Sampling And Analysis Plan For Wood Waste Dredging In Conjunction With The Restoration Of Thatcher Bay, Blakely Island, Washington

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1 Introduction

The history of wood milling activity in Thatcher Bay began in 1879 with the construction of a mill in the southeast portion of the bay. Milling activity continued for over 60 years, with the mill closing in 1942. Currently the primary evidence of the historic milling operations is the presence of approximately 5000 yd^3 of material including wood waste and wood waste contaminated sediments. The distribution and thickness of residual wood waste at the site was determined using sediment coring and GIS based interpolation techniques. Additionally, pilot studies were conducted to characterize in situ sediment redox, organic composition and sulfide impacts to nearshore flora and fauna (Breems 2008).

Information describing mill operations in Thatcher Bay provides no reason to believe that operations other than simply milling lumber occurred at the mill. Therefore we have no reason to believe that contaminates exist other than what would be typically expected from a wood milling facility. Additionally the lapse of time from the closing of the mill to the expected beginning of the sediment removal project may have allowed any non-wood based contaminates to degrade or be otherwise removed from the sediments.

The objective of the wood waste removal project is simply to remove the waste and contaminated sediments and to restore the site to a naturally functioning condition.

The entire project will be conducted on private land that is held by the Blakely Island Trust. A conservation easement through the San Juan Preservation Trust encompasses all of the backshore and upland areas surrounding Thatcher Bay (figure 1).

An eelgrass bed is present at the mouth of Thatcher Bay and a small seasonal creek enters the bay north of the project site. Neither of these areas will be affected by project construction.

Figure 1: Thatcher Bay wood waste removal site

2 Project Rank

An initial ranking of low-moderate has been determined for the Thatcher Bay wood waste site (to be referred to in this document as “the site”). This

determination was made in consultation with David Fox of the United States Army Corps of Engineers. Mr. Fox explained that the San Juan Archipelago has a current general ranking of low-moderate (U. S. Army Corps of Engineers, et al 2007).

3 Dredging Volume

Sediment volume of the site was determined by evaluating the extent and depth of the wood waste by taking sediment cores of the site. Sediment cores were obtained using a split core auger system. A total of 32 sediment cores were taken every fifty feet (15.2 m) along six predefined transects perpendicular to shore (Figure 2). Data from the sediment cores was used to extrapolate an overall footprint and depth of the wood waste (Figure 3). Several pilot cores, outside the six predefined transects, were included in the analysis of wood waste distribution. All cores were measured and segments were assigned into one of five categories: surface sediment, wood, sediment/wood, dense sediment wood and basal sediment (Figure 4). Photo documentation exists for all cores.

Figure 2: Location of cores used to define the distribution of wood waste. (From Breems 2008)

