CENWS-OD-TS-DMMO

MEMORANDUM FOR: RECORD May 27, 2009

SUBJECT: DETERMINATION REGARDING THE SUITABILITY OF FEDERAL OPERATION AND MAINTENANCE DREDGED MATERIAL FROM GRAYS HARBOR, WASHINGTON (*Public Notice CENWS-OD-TS-NS-25*) EVALUATED UNDER SECTION 404 OF THE CLEAN WATER ACT FOR OPEN-WATER DISPOSAL AT THE SOUTH JETTY OR POINT CHEHALIS DISPERSIVE SITES, OR AT SOUTH BEACH OR HALF MOON BAY BENEFICIAL USE SITES.

1. Introduction. This memorandum reflects the consensus determination of the Dredged Material Management Program (DMMP) agencies (U.S. Army Corps of Engineers, Washington Departments of Ecology and Natural Resources, and the Environmental Protection Agency) regarding the suitability of material from the Grays Harbor, Washington federal navigation channel (Figure 1) for unconfined open-water disposal. The requirements for determining the suitability of this material are documented in "*Dredged Material Evaluation Procedures [GHDMEP] and Disposal Site Management Manual, Grays Harbor and Willapa Bay, Washington"* (DMMP 1995) and the "*Dredged Material Evaluation and Disposal Procedures – Users' Manual*" (DMMP 2008). As outlined in the GHDMEP, full sediment characterization of dredged material from the federal navigation channel is required on a rotating, biennial basis for the reaches of concern in the inner portions of Grays Harbor. Under this scenario, one third of the material dredged from the Crossover, North Channel, Hoquiam, Cow Point and South Aberdeen reaches of the Grays Harbor channel is characterized every two years, resulting in characterization of the entire inner portion every six years. In Grays Harbor, no contaminant testing is required for the outer reaches of the channel (Entrance, Bar, and South channels) per exclusionary criteria specified in Section 40 CFR 230.60 of the Clean Water Act. This exclusion is based on distance from known sources of contamination, generally coarse grain sizes and the high-energy environment of these outer channel areas.

For this project an estimated 2.5 million cubic yards (mcy) of maintenance material is proposed to be dredged annually from the federal navigation channel. Approximately 1.8 million cy of this material is in the inner reaches that are characterized. This characterization event is the second of three in the third six-year round of testing. Approximately 1.2 million cy underwent GHDMEP sampling and testing as part of this event and is summarized in this SDM. Disposal is anticipated to be at the Point Chehalis and South Jetty estuarine sites or at beneficial use sites nearshore or onshore of South Beach or Half Moon Bay.

Table 1. Project Details

SAP addendum received	June 20, 2008
SAP approved	June 27, 2008
Sampling dates	July 7-8, 2008 and January 26, 2009
Final data report submitted	April 22, 2009
Recency Determination: Low Concern (6 years)	July 2014
Next sampling in rotation	2010
DAIS reference number	GRAYS-1-B-F-261

Table 2. Project Synopsis.

Time of proposed dredging	Annually, 16 July through 14 Feb, except during fish closures
Proposed disposal sites	Point Chehalis and South Jetty open water dispersive sites; Half Moon Bay and/or South Beach nearshore beneficial use sites, or HMB direct beach nourishment, as needed.
Sediment ranking	Low
Project last dredged	Annually

Table 3. GH characterization planning

Year	Sampling Period	Reaches	DMMUs
2010	Spring	CP	3
		HQ	1
		NC	1
		CX	4

Reach abbreviations: Cow Point (CP); Hoquiam (HQ); North Channel (NC); Crossover (CX)

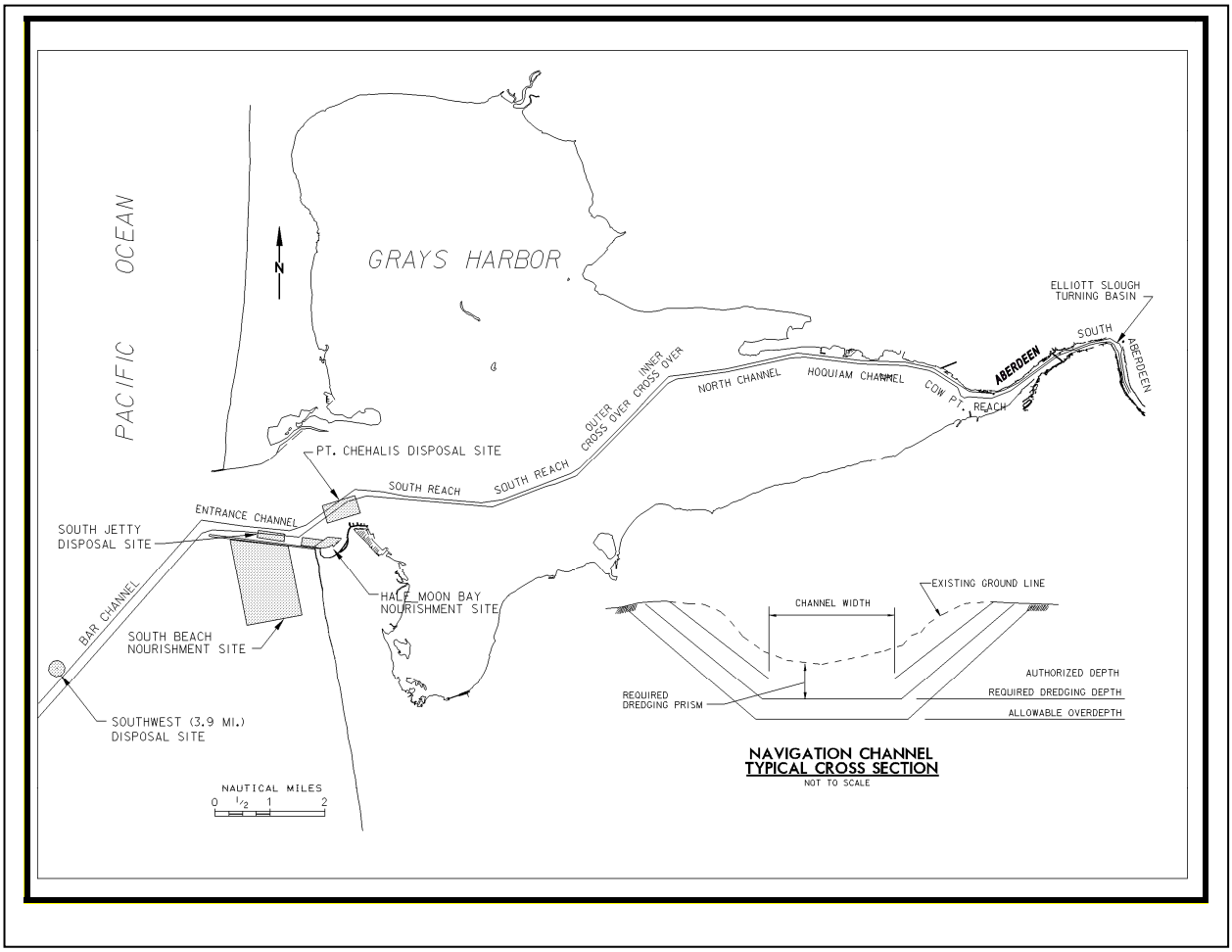


Figure 1. Grays Harbor navigation project. Samples taken for this characterization were from the Cow Point, Aberdeen and South Aberdeen reaches.

2. Background. Dredging of the Grays Harbor navigation channel takes place annually to maintain the channel at the authorized depth. Characterization of this channel is not project specific, per the GHDMEP, but performed on a rotating basis. This approach characterizes the dredging volume over time (six years) rather than for a specific dredging event. The low rank of the area, and results from over a decade of sampling in the area, continue to support this approach.

The third six-year rotation of sampling and testing based on the GHDMEP began in 2006. In order to plan holistically for this entire round of sampling, a programmatic sampling and analysis plan (PSAP) was prepared (SAIC 2006).

This PSAP looked at historic dredging volumes in various reaches of the navigation channel and devised a strategy for insuring that the sampling adequately represented those volumes. A SAP addendum is prepared biennially to address sampling issues specific to the given sampling and testing event. The SAP addendum for the 2008 testing (SAIC 2008) was reviewed and approved by the DMMP agencies prior to sampling and testing.

3. Sampling. Initial sediment sampling took place July 7-8, 2008. Due to conflicting chemistry and bioassay results, the sediment larval bioassay needed to be rerun, but the 56-day holding time for the samples had expired. This necessitated a resampling effort for DMMUs AB5 and SA9, which was accomplished on January 26, 2009.

