Quality Assurance Project Plan

Toxics in Stormwater Runoff from Puget Sound Boatyards

by
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December 2005

303(d) Listings Addressed in this Study: None

Waterbody Numbers: WA-13-0030 Budd Inlet (inner);
WA-10-0020 Commencement Bay (Inner); WA-PS-0220 Admiralty Inlet (Inner)

Project Code: 06-006

Approvals

Approved by:	December 8, 2005
Gary Bailey, Client, WQ-HQ	Date
Approved by:	December 12, 2005
Nancy Winters, Section Manager, WQ-HQ	Date
Approved by:	November 23, 2005
Art Johnson, Project Lead, Watershed Ecology Section	Date
Approved by:	November 28, 2005
Dale Norton, Unit Supervisor, Toxics Studies Unit	Date
Approved by:	December 5, 2005
Will Kendra, Section Manager, Watershed Ecology Section	Date
Approved by:	December 28, 2005
Stuart Magoon, Director, Manchester Environmental Laboratory	Date
Approved by:	December 6, 2005
Cliff Kirchmer, Ecology Quality Assurance Coordinator	Date

Table of Contents

Abstract

The Washington State Department of Ecology is preparing the third issuance of the Boatyard General Permit under the National Pollutant Discharge Elimination System. While stormwater runoff from local boatyards has been well characterized for copper, other toxic pollutants have not been analyzed. This Quality Assurance Project Plan describes a study that will obtain data on toxic metals and organic compounds in stormwater runoff and adjacent marine sediments at three Puget Sound boatyards during the winter of 2005-2006. The results will be used as the basis for future actions and requirements of the Boatyard General Permit.

Background

The Washington State Department of Ecology (Ecology) is preparing the third issuance of the Boatyard General Permit under the National Pollutant Discharge Elimination System (NPDES). A boatyard, as defined in the permit, is a commercial business engaged in the construction, repair, and maintenance of small vessels, 85% of which are 65 feet or less in length or revenues from which constitute more than 85% of gross receipts. Services typically provided include, but are not limited to: pressure washing hulls, painting and coating, engine and propulsion system repair and replacement, hull repair, joinery, bilge cleaning, fuel and lubrication system repair and replacement, welding and grinding of hull, buffing and waxing, marine sanitation device repair and replacement, and other activities necessary to maintain a vessel.

The NPDES permit for boatyards contains stormwater monitoring requirements that include total recoverable copper, oil & grease, total suspended solids (TSS), and visual monitoring www.ecy.wa.gov/programs/wq/permits/boatyard/index.html). While stormwater from these facilities has already been well characterized for copper, other toxic pollutants have not been analyzed. The Ecology Water Quality (WQ) Program has, therefore, requested a study to analyze for a range of toxic chemicals in boatyard stormwater runoff.

Project Description

In response to WQ's request, the Ecology Environmental Assessment (EA) Program will sample stormwater runoff from three Puget Sound boatyards during three runoff events during the winter of 2005-2006. One sediment sample will also be collected in the receiving waters adjacent to each yard.

The stormwater samples will be analyzed for priority pollutant metals, total petroleum hydrocarbons (TPH), organotins, base/neutral/acid compounds (BNAs), TSS, and turbidity. The sediment samples will be analyzed for priority metals, BNAs, organotins, polychlorinated biphenyls (PCBs), total organic carbon (TOC), and grain size.

Results from this study will be used to identify chemicals that are a potential concern for the receiving environment. This information will provide a basis for future actions and requirements of the Boatyard General Permit.

Organization and Schedule

Organization

Name	Organization	Phone No.	Role
Art Johnson	EAP-WES-TSU	360-407-6766	Project lead
Gary Bailey	WQ-HQ	360-407-6433	Client
Lydia Wagner	SWRO-IOU	360-407-6291	NPDES permit manager
Donna Ortiz De Anaya	NWRO-ISU	425-649-7276	NPDES permit manager
Steve Golding	EAP-WES-TSU	360-407-6701	Field assistance
Randy Coots	EAP-WES-TSU	360-407-6690	Field assistance
Dale Norton	EAP-WES-TSU	360-407-6765	Unit supervisor
Dean Momohara	Manchester Environmental Laboratory	360-871-8808	Unit supervisor
Stuart Magoon	Manchester Environmental Laboratory	360-871-8801	Lab director
Cliff Kirchmer	EAP	360-407-6455	QA officer
Carolyn Lee	EAP-WES-TSU	360-407-6430	EIM data entry

Schedule

Field Work and Laboratory Analyses	
November 2005 - March 2006	Stormwater sampling
November or December 2005	Sediment sampling
May 2006	Chemical analyses completed and all results reported to project lead
Final Report	
Report Author Lead	Art Johnson
Schedule	
Report Supervisor Draft Due	September 2006
Report Client/Peer Draft Due	October 2006
Report External Draft Due	NA
Report Final Due (Original)	December 2006
Environmental Information System (EIM) Data Set	
EIM Data Engineer	Carolyn Lee
EIM User Study ID	AJOH0049
EIM Study Name	Toxics in Stormwater Runoff from Puget Sound Boatyards
EIM Completion Due	December 2006

Quality Objectives

The Ecology Manchester Environmental Laboratory (MEL) and their contractors are expected to meet all quality control (QC) requirements of the analytical methods being used for this project. Measurement quality objectives (MQOs) for estimating the accuracy of QC samples are shown in Table 1. The lowest concentrations of interest shown in the table are the lowest concentrations practically attainable within budget constraints of this project.