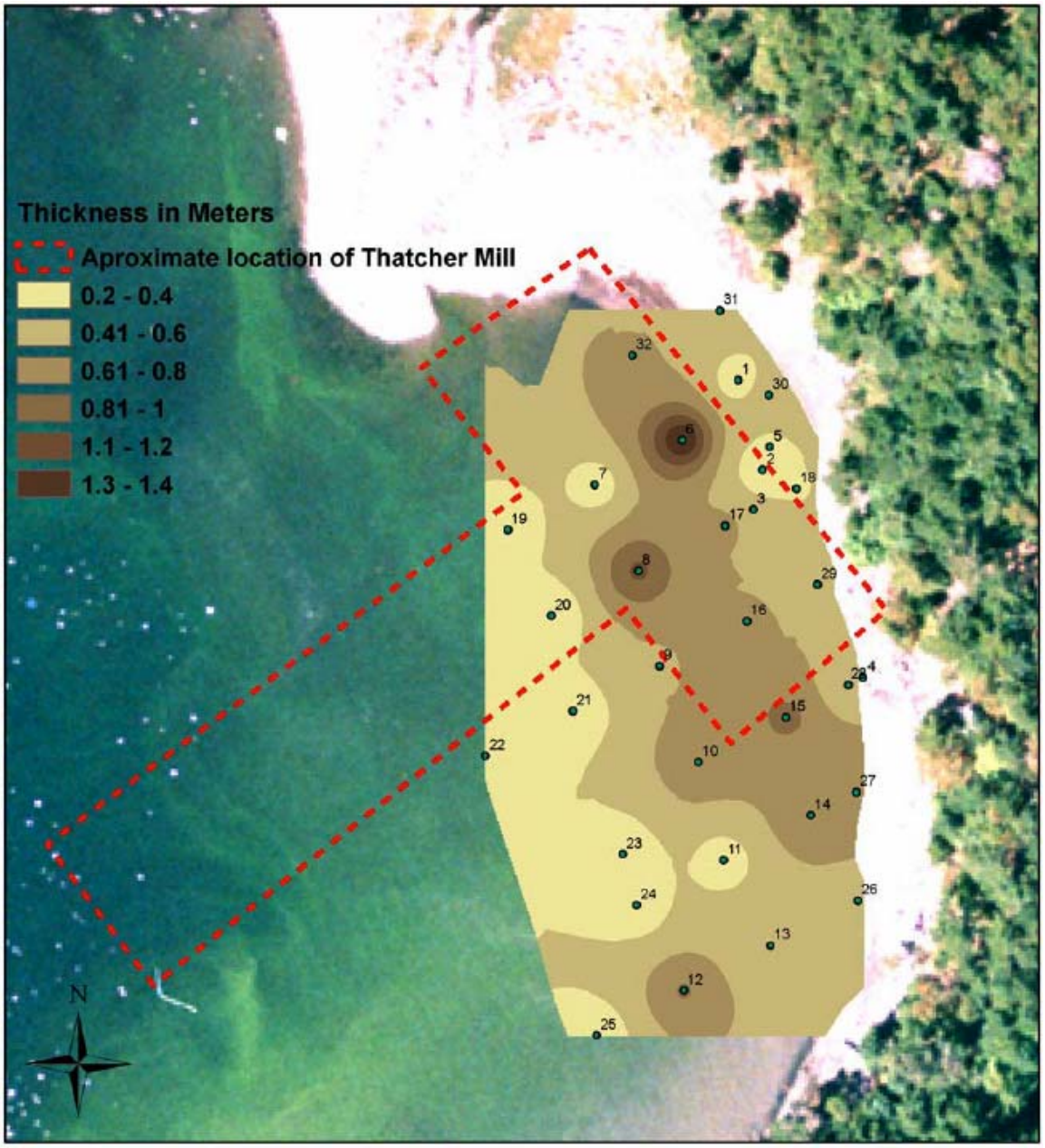

Figure 3: Maximum depth that wood waste was observed
Darker colors indicate deeper depths. A general trend of decreasing depth along transects perpendicular to shore was observed. The dashed red outline coincides with the approximate location of the mill house and dock in Thatcher Bay. The location is approximated from historical photos (Breems 2008).

Total area of the site is 1.8 acres, the site circumference is 1120ft, and sediment volume for the site was observed to be 4,960 yd^3.

Over dredging the site by one foot will ensure the full removal of contaminated sediments. When determining the lateral extent of the contaminated sediments the maximum depth was considered as the point where zero presence of wood

waste was observed. However the lower portions of the core samples had very low contaminant content; therefore an over dredge of one foot will be suitable for full contaminant removal. (Breems 2008)

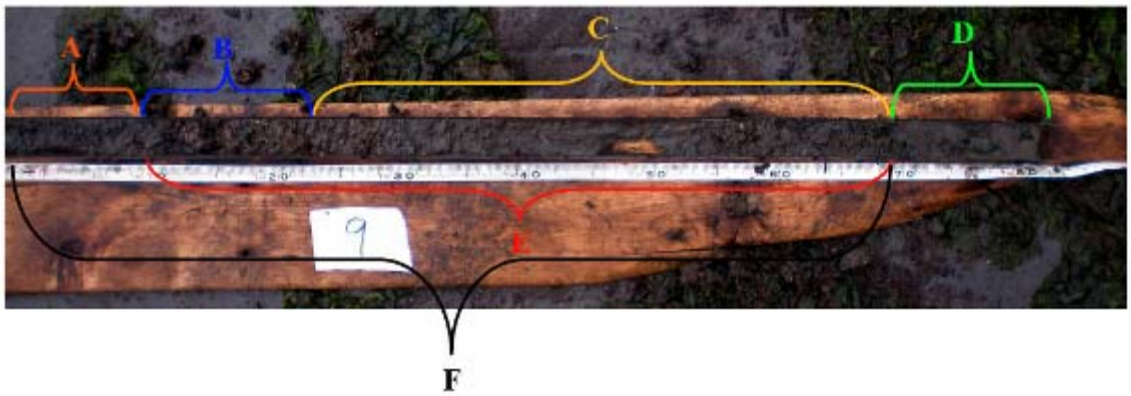

Figure 4: Visual representation of sediment categories taken from core station 9. A: Surface Sediment, B: Wood, C: Sediment/Wood, D: Basal Sediment, E: Wood Thickness, F: Wood Depth

Total area of the site is 78,408 ft2. 78,408 X 1ft over dredge = 78,408ft^3 (2,904yd^3)

To ensure complete removal of the contaminated sediment the dredge prism will extend beyond the identified footprint of the wood waste to have a final side slope of 1:1 for the entire circumference of the site.

Site circumference = 1120ft. (1120 X 1.8 [waste depth in feet]^2)/ 2 = 1822ft^3 (67.5 yds^3)

Total dredging volume is the sum of the actual wood waste/wood waste contaminated sediment, over dredge, and side slope dredge and bulking, equaling 8,725 yds^3 (Table 1).

Table 1: Total Dredging Volume (yds^3)

Wood waste/wood waste contaminated sediment	4,960
Over dredge	2,904
Side slope dredge	68
10 percent added for bulking of dredged sediment	793
Total dredge volume	8,725

4 Number of Dredged Material Management Units (DMMUs) and Field Samples

Wood waste composition on the site ranges from nearly pure wood waste to sediment with a low wood waste component. The total dredge volume is considerably smaller than the minimum DMMU for heterogeneous sediment.

Projects ranking low moderate with heterogeneous sediment require one DMMU for each surface sediment unit of up to 32,000 yds^3 and one DMMU for each subsurface unit of up to 48,000 yds^3. The Dredged Materials Management Program (DMMP) users' manual defines all sediment from the surface to four feet as surface sediment. Surveys of the site have indicated that the average depth of wood waste is 1.8 ft, within the surface sediment category. As a result the site is considered to have one DMMU with a total volume of 8,725 yds^3.

5 Sampling

Samples will be taken for full physical and chemical characterization of the sediments. A tiered sampling approach will be used; an adequate sample will be taken for all testing with a portion of the sample archived for biological testing pending the results of the chemical testing.

To accurately evaluate the extent of possible contaminants 4 samples will be taken. The samples will be composited into one sample to represent the entire site. Sampling locations will be documented with GPS and confirmed with aerial photos and ground truth measurements. Samples locations will be in close proximity to the core sample sites used to evaluate wood depth. Specifically the samples will be taken adjacent to sites 30, 8, 21,12 and 10 (see figure 5). These sites represent a range of depths and locations around the old mill footprint. The sampling locations and depths are summarized in table 2.

Table 2: Thatcher Bay sampling depths and locations

Sample #	Core Site #	Latitude	Longitude	Wood Depth	Conceptual Dredging Depth	Sampling Depth with Z Core
1	8	-122.81586	48.55216	4.04	5.04	6.04
2	10	-122.81572	48.55189	2.56	3.56	4.56
3	21	-122.81599	48.55196	3.44	4.44	5.44
4	30	-122.81559	48.55241	1.87	2.87	3.87
5	12	-122.81574	48.55157	2.66	3.66	4.66

All testing of the sediment will be in compliance with the recommendations of the Puget Sound protocols and guidelines (Puget Sound Partnership 2008).