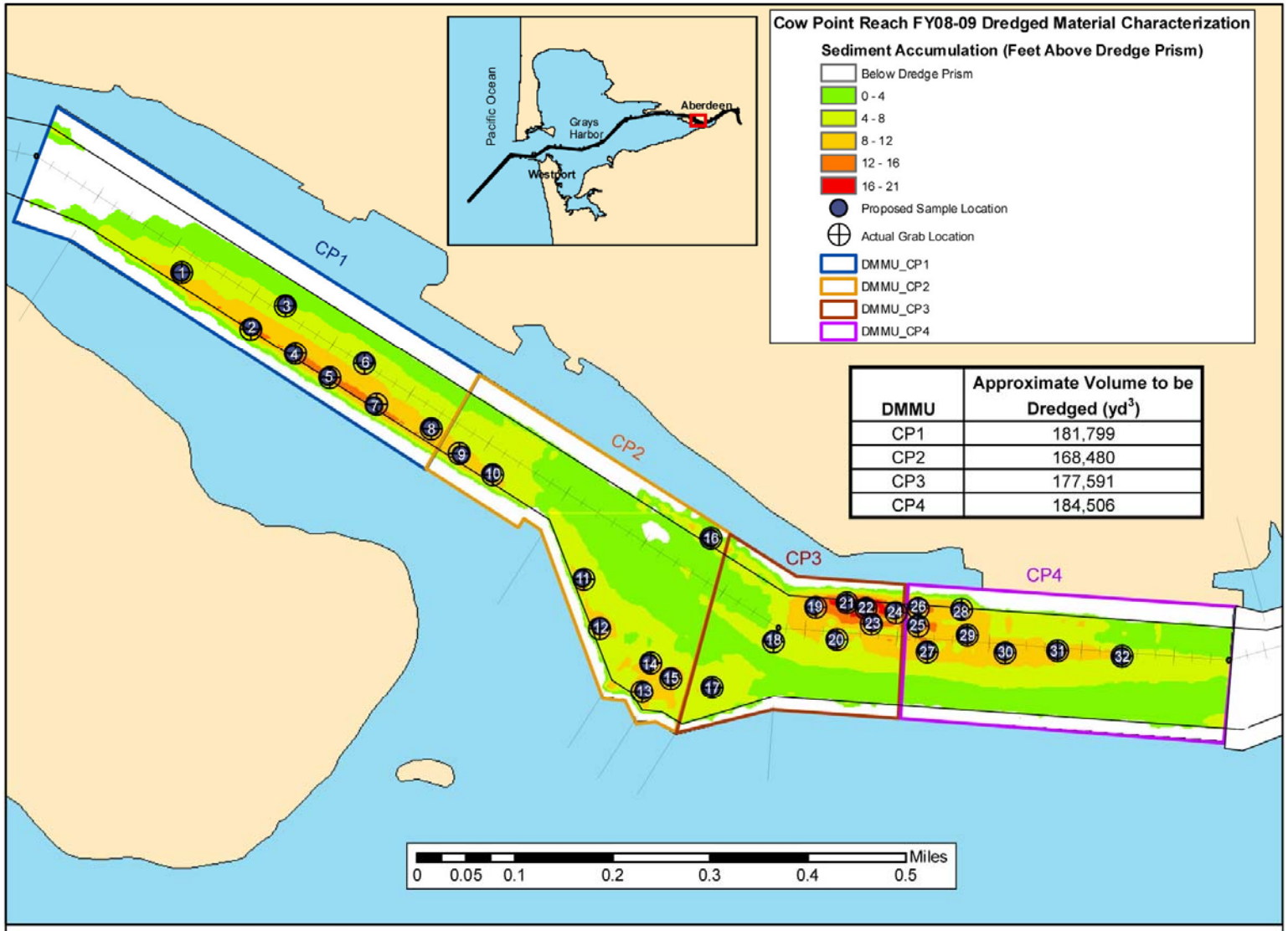
As in the past the area was ranked "low," and the material available for dredging was considered homogenous. The approved programmatic and addendum sampling and analysis plans were followed, and quality assurance/quality control guidelines specified by the GHDMEP sampling and testing guidelines were generally complied with.

The initial field sampling effort included collection of eight samples in each of nine dredged material management units (DMMUs) for a total of 72 sediment grab samples. Samples from each DMMU were composited for a single analysis per DMMU. Samples came from the Cow Point, Aberdeen and South Aberdeen reaches of the navigation channel (see Figures 2, 3 and 4). The sampling effort also included collection of reference sediment from the North Bay area of Grays Harbor in anticipation of performing confirmatory bioassays. Conventional parameters measured in these 9 DMMUs and single reference sample are depicted in Table 4.

In sampling for the larval retest, the plan was to revisit those stations originally sampled in DMMUs AB5 and SA9. However, dredging records indicated that dredging had already occurred at two of the stations from AB5 (stations 33 and 34). Therefore, for the retest, AB5 was represented by composited sediment from the four remaining stations. These four stations were located in the largest shoal in AB5, while one of the dredged stations was from a minor shoal and the other was from the very tip of the main shoal. The agencies agreed that the majority of the dredged material volume in AB5 was represented by the four remaining stations and these stations adequately reflected sediment conditions in AB5.

Table 4. Sediment conventional results.

	Reach	Cowpoint Reach				Aberdeen Reach			South Aberdeen Reach		Ref.
	DMMU	CP1	CP2	CP3	CP4	AB5	AB6	AB7	SA8	SA9	REF6
	# of samples in composite	8	8	8	8	8	8	8	8	8	1
	Volume (cubic yards)	181,799	168,480	177,591	184,506	115,427	119,428	122,769	63,833	68,895	n/a
GRAIN SIZE	% Gravel	0	0	0	0	0	0	0	16.7	0	0
	% Sand	70.4	34.3	22.8	88.8	75.3	28.3	15.6	30.4	19.4	23.8
	% Silt	17.7	36.9	51.1	8.4	16.4	41.9	69.3	46.2	41.1	50.7
	% Clay	12	28.9	26.1	2.8	8.2	29.9	15	6.7	39.5	25.5
	(clay+silt) % Fines	29.7	65.8	77.2	11.2	24.6	71.8	84.3	52.9	80.6	76.2
	Total Solids, %	46	34	42	43	41	43	64	76	39	62
	Volatile Solids, %	7.3	8.4	8.7	7.7	7.4	7.7	3.9	3.0	8.0	4.1
	Total Organic Carbon, %	2.4	2.9	2.4	2.2	2.4	2.2	0.7	0.6	2.7	1.3
	Total Sulfides, mg/kg	9.3	20	16	11	25	4.9	103	5.6	17	8.7
	Total Ammonia, mg N/kg	84	130	63	50	51	45	23	12	31	34



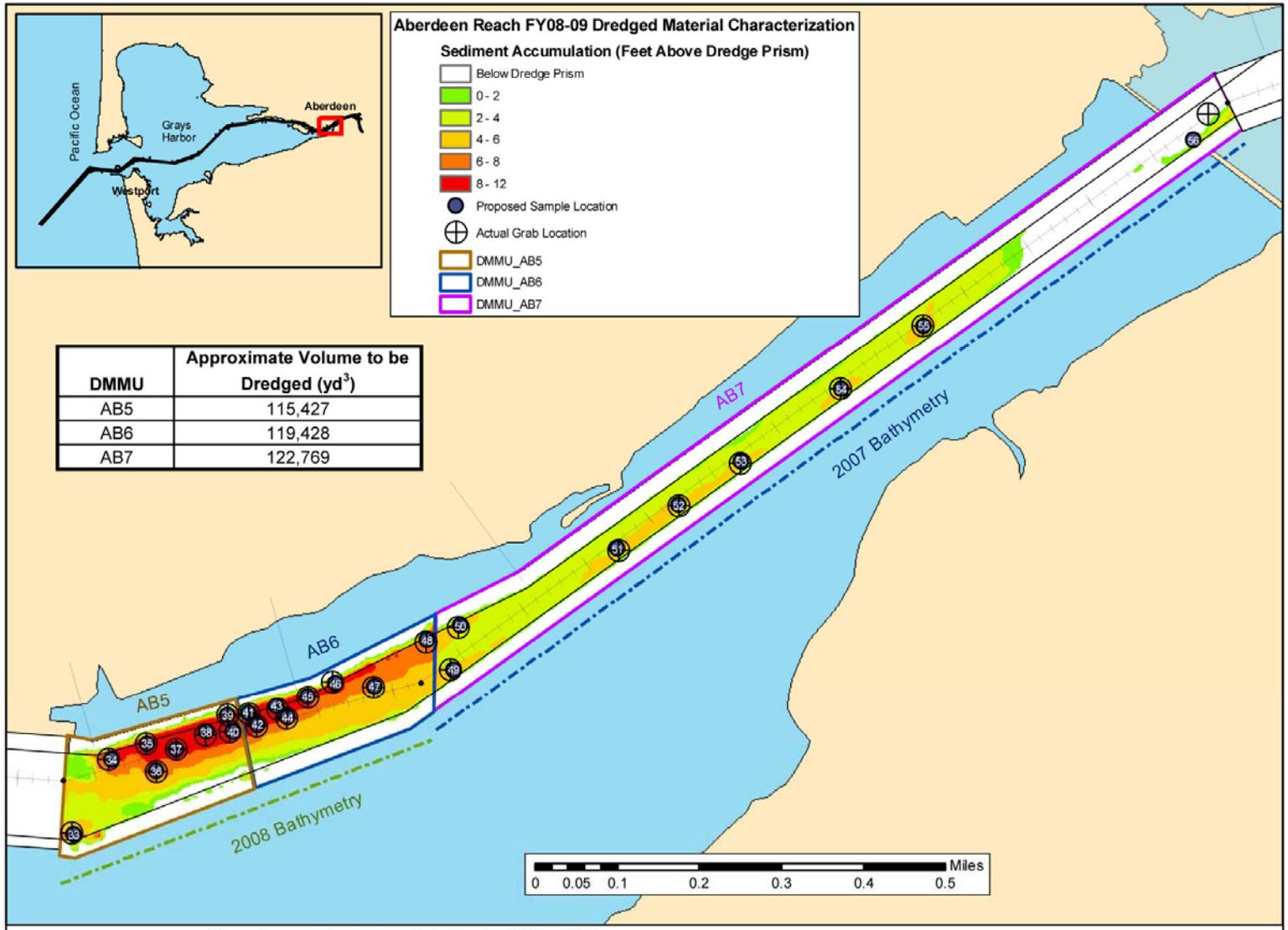
DMMU	Approximate Volume to be Dredged (yd^3)
CP1	181,799
CP2	168,480
CP3	177,591
CP4	184,506

SAIC From Science to Solutions

J. Nuwer, SAIC 2008

Sediment accumulation volume estimates were based on 2008 bathymetric data provided by USACE-Seattle District. Dredge prism is based on 38' required dredge depth, plus 2' allowable overdepth. A 1V:5H slope is included in analysis and volume calculations. DMMUs were placed within each reach in areas with the largest amount of sediment accumulation as determined using the most recent bathymetric data available.