Table 1. Measurement Quality Objectives for Boatyard Stormwater Characterization Study

Parameter	Laboratory Control Samples (% recovery)	Duplicate Samples (RPD)	Matrix Spikes (% recovery)	Matrix Spike Duplicates (RPD)	Surroate Standards (% recovery)	Lowest Concentration of Interest**
Water Samples						
Hg	80-120	20	75-125	20	NA	0.05 ug/L
As,Ag,Be,Cd, Cu,Pb,Tl,Ni, Se	85-115	20	75-125	20	NA	0.1 ug/L
Sb,Cr	85-115	20	75-125	20	NA	0.5 ug/L
Zn	85-115	20	75-125	20	NA	5 ug/L
TPH	50-150	50	25-150	50	50-150	0.1 mg/L
TSS	80-120	20	NA	NA	NA	1 mg/L
Turbidity	95-105	20	NA	NA	NA	0.5 NTU
BNAs	40-150	50	40-150	40	10-150*	1-5 ug/L
Organotins	75-125	30	70-130	50	80-120	0.05 ug/L
Sediment Samples						
Hg	80-120	20	75-125	20	NA	0.005 mg/Kg
Other Metals	85-115	20	75-125	20	NA	0.1-5 mg/Kg
BNAs	40-150	50	40-150	40	10-150*	16-320 ug/Kg
Organotins	75-125	30	70-130	50	80-120	1-5 ug/Kg
PCBs	50-150	50	50-150	40	50-150	1-5 ug/Kg
TOC	80-120	20	NA	NA	NA	0.10%
Grain size	NA	20	NA	NA	NA	0.10%

*Surrogate recoveries are compound specific
**Dry weight basis for sediment samples.
RPD = relative percent difference

The general permit states that "Permittees must comply with Washington State surface water quality standards (Chapter 173-201A WAC), sediment management standards (Chapter 173-204 WAC), ground water quality standards (Chapter 173-200 WAC), and human healthbased water quality criteria in the National Toxics Rule (40 CFR 131.36). Compliance with surface water quality standards means that stormwater discharges by a facility with permit coverage shall not cause or contribute to a violation of water quality standards in the receiving water."

For most, but not all, of the chemicals where state standards apply (Appendices A & B), the concentrations in Table 1 will allow comparison with the appropriate water or sediment quality criteria for the receiving waters. The potential impact of other chemicals being analyzed but not addressed in the state standards will be assessed based on criteria, guidelines, or benchmarks from other sources, not yet selected.

Although the state marine water quality criteria for toxics include chlorinated pesticides, dioxin, cyanide, and ammonia, these compounds are not being analyzed as they are unlikely to be detected in boatyard runoff. Oil, grease, and volatile organic compounds (VOCs) are not being analyzed because these parameters must be collected as grab samples and the study intends to rely on automatic composites.

Study Design

Boatyard Selection

Three boatyards have been selected for stormwater sampling, in consultation with Lydia Wagner and Donna Ortiz De Anaya, NPDES permit managers for boatyards in Ecology's Southwest and Northwest Regional Offices, respectively (Figure 1):

Swantown Boatworks – Permit #WAG03-1043
Port of Olympia
650 Marine Drive NE
Olympia, WA 98501-6964
Bruce Marshall, Harbor Director
(360) 528-8049
Brucem@portolympia.com

Seaview East Boatyard – Permit #WAG030042B
4701 Shilshole Avenue N.W.
Seattle, WA 98107
(206) 789-3030
John Papajani, Business Manager
john@seaviewboatyard.com

Port Townsend Shipyard – Permit #WAG03-1006
2601 Washington Street
Port Townsend, WA 98368
Ken Radon, Operations Manager
(360) 385-2355
ken@portofpt.com