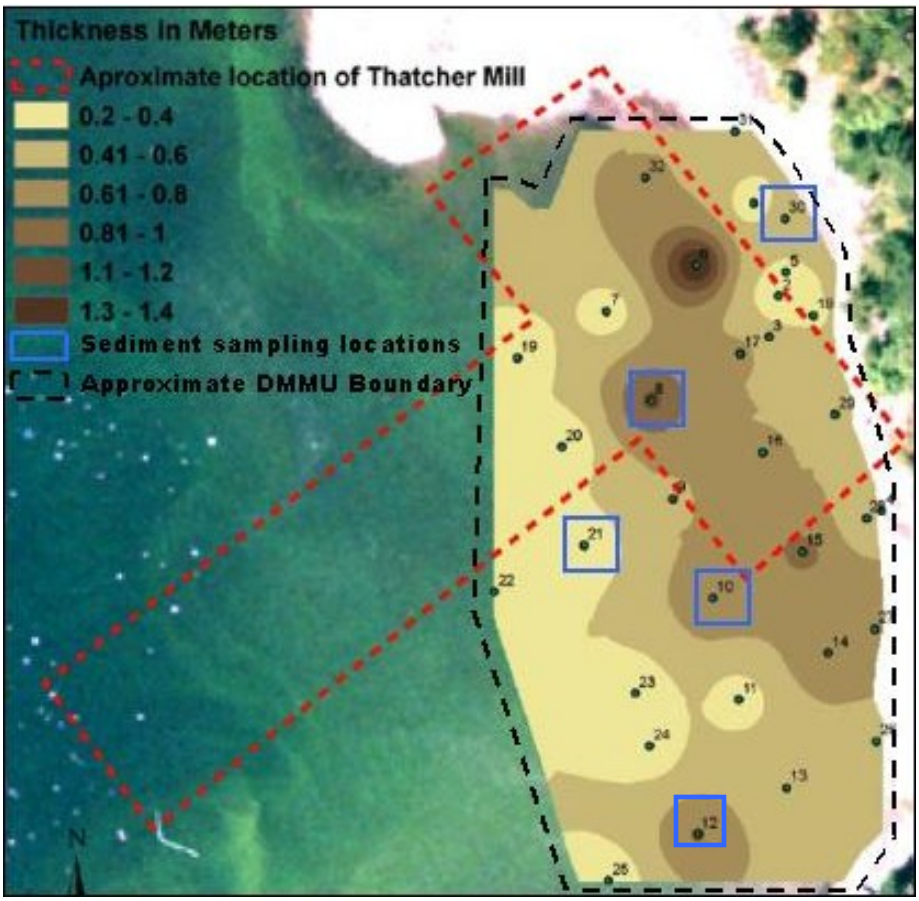

Figure 5: Thatcher Bay sediment sampling locations and DMMU location

5.1 Sampling Equipment and Sample Storage

Samples will be taken with a vibracore sampler with an aluminum core tube. Samples will be taken to a depth of approximately one foot below the dredge overdepth. Location for each core will be determined using a Garmin GPSMap 76 handheld GPS navigator with an accuracy of greater than 3 meters. Latitude and longitude of each sampling site will be recorded in decimal degrees (to six decimal places). Compaction rates will be determined prior to retrieval of the core. The bottom one foot below the maximum dredging depth for each core will be isolated to serve as the Z core. The Z core for each location will be obtained by cutting the core pipe and removing the bottom one foot of each aluminum core. The Z core will be capped and labeled, observing the in situ sediment profile and archived at -18°C for future reference. All sampling equipment will be decontaminated as specified in the Recommended Guidelines for Sampling Marine Sediment, Water Column, and Tissue in Puget Sound chapter of the Puget Sound Protocols and Guidelines (Puget Sound Partnership 2008).

Samples will be composited in a stainless steel container and mixed with a stainless steel or Teflon spoon. Composited sediment will be stored in appropriate decontaminated containers provided by Analytical Resources Inc. (Tukwilla, WA). Seven liters of composited sediment will be collected and

archived with N^2 at 4°C for biological testing. Samples will be contained and stored as indicated in table 3.

Table 3: Sample storage

SAMPLE TYPE	HOLDING TIME	SAMPLE SIZE [1]	TEMP [2]	CONTAINER	ARCHIVE [3]
Particle Size	6 Months	100-200 g (75-150 ml)	4 °C	Combined in appropriate containers provided by ARI. Approximately 3 Liters total.	X
Total Solids	14 Days	125 g (100 ml)	4 °C		
Total Volatile Solids (TVS)	14 Days	125 g (100 ml)	4 °C		
Modified TVS (for wood-waste determination)	14 Days	300 g (225 ml)	4 °C		
Total Organic Carbon	14 Days	125 g (100 ml)	4 °C		
Ammonia	7 Days	25 g (20 ml)	4 °C		
Metals (except Mercury)	6 Months	50g (40 ml)	4 °C		
Mercury	28 days	50 g (40 ml)	-18 °C		
Semi-volatiles, pesticides, and PCBs	Extract within 14 days of collection, analyze within 40 days after extraction	150 g (120 ml)	4 °C		
Total Sulfides	7 days	50 g (40 ml)	4 °C[4]	Appropriate container provided by ARI	
Volatile Organics	14 days	100 g (2-40 ml jars)	4 °C	Appropriate containers provided by ARI	
Bioassay	8 weeks	7 liters	4 °C[5]	7 1-liter glass or polyethylene	

[1] Recommended minimum field sample sizes for one laboratory analysis. Actual volumes to be collected have been increased to provide a margin of error and allow for retests.
[2] During transport to the lab, samples will be stored on ice. The mercury and archived samples will be frozen immediately upon receipt at the lab.
[3] For every DMMU, a 250 ml container is filled and frozen to run any or all of the analyses indicated.
[4] Sulfides samples will be preserved with 5 ml of 1 N zinc acetate for every 30 g of sediment.
[5] Headspace purged with nitrogen.