Figure 2 DMMUs, Estimated Dredge Volumes, and Actual Sampling Locations in Cow Point Reach



DMMU	Approximate Volume to be Dredged (yd^3)
AB5	115,427
AB6	119,428
AB7	122,769

SAIC
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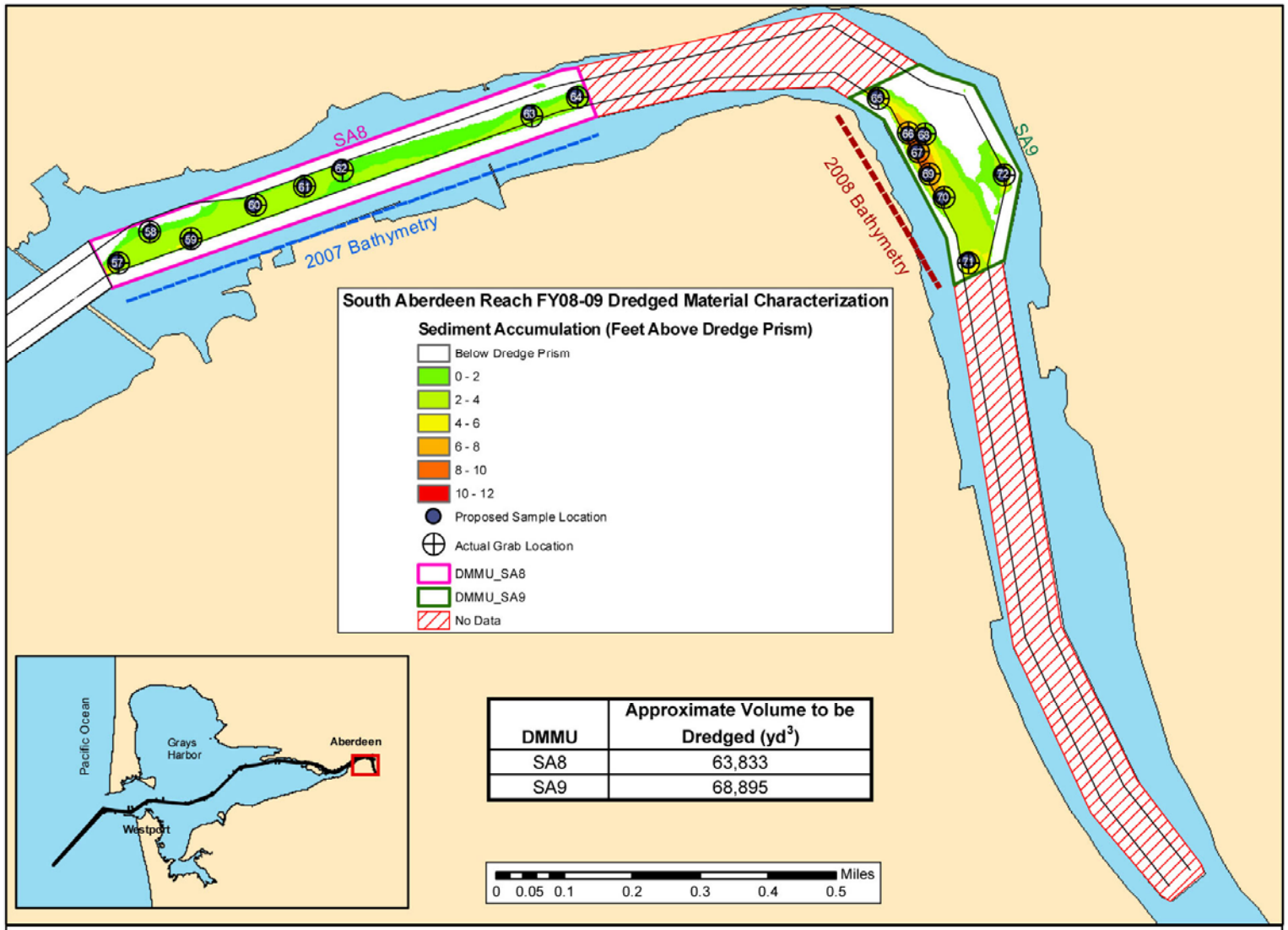
Sediment accumulation volume estimates based on 2007 and 2008 bathymetric data provided by USACE-Seattle District. Dredge prism is based on 34' required dredge depth, plus 2' allowable overdepth. A 1V:5H slope is included in analysis and volume calculations. DMMUs were placed within each reach in areas with the largest amount of sediment accumulation as determined using the most recent bathymetric data available.

Figure 3 . DMMUs, Estimated Dredge Volumes, and Actual Sampling Locations in Aberdeen Reach



DMMU	Approximate Volume to be Dredged (yd^3)
SA8	63,833
SA9	68,895

SAIC
From Science to Solutions
J. Nuwer, SAIC 2008

Sediment accumulation volume estimates based on 2007 and 2008 bathymetric data provided by USACE-Seattle District. Dredge prism is based on 34' required dredge depth, plus 2' allowable overdepth. A 1V:5H slope is included in analysis and volume calculations. DMMUs were placed within each reach in areas with the largest amount of sediment accumulation as determined using the most recent bathymetric data available.

Figure 4 . DMMUs, Estimated Dredge Volumes, and Actual Sampling Locations in South Aberdeen Reach

Chemical Analysis QA/QC. DMMP QA/QC requirements are shown in Table 5. Precision and accuracy goals were met by the analytical laboratory for this characterization with the following exceptions:

a. Precision:
   - Metals: RPDs for lead and silver were 26% and 34% respectively. However, the concentrations detected in the duplicates were over an order of magnitude less than the SL, so the slightly elevated RPDs were inconsequential.
   - Semivolatiles: Twenty-four analytes exceeded the warning limit, but none exceeded the action limit.

b. Accuracy:
   - Metals: Matrix spike recovery for antimony was 37%, but was within the laboratory control limits.
   - Semivolatiles: Nine analytes had less than 50% recovery for the matrix spike. However, no action is required by DMMP in the case of low recovery for matrix spikes for organic chemicals. Recovery was below 50% for several surrogates in the matrix spike, but within laboratory control limits.
   - Pesticides and PCBs: Recovery was below 60% for the surrogate decachlorobiphenyl for eight of the nine DMMUs, but was within laboratory control limits.
   - Guaiacols and Resin Acids: Matrix spike recovery was below 50% for three of the four resin acids. However, no action is required by DMMP in the case of low recovery for matrix spikes for organic chemicals. Recovery was below 50% for several surrogates in the analysis of guaiacols, but was within laboratory control limits. Surrogate recovery was also below 50% for the majority of samples in the analysis of resin acids. In the case of two DMMUs, CP1 and CP3, surrogate recovery was also outside of laboratory control limits. The case narrative from the laboratory stated, "As the limits are advisory and the analyst noted that these sample extracts were darkly colored and required multiple derivatization steps, no further corrective action was taken."

The QA/QC problems encountered during chemical analysis were considered minor by the DMMP agencies and did not significantly impact the overall quality of the data or its use for decision-making.

Table 5. QA/QC requirements for chemical analysis in the DMMP program.

QA ELEMENT		WARNING LIMITS	ACTION LIMITS
Precision	Metals	None	20% RPD or COV
	Organics	35% COV	50% COV or a factor of 2 for duplicates
Matrix Spikes	Metals	None	75-125% recovery
	Organics:[1] ▪ Volatiles ▪ Semivolatiles and Pesticides	▪ 70-150% ▪ 50-150%	None (zero percent recovery may be cause for data rejection however)[2]
Reference Materials	Metals	None	95% CI if specified for a particular CRM; 80-120% recovery if not.
	Organics	None	95% CI for CRMs. No action limit for uncertified RMs.
Surrogate Spikes	Organics ▪ Volatiles ▪ Pesticides ▪ Semi-volatiles	▪ 85% minimum recovery ▪ 60% minimum recovery ▪ 50% minimum recovery	EPA CLP chemical-specific recovery limits

[1] Warning limits set at the CLP advisory limits for matrix spike duplicates for those chemicals covered under CLP.
[2] Rigorous control limits are not recommended due to possible matrix effects and interferences.

4. Results of Chemical Analysis. The Agencies' approved sampling and analysis plan was followed and quality assurance/quality control guidelines specified by PSEP and DMMP were generally complied with. Chemical analysis results (Table 6) demonstrated that all dredged material management units characterized showed no detected or non-detected chemical exceedances of DMMP screening levels. In addition to routine DMMP chemicals of concern analysis of special "chemicals of concern" are required for the Grays Harbor area. Guaiacols, resin acids and dioxins/furans were considered special COCs for this characterization. These additional chemicals are added due to the historical presence of wood treatment sites and associated discharges in the upper reaches of the Grays Harbor Navigation channel.

4.1. Resin acids and guaiacols. No guaiacols were detected in any sample. Of the four resin acids, isopimaric acid was detected in a single sample, while dehydroabietic acid and abietic acid were detected in several samples. Levels of detected resin acids were much lower than levels generally associated with environmental or human health effects (Word *et al* 1990). It is important to note that the DMMP does not have interpretive criteria for guaiacols and resin acids.

4.2. Dioxins and furans (PCDD/PCDF). Sediment from each DMMU was analyzed for PCDD/PCDF by SGS Environmental Services using EPA Method 1613B. The dioxin data were provided full level-4 validation by an independent lab. Results (Table 7) showed detected levels of PCDD/PCDF in all samples. Toxic Equivalency (with non-detects calculated as ½ reporting limit) ranged from 0.31 – 2.80 ng/kg dry wt., all below the 15 TEQ suitability level set for Grays Harbor (Table 8).

The dioxin data were also evaluated for beneficial use through a statistical comparison with 6 reference samples collected throughout the Grays Harbor estuary (Figure 5). TEQs for these reference stations were as follows:

Reference Station	TEQ (u = ½ DL)
1	0.39
2	0.98
3	2.10
4	1.54
5	1.42
6	0.37

Comparison of the dioxin TEQs from the nine DMMUs with those from the reference stations showed no statistical difference between the two groups of samples.

Dioxin data were also collected in the vicinity of the Point Chehalis and South Jetty disposal sites (Figure 6). Dioxin and furan congeners were mostly undetected in these samples with TEQs ranging from 0.26 to 0.29 pptr. The DMMP agencies used the reference stations for the statistical comparison rather than samples from the vicinity of the disposal sites because of the dissimilarity in grain size between the dredged material and the latter.

4.3. Analysis of Resampled DMMUs. Sediment from the resampling effort in January 2009 was tested for all chemicals of concern except dioxins/furans. As in Round 1, there were no screening level exceedances. Results from Round 2 are not included in Table 6.

Table 6. Results of chemical analysis compared with DMMP guidelines.