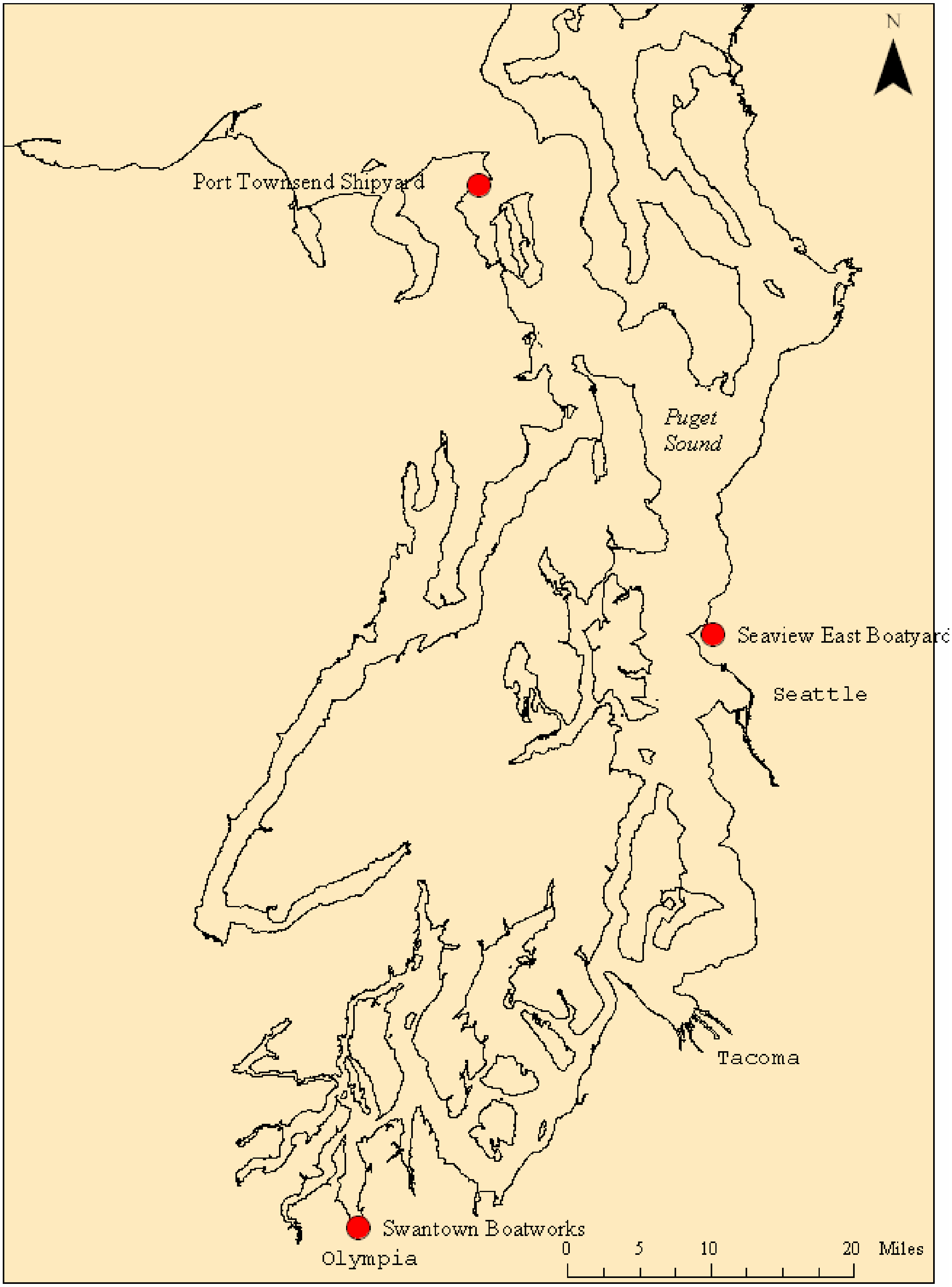

Figure 1. Location of Boatyards Selected for Stormwater Sampling in 2005-2006

These three facilities were selected to provide stormwater data that reflects a range of boatyard sizes and services. Each yard employs Best Management Practices for stormwater and monitors their discharge during winter and spring.

Swantown Boatworks in Olympia on Budd Inlet was opened in 1999 and is Puget Sound's newest boatyard. It operates a 77-ton Travelift for vessels up to 22 feet wide. The 2.9-acre paved yard has capacity for 45 recreational and commercial vessels. In addition to the boatyard and boat storage, 20,000 square feet of marine oriented repair, retail, and office space has been constructed. Swantown's stormwater is discharged to a retention pond wetland at the south end of the facility and then routed to an outfall in the intertidal zone adjacent to the haulout structure.

The Seaview East Boatyard is located on the Ballard ship canal across from Fisherman's Terminal. It was opened in 1985 at the the former Seattle Cedar Mill site. The yard has a 28,000-square foot repair building and an 88-ton Travelift. Services include paint work, fiberglass repairs, woodwork, rigging, mechanical installations, general maintenance, as well as do-it-yourself and storage facilities. Vessels are predominantly 20–60 feet in length. Stormwater runoff is discharged to the ship canal through a single drain.

The construction of the Port Townsend Shipyard was completed in 1997. It is capable of lifting large vessels up to 150 feet long. The shipyard is home to a number of marine trades businesses with expertise in maintenance and restoration, as well as a 10-acre dryland storage area. The yard has a capacity of up to 200 vessels ashore at any given time. Stormwater is discharged to Port Townsend (Admiralty Inlet) via two outfalls.

Stormwater Sampling and Analysis

The approach to stormwater sampling for the present study will generally follow Ecology (2002) guidance. A storm event will be considered appropriate for sampling if it meets the following two conditions:

1. Preceded by at least 24 hours of no greater than trace precipitation.
2. Intensity of at least 0.1 inch of rainfall (depth) in a 24-hour period.

A simple rain gauge will be installed at each sampling location to assist in determining if these conditions are met. NOAA National Weather Service rainfall records, forecasts, and uses radar to select and time sampling events at the boatyards (www.wrh.noaa.gov/seattle). The sampling effort will begin in November 2005 and continue through March 2006, as necessary.

Stormwater samples at Seaview East will be collected at the point of compliance for their NDPES permit. Port Townsend collects NPDES samples from two storm drains. Samples for the present study will be taken from the drain serving the greater part of the outside work area. In order to obtain data that will have wide application to boatyards, Swantown samples will be collected where the stormwater first enters the wetland.

The stormwater samples will either be collected as time-weighted automatic composites or manual composites. Automatic compositors will be fitted with a trigger that is actuated by rising water level in the drains. Five subsamples will be composited over a one-hour period. A relatively short compositing period is consistent with the small drainage area of boatyards.

The composites will be split into separate samples for analysis of priority pollutant metals, TPH, BNAs, organotins, TSS, and turbidity. The BNA and organotin analyses will be limited to one composite sample from each yard, as noted previously. Temperature, pH, conductivity, and flow will be recorded in the field. A detailed list of the chemicals being analyzed for this study is in Appendix C.

Sediment samples will be collected in the subtidal area (i.e., below mean lower-low water) off the stormwater discharge being sampled. Each sample will consist of the top 2 cm surface layer composited from three grabs taken with a 0.05 m^2 Ponar grab. Analyzing the top 2 cm is recommended in cases where conditions in the vicinity of a permitted discharge are being monitored (Ecology, 2003). The composites will be split into separate samples for priority metals, BNAs, organotins, PCBs (Aroclor-equivalents), TOC, and grain size. The sediment samples will be collected in November or December 2005.

