchester Laboratory will review all of the analyses that it conducts for this project and will prepare a brief case narrative, with a QC report and a summary of analytical results to accompany a complete data package. Other contract labs will be similarly responsible. The project manager will review all case narratives and data summaries, as well as raw lab data, if necessary. More specifically, the project manager will:

- Assess representativeness of results by reviewing field notes about where and how each surface sediment sample was collected.
- Assess comparability of sample results to other studies by comparing the methods and protocols described in the case narratives with the ones listed in this QA Project Plan (Table 6).
- Verify that laboratories have complied with the measurement quality objectives presented in Table 3 (e.g., required QC sample analyses, target reporting limits, control limits met, or result suitably qualified).
- Summarize these reviews briefly as part of the final Feasibility Study report.

Data Quality Assessment

After data have been reviewed and verified, the project manager will determine if the data are generally usable for characterizing sediment quality and specifically usable for the primary goal of this study. This will consist of a review of representativeness, comparability, and the ability to interpret the data according to regulatory requirements and guidelines.

The Sampling Procedures section of this QA Project Plan describes (1) the need for samples to be as representative as possible of nearby environmental conditions (e.g., where SPI camera images were taken), and (2) field sampling methods that ensure the same. To assess representativeness, the project manager will carefully review field notes, with respect to two factors in particular:

- The proximity of sediment quality triad sampling locations to SPI station coordinates
- The extent to which sample acceptance criteria were adhered to or observed

Chemical or biological results for any sediment sample found to have been collected too far from where SPI data were collected, or found acceptable despite not meeting all of the stated criteria, will be scrutinized for possible exclusion from analyses.

Analytical results for the sediment samples collected for this study must also be comparable to results routinely collected under the authority of contaminated sediment cleanup programs. To evaluate this, the project manager will review final analytical methods reported to have been used, laboratory standard operating procedures (SOPs), and QC summaries or exception reports. Where possible, the project manager will also compare analytical results from this study to any previous sediment quality triad results for the same or similar locations. Reasons that certain results may not be deemed usable include the following.

- The methods or SOPs used differ enough from those listed in this QA Project Plan that they cannot be considered adequately comparable to them
- QC reports indicate that chemistry results may have a severe bias or are highly qualified for some other reason
- The laboratory reports detection limits (actually reporting limits) greater than those listed in Table 8
- Chemical results from any sample differ *substantially* from previous results for virtually the same location

Results will, in all likelihood, be rejected if that is the recommendation made by the analytical laboratory in its QC report.

Finally, the project manager will interpret all chemical and biological results according to regulatory requirements, written guidance, and conventions. Those results that cannot be interpreted will be excluded from certain, if not all, future analyses.

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Appendix A. Field Collection Forms

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FIELD LOG - AUGUST 2006

WASHINGTON STATE DEPT. OF ECOLOGY
SPI FEASIBILITY STUDY -- PORT GAMBLE SITE

SAMPLE No.: ______________ Manchester Lab ID: ______________

CREW:

☐Tom Gries ☐Dale Norton ☐Kathy Welch ☐ ☐ ☐

WEATHER:

☐Clear ☐Cloudy ☐Fog ☐Overcast ☐Continuous layer of clouds

☐Rain ☐Windy ☐Thunderstorm

SEA STATE:

☐Calm ☐Choppy ☐Rough ☐Strong Current

GRAB USED:

☐Weighted ☐Unweighted

LOCATION:____

TARGET DGPS LAT: ___________________ **LONG:** _____________________

☐TARGET MOVED 100m

SAMPLING DATE: ______/______/2006

TIME OF 1ST GRAB: _______AM/PM **LAST GRAB:** ______ AM/PM

STRATUM: ☐Basin ☐Harbor ☐Passage ☐Rural ☐Urban

STATION DESCRIPTION:

____

STATION STATUS:

☐Target and Sampled ☐NN-Not Needed ☐NS-Not Sampled ☐NT-Not Targeted

☐OS-Other Sample ☐PB-Physically Inaccessible ☐ALT. for Sample No.: ___________

STATION FAIL REASON:

☐Abandoned ☐Washed ☐Poor Closure ☐Disturbed Surface

☐Shallow penetration ☐Rocky bottom ☐Algal Mats

GRAB NUMBER 1

GRAB ACCEPTABILITY: No. Taken: _______ No. Rejected: _______

Meter Wheel Depth: __________ m Surface Salinity: __________ ppt Temp: _________ºC

Penetration Depth: ________cm RPD: ________cm ☐Sheen Observed

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

SEDIMENT ODOR: ☐H_2S ☐Petroleum ☐Other __________

☐Slight ☐Moderate ☐Strong ☐None

PARAMETERS SAMPLED: ☐ Grain Size ☐ TOC ☐ Other conventionals

☐ Chemistry ☐ Bioassay ☐ Infauna ☐ Other Tests: ______________________________

COMMENTS:____

____

REASON FOR REJECT: ☐Abandoned ☐Washed ☐Poor Closure ☐Disturbed Surface

☐Shallow penetration ☐Rocky bottom ☐Algal Mats

SUBSEQUENT GRAB INFORMATION (if different from first) (GRAB NO. ____)

GRAB ACCEPTABILITY: No. Taken: _______ No. Rejected: _______

Meter Wheel Depth: __________ m Surface Salinity: __________ ppt Temp: _________ºC

Penetration Depth: ________cm RPD: ________cm ☐Sheen Observed

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

SEDIMENT ODOR: ☐H_2S ☐Petroleum ☐Other __________

☐Slight ☐Moderate ☐Strong ☐None

PARAMETERS SAMPLED: ☐ Grain Size ☐ TOC ☐ Other conventionals

☐ Chemistry ☐ Bioassay ☐ Infauna ☐ Other Tests: ______________________________

COMMENTS:____

____

REASON FOR REJECT: ☐Abandoned ☐Washed ☐Poor Closure ☐Disturbed Surface

☐Shallow penetration ☐Rocky bottom ☐Algal Mats

FAUNA OBSERVED :

____

____

____

COMMENTS:

____

____

____

____

RECORDED BY: ____

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Appendix B. Health and Safety Plan

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Health and Safety Plan

The following is an abbreviated *Health and Safety Plan* for Ecology's SPI Feasibility Study. It is a slightly modified version of the one found in Ecology's Environmental Assessment Program (EAP) Safety Manual, with which all participants in this study must be familiar.

Name of Ecology staff ___*Various*___

Training requirements: *First Aid and CPR, familiarity with the EAP Safety Plan, Boating Safety (recommended)* ___

Medical monitoring requirements ___*None*___

Date August 28-30, 2006___ Arrival time *9:00 - 11:00 a.m.*___

Site name and location: "Port Gamble" is a sediment cleanup site that is located in Port Gamble Bay, with the study area located both south and north of the peninsula on which the former Pope and Talbot timber mill was located.

Nearest city ___*Port Townsend*___ Nearest hospital ___*Port Townsend*___

Emergency numbers _Statewide 911_ Hospital ___ Ambulance ___

Is site currently active? Yes __*X*__ No ___ Will the buddy system be used? Yes __*X*__ No ___

Site description This is a MTCA wood waste cleanup site that is largely under water. The 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 at least 18 surface sediment samples from Port Gamble Bay___

Known contaminants on site: Wood waste (formalin preservative for benthic samples)___

Routes of chemical exposure: Inhalation ___*X*___ Dermal ___*X*___ No exposure ___

Overall risk of chemical exposure: Serious ___ Moderate ___ Low __*X*__ Unknown ___

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* ______

Other (specify): ____

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

Expected parameters/contaminants to be sampled: *Sediment conventionals and benthic organisms*

Sampling matrix: Air ______ Surface water ______ Groundwater ______ Soil ______
Sediment ___*X*___ Containers ______ Other ______