Samples for chemicals of concern testing will be stored in appropriate containers provided by Analytical Resources Incorporated, for a total of approximately 3 liters of sediment. The Samples will be preserved on ice at 4°C. A sub-sample of the sediment for mercury analysis will be removed at the laboratory and stored at -18°C.

Samples for volatiles testing will be stored in appropriate containers with silicone vapor barriers provided by Analytical Resources Inc. with no headspace.

Samples for sulfides testing will be selected randomly from one core prior to compositing. Sediment will be collected from the center of the core and stored in two appropriate containers with 1 Normal zinc acetate (5ml per 30g) and silicone vapor barriers provided by Analytical Resources Inc. The sample will be thoroughly shaken to ensure full mixing of the zinc acetate with the sediment.

All samples will be stored and shipped on ice via an express carrier to the appropriate lab for analysis.

Sample collection, transport, storage, and custody will be recorded on a chain of custody form that will accompany each sample and will be kept with whom the sample resides.

5.2 Sampling Analysis

Triplicate samples will be analyzed by Analytical Resources Inc. (ARI) (Tukwilla, WA) for conventional parameters including: grain size, total organic carbon, percent solids, total sulfides and ammonia. ARI will also test duplicate samples for the standard chemicals of concern (COC) for Puget Sound as determined by the USACOE Dredged Material Management Program and listed below (Table 4). All chemical testing will be conducted in compliance with the Puget Sound protocols and guidelines by ARI (Table 5) (Puget Sound Partnership 2008).

Total wood waste fraction of the sediments will be determined using ASTM D 2974 Method C on a 300 gram sample as referred to in the 1997 DMMP clarification paper entitled, *Management of Wood Waste under Dredged Material Management Programs (DMMP) and the Sediment Management Standards (SMS) Cleanup Program* (DMMP 1997). ARI has developed a standard operating procedure based on this method. A second grain-size analysis will be conducted on the inorganic residue from the modified TVS procedure. The results of this second grain-size analysis will be used to select appropriate reference sediment should bioassays be required.

Table 4: Dredged Material Management Program guideline chemistry values for chemicals of concern.

CHEMICAL	CAS[1] NUMBER	SL	BT	ML
METALS (mg/kg)				
Antimony	7440-36-0	150	---	200
Arsenic	7440-38-2	57	507.1	700
Cadmium	7440-43-9	5.1	11.3	14
Chromium[2]	7440-47-3	---	267	---
Copper	7440-50-8	390	1,027	1,300
Lead	7439-92-1	450	975	1,200
Mercury	7439-97-6	0.41	1.5	2.3
Nickel	7440-02-0	140	370	370
Selenium[2]	7782-49-2	---	3	---
Silver	7440-22-4	6.1	6.1	8.4
Zinc	7440-66-6	410	2,783	3,800
ORGANICS (µg/kg)				
PAHs				
Total LPAH	---	5,200	---	29,000
Naphthalene	91-20-3	2,100	---	2,400
Acenaphthylene	208-96-8	560	---	1,300
Acenaphthene	83-32-9	500	---	2,000
Fluorene	86-73-7	540	---	3,600
Phenanthrene	85-01-8	1,500	---	21,000
Anthracene	120-12-7	960	---	13,000
2-Methylnaphthalene[3]	91-57-6	670	---	1,900
Total HPAH	---	12,000	---	69,000

CHEMICAL	CAS[1] NUMBER	SL	BT	ML
Fluoranthene	206-44-0	1,700	4,600	30,000
Pyrene	129-00-0	2,600	11,980	16,000
Benz(a)anthracene	56-55-3	1,300	---	5,100
Chrysene	218-01-9	1,400	---	21,000
Benzofluoranthenes (b, j ,k)[7]	205-99-2 205-82-3 207-08-9	3,200	---	9,900
Benzo(a)pyrene	50-32-8	1,600	---	3,600
Indeno(1,2,3-c,d)pyrene	193-39-5	600	---	4,400
Dibenz(a,h)anthracene	53-70-3	230	---	1,900
Benzo(g,h,i)perylene	191-24-2	670	---	3,200
CHLORINATED HYDROCARBONS				
1,3-Dichlorobenzene	541-73-1	170	---	---
1,4-Dichlorobenzene	106-46-7	110	---	120
1,2-Dichlorobenzene	95-50-1	35	---	110
1,2,4-Trichlorobenzene	120-82-1	31	---	64
Hexachlorobenzene (HCB)	118-74-1	22	168	230
PHTHALATES [4]				
Dimethyl phthalate	131-11-3	71	---	1,400
Diethyl phthalate	84-66-2	200	---	1,200
Di-n-butyl phthalate	84-74-2	1,400	---	5,100
Butyl benzyl phthalate	85-68-7	63	---	970
Bis(2-ethylhexyl) phthalate	117-81-7	1,300	---	8,300
Di-n-octyl phthalate	117-84-0	6,200	---	6,200
PHENOLS				
Phenol	108-95-2	420	---	1,200
2-Methylphenol	95-48-7	63	---	77
4-Methylphenol	106-44-5	670	---	3,600
2,4-Dimethylphenol	105-67-9	29	---	210
Pentachlorophenol	87-86-5	400	504	690
MISCELLANEOUS EXTRACTABLES				
Benzyl alcohol	100-51-6	57	---	870
Benzoic acid	65-85-0	650	---	760