DMMP Chemistry Results	SL	BT	ML	CP1		CP2		CP3		CP4		AB5		AB6		AB7		SA8		SA9	
Total Organic Carbon, %				2.4		2.9		2.4		2.2		2.4		2.2		0.7		0.6		2.7	
METALS (mg/kg dry)																					
Antimony	150	---	200	0.08		0.1		0.16		0.1		0.08		0.08		0.09		0.05	B	0.08	
Arsenic	57	507	700	3.52		4.22		3.93		3.81		3.88		3.28		2.43		1.56		3.44	
Cadmium	5.1	11.3	14	0.199		0.21		0.206		0.204		0.223		0.183		0.125		0.101		0.197	
Chromium	---	267	---	24.6		24.9		25.2		22		23.8		22.1		20.2		13.2		23.9	
Copper	390	1,027	1,300	36.2		35.5		37.4		33.5		33.7		29.8		27.9		37.1		34.2	
Lead	450	975	1,200	7.85		8.9		8.24		7.7		8.32		7.28		5.14		3.05		7.95	
Mercury	0.41	1.5	2.3	0.044		0.053		0.049		0.042		0.045		0.043		0.025		0.008	J	0.046	
Nickel	140	370	370	15.8		14.9		15.3		14.2		14.8		14		17.8		20		15.3	
Selenium	---	3.0	---	0.7	J	0.8	J	0.7	J	0.7	J	0.7	J	0.5	J	0.4	U	0.5	U	0.7	J
Silver	6.1	6.1	8.4	0.208		0.209		0.18		0.156		0.163		0.14		0.11		0.107		0.169	
Zinc	410	2,783	3,800	41.8		41.8		41.8		40.2		41.1		38.5		38.7		38.2		40.2	
ORGANOMETALLICS (ug/l)																					
Tributyltin (porewater)	0.15	0.15	---	0.012	U	0.012	U	0.012	U	0.012	U	0.012	U	0.012	U	0.012	U	0.015	U	0.02	U
LPAH (ug/kg dry)																					
2-Methylnaphthalene	670	---	1,900	1.5	J	17		6.5		6.7		3.3	J	7.7		2.8	J	5	U	8.2	
Acenaphthene	500	---	2,000	5	U	13		4.3	J	7.1		3.2	J	4.6	J	1.5	J	5	U	8.6	
Acenaphthylene	560	---	1,300	5	U	5	U	1.7	J	2.1	J	4.9	U	2.1	J	5	U	5	U	5	U
Anthracene	960	---	13,000	5	U	5.5		3	J	3.4	J	2.2	J	2.7	J	1.6	J	5	U	3.7	J
Fluorene	540	---	3,600	1.2	J	14		6.4		8.5		4	J	7.6		2.2	J	5	U	9	
Naphthalene	2,100	---	2,400	2.8	J	26		7.4		8.4		4	J	10		3	J	2.6	J	9.9	
Phenanthrene	1,500	---	21,000	4.4	J	41		24		32		13		22		8.2		2.1	J	30	
Total LPAH	5,200	---	29,000	9.9	J	116.5		53.3	J	68.2	J	29.7	J	56.7	J	19.3	J	4.7	J	69.4	J
HPAH (ug/kg dry)																					
Benzo(a)anthracene	1,300	---	5,100	2.8	J	8.8		6.5		9.9		4.1	J	8.9		4.5	J	6.3	U	9.2	
Benzo(a)pyrene	1,600	---	3,600	7.5	U	5.8	J	5.3	J	5.9	J	2.6	J	6.8	J	2.9	J	24		6.4	J
Benzo(g,h,i)perylene	670	---	3,200	6.3	U	6.9		6.1	U	4.8	J	2.3	J	6.1	U	2.3	J	6.3	U	4.6	J
Benzofluoranthenes (b+j+k)	3,200	---	9,900	4.5	J	15		12		15		5.7	J	17		5.9	J	10	U	13	
Chrysene	1,400	---	21,000	2.1	J	9.7		7.8		11		4.8	J	10		3.3	J	6.3	U	8.2	

DMMP Chemistry Results	SL	BT	ML	CP1		CP2		CP3		CP4		AB5		AB6		AB7		SA8		SA9	
Dibenzo(a,h)anthracene	230	---	1,900	10	U	10	U	9.7	U	9.9	U	9.9	U	9.8	U	9.9	U	10	U	10	U
Fluoranthene	1,700	4,600	30,000	6.6		35		27		35		14		28		13		2	J	31	
Indeno(1,2,3-c,d)pyrene	600	---	4,400	29		32		9.7	U	9.9	U	29		33		29		10	U	31	
Pyrene	2,600	11,980	16,000	5.8		28		21		25		12		24		11		1.8	J	24	
Total HPAH	12,000	---	69,000	50.8	J	141.2	J	79.6	J	106.6	J	74.5	J	127.7	J	71.9	J	27.8	J	127.4	J
CHLORINATED HYDROCARBONS (ug/kg dry)																					
1,2,4-Trichlorobenzene	31	---	64	13	U	13	U	12	U	12	U	12	U	12	U	12	U	13	U	12	U
1,2-Dichlorobenzene	35	---	110	13	U	13	U	12	U	12	U	12	U	12	U	12	U	13	U	12	U
1,3-Dichlorobenzene	170	---	---	13	U	13	U	12	U	12	U	12	U	12	U	12	U	13	U	12	U
1,4-Dichlorobenzene	110	---	120	13	U	13	U	12	U	12	U	12	U	12	U	12	U	13	U	12	U
Hexachlorobenzene	22	168	230	13	U	13	U	12	U	12	U	12	U	12	U	12	U	13	U	12	U
PHTHALATES (ug/kg dry)																					
Bis(2-ethylhexyl)phthalate	1,300	---	8,300	380	U	72	J	58	J	370	U	370	U	64	J	370	U	380	U	370	U
Butyl benzyl phthalate	63	---	970	13	J	38		39		34		23	J	26		20	J	9.1	J	45	
Di-n-butyl phthalate	1,400	---	5,100	9.8	J	19	J	15	J	15	J	10	J	16	J	11	J	9.3	J	20	J
Di-n-octyl phthalate	6,200	---	6,200	50	U	50	U	48	U	50	U	49	U	49	U	50	U	50	U	50	U
Diethyl phthalate	200	---	1,200	2.8	J	25	U	24	U	25	U	3.1	J	7.3	J	4	J	4	J	9.4	J
Dimethyl phthalate	71	---	1,400	25	U	25	U	24	U	25	U	25	U	24	U	25	U	25	U	25	U
PHENOLS (ug/kg dry)																					
2 Methylphenol	63	---	77	25	U	25	U	24	U	25	U	25	U	24	U	25	U	25	U	25	U
2,4-Dimethylphenol	29	---	210	25	U	25	U	24	U	25	U	25	U	24	U	25	U	25	U	25	U
4 Methylphenol	670	---	3,600	50	U	18	J	48	U	50	U	49	U	14	J	50	U	22	J	50	U
Pentachlorophenol	400	504	690	25	U	25	U	24	U	25	U	25	U	24	U	25	U	25	U	25	U
Phenol	420	---	1,200	7.4	J	15	J	13	J	13	J	14	J	24	J	16	J	15	J	24	J
MISCELLANEOUS EXTRACTABLES (ug/kg dry)																					
Benzoic acid	650	---	760	70	JB	58	JB	51	JB	51	JB	64	JB	60	JB	53	JB	43	JB	60	JB
Benzyl alcohol	57	---	870	25	U	25	U	24	U	25	U	25	U	24	U	25	U	25	U	11	J
Dibenzofuran	540	---	1,700	25	U	11	J	24	U	5	J	25	U	4.7	J	25	U	25	U	6	J
Hexachlorobutadiene	29	---	270	13	U	13	U	12	U	12	U	12	U	12	U	12	U	13	U	12	U
Hexachloroethane	1,400	---	14,000	25	U	25	U	24	U	25	U	25	U	24	U	25	U	25	U	25	U
N-Nitrosodiphenylamine	28	---	130	13	U	13	U	12	U	12	U	12	U	12	U	12	U	13	U	12	U

DMMP Chemistry Results	SL	BT	ML	CP1		CP2		CP3		CP4		AB5		AB6		AB7		SA8		SA9	
VOLATILE ORGANICS (ug/kg dry)																					
Ethylbenzene	10	---	50	1.8	U	2.2	U	2.5	U	2.2	U	1.7	U	1.9	U	1.1	U	1.1	U	2.3	U
Tetrachloroethene	57	---	210	1.8	U	2.2	U	2.5	U	2.2	U	1.7	U	1.9	U	1.1	U	1.1	U	2.3	U
Total Xylene (m,p,o)	40	---	160	0.6	J	6.5	U	7.5	U	6.6	U	5.1	U	5.7	U	0.271	J	0.241	J	6.9	U
Trichloroethene	160	---	1,600	1.8	U	2.2	U	2.5	U	2.2	U	1.7	U	1.9	U	1.1	U	1.1	U	2.3	U
PESTICIDES AND PCBs (ug/kg dry)																					
Aldrin	10	---	---	0.97	U	1	U	0.95	U	1	U	0.99	U	0.99	U	0.95	U	0.98	U	0.98	U
Chlordane	10	37	---	0.83	J	1	U	0.95	U	0.33	J	0.99	U	0.99	U	1.6		0.98	U	0.14	J
Dieldrin	10	---	---	1.9	U	2	U	1.9	U	2	U	2	U	2	U	1.9	U	2	U	2	U
Heptachlor	10	---	---	0.97	U	1	U	0.95	U	1	U	0.99	U	0.99	U	0.95	U	0.98	U	0.98	U
Lindane	10	---	---	0.97	U	1	U	0.95	U	1	U	0.99	U	0.99	U	0.95	U	0.98	U	0.98	U
Total DDT	6.9	50	69	0.3	J	6	U	5.7	U	0.38	J	0.36	J	6	U	5.7	U	6	U	6	U
Total PCBs	130	---	3,100	9.7	U	10	U	9.5	U	10	U	9.9	U	9.9	U	9.5	U	9.8	U	9.8	U
Total PCBs (mg/kg OC)	---	38	---	0.4	U	0.34	U	0.4	U	0.45	U	0.41	U	0.45	U	1.36	U	1.56	U	0.36	U
RESIN ACIDS AND GUAIACOLS (ug/kg dry)																					
3,4,5-Trichloroguaiacol				20	U	20	U	20	U	20	U	20	U	20	U	20	U	19	U	20	U
Tetrachloroguaiacol				20	U	20	U	20	U	20	U	20	U	20	U	20	U	19	U	20	U
Pimaric Acid				99	U	99	U	99	U	98	U	98	U	98	U	98	U	97	U	99	U
Isopimaric Acid				99	U	110		99	U	98	U	98	U	98	U	98	U	97	U	99	U
Dehydroabietic Acid				120		320		110		130		240		98	U	98	U	97	U	150	
Abietic Acid				99	U	120		99	U	98	U	98	U	98	U	98	U	97	U	99	U

Notes:

SL = screening level
BT = bioaccumulation trigger
ML = maximum level
J = estimated concentration
U = undetected
M = Estimated value for an analyte detected and confirmed by analyst but with low spectral parameter matches.
OC = organic carbon
Shaded DMMU (AB5 and SA9) were used for confirmatory bioassays.