The PCB analysis for this study is being limited to sediments because of the expense of conducting a low-level analysis for these compounds in water samples. Results on sediment samples should indicate if PCBs are a potential concern in stormwater runoff from any of the boatyards. TPH analyses are being confined to stormwater because petroleum has limited tendency to accumulate in subtidal sediments.

Sampling Procedures

The stormwater samples will be 1-hour composites. Each composite will consist of five subsamples per event, taken at 15 minute intervals. Required sample volumes, sample containers, preservation, and holding times are shown in Table 2.

Table 2. Sample Containers, Preservation, and Holding Times

Parameter	Min. Quantity Required	Container*	Preservation	Holding Time
Water Samples				
PP metals	500 mL	1 L HPDE bottle	HNO_3 to pH<2	6 months (28 days Hg)
TPH gas	40 mL	(3) 40 mL vials w/ septum	HCl to pH<2 Cool to 4°C	14/14 days
TPH diesel	1,000 mL	1 L glass jar†	HCl to pH<2 Cool to 4°C	7/14 days
TSS	1,000 mL	1,000 mL poly bottle	Cool to 4°C	7 days
Turbidity	100 mL	500 mL poly bottle	Cool to 4°C	48 hours
BNAs	1 gal.	1 gal. glass jar†	HCl to pH<2, 4°C	7/14 days
Organotins	**	**	**	7/14 days
Sediment Samples				
PP metals	150	8 oz. glass jar†	Cool to 4°C	6 months (28 days Hg)
BNAs /PCBs	250 g	8 oz. glass jar†	Cool to 4°C	1 year
Organotins	200 g	8 oz. glass jar†	Cool to 4°C	1 year
TOC	20 g	2 oz. glass jar	Cool to 4°C	28 days
Grain Size	100	8 oz. glass jar	Cool to 4°C	6 months

*Sample containers to be obtained from Manchester Laboratory or their contractor

†Organic free with Teflon lined lids

**To be contracted out; information not available at this time.

The automatic composites will be taken with an ISCO 3700 compositor (five-gallon capacity) equipped with a water-level actuator. The manual composites will be taken with a priority pollutant, cleaned glass jar. Each subsample will be approximately one gallon.

The glass carboys used in the automatic compositors will be precleaned with detergent and sequential rinses with tap water, dilute nitric acid, deionized water, and pesticide-grade acetone. New Teflon and new silastic tubing will be used for each sample. The tubing will be precleaned following the same procedure as for the carboy.

The composites will be kept on ice during collection. The samples will be returned to Ecology HQ on the day of collection and held in a secure cooler for transport with chain-of-custody record to MEL the following day.

The following information will be recorded in a field log for each sampling event:

- Name of facility
- Location and GPS coordinates of sampling site
- Sampling date and time
- Method of sample collection
- Name of samplers
- Parameters collected
- Field measurements of temperature, pH, conductivity, and flow
- Unusual circumstances that may affect the results
- Number of dry days before sample was collected
- Date and time the rainfall began
- Date and time the discharge began at the sampling site
- Inches of rain during a 24-hour period

Sediment sampling methods will be consistent with PSEP (1996) protocols and requirements of the Sediment Management Standards (Ecology, 2003). The samples will be collected from an Ecology vessel using a 0.05 m^2 stainless steel Ponar grab. Sampling sites will be located and positions recorded using GPS and landmarks. A grab will be considered acceptable if not over-filled with sediment, overlying water is present and not excessively turbid, the sediment surface is relatively flat, and the desired depth penetration has been achieved. A field log will be maintained during sampling to record date, time, GPS coordinates, water depth, grab penetration depth, and description of the material obtained.

All samples will be composites of the top 2 cm layer. After siphoning off overlying water, the top 2 cm of sediment from each of three grabs per sampling site will be removed with stainless steel scoops, placed in a stainless steel bowl, and homogenized by stirring. Material touching the side walls of the grab will not be taken.

Subsamples of the homogenized sediment will be put into appropriate sample containers (Table 2) and placed on ice immediately upon collection. Sample containers, preservation, and holding times for sediment are shown in Table 2. The samples will be returned to Ecology HQ and held in a secure cooler for transport with chain-of-custody record to MEL the following day.

Stainless steel implements used to collect and manipulate the sediments will be cleaned by washing with Liquinox detergent, followed by sequential rinses with tap water, dilute nitric acid, deionized water, and pesticide-grade acetone. The equipment will then be air dried and wrapped in aluminum foil. Between-sample cleaning of the Ponar grab will consist of thorough brushing with on-site water.

Measurement Procedures

Project samples will be analyzed by MEL, except for organotins in water and grain size which will be contracted out. Analytical methods to be used for this project are shown in Table 3. MEL and their contractors may use other methods after consulting with the project lead.