Dibenzofuran	132-64-9	540	---	1,700
CHEMICAL	**CAS[1] NUMBER**	**SL**	**BT**	**ML**
Hexachloroethane	67-72-1	1,400	---	14,000
Hexachlorobutadiene	87-68-3	29	---	270
N-Nitrosodiphenylamine	86-30-6	28	---	130
VOLATILE ORGANICS[5]				
Trichloroethene	79-01-6	160	---	1,600
Tetrachloroethene	127-18-4	57	---	210
Ethylbenzene	100-41-4	10	---	50
Total Xylene (sum of o-, m-, p-)	95-47-6 108-38-3 106-42-3	40	---	160
PESTICIDES & PCBs				
Total DDT (sum of 4,4'-DDD, 4,4'-DDE and 4,4'-DDT)	72-54-8 72-55-9 50-29-3	6.9	50	69
Aldrin	309-00-2	10	---	---
Total Chlordane [7] (sum of cis-chlordane, trans-chlordane, cis-nonachlor, trans-nonachlor, oxychlordane)	5103-71-9 5103-74-2 5103-73-1 39765-80-5 27304-13-8	10	37	---
Dieldrin	60-57-1	10	---	---
Heptachlor	76-44-8	10	---	---
Gamma-BHC (Lindane)	58-89-9	10	---	---
Total PCBs	---	130	38 [6]	3,100

(1) Chemical Abstract Service Registry Number
(2) As no SL value exists to trigger toxicity testing, this chemical will only be evaluated for its bioaccumulative potential.
(4) Based on 1998 LAET/HAET's; see
http://www.nws.usace.army.mil/PublicMenu/Doc_list.cfm?sitename=dmmo&pagename=17th_ARM_MAy_5_2004
(5) Volatile organics are not required to be analyzed for dredging projects in Grays Harbor and Willapa Bay.
(6) This value is normalized to total organic carbon, and is expressed in mg/kg carbon.
(7) Components of benzofluoranthenes and chlordane were clarified at the 2007 SMARM.

Table 5: Analytical methods used by ARI

Parameter	Preparation Method	Analysis Method	Technique
PSDDA Volatiles *(8 analytes)*	5030	8260	GC/MS
PSDDA Semivolatiles *(20 to 200 ug/Kg)*	3550 GPC Cleanup	8270	GC/MS
PSDDA Pest + HCB/HCBD *(PSDDA Target List)*	3550	8081	GC/ECD
PSDDA PCB (20 ppb)	3550	8082	GC/ECD
PSDDA Total Metals **ICP:** Sb, As, Cd, Cr, Cu, Pb, Ni, Ag, Zn **GFAA:** Se **CVAA**: Hg	3050/7471	6010/7010/ 7471	ICP/GFAA/CVAA
Total Solids		PSEP	Gravimetric
Total Volatile Solids		PSEP	Gravimetric
Modified Total Volatile Solids		ASTM D 2974 Method C	Combustion
Total Organic Carbon		PSEP	Combustion
Ammonia		350.1	Auto-phenate
Total Sulfides		PSEP	Distillation

In the event that the organic fraction of the wood waste is determined to be greater than 25% by weight and/or the sediment is determined to contain a COC concentration that is above its corresponding screening level, a biological assessment is required.

Three bioassays will be conducted: a 10-day amphipod mortality test, a 20-day juvenile infaunal growth test, and a sediment larval test. Bioassay testing will be conducted by Northwest Aquatic Sciences of Bend, OR. Reference sediment will be collected from Samish bay UW and WDFW staff. The precise location of the collection site will be determined based on the physical characteristics of the sediment. Grain size for the bioassay tests will be determined using the organic free sediment remaining from the modified TVS test for the site as suggested in

the DMMP users' manual. Wet sieving in the field according SAIC SOP methods will be used to collect appropriate reference sediment.

Appropriate species will be selected from the suggested species listed in the DMMP users' manual based on the sediment grain size and TOC findings for the site. If the species prescribed for a bioassay by the DMMP is unavailable or determined to be inappropriate, the DMMO will be contacted to assist in identifying an appropriate species prior to the initiation of testing. Interstitial ammonia levels will be tested prior to initiation of bioassay testing. Should ammonia levels exceed 20mg/L EPA/ACOE protocols to reduce ammonia levels will be used (DMMO 1997). Specific bioassay tests and methods will be used as indicated in the Puget Sound Protocols and Guidelines: Recommended Guidelines for Conducting Laboratory Bioassays on Puget Sound Sediments (U. S. Environmental Protection Agency 1995).

The overall objective of the dredging operation is to remove the negative impact on benthic habitat associated with excessive wood debris presence and decomposition in Thatcher Bay. The presence and decomposition of wood debris has been shown to facilitate the production of hydrogen sulfide and ammonia which are known to impact the diversity and abundance of the benthic infaunal community (Elliott, Spear, and Wyllie-Echeverria 2006; Wang and Chapman 1999; Jackson 1986). The negative impacts from wood waste decomposition are associated with elevated wood debris present in an anoxic environment (Samis et al. 1999). The use of a dispersive disposal site provides for dispersion and oxygenation of the sediment ameliorating the negative effects of anaerobic decomposition. Therefore the primary objective of sample analysis and potential bioassay assessment is to identify contaminants not associated with the decomposition of the wood debris.

5.3 Reporting

5.3.1 Sediment Characterization Report

A Sediment Characterization Report will be written to summarize the sampling conducted, the handling of the samples, and the testing results. The report will contain the following:

- A quality assurance report documenting deviations from the sampling and analysis plan and the effects of quality assurance deviations on the testing results.
- A plan view showing the actual sampling locations.
- The sampling coordinates in latitude and longitude within an accuracy of ±3m.
- Methods used to locate the sampling positions.

- The compositing scheme.
- The type of sampling equipment used, the protocols used during sampling and compositing and an explanation of any deviations from the sampling plan.
- Sampling logs with sediment descriptions.
- Chain-of-custody procedures and explanation of any deviations from the sampling plan.
- Chemical and biological testing results, including quality assurance data. Chemical testing results shall be presented in the same order as the list of chemicals of concern presented in Table 4 to facilitate data entry into DAIS.
- Explanation of deviations from the analysis plan.
- Comparison to SMS for beneficial use projects or where “Z” samples have been analyzed.