Table 7. Summary of PCDD/PCDF Data.

	CP1		CP2		CP3		CP4		AB5		AB6		AB7		SA8		SA9	
	ng/kg dry weight																	
Dioxins																		
2,3,7,8-TCDD	0.06	U	0.07	U	0.06	U	0.33	J	0.71	J	0.38	J	0.06	U	0.06	U	0.45	J
1,2,3,7,8-PeCDD	0.52	J	0.41	J	0.69	J	0.26	U	0.86	J	0.43	J	0.26	U	0.25	U	0.54	J
1,2,3,4,7,8-HxCDD	0.26	U	0.31	U	0.28	U	0.26	U	0.28	U	0.27	U	0.26	U	0.25	U	0.29	U
1,2,3,6,7,8-HxCDD	0.58	J	0.18	U	0.16	U	0.42	J	0.9	J	0.52	J	0.15	U	0.15	U	0.63	J
1,2,3,7,8,9-HxCDD	1.48	J	1.08	J	2.26	J	0.93	J	2.42	J	1.14	J	0.44	J	0.23	U	1.49	J
1,2,3,4,6,7,8-HpCDD	8.76		17.7		18.3		7.71		14.5		8.89		2.54	J	1.26	J	13.4	
OCDD	50.6		133		137		65.4		97.2		59.5		17.6		7.64	J	104	
Furans																		
2,3,7,8-TCDF	0.14	U	0.3	J	0.47	J	0.14	U	0.71	J	0.29	J	0.21	J	0.18	J	0.33	J
1,2,3,7,8-PeCDF	0.33	U	0.39	U	0.35	U	0.33	U	1.45	J	0.34	U	0.33	U	0.32	U	0.37	U
2,3,4,7,8-PeCDF	0.21	U	0.25	U	0.24	J	0.21	U	0.72	J	0.21	U	0.21	U	0.2	U	0.23	U
1,2,3,4,7,8-HxCDF	0.34	U	0.41	U	0.36	U	0.34	U	2.3	J	0.35	U	0.34	U	0.33	U	0.38	U
1,2,3,6,7,8-HxCDF	0.14	U	0.16	U	0.14	U	0.14	U	0.56	J	0.14	U	0.14	U	0.13	U	0.15	U
1,2,3,7,8,9-HxCDF	0.28	U	0.34	U	0.3	U	0.28	U	0.3	U	0.29	U	0.28	U	0.27	U	0.31	U
2,3,4,6,7,8-HxCDF	0.36	U	0.43	U	0.38	U	0.36	U	0.39	U	0.37	U	0.36	U	0.34	U	0.4	U
1,2,3,4,6,7,8-HpCDF	2.53	J	3.34	J	7.07		2.36	J	5.39		2.6	J	0.85	J	0.52	J	3.52	J
1,2,3,6,7,8,9-HpCDF	0.26	U	0.31	U	0.27	U	0.25	U	0.48	J	0.26	U	0.26	U	0.25	U	0.29	U
OCDF	5.44	J	7.24	J	13.6		3.6	J	9.03	J	5.49	J	1.79	J	1.0	J	6.84	J

Table 8. Summary of Toxicity Equivalence Factors for PCDDs/PCDFs.

	TEF	CP1	CP2	CP3	CP4	AB5	AB6	AB7	SA8	SA9	CP1	CP2	CP3	CP4	AB5	AB6	AB7	SA8	SA9
		ND=1/2 RL TEQ									ND=0 TEQ								
Dioxins																			
2,3,7,8-TCDD	1	0.03	0.04	0.03	0.33	0.71	0.38	0.03	0.03	0.45	0.00	0.00	0.00	0.33	0.71	0.38	0.00	0.00	0.45
1,2,3,7,8-PeCDD	1	0.52	0.41	0.69	0.13	0.86	0.43	0.13	0.13	0.54	0.52	0.41	0.69	0.00	0.86	0.43	0.00	0.00	0.54
1,2,3,4,7,8-HxCDD	0.1	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1,2,3,6,7,8-HxCDD	0.1	0.06	0.01	0.01	0.04	0.09	0.05	0.01	0.01	0.06	0.06	0.00	0.00	0.04	0.09	0.05	0.00	0.00	0.06
1,2,3,7,8,9-HxCDD	0.1	0.15	0.11	0.23	0.09	0.24	0.11	0.04	0.01	0.15	0.15	0.11	0.23	0.09	0.24	0.11	0.04	0.00	0.15
1,2,3,4,6,7,8-HpCDD	0.01	0.09	0.18	0.18	0.08	0.15	0.09	0.03	0.01	0.13	0.09	0.18	0.18	0.08	0.15	0.09	0.03	0.01	0.13
OCDD	0.0003	0.02	0.04	0.04	0.02	0.03	0.02	0.01	0.00	0.03	0.02	0.04	0.04	0.02	0.03	0.02	0.01	0.00	0.03
Furans																			
2,3,7,8-TCDF	0.1	0.01	0.03	0.05	0.01	0.07	0.03	0.02	0.02	0.03	0.00	0.03	0.05	0.00	0.07	0.03	0.02	0.02	0.03
1,2,3,7,8-PeCDF	0.03	0.00	0.01	0.01	0.00	0.04	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00
2,3,4,7,8-PeCDF	0.3	0.03	0.04	0.07	0.03	0.22	0.03	0.03	0.03	0.03	0.00	0.00	0.07	0.00	0.22	0.00	0.00	0.00	0.00
1,2,3,4,7,8-HxCDF	0.1	0.02	0.02	0.02	0.02	0.23	0.02	0.02	0.02	0.02	0.00	0.00	0.00	0.00	0.23	0.00	0.00	0.00	0.00
1,2,3,6,7,8-HxCDF	0.1	0.01	0.01	0.01	0.01	0.06	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00
1,2,3,7,8,9-HxCDF	0.1	0.01	0.02	0.02	0.01	0.02	0.01	0.01	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2,3,4,6,7,8-HxCDF	0.1	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1,2,3,4,6,7,8-HpCDF	0.01	0.03	0.03	0.07	0.02	0.05	0.03	0.01	0.01	0.04	0.03	0.03	0.07	0.02	0.05	0.03	0.01	0.01	0.04
1,2,3,6,7,8,9-HpCDF	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OCDF	0.0003	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Totals		1.00	0.97	1.45	0.83	2.80	1.25	0.38	0.31	1.56	0.86	0.80	1.33	0.59	2.75	1.14	0.10	0.04	1.44

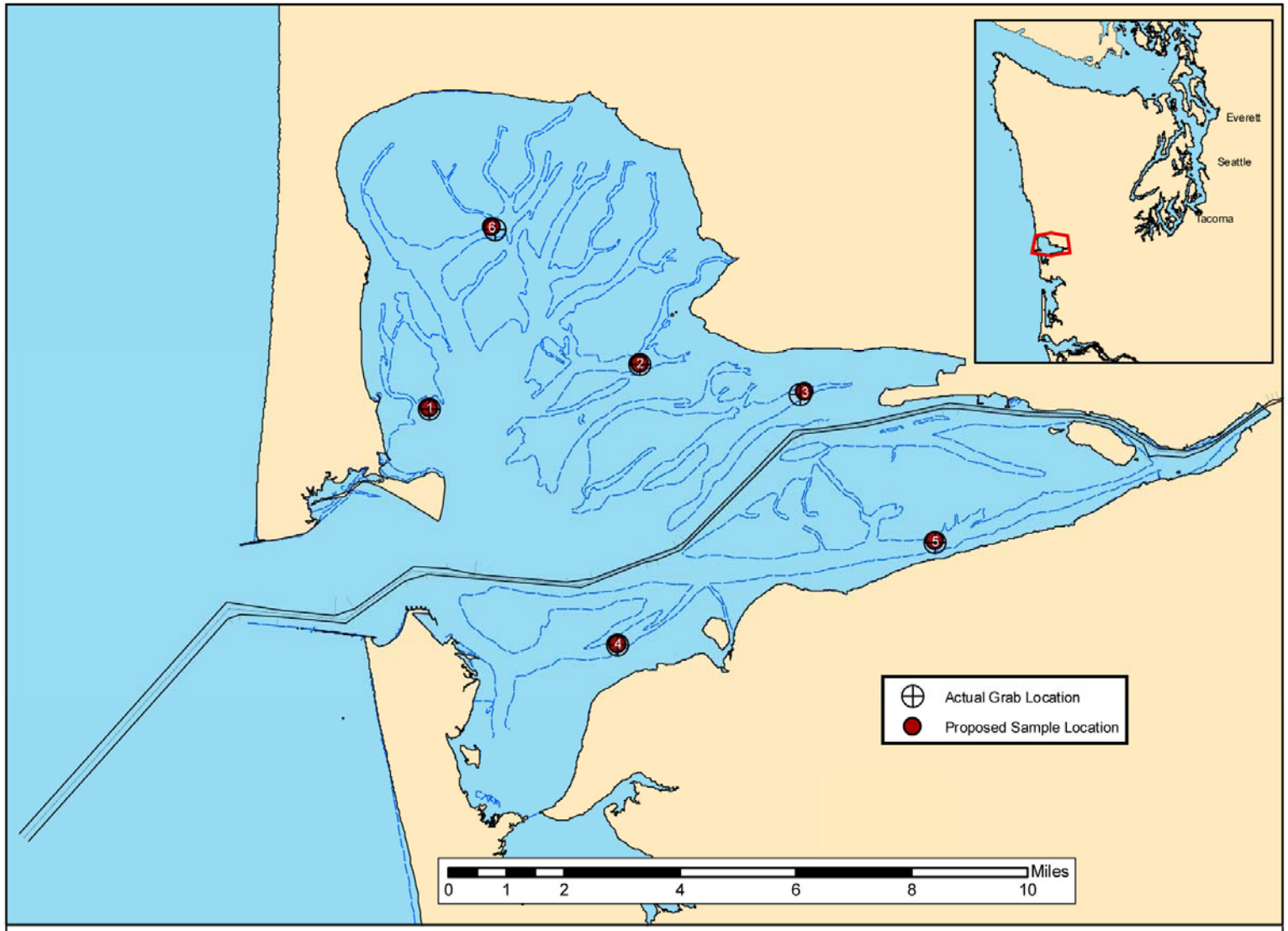


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Figure 5. **Actual Reference Sediment Sampling Locations**