Analysis	Number of Samples	Expected Range of Results	Reporting Limit*	Sample Preparation Method	Analytical Method
Water Samples					
Mercury	13	<0.05-0.1 ug/L	0.05 ug/L	Acid digest	EPA 245.1/245.5
Other metals	13	<0.1-100 ug/L	0.1 - 5 ug/L	Acid digest	EPA 200.8
NWTPH-Gx	12	<0.1-10 mg/L	0.1 mg/L		NWTPH-Gx
NWTPH-Dx	12	<0.1-10 mg/L	0.1 mg/L		NWTPH-Dx
TSS	12	1 - 500 mg/L	1 mg/L		EPA 160.2
Turbidity	12	1-100 NTU	0.5 NTU		SM 2130B
Organotins	13	<0.05-5 ug/L	0.05 ug/L	**	**
BNAs	5	<1-100 ug/L	1-5 ug/L	Extraction	EPA 8270
Sediment Samples					
Mercury	4	<0.005-1 mg/Kg	0.005 mg/Kg	Acid digest	EPA 245.1/245.5
Other metals	4	<0.1-1000 mg/Kg	0.1-5 mg/Kg	Acid digest	EPA 200.8
BNAs	4	<16-10,000 ug/Kg	16-320 ug/Kg	Extraction	EPA 8270
PCBs	4	<1 - 100 ug/Kg	1-5 ug/Kg	Extraction	EPA 8082
Organotins	4	<1 - 100 ug/Kg	1-5 ug/Kg	Extraction	Krone (1989) Jiang (1996)[†]
TOC	4	0.1 - 10%	0.10%		PSEP 1986
Grain Size	4	1 - 100%	0.10%		Plumb 1981[††]
Percent Solids	5	30-60%	0.10%		SM 2540B

*Dry weight basis for sediment samples.

**To be contracted out; information not available at this time.

[†]Krone, C.A. et al. 1989. A Method for Analysis of Butyltin Species and the Measurement of Butyltins in Sediment and English Sole Livers from Puget Sound. Mar. Environ Res. 27:1-18. Jiang, G.B. et al. 1996. Optimization Study for the Speciation Analysis of Organotin and Organogermanium Compounds by On-column Capillary Gas Chromatography with Flame Photometric Detection using Quartz Surface-Induced Luminescene. Journal of Chromatography A, 727, pp. 119-129.

[††]Plumb, R.H. 1981. Procedures for Handling and Chemical Analysis of Sediment and Water Samples. EPA/COE Technical Committee on Criteria for Dredged and Fill Material. USAE Waterways Experiment Station, Vicksburg, Mississippi.

The organic compounds addressed in the Washington State Marine Sediment Quality Standards (Chemical Criteria) (Appendix B) are of particular interest in this study. MEL will conduct the BNA analysis in such a way as to optimize reporting limits for these compounds.

The estimated analytical costs for this project are shown in Table 4.

Table 4. Laboratory Cost Estimate for Boatyard Stormwater Characterization Study*

Matrix/Analysis	Cost per Sample	Field Samples	Field Duplicates	Field Blank	Matrix Spikes	Total Analyses	Cost Subtotals
Water							
PP metals	175	9	3	1		13	2,275
TPH gas	75	9	3			12	900
TPH diesel	125	9	3			12	1,500
TSS	10	9	3			12	120
Turbidity	10	9	3			12	120
Organotins	225	9	3	1	2	15	3,375
BNAs	250	3	1	1	2	7	1,750
				Water Sample Cost =			10,040
Sediment							
PP metals	185	3	1			4	740
Organotins	200	3	1		2	6	1,200
BNAs	275	3	1		2	6	1,650
PCBs	100	3	1		2	6	600
TOC	39	3	1			4	156
Grain Size	100	3	1			4	400
				Sediment Sample Cost =			4,746
				Total Laboratory Cost =			$14,786

*Manchester Laboratory costs are the 50% discounted price.

Quality Control Procedures

Field and laboratory QC samples to be submitted for this project are shown in Tables 5 and 6, respectively.

Table 5. Field QC Samples for Boatyard Stormwater Characterization Study

Analysis	Duplicates*	Field Blanks
Water Samples		
PP metals	3	1
NWTPH-Gx	3	
NWTPH-Dx	3	
TSS	3	
Turbidity	3	
Organotins	3	1
BNAs	1	1
Sediment Samples		
PP metals	1	
BNAs	1	
PCBs	1	
Organotins	1	
TOC	1	
Grain Size	1	

*field split sample

Table 6. Laboratory QC Samples for Boatyard Stormwater Characterization Study

Analysis	Check Stnds/ LCS	Method Blanks	Surrogate Spikes	Analytical Duplicates	Matrix Spikes
Water Analyses					
PP metals	1/batch	2/batch	NA	none	1/batch
NWTPH-Gx	1/batch	2/batch	all samples	none	NA
NWTPH-Dx	1/batch	2/batch	all samples	none	NA
TSS	1/batch	1/batch	NA	none	NA
Turbidity	1/batch	1/batch	NA	none	NA
Organotins	1/batch	2/batch	all samples	none	2/batch
BNAs	1/batch	2/batch	all samples	none	2/batch
Sediment Analyses					
PP metals	1/batch	2/batch	NA	none	1/batch
BNAs	1/batch	2/batch	all samples	none	2/batch
PCBs	1/batch	2/batch	all samples	none	2/batch
Organotins	1/batch	2/batch	all samples	none	1/batch
TOC	1/batch	1/batch	NA	none	NA
Grain Size	NA	NA	NA	none	NA

LCS = labratory control sample

Data Management Procedures

Field data and observations will be recorded in a bound notebook of waterproof paper.

The data package from MEL will include a case narrative discussing any problems with the analyses, corrective actions taken, changes to the referenced method, and an explanation of data qualifiers. The data package should also include all associated QC results. This information is needed to evaluate the accuracy of the data and to determine whether the MQOs were met. This should include results for all blanks, surrogate compounds, and check standards included in the sample batch, as well as results for analytical duplicates and matrix spikes.