5.3.2 Dredged Analysis Information System (DAIS)

With the approval of this sampling and analysis plan a checklist of data required for the Corps Dredged Analysis Information System (DAIS) will be received. After all sampling and testing are completed the completed checklist will be submitted to Corps Seattle District for a quality assurance evaluation.

5.3.3 Environmental Information Management Database (EIM)

In order to document and monitor dredging activity the Washington State Department of Ecology requires the submittal of quality control and calibration data. Data reporting requirements will be provided by Ecology with the approval of this sampling and analysis plan. The EIM data will be compiled and reported to Ecology.

5.3.4 Sampling and Testing Costs

A report of the costs associated with the sampling and testing completed as outlined in this report will be provided to the Corps.

6 Conceptual Dredging Plan

6.1 Sediment Removal

Wood Waste will be removed during a single event during the appropriate work window. Excavation will be accomplished with the use of a derrick barge with a 5-foot draft and a 60-foot boom radius and equipped with a level cut clamshell

dredge (figure 6). Dredge removal will occur during high tide. The objective will be to remove the maximum amount of wood waste with minimal amount of over dredge. All dredge spoils will be deposited in a hopper barge for transport to the disposal site.

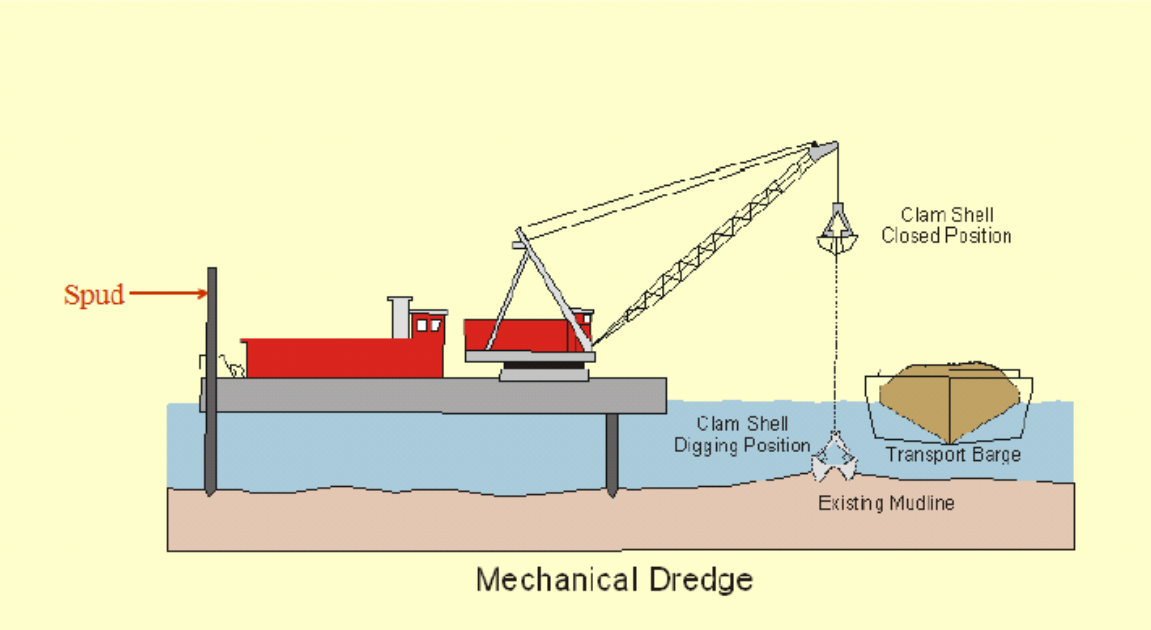

Figure 6: Proposed equipment for dredging Thatcher Bay

Removal operations will be guided by detailed drawings of the dredging prism interpolated from the coring data and the resulting cross sections of the wood waste footprint (figures 7 & 8).