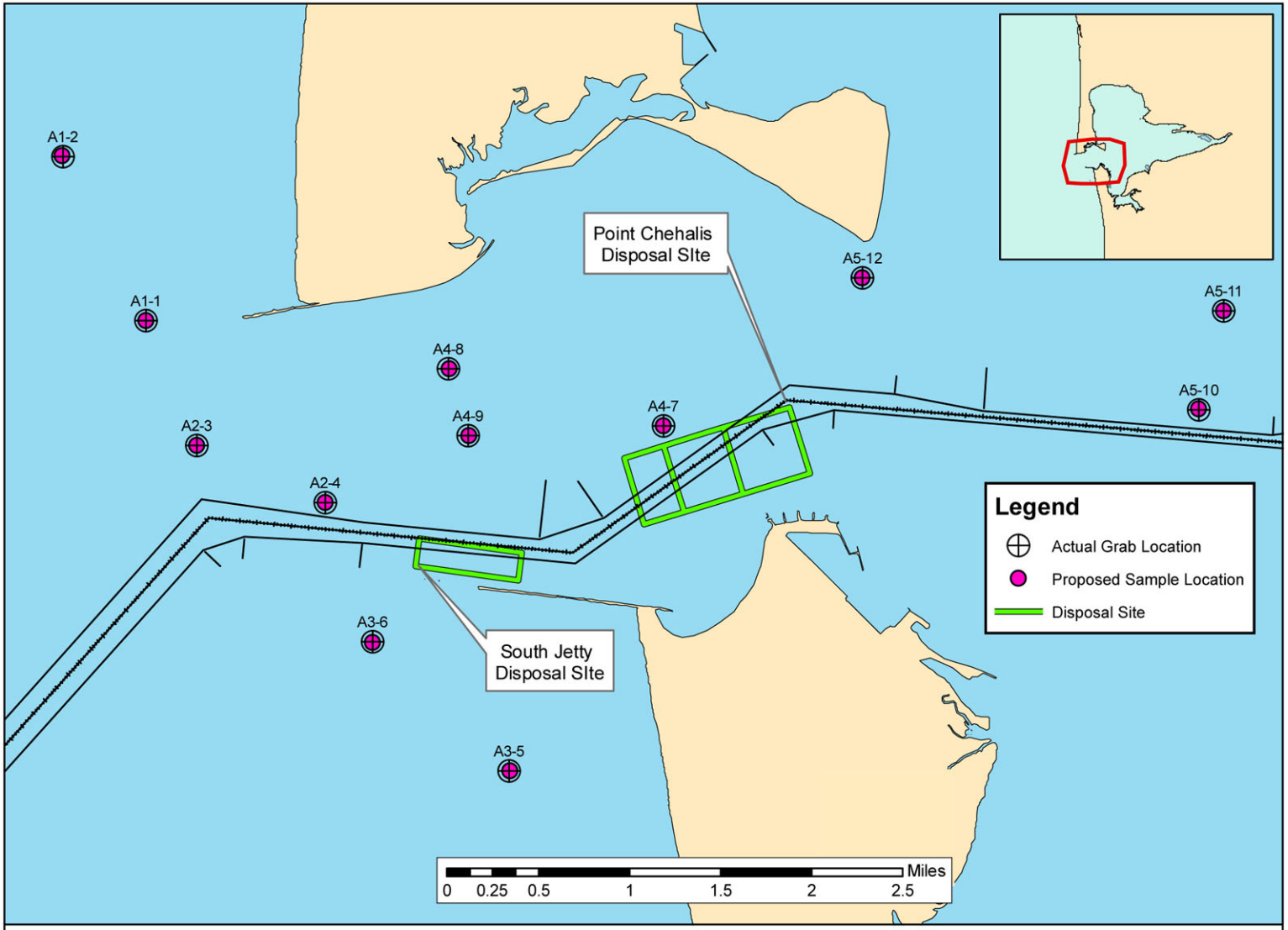

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Figure 6. **Actual Sediment Sampling Locations for the Disposal Site Vicinity**

Table 9. Results of chemical analysis compared with SMS guidelines.

SMS Chemistry Results	SQS	CSL	CP1		CP2		CP3		CP4		AB5		AB6		AB7		SA8		SA9	
Total Organic Carbon (%)			2.4		2.9		2.4		2.2		2.4		2.2		0.7		0.6		2.7	
METALS (mg/kg dry)																				
Arsenic	57	93	3.52		4.22		3.93		3.81		3.88		3.28		2.43		1.56		3.44	
Cadmium	5.1	6.7	0.199		0.21		0.206		0.204		0.223		0.183		0.125		0.101		0.197	
Chromium	260	270	24.6		24.9		25.2		22		23.8		22.1		20.2		13.2		23.9	
Copper	390	390	36.2		35.5		37.4		33.5		33.7		29.8		27.9		37.1		34.2	
Lead	450	530	7.85		8.9		8.24		7.7		8.32		7.28		5.14		3.05		7.95	
Mercury	0.41	0.59	0.044		0.053		0.049		0.042		0.045		0.043		0.025		0.008	J	0.046	
Silver	6.1	6.1	0.208		0.209		0.18		0.156		0.163		0.14		0.11		0.107		0.169	
Zinc	410	960	41.8		41.8		41.8		40.2		41.1		38.5		38.7		38.2		40.2	
LPAH (mg/kg OC)																				
2-Methylnaphthalene	38	64	0.06	J	0.59		0.27		0.30		0.14	J	0.35		0.40	J	0.83	U	0.30	
Acenaphthene	16	57	0.21	U	0.45		0.18	J	0.32		0.13	J	0.21	J	0.21	J	0.83	U	0.32	
Acenaphthylene	66	66	0.21	U	0.17	U	0.07	J	0.10	J	0.20	U	0.10	J	0.71	U	0.83	U	0.19	U
Anthracene	220	1200	0.21	U	0.19		0.13	J	0.15	J	0.09	J	0.12	J	0.23	J	0.83	U	0.14	J
Fluorene	23	79	0.05	J	0.48		0.27		0.39		0.17	J	0.35		0.31	J	0.83	U	0.33	
Naphthalene	99	170	0.12	J	0.90		0.31		0.38		0.17	J	0.45		0.43	J	0.43	J	0.37	
Phenanthrene	100	480	0.18	J	1.41		1.00		1.45		0.54		1.00		1.17		0.35	J	1.11	
Total LPAH	370	780	0.41	J	4.02		2.22	J	3.10	J	1.24	J	2.58	J	2.76	J	0.78	J	2.57	J
HPAH (mg/kg OC)																				
Benzo(a)anthracene	110	270	0.12	J	0.30		0.27		0.45		0.17	J	0.40		0.64	J	1.05	U	0.34	
Benzo(a)pyrene	99	210	0.31	U	0.20	J	0.22	J	0.27	J	0.11	J	0.31	J	0.41	J	4.00		0.24	J
Benzo(g,h,i)perylene	34	88	0.26	U	0.24		0.25	U	0.22	J	0.10	J	0.28	U	0.33	J	1.05	U	0.17	J
Benzofluoranthenes	230	450	0.19	J	0.52		0.50		0.68		0.24	J	0.77		0.84	J	1.67	U	0.48	
Chrysene	110	460	0.09	J	0.33		0.33		0.50		0.20	J	0.45		0.47	J	1.05	U	0.30	
Dibenzo(a,h)anthracene	12	33	0.42	U	0.34	U	0.40	U	0.45	U	0.41	U	0.45	U	1.41	U	1.67	U	0.37	U
Fluoranthene	160	1200	0.28		1.21		1.13		1.59		0.58		1.27		1.86		0.33	J	1.15	
Indeno(1,2,3-c,d)pyrene	34	88	1.21		1.10		0.40	U	0.45	U	1.21		1.50		4.14		1.67	U	1.15	
Pyrene	1000	1400	0.24		0.97		0.88		1.14		0.50		1.09		1.57		0.30	J	0.89	
Total HPAH	960	5300	2.12	J	4.87	J	3.32	J	4.85	J	3.10	J	5.80	J	10.27	J	4.63	J	4.72	J
CHLORINATED HYDROCARBONS (mg/kg OC)																				