All project data will be entered into Excel spreadsheets. All entries will be independently validated for accuracy by another individual on the project team.

All project data will be entered into Ecology's Environmental Information Management System (EIM). Data entered into EIM follow a formal data validation review procedure where data is reviewed by the project manager of the study, the person entering the data, and an independent reviewer.

Audits and Reports

MEL participates in performance and system audits of their routine procedures. Results of these audits are available on request.

A draft technical report will be prepared for review by the client and other interested parties. This report will be completed in July 2006. A final technical report is anticipated by October 2006. The responsible staff member is Art Johnson.

The project data will be entered into EIM on or before December 2006. The responsible staff member is Carolyn Lee.

Data Verification and Validation

MEL will conduct a review of all laboratory data and prepare case narratives. MEL will verify that methods and protocols specified in the Quality Assurance (QA) Project Plan were followed; that all calibrations, checks on quality control, and intermediate calculations were performed for all samples; and that the data are consistent, correct, and complete, with no errors or omissions. Evaluation criteria will include the acceptability of holding times, instrument calibration, procedural blanks, spike sample analyses, precision data, laboratory control sample analyses, and appropriateness of data qualifiers assigned. MEL will prepare written data verification reports based on the results of their data review. A case summary will meet the requirements for a data verification report.

To determine if project MQOs have been met, results for surrogate recoveries and estimates of precision and bias will be compared to QC limits. The MQOs correspond to the laboratory's QC limits for this project. To evaluate whether the targets for reporting limits have been met, the results will be examined for "non-detects" and to determine if any values exceed the lowest concentration of interest.

The project lead will review the laboratory data packages and MEL's data verification report and validate the data. Based on these assessments, the data will be either accepted, accepted with appropriate qualifications, or rejected and re-analysis considered. Data validation will be documented in the final project report.

Data Quality (Usability) Assessment

Once the data have been verified and validated, the project lead will determine if the data can be used to make the calculations, determinations, and decisions for which the project was conducted. If the results are satisfactory, data analysis will proceed and include but not necessarily be limited to: 1) Results for water samples will be compared to the marine aquatic life and human health criteria, 2) Graphs will be prepared that plot the chemical concentration/criterion ratio as a means of identifying chemicals of potential concern, 3) A literature search will be conducted to locate and select appropriate criteria for chemicals not covered in the state standards, and 4) Results for sediment samples will be compared to the sediment quality standards and evaluated similarly.

The stormwater results will be compared to similar data on stormwater from other types of urban sources, as available. The sediment results will be compared to sediment quality data on reference areas in South Puget Sound (Ecology SEDQUAL Database).

References

Ecology, 2002. How to Do Stormwater Sampling: A Guide for Industrial Facilities. Washington State Department of Ecology. Olympia, WA. Publication No. 02-10-071. www.ecy.wa.gov/biblio/0210071.html.

Ecology, 2003. Sediment Sampling and Analysis Plan Appendix: Guidance on the Development of Sediment Sampling and Analysis Plans Meeting the Requirements of the Sediment Management Standards (Chapter 173-204 WAC). Washington State Department of Ecology, Olympia, WA. Publication No. 03-09-043. www.ecy.wa.gov/biblio/0309043.html.

PSEP, 1996. Recommended Protocols and Guidelines for Measuring Selected Environmental Variables in Puget Sound. Prep. by Tetra Tech. Inc. for EPA Region 10, Seattle, WA (w/1996 updates by METRO, Seattle, WA.)

Appendices

Appendix A

Washington State Criteria for Protection of Aquatic Life and Human Health (Toxics Substances, Marine Waters, Chapter 173-201A WAC; ug/L)

	Marine Life			
Pollutant, CAS No., & NPDES Application Ref. No.	Acute	Chronic		Human Health
ACROLEIN 107028 1V				780
ACRYLONITRILE 107131 2V				0.66
ALDRIN 309002 1P	0.71	0.0019		0.00014
AMMONIA unionized	233	35		
ANTHRACENE 120127 3B				110000
ANTIMONY (INORGANIC) 7440360 1M				4300
ARSENIC (dissolved) 7440382 2M	69	36		
ARSENIC (inorganic)				0.14
BENZENE 71432 3V				71
BENZIDINE 92875 4B				0.00054
BENZO(a)ANTHRACENE 56553 5B				0.031
BENZO(a)PYRENE 50328 6B				0.031
BENZO(b)FLUORANTHENE 205992 7B				0.031
BENZO(k) FLUORANTHENE 207089 9B				0.031
BHC - ALPHA 319846 2P				0.013
BHC - BETA 319857 3P				0.046
BHC - GAMMA 58899 4P (Lindane)	0.16			0.063
BIS(2-CHLOROETHYL)ETHER 111444 11B				1.4
BIS(2 CHLOROISOPROPYL)ETHER 39638329 12B				170000
BIS(2-ETHYLHEXYL) PHTHALATE 117817 13B				5.9
BROMOFORM 75252 5V				360
CADMIUM - 7440439 4M	42.00	9.3		
CARBON TETRACHLORIDE 56235 6V				4.40
CHLOROBENZENE 108907 7V				21000
CHLORDANE 57749 6P	0.09	0.004		0.00059
CHLORODIBROMOMETHANE 124481 8V				34
CHLORINE (Total Residual) 7782505	13	7.50		
CHLOROETHYL ETHER (BIS - 2) 111444				1.40
CHLOROFORM 67663 11V				470
CHLOROISOPROPYL ETHER (BIS-2) 108601				170000
CHLORPYRIFOS 2921882	0.011	0.0056		
CHROMIUM(HEX) 18540299	1100	50		