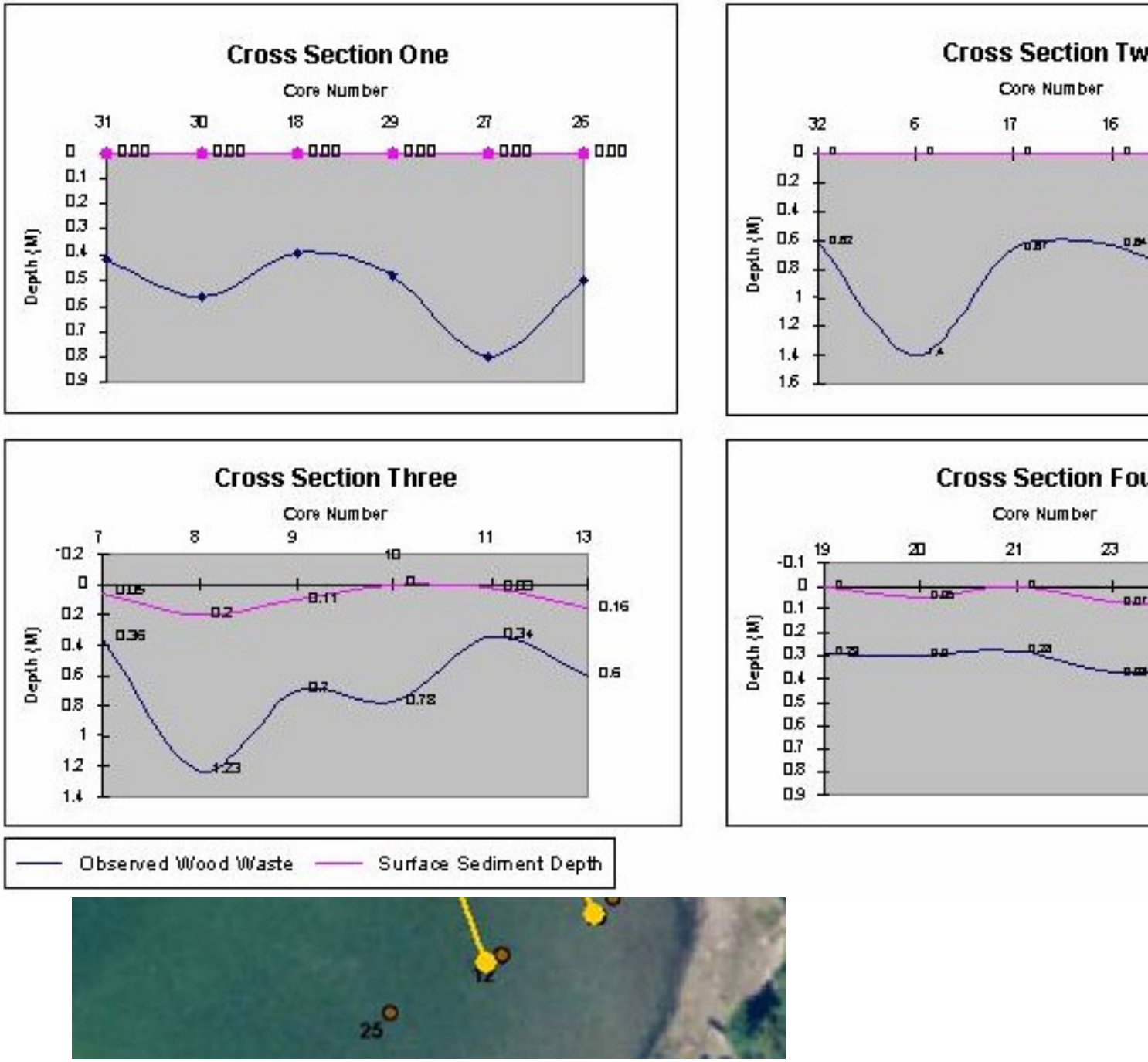

Figure 7: Location of wood waste cross sections

Figure 8: Cross sections

6.2 Site Restoration

The site will be restored by replacing the removed sediment with substrate suitable for forage fish spawning composed of course grain sand & pea gravel 1-7 mm in diameter (Penttila 2008). The current bathymetry and shoreline will be replicated. The importation of replacement sediments precludes the need for long-term side slope stability, for this reason a 1:1 side slope ratio is prescribed during the removal effort.

Forage fish spawning has been documented on the sediment adjacent to the site (Friends of the San Juans 2004). Expansion of the spawning bed is expected following the importation of appropriate spawning substrate. Additionally the forested backshore and the greater site topography of the site provide for shade (Breems 2008), which has been demonstrated to increase the survival of forage fish eggs (Moulton and Penttila 2000)

6.3 Sediment Disposal

All dredge spoils will be deposited on a hopper barge. Sediment will be towed to an appropriate open water dispersive disposal site and deposited with a controlled release. Rosario Strait is a suitable disposal site and is in close proximity to Thatcher Bay.

Currently the anoxic conditions created by the elevated organic composition of the site are limiting the natural decomposition of the wood waste. The open water disposal of this sediment will oxygenate and disperse the organic sediment within the designated disposal site. The combined effect of dispersal and oxygenation will facilitate the natural decomposition of the sediment. We do not anticipate any contamination risk from the disposal of the sediments from the site.

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MEMORANDUM

To:	David Fox, US Army Corps of Engineers	**Date:**	April 24, 2009, modified May 5, 2009
From:	James Keithly, Anchor QEA L.L.C Alison Studley, Skagit Fisheries Enhancement Group	**Project:**	SFEG Dredge Design
Cc:	Project Files		
Re:	Thatcher Bay Sampling and Analysis Plan ADDENDUM		

The purpose of this addendum is to modify the *Sampling and Analysis Plan for Wood Waste Dredging in Conjunction with the Restoration of Thatcher Bay, Blakely Island, Washington (SAP; Breems 2008).* This addendum documents the following changes:

- Revised conceptual dredging plan and revised dredge volume (SAP Section 3)
- Revised target sample intervals (SAP Section 5)
- Modifies subsampling procedures for volatiles and adds description to the subsampling procedure for sulfides (SAP Section 5.1)
- Adds analysis for dioxins/furans (SAP Section 5.2)

CONCEPTUAL DREDGING PLAN

A revised conceptual dredging plan for Thatcher Bay is presented in Figure 1. This plan divides the wood waste area based upon the measured depth of wood waste previously documented (Breems 2008). This conceptual plan assumes a 2-foot overdredge allowance and this results in a total dredging volume of 12,900 cubic yards (cy). Revised volumes for Table 1 from the SAP are presented below.

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Table 1. Total Dredging Volume (cy; revised)

Wood waste/wood waste contaminated sediment	6.420
Over dredge (2-feet)	5,900
Slide slope dredging	580
10 percent additional for bulking	Not required
Total dredging volume	12,900

TARGET SAMPLE INTERVALS

Because the conceptual dredging plan developed by Anchor QEA includes a 2-foot over dredge and slightly modifies the target dredging elevations, the target sample intervals are modified slight as indicated below in Table 2. Note sample location latitude and longitude from the SAP are not repeated below.

Table 2. Thatcher Bay Sampling Depths and Locations (Depths in Feet)

Sample #	Core Site #	Wood Depth	Neatline Dredging Depth	Total Dredge Depth (neatline + overdredge)	Sampling Depth with Z Core
1	8	4.04	4.5	6.5	7.5
2	10	2.56	2.5	4.5	5.5
3	21	3.44	3.5	5.5	6.5
4	30	1.87	2	4	5
5	12	2.66	3	5	6

MODIFIED PROCEDURES FOR COLLECTION OF SULFIDE AND VOLATILES SAMPLES

Following DMMP guidance (DMMO 2008), the additional detail covering the collection procedures for sulfides and volatiles are discussed below.