SMS Chemistry Results	SQS	CSL	CP1		CP2		CP3		CP4		AB5		AB6		AB7		SA8		SA9	
1,2,4-Trichlorobenzene	0.81	1.8	0.54	U	0.45	U	0.50	U	0.55	U	0.50	U	0.55	U	***1.71***	***U***	***2.17***	***U***	0.44	U
1,2-Dichlorobenzene	2.3	2.3	0.54	U	0.45	U	0.50	U	0.55	U	0.50	U	0.55	U	1.71	U	2.17	U	0.44	U
1,4-Dichlorobenzene	3.1	9	0.54	U	0.45	U	0.50	U	0.55	U	0.50	U	0.55	U	1.71	U	2.17	U	0.44	U
Hexachlorobenzene	0.38	2.3	***0.54***	***U***	***0.45***	***U***	***0.50***	***U***	***0.55***	***U***	***0.50***	***U***	***0.55***	***U***	***1.71***	***U***	***2.17***	***U***	***0.44***	***U***
PHTHALATES (mg/kg OC)																				
Bis(2-ethylhexyl)phthalate	47	78	15.83	U	2.48	J	2.42	J	16.82	U	15.42	U	2.91	J	52.86	U	63.33	U	13.70	U
Butyl benzyl phthalate	4.9	64	0.54	J	1.31		1.63		1.55		0.96	J	1.18		2.86	J	1.52	J	1.67	
Di-n-butyl phthalate	220	1700	0.41	J	0.66	J	0.63	J	0.68	J	0.42	J	0.73	J	1.57	J	1.55	J	0.74	J
Di-n-octyl phthalate	58	4500	2.08	U	1.72	U	2.00	U	2.27	U	2.04	U	2.23	U	7.14	U	8.33	U	1.85	U
Diethyl phthalate	61	110	0.12	J	0.86	U	1.00	U	1.14	U	0.13	J	0.33	J	0.57	J	0.67	J	0.35	J
Dimethyl phthalate	53	53	1.04	U	0.86	U	1.00	U	1.14	U	1.04	U	1.09	U	3.57	U	4.17	U	0.93	U
PHENOLS (ug/kg dry)																				
2 Methylphenol	63	63	25	U	25	U	24	U	25	U	25	U	24	U	25	U	25	U	25	U
2,4-Dimethylphenol	29	29	25	U	25	U	24	U	25	U	25	U	24	U	25	U	25	U	25	U
4 Methylphenol	670	670	50	U	18	J	48	U	50	U	49	U	14	J	50	U	22	J	50	U
Pentachlorophenol	360	690	25	U	25	U	24	U	25	U	25	U	24	U	25	U	25	U	25	U
Phenol	420	1200	7.4	J	15	J	13	J	13	J	14	J	24	J	16	J	15	J	24	J
MISCELLANEOUS EXTRACTABLES																				
Benzoic acid (ug/kg dry)	650	650	70	J B	58	J B	51	J B	51	J B	64	J B	60	J B	53	J B	43	J B	60	J B
Benzyl alcohol (ug/kg dry)	57	73	25	U	25	U	24	U	25	U	25	U	24	U	25	U	25	U	11	J
Dibenzofuran (mg/kg OC)	15	58	1.0	U	0.4	J	1.0	U	0.2	J	1.0	U	0.2	J	3.6	U	4.2	U	0.2	J
Hexachlorobutadiene (mg/kg OC)	3.9	6.2	0.5	U	0.4	U	0.5	U	0.5	U	0.5	U	0.5	U	1.7	U	2.2	U	0.4	U
N-Nitrosodiphenylamine (mg/kg OC)	11	11	0.5	U	0.4	U	0.5	U	0.5	U	0.5	U	0.5	U	1.7	U	2.2	U	0.4	U
PCBs (mg/kg OC)																				
Total Aroclors	12	65	0.4	U	0.34	U	0.4	U	0.45	U	0.41	U	0.45	U	1.36	U	1.56	U	0.36	U

Values in Bold italics are non-detects that exceed SQS when OC normalized. See text for details.
SQS = sediment quality guideline; CSL = cleanup action level
B = detected in blank
J = estimated concentration
U = undetected
OC = organic carbon

6. Comparison with SMS Guidelines. Chemical results were carbon normalized if necessary, and compared with Washington State Sediment Management Standards (Table 8) to determine if the sediments were suitable for beneficial uses under both DMMP and state guidelines. Levels of all detected compounds were below SMS guidelines. Non-detected levels of two chemicals, 1,2,4-trichlorobenzene and hexachlorobenzene, exceeded SMS guidelines when carbon-normalized. However, laboratories often experience difficulty in obtaining low MDLs for these chemicals. Also, these chemicals have not been detected historically in the navigation channel. The agencies used Best Professional Judgment (BPJ) in determining that the OC-normalized non-detections of 1,2,4-trichlorobenzene and hexachlorobenzene can be set aside for the purpose of this analysis. All sediments were thus found suitable for beneficial use under SMS guidelines.

7. Biological Testing. The standard suite of three bioassay tests (amphipod toxicity, larval development, and polychaete growth) was performed on sediments chosen for confirmatory testing. The DMMP selected DMMUs 5 (from Aberdeen Reach) and 9 (from South Aberdeen Reach) for bioassay testing based on: 1) Location--no recent bioassay tests for these reaches; 2) Grain size—the chosen DMMU represented two different grain size characteristics; and 3) Chemical results—the chosen DMMUs both had dehydroabietic acid and dioxins detected in the higher range of detections for this characterization. Grays Harbor disposal sites are dispersive sites, which under DMMP guidelines require slightly more conservative bioassay data interpretation than with non-dispersive sites due to the inability to monitor disposed material over time (Table 10).

Table 10. Solid Phase Bioassay Performance Standards and Evaluation Guidelines.

Bioassay	Negative Control Performance Standard	Reference Sediment Performance Standard	Dispersive Disposal Site Interpretation Guidelines		Nondispersive Disposal Site Interpretation Guidelines	
			1-hit rule	2-hit rule	1-hit rule	2-hit rule
Amphipod	$M_C \leq 10\%$	$M_R - M_C \leq 20\%$	$M_T - M_C > 20\%$ and M_T vs. M_R SS (p=.05) and		$M_T - M_C > 20\%$ and M_T vs. M_R SS (p=.05) and	
			$M_T - M_R > 10\%$	NOCN	$M_T - M_R > 30\%$	NOCN
Larval	$N_C \div I \geq 0.70$	$N_R \div N_C \geq 0.65$	$N_T \div N_C < 0.80$ and N_T/N_C vs. N_R/N_C SS (p=.10) and		$N_T \div N_C < 0.80$ and N_T/N_C vs. N_R/N_C SS (p=.10) and	
			$N_R/N_C - N_T/N_C > 0.15$	NOCN	$N_R/N_C - N_T/N_C > 0.30$	NOCN
Neanthes growth	$M_C \leq 10\%$ and $MIG_C \geq 0.38$	$M_R \leq 20\%$ and $MIG_R \div MIG_C \geq 0.80$	$MIG_T \div MIG_C < 0.80$ and MIG_T vs. MIG_R SS (p=.05) and		$MIG_T \div MIG_C < 0.80$ and MIG_T vs. MIG_R SS (p=.05) and	
			$MIG_T/MIG_R < 0.70$	NOCN	$MIG_T/MIG_R < 0.50$	$MIG_T/MIG_R < 0.70$

M = mortality, N = normal larvae, I = initial count, MIG = mean individual growth rate mg/individual/day)
SS = statistically significant, NOCN = no other conditions necessary, N/A = not applicable
Subscripts: R = reference sediment, C = negative control, T = test sediment

Biological testing was conducted in two rounds, both of which are documented in the following.

7.1. Round 1 Bioassays.

Negative control and reference sediments met DMMP performance criteria for both the larval and amphipod tests (Table 11). For the *Neanthes* growth test, the mortality performance standard was met for both the control and reference, as was the mean individual growth (MIG) rate performance standard for the negative control. The MIG performance standard was not met for the reference sediment.

Table 101. Bioassay control and reference performance summary

Bioassay	Negative Control Performance Standard	Positive Control Performance (PSEP Guidelines)	Reference Sediment Performance Standard
Amphipod toxicity (*E. estuarius*)	2% mortality ≤ 10%; pass	$CdCl_2$, 96 hr EC50, 6.1 mg/L Cd Lab control limits: 3.4 - 11.8 mg/L Cd pass	9% ref. mortality – 2% control mortality ≤ 20%; pass
Larval development (*D.excentricus*)	5.8% CMA ≤ 30%; pass	$CuCl_2$, normality, 7.1 µg/L Cu 5.6 – 17.0 µg/L Cu pass	0.4% NCMA ≤ 35%; pass
Polychaete growth (*N. arenaceodentata*)	4% mortality ≤ 10% 1.17 MIG ≥ 0.38 pass	$CdCl_2$, 96 hr EC50, 4.8 mg/L Cd 2.5 – 17.7 mg/L Cd pass	0% mortality ≤ 20% 69% ref MIG < 80% control MIG fail

Bolded values are test results. Non-bolded values are performance standards.
CMA = Combined mortality and abnormality; MIG – mean individual growth (mg/day/worm); NCMA = Normalized combined mortality and abnormality (normalized to seawater control)

The amphipod bioassay test results are shown in Table 12. The two test sediments performed well and there were no hits for either DMMU.

Table 12. Amphipod Mortality Bioassay (*E. estuarius*) Results and Evaluation Guidelines (SAIC, 2009)

Sample ID	% Mortality	Mean Survival	1-Hit Rule[1]		2-Hit Rule[1]	
			$M_T – M_C$ > 20%; M_T vs M_R SD (p = 0.05); $M_T – M_R$ > 10%	Hit/No-Hit	$M_T – M_C$ > 20%; M_T vs M_R SD (p = 0.05); NOCN	Hit/No-Hit
Control	10.0 0.0 0.0 0.0 0.0	98.0 ± 4.5	n/a	n/a	n/a	n/a
Reference	0.0 0.0 10.0 35.0 0.0	91.0 ± 15.2	n/a	n/a	n/a	n/a
GH08-AB5-33-40-S	10.0 0.0 0.0 0.0 0.0	98.0 ± 4.5	0.0; M_T not SD > M_R; -7.0	No-Hit	0.0; M_T not SD > M_R	No-Hit
GH08-SA9-65-72-S	5.0 10.0 0.0 0.0 0.0	97.0 ± 4.5	1.0; M_T not SD > M_R; -6.0	No-Hit	1.0; M_T not SD > M_R	No-Hit

M = mortality; SD = statistically different; NOCN = no other conditions necessary; N/A = not applicable

Subscripts: R = reference; C = negative control; T = test sediment

[1]Dispersive disposal site interpretation guidelines

The *Neanthes* results are displayed in Table 13. The test sediments performed well, but as was discussed previously the reference sediment failed to meet its performance standard for growth. The DMMP agencies discussed ways of resolving this issue. One possibility was to drop the reference sediment from the evaluation, and compare the test sediments to the negative control. Such an evaluation would result in a hit under the 2-hit rule for GH08-AB5-33-40-S. The other possibility was to simply recognize that despite the lackluster performance of the reference sediment, both DMMUs significantly out-performed the reference. In the end, the DMMP agencies decided to set aside the *Neanthes* results until a retest could be performed for the larval test.