	Marine Life			
Pollutant, CAS No., & NPDES Application Ref. No.	Acute	Chronic		Human Health
CHRYSENE 218019 18B				0.031
COPPER - 744058 6M	4.80	3.10		
CYANIDE 57125 14M	1.00	1.00		220000
DDT 50293 7P	0.13	0.001		0.00059
DDT METABOLITE (DDE) 72559 8P	0.13	0.001		0.00059
DDT METABOLITE (DDD) 72548 9P	0.13	0.001		0.00084
DIBENZO(a,h)ANTHRACENE 53703 19B				0.031
DIBUTYLPHTHALATE 84742				12000
1,2 DICHLOROBENZENE 95501 20B				17000
1,3 DICHLOROBENZENE 541731 21B				2600
1,4 DICHLOROBENZENE 106467 22B				2600
3,3 DICHLOROBENZIDINE 91941 23B				0.077
DICHLOROBROMOMETHANE 75274 12V				22
1,2 DICHLOROETHANE 107062 15V				99
1,1 DICHLOROETHYLENE 75354 16V				3.20
2,4 DICHLOROPHENOL 120832 2A				790.00
1,3 -DICHLOROPROPYLENE 542756 18V				1700
DIELDRIN 60571 10P	0.71	0.0019		0.00014
DIETHYLPHTHALATE 84662 24B				120000
DIMETHYLPHTHALATE 131113 25B				2900000
DI-n-BUTYL PHTHALATE 84742 26B				12000
2-METHYL-4,6 -DINITROPHENOL 534521 4A				765
2,4-DINITROPHENOL 51285 5A				14000
DINITROTOLUENE 2,4 121142 27B				9.10
DIOXIN (2,3,7,8-TCDD) 1746016				0.000000014
1,2 DIPHENYLHYDRAZINE 122667 30B				0.54
ENDOSULFAN a 959988 11P, b 33213659 12P	0.034	0.0087		2.0
ENDOSULFAN SULFATE 1031078 13P				2.0
ENDRIN 72208 14P	0.037	0.0023		0.81
ENDRIN ALDEHYDE 7421934 15P				0.81
ETHYLBENZENE 100414 19V				29000
FLUORANTHENE 206440 31B				370
FLUORENE 86737 32B				14000
HEPTACHLOR 76448 16P	0.0530	0.0036		0.00021
HEPTACHLOR EPOXIDE 1024573 17P				0.00011
HEXACHLOROBENZENE 118741 33B				0.00077
HEXACHLOROBUTADIENE 87683 34B				50
HEXACHLOROCYCLOHEXANE-ALPHA 319846 2P				0.013
HEXACHLOROCYCLOHEXANE-BETA 319857 3P				0.046
HEXACHLOROCYCLOPENTADIENE 77474 35B				17000

	Marine Life			
Pollutant, CAS No., & NPDES Application Ref. No.	Acute	Chronic		Human Health
HEXACHLOROETHANE 67721 36B				8.90
INDENO(1,2,3-cd)PYRENE 193395 37B				0.031
ISOPHORONE 78591				600
LEAD - 7439921 7M	210.00	8.10		
METHYL BROMIDE 74839 20V				4000
METHYLENE CHLORIDE 75092 22V				1600
MERCURY 7439976 8M	1.80	0.0250		0.15
NICKEL - 7440020 9M	74.00	8.20		4600
NITROBENZENE 98953 40B				1900
NITROSODIMETHYLAMINE N 62759 41B				8.10
NITROSODIPHENYLAMINE N 86306 43B				16
PENTACHLOROPHENOL 87865 8A	13.	7.90		8.20
PHENOL 108952 10A				4600000
PCB's 53469219, 11097691, 1104282, 11141165,	10	0.03		0.000170
12672296, 11096825, 12674112 18P-24P				
PYRENE 129000 45B				11000
SELENIUM 7782492 10M	290	71		
SILVER - 7740224 11M	1.90	NA		
TETRACHLOROETHANE 1,1,2,2 79345 23V				11.00
TETRACHLOROETHYLENE 127184 24V				8.85
THALLIUM 7440280 12M				6.30
TOLUENE 108883 25V				200000
TOXAPHENE 8001352 25P	0.21	0.0002		0.00075
TRICHLOROETHANE 1,1,2 79005 28V				42.00
TRICHLOROETHYLENE 79016 29V				81.00
TRICHLOROPHENOL 2,4,6 88062 11A				6.50
VINYL CHLORIDE 75014 31V				525
ZINC- 7440666 13M	90.00	81.00		

Appendix B

Washington State Marine Sediment Quality Standards (Chemical Criteria)

Chemical Parameter	Sediment Quality Standards WAC 173-204-320	Sediment Impact Zone Maximum Level, WAC 173-204-420 and Sediment Cleanup Screening Level/Minimum Cleanup Level, WAC 173-204-520
	MG/KG DRY WEIGHT (PARTS PER MILLION (PPM) DRY)	MG/KG DRY WEIGHT (PARTS PER MILLION (PPM) DRY)
ARSENIC	57	93
CADMIUM	5.1	6.7
CHROMIUM	260	270
COPPER	390	390
LEAD	450	530
MERCURY	0.41	0.59
SILVER	6.1	6.1
ZINC	410	960
	MG/KG ORGANIC CARBON (PPM CARBON)	MG/KG ORGANIC CARBON (PPM CARBON)
LPAH	370	780
NAPHTHALENE	99	170
ACENAPHTHYLENE	66	66
ACENAPHTHENE	16	57