Subsampling – Volatile Organic Compounds

The subsamples for VOCs will be collected immediately after the core has been cut open or upon extrusion (prior to sample characterization) and placed into the two 40-mL glass for VOCs. To reduce potential outside contamination from working surfaces and loss of volatile compounds to be analyzed, this sample will be taken from a portion of the core that has not been exposed to working surfaces. The core will be positioned such that the inner surface can be sampled. Only pre-cleaned stainless steel instruments will be used to collect sample

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material. Subsample material will be collected along the entire length of the representative core section and transferred to the glass containers. Each glass container will be filled completely with sample sediment, allowing no headspace. Samples will be stored in the dark at 4° ±2°C .

Subsampling – Total Sulfides

The sulfide sample will be collected immediately after the VOC sample is collected. Exposure to air must be held to a minimum, and the sample should be kept moist to minimize oxidation. A complete sample will require between 50 and 60 grams of material. Subsample material will be collected along the entire length of the representative core section, transferred to the 120-mL glass container, fixed with 5 mL of 2N zinc acetate, capped, and shaken vigorously. The sample label will clearly indicate the addition of zinc acetate preservative. Pre-cleaned stainless steel instruments will be used to collect sample material. Samples will be stored in the dark at 4° ±2°C .

SAMPLE ANALYSIS / ADDITION OF DIOXIN AND FURAN ANALYSIS

Dioxins and furans will be added to the analyte list and the following changes and additions to Tables 3 and 4 are included to provide the necessary details for that analysis. The information contained in Supplemental information on polychlorinated dioxins and furans (PCDD/F) for use in preparing a Quality Assurance Project Plan (QAPP) (USACE 2008) will be followed for this analysis.

May 5, 2009 addition:

Dioxin/furan congener analyses will be conducted by Analytical Perspectives in Wilmington, North Carolina. Analytical Perspectives' Standard Reference Material (SRM) results from previous analysis and results from round-robin laboratory intercalibration studies will be submitted to the DMMO in lieu of performing a SRM for the Thatcher Bay Project.

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Table 3. Sample Storage

Parameter	Sample Size	Container Size and Type	Holding Time	Preservative
Dioxins/Furans	150 g	8-oz Glass	1 year to extraction	Freeze -18°C
			1 year after extraction	Freeze -18°C

Table 4. DMMP Guideline Chemistry Values for Dioxins and Furans, Analytical Method and Method Reporting Limits

Parameter	Dredged Material Management Program Criteria			Analytical Method	Method Reporting Limit (MRL)
	Screening Level	Bioaccumulation Trigger	Maximum Level		
Dioxin/Furans, ng/kg dry weight					
Dioxins					
2,3,7,8-TCDD	---	---	---	1613B	1.0
1,2,3,7,8-PeCDD	---	---	---	1613B	5.0
1,2,3,4,7,8-HxCDD	---	---	---	1613B	5.0
1,2,3,6,7,8-HxCDD	---	---	---	1613B	5.0
1,2,3,7,8,9-HxCDD	---	---	---	1613B	5.0
1,2,3,4,6,7,8-HpCDD	---	---	---	1613B	5.0
OCDD	---	---	---	1613B	10
Furans					
2,3,7,8-TCDF	---	---	---	1613B	1.0
1,2,3,7,8-PeCDF	---	---	---	1613B	5.0
2,3,4,7,8,-PeCDF	---	---	---	1613B	5.0
1,2,3,4,7,8-HxCDF	---	---	---	1613B	5.0
1,2,3,6,7,8-HxCDF	---	---	---	1613B	5.0
1,2,3,7,8,9-HxCDF	---	---	---	1613B	5.0
2,3,4,6,7,8-HxCDF	---	---	---	1613B	5.0
1,2,3,4,6,7,8-HpCDF	---	---	---	1613B	5.0
1,2,3,4,7,8,9-HpCDF	---	---	---	1613B	5.0
OCDF	---	---	---	1613B	10

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May 5, 2009 Addition:

DATA VALIDATION

During the validation process, analytical data will be evaluated for method quality control and laboratory quality control compliance, and its validity and applicability for program purposes will be determined. Based on the findings of the validation process, data validation qualifiers may be assigned. The validated project data, including qualifiers will be entered into the project database, thus enabling this information to be retained or retrieved, as needed.

Data validation includes signed entries by the field and laboratory technicians on field data sheets and laboratory datasheets, respectively; review for completeness and accuracy by the Field Staff and Laboratory Manager; review by the Data Manager for outliers and omissions; and the use of Quality Control criteria to accept or reject specific data.

All laboratory data will be reviewed and verified to determine whether all Quality Control Objectives have been met and that appropriate corrective actions have been taken, when necessary. The project QA/QC Manager or designee will be responsible for the final review of all data generated from analyses of samples.

The first level of review will take place in the laboratory as the data are generated. The laboratory department manager or designee will be responsible for ensuring that the data generated meet minimum QA/QC requirements and that the instruments were operating under acceptable conditions during generation of data.

The analysts and/or laboratory department manager will prepare a preliminary Quality Control checklist for each parameter and for each sample delivery group (SDG) as soon as analysis of an SDG has been completed. Any deviations from the Quality Control Objectives listed on the checklist will be brought to the attention of the Laboratory Manager to determine whether corrective action is needed and to determine the impact on the reporting schedule.

Data packages will be checked for completeness immediately upon receipt from the laboratory to ensure that data and QA/QC information requested are present. Data quality

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will be assessed by a reviewer using current Functional Guidelines data validation requirements (EPA 1999) by considering the following:

- *Holding times*
- *Initial calibrations*
- *Continuing calibrations*
- *Method blanks*
- *Surrogate recoveries*
- *Detection limits*
- *Reporting limits*
- *Laboratory control samples*
- *MS/MSD samples*
- *Laboratory replicates*
- *SRM results*

The data will be validated in accordance with the project specific Quality Control Objectives, analytical method criteria, and the laboratory's internal performance standards based on their SOPs.

REFERENCES

Breems, J. 2008. Sampling and Analysis Plan For Wood Waste Dredging In Conjunction With The Restoration Of Thatcher Bay, Blakely Island, Washington. Prepared for Skagit Fisheries Enhancement Group, Mount Vernon, Washington.

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