Table 13. Juvenile Polychaete Growth Bioassay (*N. arenaceodentata*) Results and Evaluation Guidelines (SAIC, 2009)

Sample ID	Individual Growth Rate[1]	Mean Individual Growth Rate[1]	Dispersive Guidelines			
			1-Hit Rule[2]		2-Hit Rule[2]	
			$MIG_T \div MIG_C < 0.80$; MIG_T vs MIG_R SD ($p = 0.05$); $MIG_T/MIG_R < 0.70$	Hit/ No-Hit	$MIG_T \div MIG_C < 0.80$; MIG_T vs MIG_R SD ($p = 0.05$); NOCN	Hit/ No-Hit
Control	1.154 1.147 1.471 1.093 0.963	1.166	n/a	n/a	n/a	n/a
Reference	0.791 0.734 0.544 0.980 0.968	0.803	n/a	n/a	n/a	n/a
GH08-AB5-33-40-S	0.676 0.909 0.868 0.929 1.163	0.909	0.78; 0.909 vs. 0.803 not SD[3]; and 0.909 vs. 1.166 is SD[4] 1.13 (0.78)[4]	No-Hit[3,4]	0.78; 0.909 vs. 0.803 not SD[3]; and 0.909 vs. 1.166 is SD[4]	No-Hit[3]/ Hit[4]
GH08-SA9-65-72-S[1.154]	1.579 0.767 0.803 0.846 0.734	0.946	0.81; 0.946 vs 0.803[3] and 1.166[4] not SD; 1.18 (0.81)[4]	No-Hit[3,4]	0.81; 0.946 vs 0.803[3] and 1.166[4] not SD	No-Hit[3,4]

MIG = mean individual growth rate (mg/individual/day)

SD = statistically different

NOCN = no other conditions necessary

N/A = not applicable

Subscripts: R = reference; C = negative control; T = test sediment

[1]mg/individual/day

[2]Dispersive disposal site interpretation guidelines

[3]Result compared to reference sediment which did not meet MIG performance standard

[4]Result compared to negative control

The larval bioassay results are included in Table 14. The test was not aerated. Both DMMUs scored hits under the 1-hit rule, which would normally make the dredged material unsuitable for open-water disposal. However, the July 2008 DMMP Users Manual (Section 4.9, page 4-13) provides guidance in this situation:

> "If all chemicals-of-concern are below the screening level, yet the safety-net biological testing indicates a potential for adverse biological effects, best professional judgment will need to be applied in resolving the apparent conflict between the chemical and biological testing data. Additional chemical or biological testing may be needed to determine the nature of the problem."

Based on this guidance, and the fact that there had never been a bioassay failure in the history of safety-net testing in Grays Harbor, the DMMP agencies decided that the larval test should be run a second time with side-by-side testing using *Dendraster excentricus* and *Mytilus galloprovincialis*.

Table 14. Larval Development Bioassay (*D. excentricus*) Results and Evaluation Guidelines (SAIC, 2009)

Sample ID	Normal Survival (%)	Mean Normal Survival Larvae (%)	Dispersive Guidelines			
			1-Hit Rule[1]		2-Hit Rule[1]	
			$N_T \div N_C < 0.80$; N_T/N_C vs N_R/N_C SD ($p = 0.10$); $N_R/N_C - N_T/N_C > 0.15$	Hit/ No-Hit	$N_T \div N_C < 0.80$; N_T/N_C vs N_R/N_C SD ($p = 0.10$); NOCN	Hit/ No-Hit
Sea Water Control[2,3]	256 (90.3) 227 (80.1) 304 (107.3 287 (101.3) 261 (92.1)	267 (92.5 ± 8.2)	n/a	n/a	n/a	n/a
Reference[4]	246 (92.1) 294 (110.1) 271 (101.5) 245 (91.8) 274 (102.6)	266 (99.6 ± 4.4)	n/a	n/a	n/a	n/a
GH08-AB5-33-40-S[4]	200 (74.9) 180 (67.4) 181 (67.8) 198 (74.2) 190 (71.2)	189.8 (71.1 ± 3.5)	0.711; 0.711 vs 0.996 is SD; 0.996 – 0.711 > 0.15	Hit	0.711; 0.711 vs 0.996 is SD;	Hit
GH08-SA9-65-72-S[4]	221 (82.8) 210 (68.7) 218 (81.6) 198 (74.2) 193 (72.3)	208 (77.9 ± 4.6)	0.779; 0.779 vs 0.996 is SD; 0.996 – 0.779 > 0.15	Hit	0.779; 0.779 vs 0.996 is SD;	Hit

M = mortality; SD = statistically different; NOCN = no other conditions necessary; N/A = not applicable

N = normal development; $N_C = 267$; $N_R = 266$

I = initial count (stocking density) = 283.4

Subscripts: R = reference; C = negative control; T = test sediment

[1]Dispersive disposal site interpretation guidelines

[2]Only seawater control is used for evaluation of test results

[3]Percent survival relative to initial count (stocking density)

[4]Percent survival relative to seawater control normal survival

7.2. Round 2 Bioassay – Larval Retest.

DMMUs AB5 and SA9 were resampled on January 26, 2009 and a second round of larval testing ensued. The agencies had agreed to side-by-side testing using *Dendraster excentricus* and *Mytilus galloprovincialis*, but at the time of testing, the bioassay lab's local source of *Dendraster excentricus* was spawned out and their California supplier wouldn't have *Dendraster* available for several months. So the agencies agreed to test with *Mytilus galloprovincialis* only. The retest was aerated. Table 15 includes the results for the retest. Both DMMUs performed well, with mean normal survival greater than 80% of control. There were no hits in this bioassay.

Table 15. Larval Development Bioassay (*Mytilus galloprovincialis*) Retest Results and Evaluation Guidelines (SAIC, 2009)

Sample ID	Normal Survival (%)	Mean Normal Survival Larvae (%)	Dispersive Guidelines			
			1-Hit Rule[1]		2-Hit Rule[1]	
			$N_T \div N_C < 0.80$; N_T/N_C vs N_R/N_C SD ($p = 0.10$); $N_R/N_C - N_T/N_C > 0.15$	Hit/ No-Hit	$N_T \div N_C < 0.80$; N_T/N_C vs N_R/N_C SD ($p = 0.10$); NOCN	Hit/ No-Hit
Sea Water Control[2,3]	178 (71.2) 246 (98.4) 227 (90.8) 226 (90.4) 249 (99.6)	225.2 (90.1 ± 11.4)	n/a	n/a	n/a	n/a
Reference[4]	223 (89.2) 239 (95.6) 199 (79.6) 217 (86.8) 233 (93.2)	222.2 (88.9 ± 4.9)	n/a	n/a	n/a	n/a
GH08-AB5-35-40-S[4,5]	188 (75.2) 173 (69.2) 187 (74.8) 207 (82.8) 188 (75.2)	188.6 (75.4 ± 5.4)	0.83; 0.754 vs 0.889 is SD; 0.889 – 0.754 < 0.30	No-Hit	0.83; 0.754 vs 0.889 is SD;	No-Hit
GH08-SA9-65-72-S[4]	201 (80.4) 192 (76.8) 206 (82.4) 204 (81.6) 208 (83.2)	202.2 (80.9 ± 2.8)	0.90; 0.809 vs 0.889 is SD; 0.889 – 0.809 < 0.90	No-Hit	0.90; 0.809 vs 0.889 is SD;	No-Hit

M = mortality; SD = statistically different; NOCN = no other conditions necessary; N/A = not applicable

N = normal development; $N_C = 225.2$; $N_R = 222.2$

I = initial count (stocking density) = 250

Subscripts: R = reference; C = negative control; T = test sediment

[1]Dispersive disposal site interpretation guidelines

[2]Only seawater control is used for evaluation of test results

[3]Percent survival relative to initial count (stocking density)

[4]Percent survival relative to seawater control normal survival

[5]Sediment was not collected at Stations 33 and 34 for the re-analysis effort because maintenance dredging had already taken place at these locations.

Table 16 summarizes the results from both rounds of bioassays. Based on these results, the DMMP agencies agreed that both AB5 and SA9 passed biological testing.

Table 16. Summary of Bioassay Interpretive Criteria (SAIC, 2009)

Station ID	Amphipod Mortality		Larval Development		Juvenile Polychaete Growth (compared to reference)		Juvenile Polychaete Growth (compared to control)	
	1-Hit Rule	2-Hit Rule	1-Hit Rule	2-Hit Rule	1-Hit Rule	2-Hit Rule	1-Hit Rule	2-Hit Rule
Initial Bioassays; Dispersive Disposal Site Bioassay Interpretive Results								
GH08-AB5-33-40-S	No-Hit	No-Hit	Hit	Hit	No-Hit	No-Hit	No-Hit	Hit
GH08-SA9-65-72-S	No-Hit	No-Hit	Hit	Hit	No-Hit	No-Hit	No-Hit	No-Hit
Larval Redevelopment Bioassay Re-Test; Dispersive Disposal Site Bioassay Interpretive Results								
GH08-AB5-33-40-S	-	-	No-Hit	No-Hit	-	-	-	-
GH08-SA9-65-72-S	-	-	No-Hit	No-Hit	-	-	-	-

8. Suitability. This memo documents the suitability of all proposed dredged sediments in the Grays Harbor navigation channel for open water disposal or beneficial use. The data gathered were deemed sufficient and acceptable for regulatory decision-making under the DMMP program. Based on the results of the chemical and biological testing and the discussions above, the DMMP agencies concluded that the total dredging volume remains suitable for open water disposal. Open water disposal may be at the South Jetty or Point Chehalis estuarine disposal site.

Based on agency best professional judgment regarding acceptable dioxin concentrations in beneficial use material, sediment tested from the Cow Point, Aberdeen and South Aberdeen reaches of the Inner Harbor may be used at an approved beneficial use (nearshore or onshore) site. This is in addition to material from the Outer Reaches (exclusionary), which was the subject of a separate suitability determination in 2008.

9. References.

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