Chemical Parameter	Sediment Quality Standards WAC 173-204-320	Sediment Impact Zone Maximum Level, WAC 173-204-420 and Sediment Cleanup Screening Level/Minimum Cleanup Level, WAC 173-204-520
FLUORENE	23	79
PHENANTHRENE	100	480
ANTHRACENE	220	1200
2-METHYLNAPHTHALENE	38	64
HPAH	960	5300
FLUORANTHENE	160	1200
PYRENE	1,000	1400
BENZ(A)ANTHRACENE	110	270
CHRYSENE	110	460
TOTAL BENZOFLUORANTHENES	230	450
BENZO(A)PYRENE	99	210
INDENO (1,2,3,-C,D) PYRENE	34	88
DIBENZO (A,H) ANTHRACENE	12	33
BENZO(G,H,I)PERYLENE	31	78
1,2-DICHLOROBENZENE	2.3	2.3
1,4-DICHLOROBENZENE	3.1	9
1,2,4-TRICHLOROBENZENE	0.81	1.8
HEXACHLOROBENZENE	0.38	2.3
DIMETHYL PHTHALATE	53	53

Chemical Parameter	Sediment Quality Standards WAC 173-204-320	Sediment Impact Zone Maximum Level, WAC 173-204-420 and Sediment Cleanup Screening Level/Minimum Cleanup Level, WAC 173-204-520
DIETHYL PHTHALATE	61	110
DI-N-BUTYL PHTHALATE	220	1700
BUTYL BENZYL PHTHALATE	4.9	64
BIS (2-ETHYLHEXYL) PHTHALATE	47	78
DI-N-OCTYL PHTHALATE	58	4500
DIBENZOFURAN	15	58
HEXACHLOROBUTADIENE	3.9	6.2
N-NITROSODIPHENYLAMINE	11	11
TOTAL PCBs	12	65
	UG/KG DRY WEIGHT {PARTS PER BILLION (PPB) DRY}	UG/KG DRY WEIGHT {PARTS PER BILLION (PPB) DRY}
PHENOL	420	1200
2-METHYLPHENOL	63	63
4-METHYLPHENOL	670	670
2,4-DIMETHYL PHENOL	29	29
PENTACHLOROPHENOL	360	690
BENZYL ALCOHOL	57	73
BENZOIC ACID	650	650

Appendix C

Chemicals to be Analyzed for the 2005-2006 Boatyard Stormwater Characterization Study

Metals
Antimony
Arsenic
Beryllium
Cadmium
Chromium
Copper
Lead
Mercury
Nickel
Selenium
Silver
Thallium
Zinc

Total Petroleum Hydrocarbons
NWTPH-Dx (kerosene, diesel, lube oils, heavy fuel oils, other semivolatile petroleum products
NWTPH-Gx (gasoline range petroleum hydrocarbons)

BNAs
Acenaphthene
Acenaphthylene
Aniline
Anthracene
Benzidine
Benzo (a) anthracene
Benzo (a) pyrene
Benzo (b) fluoranthene
Benzo (k) fluoranthene
Benzo (g,h,i) perylene
Benzo (a,l) pyrene
Benzoic Acid
Benzyl Alcohol
Butylbenzylphthalate
4-Bromophenyl-Phenylether
Di-N-Butylphthalate
Caffeine
Carbazole
Cholesterol
4-Chloro-3-Methylphenol

4-Chloroaniline
Bis(2-Chloroethoxy) Methane
Bis(2-Chloroethyl) Ether
BNAs (cont.)
Bis(2-Chloroisopropyl) Ether
2-Chloronaphthalene
2-Chlorophenol
4-Chlorophenyl-Phenylether
Chrysene
3B-Coprostanol
Dibenzo (a,h) anthracene
Dibenzofuran
Dibenzo (a,j) acridine
Dibenzo (a,e) pyrene
Dibenzo (a,i) pyrene
Dibenzo (a,h) pyrene
3,3'-Dichlorobenzidine
1,2-Dichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
2,4-Dichlorophenol
2,4-Dimethylphenol
2,4-Dinitrophenol
2,4-Dinitrotoluene
2,6-Dinitrotoluene
1,2-Diphenylhydrazine
Fluoranthene
Fluorene
2-Fluorophenol
Hexachlorobenzene
Hexachlorobutadiene
Hexachlorocyclopentadiene
Hexachloroethane
Indeno (1,2,3-cd) pyrene
Isophorone
p-Isopropyltoluene
4,6-Dinitro-2-Methylphenol
1-Methylnaphthalene
2-Methylnaphthalene
2-Methylphenol
4-Methylphenol
Naphthalene
2-Nitroaniline
3-Nitroaniline
4-Nitroaniline
Nitrobenzene
2-Nitrophenol

4-Nitrophenol
N-Nitroso-Di-N-Propylamine
N-Nitrosodiphenylamine
BNAs (cont.)
4-Nonyl Phenol
2,2’-Oxybis[1-chloropropane]
Pentachlorophenol
Bis (2-Ethylhexyl) Phthalate
Diethylphthalate
Dimethylphthalate
Di-N-Octyl Phthalate
Phenanthrene
Phenol
Pyridine
Pyrene
Retene
B-Sitosterol
1,2,4-Trichlorobenzene
2,4,5-Trichlorophenol
2,4,6-Trichlorophenol

Organotins
Monobutyltin
Dibutyltin
Tributyltin
Tetrabutyltin

PCBs
PCB-l0l6
PCB-l22l
PCB-l232
PCB-l242
PCB-l248
PCB-l254
PCB-l260